REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE GYPSY MOTH.

JANUARY, 1897.

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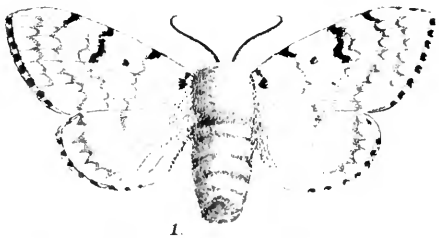

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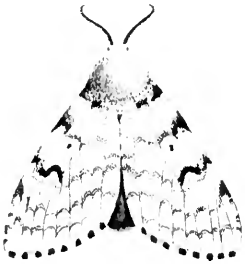

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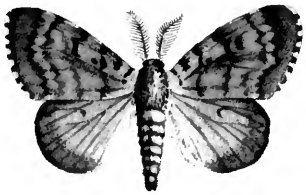

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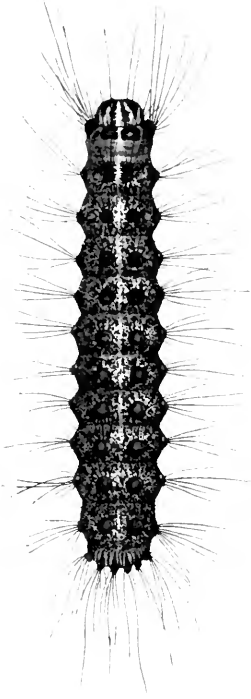

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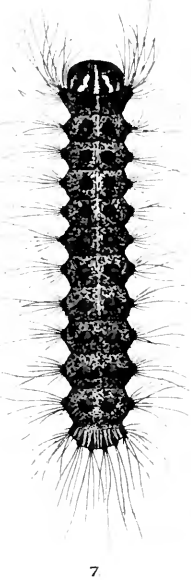

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Drawn by Joseph Bridgham.

Geo. H. Walker & Co., Boston.

GYPSY MOTH.

An Explanation of Plate I, with a Short Description of the Different Forms of the Gypsy Moth and its Feeding Habits.

The Eggs.

[Fig. 8, cluster of eggs on bark; Figs. 9 and 10, eggs magnified.]

The eggs are deposited in clusters, averaging about five hundred eggs each, and covered with yellow hairs from the body of the female moth. These egg-clusters are usually found in sheltered places on the bark or in the crevices and cavities of trees, stumps and undergrowth; also on fences and buildings and in the crevices of stone walls and other objects, near the plants or trees on which the insect feeds. The eggs are laid in July, August and September, and hatch after the foliage starts in the late spring or early summer of the ensuing year; therefore the insect passes the fall, winter and early spring in the egg.

The Larva or Caterpillar.

[Figs. 6 and 7.]

When first hatched the caterpillars are less than one-fifth of an inch in length. As they grow larger they may be seen in clusters upon the trunks and branches of trees or in the cavities and other hiding places where they gather in June, July and the first part of August.

The Pupa.

[Fig. 5.]

The caterpillar when fully grown sheds its outer covering and becomes a pupa or chrysalis. This usually occurs in July or August. The pupa may be found in the same situations as the eggs. In Massachusetts the insect usually remains in the pupal state from ten to thirteen days, emerging as a moth at the end of that period.

The Moth.

[Figs. 1 and 2, female; Figs. 3 and 4, male.]

The female moth usually deposits her eggs very near the abandoned pupa case, and within a few hours after emerging from it. She dies soon after. The male is a rapid flyer. The female does not fly.

Habits of the Caterpillars.

The gypsy moth feeds only when in the larval or caterpillar state. In Massachusetts the eggs of the gypsy moth begin hatching about April 20, and the young continue to emerge until the middle of June. The length of larval life varies somewhat according to circumstances, but probably averages ten weeks; therefore the feeding season in this country lasts about four months. When the caterpillars are first

hatched from the eggs they are light in color and covered with whitish hairs. In a few hours they assume a dark hue. They usually remain on or near the egg-cluster until they change in color, and should the weather be cold they sometimes remain for several days in a semi-torpid condition upon the egg-cluster. If the temperature is favorable they usually search for food before they are twenty-four hours old. During the first few weeks of their existence they remain most of the time on the leaves, feeding mainly on the under side. Their feeding habits are so uncertain that no rule can be given which will apply to all individuals, but before they are half-grown they generally begin to manifest their gregarious instincts. At that time and for the rest of their existence as caterpillars they spend a large part of the day clustered in sheltered situations, and feed principally at night, going up the trees and out on the branches after dark and returning before day-break. Where they are so abundant that the food supply is insufficient they evince much restlessness, and feed in numbers during all hours of the day and night. They may then be seen hastening to and fro, both up and down the trees. Those which have fed sufficiently are at once replaced by hungry new-comers, and the destruction of the foliage goes on incessantly.

At such times the trunks and lower branches of trees are covered with a moving mass of caterpillars, hurrying throngs are passing and repassing, and nearly every leaf or denuded stem bears up one or more of the feeding insects. The rustling caused by their movements and the continual dropping of excrements is plainly audible. On tall trees the larger caterpillars appear to crawl to the higher limbs, and they seem to prefer to feed well out toward the end of the branches. They do not feed gregariously except when in great numbers; therefore they seldom strip one branch, as do the larvæ of the *Euvanessa antiopa*, but scatter throughout the trees, eating a little from each leaf. Early in the season, when they are small and few in numbers, their ravages are scarcely noticed: but as they grow larger and more numerous, their inroads on the tree decrease the foliage area night by night, until suddenly all the remaining leaves are eaten, and the tree is stripped in a single night.

Food Plants.

The gypsy moth is known to destroy the foliage of nearly all native and introduced trees and plants of economic importance. The list of its food plants includes nearly all evergreen and deciduous trees, most bushes, shrubs, vines and vegetables, and it has been seen to eat grass and grain. Wherever the caterpillars become numerous they move slowly, devouring nearly every green leaf and bud as they go. They feed during a much longer season than the canker worm or the tent caterpillar. In the months of June, July and August, 1891, trees which had been stripped early in the season and whose leaves had again put out were again defoliated by these caterpillars and kept bare all summer; therefore not only was all prospect of a fruit harvest destroyed, but many trees were killed by this continual defoliation.

Commonwealth of Massachusetts.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

I have the honor to present herewith to the General Court the report of the committee of the State Board of Agriculture in charge of the gypsy moth work to said Board, and the reports of the director of field work and the entomologist to said committee, as the report of the State Board of Agriculture on the extermination of the gypsy moth: the statement of receipts and expenditures and the recommendations and suggestions contained in said reports being adopted by said Board and presented in accordance with the provisions of chapter 210, Acts of 1891, as their recommendations and suggestions.

Wm. R. Sessions,
Secretary of the State Board of Agriculture.

Boston, Jan. 1, 1897.

Commonwealth of Massachusetts.

To the Massachusetts State Board of Agriculture.

The committee in charge of the gypsy moth work, committed to the Board of Agriculture by the Legislature, herewith presents the report of expenditures and of work performed for the year 1896.

On the first of January, 1896, there remained unexpended, of the appropriation of 1895, $39,722.09. This was retained with the expectation that the sum would be sufficient to maintain the reduced force of 121 men to continue such work as could be done during suitable winter weather until the Legislature should make an appropriation for the season's work. In January, February and the first half of March much effective work was done in the way of destroying the eggs of the moth upon the trees, cutting and burning worthless, decayed, infested trees and underbrush, and preparing infested localities for the summer's work. As the season wore on and most of the appropriation became exhausted, it was found necessary to further reduce the number of men employed, thus greatly handicapping the effectiveness of the work.

The Board of Agriculture had unanimously adopted and approved the report of the gypsy moth committee, recommending to the Legislature an appropriation of $200,000. The Board had also adopted resolutions, unanimously recommending that whatever appropriation, if any, the Legislature saw fit to grant, should be promptly forthcoming, as the work had in the past been hindered nearly as much by delay as by reduction of the appropriations. The committee reported to the Legislature on the work of the season of 1895, placing the report in the hands of the clerk of the Senate on the first day of the session. The report was thus pre-

sented at the first available opportunity, ten days in advance of the time required by law, so that the Legislature might have every opportunity for the most speedy action.

In March, the appropriation of 1895 being exhausted, and the Legislature having taken no action, most of the men were discharged. This delay was a repetition of the experience of past seasons, except that the loss of time was greater. This lapse of the spring work was unfortunate in the last degree, and was productive of most serious results.

An emergency appropriation of $10,000, to continue the work until the Legislature should provide for the work of the season, was finally granted, and became available April 28. With this amount good work was done during the month of May, in burning over the ground in infested localities in the woods, thereby destroying the moth eggs concealed upon the ground or near it, and putting much of the territory into such condition that little damage was done by the moth during the season. In several of these places no caterpillars have since appeared. This appropriation was not sufficient, however, to do one-half of the work that was absolutely necessary at that time, and many large colonies in forested land, in the inner towns, were necessarily neglected. There the caterpillars hatched and later in the season became very destructive. The appropriation of $90,000 for the work of the season, less than one-half the sum recommended by the Board, finally became available June 4. It was then too late to carry out the plans made for the season's work. This delay, together with the small amount of the appropriation, necessitated a complete change in those plans. Moreover, extra work was made necessary by the hatching of the eggs, which it had been planned to destroy in the spring had the appropriation been available at that time. Burlap was purchased and applied as quickly as possible to the trees in all of the outer towns of the infested region, and in Everett, which had been necessarily somewhat neglected the previous year. Before the burlap had all been put on in these towns the caterpillars had begun to cluster. In order to do the necessary work it was imperative to increase largely the force of men at once, and to put all hands at work killing caterpillars under the burlaps in the outer

towns. While this was being done, the woodland in the inner towns was necessarily neglected, with the result that in places where no egg-killing had been done earlier in the season, owing to the exhaustion of the appropriation, the caterpillars were doing much damage and were also spreading over more territory.

The small amount of the appropriation would not admit of exterminative work all over the infested territory, and, in order to prevent the moth from spreading into new territory, outside the towns already infested, the outer towns have been closely attended to throughout the season. The condition in these towns is encouraging. Most of the colonies in the outer towns are apparently exterminated and the spread of the moth into new territory has been prevented. We have, however, to report that two colonies have been found in Brookline, a town adjoining the boundary of the infested territory as heretofore reported. The discovery of the moth in Brookline in 1896 is not to be taken in any sense as indicating that the insect has spread into that town from older infested territory since the committee's last report, or within a year. The two colonies are not newly established, but are several years old; and, had the committee had sufficient means to carry out their plan inaugurated several years since, viz., to carefully examine all towns contiguous to the outermost infested towns, both these colonies would have been found before. This examination has been pursued from year to year as means could be spared from the work in known infested territory, and Brookline has this year had its first thorough examination. This work has been repeatedly reported as necessary, and lack of means only had prevented its being done in Brookline previous to 1896. An effort has been made during the season to stamp out these colonies, but considerable work will need to be expended on them the coming year.

Every effort warranted by the amount of money available has been made to prevent injury by the moth in the central infested towns, and as far as possible to prevent an increase in the number of the moths. This effort has been successful in the inhabited and cultivated territory. The same cannot be said of the woodland, of which we have heretofore re-

ported that there were not less than fifty square miles. In several places in the woodland the trees were entirely stripped of foliage and in some cases the second crop of leaves was eaten. Where the trees have been stripped two years in succession we find that many of them are dying. This condition was not unexpected by the committee. Former reports have from year to year shown that the woodland was the most serious menace to possible extermination and that it was likely to be found infested in many places.

The committee has each year warned the Legislature that with reduced appropriations this woodland could not be attended to and must remain a breeding-place for the moths, from which they would be likely to spread into adjoining territory; and that, even if the cultivated land adjacent to these woodlands was cleared of the moth, it was still liable to become reinfested. In no year since 1892 has the committee had an opportunity to carry out the plans made for the work of the following season. In 1893 the committee asked for $165,000; only $100,000 was appropriated. In 1894 $165,000 was asked; $100,000 was appropriated. In 1895 $200,000 was asked; $150,000 was appropriated. In 1896 $200,000 was asked; $100,000 was appropriated. An examination of the reports will show that these sums were granted after long delays, so late in the season that it was impossible to use the reduced amount to the best advantage. The result is that extermination can now only be accomplished by the expenditure of a sum very much larger than might in the opinion of the committee have been sufficient had the recommendations of former reports been followed. The committee feels certain that an annual appropriation of $100,000 will not accomplish extermination, and it is doubtful whether that sum annually expended will prevent the moth from spreading into new territory unless it is promptly made available, so that every possible advantage may be taken of good weather and other favorable conditions to prosecute the work economically.

The committee is on record in former reports as believing that the only sure way to prevent the moth from spreading into new country is to do everything possible in every infested locality to completely eradicate the pest. This is

still the unanimous opinion of the committee. To carry out this plan the committee recommends the appropriation of $200,000 for the work of 1897. As the appropriation for 1896 is almost exhausted, in order to continue the work economically it will be necessary that a part at least of the appropriation be made immediately available; otherwise, the present force of trained and experienced employees must be discharged at once, and the very important work that can be done only before the caterpillars hatch out will again be left undone. Leaving this work undone will put the work of the whole season at a great disadvantage, and in part undo the work of the last five years. The committee has, in former years, sought advice of the eminent economic entomologists of the country, and are warranted in stating that the present methods of work are approved by all those economic entomologists who have had an opportunity to become familiar with them.

The effort of Massachusetts to exterminate this pest has attracted wide attention among the economic entomologists of the country, and with one accord they advise a continuance of the work. At the last annual meeting of the Association of Economic Entomologists, held at Buffalo, Aug. 22, 1896, after thorough discussion, a resolve was unanimously passed, commending the work already accomplished and urging its continuance.

At the National Farmers' Congress, held at Indianapolis, Ind., Nov. 10, 11 and 12, 1896, the matter was considered, and the following resolution was adopted: —

Resolved, That the Farmers' National Congress views with alarm the ravages made by the gypsy moth upon the trees and foliage in the New England States,* and petitions the Congress of the United States to cause an investigation of the subject to be made, and to take such measures for the extermination of the pest as may seem wise, as its spread over the country would prove a national calamity.

The experimental work has been continued in charge of Mr. A. H. Kirkland, assistant entomologist to the committee,

* This is an error, as the gypsy moth in this country is confined to a small area in eastern Massachusetts.

under the direction of Prof. C. H. Fernald. Particular attention has been given to the investigation of various forms of poison, with a view to discovering an insecticide that will be more effectual in destroying the gypsy moth caterpillars than those poisons heretofore in general use. Considerable success has attended these experiments, and insecticides have been perfected that promise to be of great value in future work. Much work has also been done in seeking for and encouraging native parasites that prey upon the gypsy moth, and in studying their life history, with the hope that something more may be found that will give effectual aid in destroying the pest.

For details of the work of the past year, reference is made to the reports of Prof. C. H. Fernald, entomologist, and E. H. Forbush, director, presented herewith as a part of the report of the committee.

The committee desires to put on record here its obligation to Prof. C. H. Fernald and Mr. E. H. Forbush for the eminently satisfactory manner in which they have discharged the onerous duties devolving upon them in conducting the work which the Legislature has entrusted to the committee of the Board of Agriculture.

The following is the financial report of the gypsy moth committee of the State Board of Agriculture for the year 1896: —

Financial Report for 1896.

Balance on hand Jan. 1, 1896,		$39,722 09
Emergency appropriation, April 28, 1896,	$10,000 00	
Appropriation June 4, 1896,	90,000 00	
		100,000 00
		$139,722 09

Expenditures.

Wm R Sessions, expenses,	$16 37
Augustus Pratt, expenses,	85 05
E. W. Wood, expenses,	22 07
John G Avery, expenses,	145 95
F. W. Sargent, expenses,	59 94
S. S. Stetson expenses,	57 50
C. H. Fernald, expenses and remuneration,	655 65
Amount carried forward,	$1,042 53

Amount brought forward, . . .	$1,042 53	
E. H. Forbush, director, salary, . . .	2,400 00	
Travelling expenses of director and men, .	4,793 56	
Teaming, livery and board of horses, . .	3,132 22	
Wages of employees, ...	104,975 87	
Rent of storehouse and office, . . .	466 50	
Supplies, tools, insecticides, etc., . . .	14,061 56	
Balance on hand Jan. 1, 1897, . . .	8,849 85	
		$139,722 09

E. W. WOOD,
S. S. STETSON,
JOHN G. AVERY,
AUGUSTUS PRATT,
F. W. SARGENT,
WM. R. SESSIONS,

Committee of the Board of Agriculture in Charge of the Gypsy Moth Work.

Report of the Entomologist.

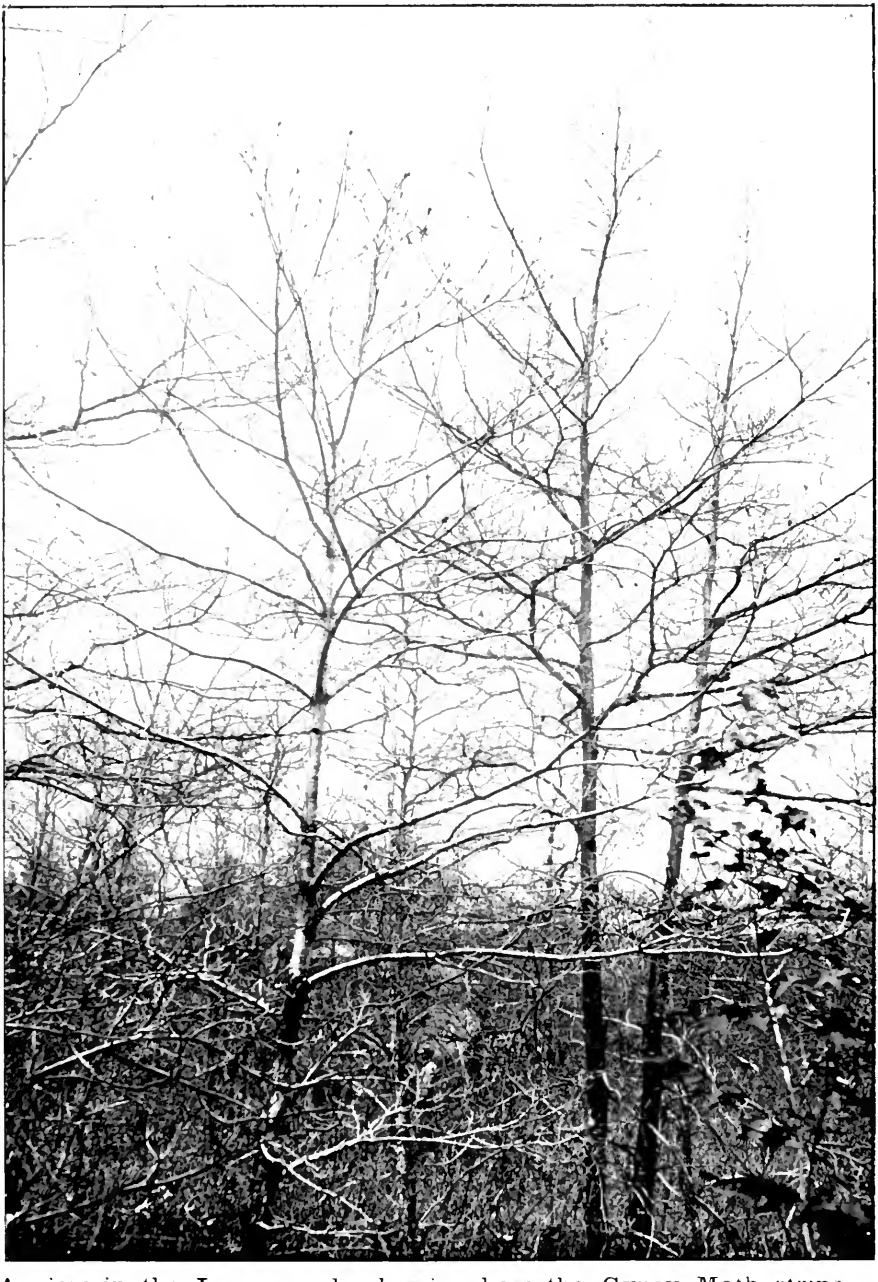
To the Committee on the Gypsy Moth.

Gentlemen: — During the past year all has been accomplished towards the extermination of the gypsy moth that could possibly be done, or that could have been expected with the small amount appropriated by the last Legislature. For several years past the appropriations asked for this work have been cut down from one-fourth to one-half, but no change has been made in the law which requires the committee to work for the extermination of this insect.

There is no question but that the gypsy moth is one of the most destructive and expensive pests that could have been brought into this country, and only the most active and vigorous measures are of any avail against it. It is claimed, by some who have little or no knowledge of the matter, that it is not possible to exterminate this insect; but I do not know of any economic entomologist, who has made a thorough, personal investigation of the work, who does not believe that extermination is possible if the Legislature appropriates sufficiently large sums of money, making them available when needed in the work.

At the last meeting of the Association of Economic Entomologists, held in Buffalo, N. Y., Aug. 22, 1896, after a full discussion of the work on the gypsy moth, the following resolutions were presented by Dr. John B. Smith, professor of entomology in Rutgers College and entomologist to the New Jersey State Agricultural College Experiment Station, and unanimously adopted: —

Resolved, That in the opinion of this association the work done by the gypsy moth committee in Massachusetts is of the utmost importance and value, not only to that State but to all the surrounding States and to the country at large.



A view in the Lynn woods showing how the Gypsy Moth strips nearly all trees and plants. Many of these trees are now dead or dying. (See page 40.)

From a photograph taken July 10, 1896.

Resolved, That in our opinion the cessation of the work of that committee would be a national misfortune, and a failure on the part of the State of Massachusetts to continue it would be a calamity which would involve immense loss to the people of that State and of the entire country.

Resolved, That we have full confidence in the ability of the officers now in charge of the work of this commission, as evidenced by the report recently issued, which contains not only matter of extreme importance to the economic entomologist, but of the highest value to the farmer and fruit grower.

While the gypsy moth has not spread over the State at large, all reports to the contrary notwithstanding, it has, nevertheless, become so thoroughly established in its present definitely bounded district in the eastern part of this Commonwealth that it will be no slight task to exterminate it or even hold it in check. The State can adopt one of three courses: —

First. It can continue the policy of extermination, which would require large appropriations for a term of years.

Second. It can change the law, which now requires the committee to work for extermination, and adopt the policy of holding the insect in check. This would require a perpetual annual appropriation.

Third. It can abandon the work entirely. This would leave it for the cities, towns and individuals to deal with the pest.

It is for the Legislature to decide which will be the best and wisest policy for this Commonwealth. If the first course is adopted, there will be required an appropriation of not less than $200,000 a year for a term of not less than five years, and then an appropriation of not less than $100,000 a year for a term of not less than five years. After this an appropriation of perhaps $15,000 a year for a period of five years will be required. The sum total of all these appropriations for fifteen years is $1,575,000, or an average of $105,000 a year. A man with taxable property to the amount of $5,000, which is a little more than the average value of the farms in this State, would have to pay for the support of this work an average annual tax of 21 cents and 7 mills, and this would amount in the fifteen years to $3.25.

If the Legislature should see fit to adopt the second course, namely, that of mere restriction, it would be necessary to appropriate each year to the end of time a sum of money sufficient to prevent the insect from spreading and also from causing serious damage in the infested region. Those who are most familiar with this insect and the difficulty in destroying it estimate the cost of holding it in check at a much higher figure than some who have little or no practical knowledge of the matter. The cost has been variously conjectured and estimated at from $25,000 to $100,000 annually. My own opinion is that the latter sum would be required even in the present infested region; and, if the insect should escape and spread elsewhere, as it would probably do in time with the cessation of exterminative methods, a still larger sum would be necessary. If, however, adopting the average non-scientific view, we assume that only $50,000 annually be required to hold this insect in check, I leave it for those who believe that it is the wisest policy for the State to adopt this course to estimate what the annual appropriations of $50,000 would amount to from now to the end of time. If, however, we estimate the cost for a period of forty years, or from the time a man might take charge of a farm worth, say, $5,000, till the time he gives up the work, assuming the taxable property and rate of taxation to remain uniformly as at present, this man would have to pay, under this proposed restrictive method, an annual tax of 10 cents and 6 mills, which in forty years would amount to $4.24.

If, however, the third course, that of abandoning the work entirely, be adopted, the gypsy moth will surely spread not only over this Commonwealth but over the entire country. We must bear in mind that this insect feeds on nearly all plants of value that grow in this State, and is capable of greatly injuring or even destroying them. In the report of this committee issued in January, 1894, page 10, it was stated that "A conservative estimate made by Professor Fernald places the probable annual damage which this insect would do in Massachusetts alone, if allowed to spread, at $1,000,000." I have published elsewhere an estimate from the most carefully obtained data, that the cost of applying Paris green to potatoes to protect them from the ravages of

the Colorado potato beetles in this State alone amounts to $76,000 annually, — a sum equal to about one twenty-fifth of the value of the crop; and this has continued for many years, with every prospect that it will go on indefinitely. If, therefore, it costs one twenty-fifth of the value of the potato crop to apply an insecticide to protect it from the ravages of the Colorado potato beetle, who can deny that it will cost quite as large a proportion of the value of all the vegetable products of the farms, orchards, gardens and forests, which the gypsy moth will attack, to protect them from the ravages of this omnivorous pest? The value of these products in this State for the year 1885, as given in the State census, is $26,497,202, and one twenty-fifth of this sum is more than $1,000,000. It should be remembered that the cost of applying an insecticide to a low-growing plant like the potato is far less than would be that of its application to fruit and forest trees or grass and grain fields. In these estimates no account has been taken of ornamental trees and shrubs in this Commonwealth, for the reason that I have no means of learning the number or value of these. Their estimated value would depend largely upon their location. Those in city parks have a far greater value than those along the sides of country roads. Professor Lintner, State entomologist of New York, informs me that the Saratoga elms are insured at $500 each.

If the work of exterminating the gypsy moth should be abandoned by the State, this insect, already infesting some of the metropolitan parks, would surely spread not only to all of the parks belonging to this system but to all of those in the metropolitan region. In this case one of two things would follow: either the trees and shrubs of all the parks of the region would be abandoned to these voracious insects, to be stripped of their foliage, leaving them as bare and unsightly as in winter; or else there would be a perpetual war against them by park commissioners.

I have no data from which to estimate what the cost of such work would be, but even a superficial survey of the problem would very quickly convince one that it would be enormous. If every tree and shrub in the parks of the entire metropolitan system must be sprayed with an insecticide

during the time these insects are in the caterpillar stage, all the trees burlapped during the same time and the caterpillars gathered under them destroyed daily, we can see at once, without making a closer estimate, that the annual expense to cities and towns in the metropolitan district, one-half of which would have to be paid by the city of Boston alone, would be far greater than would be the case if the policy of extermination should be pursued.

From the facts and figures given above it will be readily seen that the policy of extermination, with the full amounts called for each year by the committee, is the wisest and most economical course that can possibly be pursued; and that the policy of merely holding the insect in check will inevitably end in the abandonment of the work by the State, and the expense of destroying this insect will fall upon every land owner, every householder, if he has any trees or shrubs on his premises, and even on every tax payer, who will have to pay his part towards the expense of fighting this insect in the public parks and grounds of the city or town in which he resides.

Respectfully submitted,

C. H. FERNALD.

A view showing forest trees stripped by the Gypsy Moth.

From a photograph taken in Medford, July 10, 1896, in the Middlesex Fells Reservation, Metropolitan Park System.

Field Director's Report.

To the Committee on the Gypsy Moth.

Gentlemen: — In the first three months of 1896, much good work was done during favorable weather, with the limited force at my command. The eggs of the moth were treated where they were found above the "snow line" on trees and other objects. Dead or dying trees in infested localities were cut and burned, when other work could not be done to advantage. When the snow was not too deep, the undergrowth was cleared from infested places in the woodland. The cavities in orchard trees were filled or covered. Loose bark and dead limbs were removed where the necessities of the work demanded, and the infested localities were put in a good defensive condition and prepared for the summer's work, so far as this could be done by the number of men that could be employed with the remainder of the appropriation of 1895. Very little work was done during storms, or when the snow lay deep upon the ground.

The delay in making the appropriation rendered impossible the carrying out of our plans for the work of the season. A few colonies were known in the outer towns where the moth had been nearly exterminated. It had been planned to enter these colonies as soon as the condition of the weather should permit in the spring, and to clear them up and do such work as would ensure the complete extermination of the moth in them during the season of 1896. Much of this work had to be abandoned. This in some cases postponed the extermination of the moth there to another year.

When it was seen that there would be great delay in

making an appropriation for the year's work, the remainder of the appropriation of 1895 was used as far as it would go in some of the badly infested localities, by destroying the eggs of the moth there and thus preventing any outbreak of caterpillars which might otherwise occur in the spring and summer, should the appropriation be so long delayed as to prevent any further work being done. Most of the field work was discontinued in March, and nearly all the men were discharged for lack of money to pay their wages.

When the emergency appropriation of $10,000 became available, April 28, it was applied in destroying the eggs on the trees in the worst infested localities, and in burning over the ground to destroy the scattered eggs of the moth in colonies where this work was deemed most necessary. The work was begun at once in the outer towns. But the caterpillars were then already beginning to hatch out. Before the burning had progressed far toward the centre, they were going up the trees. For this reason the burning ceased to be effective and was discontinued. The lapse of this work was seriously felt later.

All through the month of May the caterpillars were hatching out and spreading abroad from those worst infested localities in the central towns, where, on account of the delay of the appropriation, little or no winter work had been done. The weather of the two previous years had been particularly favorable for a great increase of the moth, and many forebodings were felt as to what might result from the enforced delay. The season of 1896 also presented favorable conditions for the multiplication of the moth, and the worst fears were partly realized in the stripping and death of trees in the woodlands, and in the spreading of the caterpillars therefrom over territory in the central towns which had been previously cleared at great labor and expense.

Some badly infested localities in the central towns had been carefully treated during the fall and winter, everything possible but the burning having then been done. This it was intended to do in the spring, as, the leaves having fallen from the trees during the fall and winter, a ground fire would then be most effective. In some of these colonies where the burning was not done the scattered eggs on the ground

among the dead leaves produced a sufficient number of caterpillars to strip the foliage entirely from the trees in the centre of each colony, so that all the labor of the season of 1895 served only to prevent the increase of the colonies, and failed to contribute to the progress of extermination. The number of the moths remained about the same, and they did quite as much injury in these colonies in 1896 as in 1895.

When in June the reduced appropriation for the season's work became available, there was no time to do more than put on the burlap in the outer towns before the caterpillars began to cluster beneath it. In many of the colonies where the eggs had hatched in April and May, and the caterpillars had scattered so as to extend the limits of the colonies and increase the number of infested trees, it became necessary to put on a much larger number of burlaps than last year. After June 20 no time remained for putting on burlaps, for it required all hands to properly attend those already on, otherwise, those put on would not have accomplished their object. Therefore, for lack of time and means no burlaps were put on the trees in the central towns excepting in Everett and on a few estates elsewhere, mostly where the property owners attended them. The defoliation and serious injury and even death of many trees which occurred during the summer might have been prevented by burlapping these trees and killing the caterpillars, had the appropriation been made in season.

Successful Spraying.

The results reached in 1895 with arsenate of lead suggested a trial with this insecticide on a larger scale during 1896. It was used on fruit, shade and forest trees, at a strength of twenty pounds to one hundred and fifty gallons of water, with glucose added. In one locality in the Middlesex Fells the trees had been entirely defoliated during part of the summer of 1895. This place was chosen for experimental spraying. No work was done in this colony during the winter of 1895–96, and the eggs therefore hatched in the spring. The colony was situated in a grove of young trees, mostly oaks, averaging some thirty feet in height. The trees on several acres were sprayed. At the time of spraying, although the

caterpillars were large and numerous and had destroyed much of the foliage before this work was begun, the insecticide was very effective, and the result at the close of the season was that the eggs deposited, as compared with those deposited the previous season, were as one (or less than one) to one hundred. Most of the egg-clusters were small, containing few eggs. This indicated a lack of vitality and development in the parent moths. Similar results were obtained in other localities. Little injury was done to the foliage by spraying, and the insecticide remained on the leaves throughout the season. Our experiments with other new insecticide mixtures give promise of equally good or better results.

While the spraying was in operation, improvements were made in the apparatus. A relief valve was attached to each pump, to regulate the pressure, thus saving labor in pumping, as well as doing away with unnecessary strain on the hose and couplings. Experiments have also been made with intent to improve the effectiveness of the pumps, and to save labor by using horse-power, steam power or compressed air. We are now directing efforts to invent and improve machinery by which both the cost and labor of spraying large trees may be reduced, and by which spraying may be made more effective. Experiments in improving the burning machinery are also in progress.

The Fall Work.

When the burlapping season was over and the eggs of the moth were deposited, most of the force was concentrated in badly infested localities, where the men were engaged in destroying the eggs of the moth until most of the foliage had fallen from the deciduous trees. Then the larger part of the force was sent into the outer towns, and used in inspecting those portions of such towns which stood most in need of an examination, or in working for the extermination of the moth in those colonies where the moth had not already been exterminated. When the snow came most of the men were again concentrated in the badly infested localities in the inner towns, where everything was done that could be done with the small balance of the appropriation then remaining.

The Condition of the Infested Region.

The condition of the infested territory is now better known than ever before. Because of inadequate appropriations, it has been impossible in any one year to inspect thoroughly the entire territory; therefore no detailed report of the condition of the infested towns has ever been published. The present report may be considered as approximately accurate, for the appropriation of $150,000, made in 1895, although not providing for all the work necessary, made possible a thorough inspection of nearly all the towns in the infested region during that year and the early part of 1896. The outer tier of towns in the infested region has been looked over far more carefully within the past two years than ever before. These towns were nearly all given a tree-by-tree inspection in 1895, or in the winter of 1895–96, and most of those which did not then have a thorough inspection have been inspected during the fall of 1896.

Beverly.

Beverly is the easternmost place which has been found infested. Several colonies were found in 1891 and in 1892, and one was found in 1894. No moths have been found in the city during the past year, although the localities previously infested have been carefully looked after, and the greater part of that portion of the city which has been most exposed to infestation has been carefully searched.

Salem.

Many colonies of the moth were found scattered over the main streets and roads of Salem in the fall of 1891. A more extended inspection, later, showed that there were also numerous colonies in Salem Great Pastures and a few in the woods. Nearly all the colonies that have been found near the centre of population have been exterminated, one of the worst being at Harmony Grove Cemetery. As much as was feasible with the means provided has been done to exterminate the colonies found in the pastures. In many cases this work has been a success, in others the lack of money

has resulted in a cessation of the work and a consequent failure to exterminate. The woodland colonies have been carefully treated. Most of the known colonies in Salem have been thoroughly examined during the present year. Salem is now in far better condition as regards the gypsy moth than in former years, but some colonies in the pastures should be burned over before the eggs hatch in the spring.

Marblehead.

Marblehead was found infested in 1891, and several colonies have been found there since. Only two caterpillars were found in the town in 1895. A careful inspection made during the fall of 1896 has shown one small colony in the south-eastern portion of the town, near Swampscott, and two egg-clusters near the centre. The work of this winter ought to exterminate the moth from Marblehead, but it must be carefully watched, as it adjoins other infested towns.

Swampscott.

In the summer of 1891 the gypsy moths swarmed in certain parts of Swampscott. They were found in small colonies along the roads, and had penetrated into the woods, where the largest colonies were found. The largest colony in the town and one of the worst in the infested region has been entirely cleared during the past five years, and no moths are now found there. The colony covered an area of about one hundred acres, a large part of which is woodland. There is a smaller colony also in the woodland which needs attention. Outside of this, there were three localities in which the moths were found in the fall inspection. These have been examined and the eggs destroyed. Most of the town has been thoroughly inspected during 1896.

Nahant.

Nahant has also been carefully gone over this year, and no moths have been found there. In past seasons small colonies of the moth have been exterminated in this town.

Winthrop.

Winthrop was found to be generally infested in 1891 and 1892. It has shown a continual improvement from year to year, and during the past autumn has been carefully inspected. Only three small egg-clusters were found.

Boston.

No gypsy moths have ever been found in the business part of the city. There is very little sustenance for leaf-feeders there, except on occasional street trees and in the parks. In the residential portion, however, many colonies of the moth have been found. That part of East Boston on Breed's Island known as Orient Heights was found badly infested in 1891, but from year to year there has been a steady improvement in its condition. With the exception of one colony, the moths appear to be exterminated there. The major part of East Boston was not so badly infested, and at present only one colony is known there. The only remaining colony known in South Boston has been carefully gone over the present year, and appears to be cleared. No moths have been found in the south end of Boston since 1895. The greatest swarm found in Boston was in the Dorchester district, one locality there yielding eighteen bushels of caterpillars in a short time. This district is now nearly free from the moth. Only one caterpillar has been found this year in the Roxbury district, which was considerably infested in 1894. In 1893 an old colony was found in Franklin Park, which, on account of the nature of the ground, was very difficult to exterminate. No moths have been found in the park during the present year. This locality, however, should be carefully watched.

Brighton was found to be infested in 1891. All of the widely dispersed colonies in this district now appear to be exterminated. No moths have been found in Charlestown in 1896.

A search of Boston was made in 1895, but no careful inspection of the whole city and its suburbs has been attempted

in 1896, for the means provided were not sufficient to do this and attend to other work which was more pressing.

Brookline.

Two colonies of the moth were found in 1896 in Brookline. A thorough inspection of the town is now in progress. So far, no moths have been found outside of these two colonies. These colonies were of several years' growth, and would have been found before had means been provided from year to year to inspect thoroughly all the outer towns. On account of the nature of the ground and the fact that the moths were first found late in the season, it is improbable that these colonies have been exterminated.

Watertown.

Several moth colonies were found in Watertown in 1891 and in 1892, and more were found later. Some of them were so situated as to render extermination extremely difficult. Much careful work has been done in these colonies. Only two places were found infested in this town in 1896. One is an extension of a Cambridge colony, situated near the Watertown line; the other, where only two caterpillars were found, is also in the eastern part of the town.

Waltham.

In only one colony in Waltham have any moths been found in 1896, all the old colonies having been exterminated previous to 1895. A careful search of the town in that year revealed one colony in the woods, which has since been carefully watched, burlapped and treated in such a way that, if it is not already exterminated, it should be by the work of another summer.

Lexington.

The greater portion of Lexington appears to be cleared, although the moth formerly existed there in many colonies scattered over the town. There are two colonies in the woodland in the northern part of the town, in which nearly everything possible has already been done to destroy all forms of the moth and to put the colonies in a condition for

the most careful work another year. If any caterpillars appear in these colonies when the eggs hatch in the spring, there will be little difficulty in destroying them all at that time. But few caterpillars have been found during the summer in East Lexington village, where a large and difficult colony was formerly located. The eastern corner of Lexington extends into one of the badly infested spots in the woodland, of which reports have been previously made. There were many trees infested in some of the woodland colonies this year. Much work, however, was done there, and these colonies all now appear to be in good condition. If sufficient work can be done there during this winter and in the early spring, nothing is to be feared from them.

Burlington.

The only colony in Burlington in which the moth was found in considerable numbers in 1896 was discovered in 1895 in the woodland. This colony has been carefully attended and watched during the summer, the undergrowth cleared out in the fall, and everything done to destroy the moth and put the locality in the best possible condition for another thorough inspection in 1897. The northern part of the town needs a tree-by-tree inspection.

Woburn.

Woburn was carefully examined in 1895. All the known colonies have been watched and worked over, and no moths are now known to exist in the town except in the southwestern portion, near the Winchester-Lexington boundary, where more work is needed. In this region the large and dangerous colony reported to the Legislature last year has been annihilated by fire.

Reading.

No moths have been found in Reading for the past two years. All the known colonies appear to have been stamped out. They have been carefully watched. An inspection of the town is now going on. The southern and central portions, contiguous to other infested towns, have now been examined.

Lynnfield.

In all the widely scattered colonies in Lynnfield, known before 1894, the moths were exterminated in that year or previously. A thorough examination of the southern part of the town in 1895 revealed several colonies in the woodland. Some of these were extensions of Saugus colonies. Others had existed in the woodland for several years, but there had been no woodland inspection, except along roads and paths, on account of lack of money. These wood colonies have already been nearly exterminated. They have all been carefully treated, the brush has been cut out and burned, and they have been burlapped for two years. In some of them no moths have been found this year, in others only a few have been found. A search of all the woodland in the town is now in progress. In this search only one small colony has been found thus far outside of those heretofore known. The situation of the town, the extent of its woodland and its popularity as a place for outings and picnics (potent factors in the distribution of the moth) may be named as reasons why it should be carefully watched.

Peabody.

Nearly all the moth colonies which were found scattered over Peabody, in 1891 and since, have been exterminated. Only three are now known. One is a large woodland colony, which it may take some time yet to exterminate.

Danvers.

Only two colonies of the moth have ever been found in Danvers. One of these was on the Salem line; the other on the Beverly line, extending over into and mostly in Beverly. These have both been exterminated.

Lynn.

Lynn was found infested in 1891, and the moth colonies were generally scattered over the city. At one time there were over twelve hundred estates infested, mostly in and about the centre of population. The condition of the city

has been improving of late years until 1896, when during the fall inspection of the known colonies eggs have been found on only one estate of the twelve hundred.

For several years it has been known that the gypsy moth has obtained a foothold in the public park known as the "Lynn Woods." This woodland has been inspected from time to time, but it should have, as soon as possible, a more thorough and careful inspection than the resources provided have previously allowed. During June of the present year a colony was found by an inspector, where the caterpillars had become so numerous as to strip the leaves from the trees and all vegetation over a small area. It is probable that there may be a repetition of this occurrence in other portions of the woodland, unless a careful and thorough inspection of the whole tract is made before the eggs hatch in the spring. The known colonies in the woods have all been carefully looked after, so that there is no danger of serious injury resulting to the park from them. If means are provided, the entire wood can be freed from the moth in a comparatively short time.

Wakefield.

Wakefield was found generally infested in 1891 and in 1892. Colonies were scattered about over the inhabited part of the town, and also in the woods. The condition of the town has been greatly improved from year to year, until at the present time only five colonies are known there, and in these only a very few moths have been found this year.

Stoneham.

In 1891 the central part of Stoneham was found to be more or less infested by the moths, and a later inspection showed that the woodland of the south-eastern part, adjoining Melrose, was also more or less infested, and that colonies were scattered through the northern end of the town. The condition there and in the central part of the town has been improved from year to year, and in the northern part the moths appear to have been exterminated. The moths have been found in only two localities in the centre in 1896.

The greatest danger of an increase and spread of the moth lies now in the Middlesex Fells region, adjoining Medford and Melrose. Careful and thorough work should be done there as soon as possible.

Winchester.

The moths were early found to be scattered throughout the Winchester village, and a later inspection showed that they had penetrated into the woods, not only in the south-eastern section, near the Middlesex Fells, but also in the western portion of the town, lying near Woburn and Lexington and north of western Arlington. This woodland is a portion of one of the badly infested wooded localities reported a year ago to the Legislature, with an urgent recommendation that sufficient money be appropriated to make it possible to prosecute actively the work of extermination therein. Careful work has been done in the western Winchester woods, with the result that very few moths are now found there. The work should be followed up during the winter by such cutting and burning as is necessary and can be done to advantage, and the remaining eggs should be destroyed before the coming spring. There has been a great improvement in the condition of Winchester the past year, and little has been found in the centre of the town during the past two years, although several bad colonies were formerly known there.

Arlington.

In 1891 a few of the worst infested localities in the region were found in Arlington, the woodland being infested, as as well as the open and cultivated land. The moths were found scattered throughout the town. Since that time they have been almost entirely cleared from the eastern part, but in the woodland adjoining Lexington and Winchester there remains considerable work to be done. An advance, however, has been made there from year to year.

Belmont.

Belmont was one of the towns found infested by the first Gypsy Moth Commission in 1890. The first work done un-

der the second commission was to enter and inspect a portion of the town and to destroy what egg-clusters were found. Many colonies were immediately located, most of them of several years' standing. The inspection of the town which followed showed that the moths were not only distributed along the roads and on the farms, but also in the woods. Handicapped by insufficient means, we have found it impossible to do all the work required in some of the woodland colonies, but most of them are in good condition. Many of the Belmont colonies have been exterminated. There are still several colonies in the town which need immediate attention.

Cambridge.

One large colony was found in Cambridge in 1890, which was so situated as to facilitate the distribution of the moth over the city. The search of the city made in 1891 showed that the moths had been scattered over most of the western portion, as well as all about Harvard Square. A few colonies have been found in Cambridgeport. The work has resulted in a gradual improvement in the condition of the city, so that now the moths have been exterminated from most of the colonies originally known. During the past year scattered caterpillars have been found, particularly in the western part of the city. Cambridge should have a thorough inspection at once, for by careful work the moths there can soon be exterminated.

Somerville.

In 1891 the moths were found scattered in colonies throughout the greater portion of Somerville. They were in considerable numbers in West Somerville. There has been a steady improvement in the condition of the city. All the known colonies have been carefully attended in 1896, and much work has been done in covering holes in trees in infested localities and preparing them for another season's work. The moth has been exterminated in nearly all the known colonies.

Chelsea.

Chelsea was found infested by the first commission in 1890. There were some badly infested localities, and the moth colo-

nies were found scattered generally about the city in 1891. Most of the colonies in Chelsea have been exterminated within the last three years. The city has been entirely inspected during the fall, and only a very few egg-clusters have been found there.

Revere.

The first inspection of Revere, in 1891, showed that the moths were in all parts of the town except upon the salt marsh, where none were found. The work of the past three years in Revere has been quite effective, and only one egg-cluster has been found there in the last inspection.

Saugus.

In the inspection of 1891 colonies of the moth were found in Saugus along the principal roads leading through the town from Malden, Melrose and Revere to Lynn; and many other colonies were found, not only in the village, but in the farming section of the town. Careful inspection of the woods was not made until later. The inspection of the woodlands in Saugus and other central towns was always more or less incomplete, on account of inadequate resources; but colonies were found in the woodlands during 1893, 1894 and 1895, showing that these woodlands were more or less infested, and in some cases the colonies were quite large. For lack of sufficient means we have not been able to do all the work that was required in these colonies, and, as a consequence, although a great deal of time has been expended on them and they have been partially held in check, they have increased and extended their limits, so that they now not only threaten to extend still farther into the Saugus woods, but to reinfest Lynn, Salem, Swampscott and other places where the moth is now nearly exterminated. If the work of extermination is to be continued with any prospect of success, it is an absolute necessity that the eggs in this woodland be destroyed before the caterpillars hatch out in the spring. This it will be impossible to do without an immediate and adequate appropriation.

Melrose.

In 1891 Melrose was found to be considerably infested. Many bad colonies were found then and later in the villages and woodlands. At the present time all the northern part of the town has been carefully gone over, and very few moths have been found. A large amount of work remains to be done in the southern portion, especially in the woodlands, and much work might profitably be done there during the present winter and the spring of 1897. Careful inspection now begun should be continued and finished before the eggs hatch in the spring.

Malden.

The western portion of Maiden, being contiguous to that portion of Medford where the moth was first introduced, early became infested, and Edgeworth in 1891 was literally overrun by the caterpillars. Much careful work was then done in destroying egg-clusters and caterpillars, and this has been followed up year by year sufficiently to hold the moth in check throughout the entire city. Very little injury to the foliage has been done since 1891, except in a few cases. During the present year there was an outbreak in the southern part of the city, near the city pumping station, where the trees on about half an acre were more or less defoliated. While the moths have been held in check in Malden, even in that portion of the city contained in the woodland of the Middlesex Fells, they cannot be said to be exterminated anywhere; for, as the city is generally infested, any colony cleared is likely to become reinfested. Malden is in such a condition, however, that, were sufficient means provided at once to clear this and the neighboring towns, the moths could be almost entirely exterminated from the city in one year's time.

Everett.

The north-western portion of Everett, which is contiguous to Medford and Malden, was badly infested by the moth in 1891, and moth colonies were scattered generally over the city. The work in the city in 1891 greatly improved its

condition, which has since varied from time to time, according to the amount of work that could be done there. In 1894 Everett was in very fair condition; but in 1895, owing to the pressure of work elsewhere, comparatively little work was done there, and the moths increased rapidly. During the past summer Everett has been burlapped, the burlaps carefully attended and the infested localities examined during the fall. More caterpillars were taken there than in any other city or town, and it is now in much better condition than in 1895.

Medford.

Medford, the original home of the gypsy moth in this country, was found very badly infested from the first, and much work was done there in the early part of 1891. During the winter of 1891–92 a great deal of careful work was done in the city, and everything possible with the resources provided has been done there since. No burlap was put on in Medford in 1896, on account of the lateness of the appropriation; but the work of 1895 was so well done that only here and there in the centres of population were the moths troublesome in 1896. They have increased greatly, however, in the Medford woods within two years. This tract contains a large part of the Middlesex Fells reservation and other woodlands. This woodland centre has been necessarily more or less neglected, owing to lack of means year by year to attend properly to all the woodland in the infested territory. During the past two years several swarms of the moth have developed in the Medford woods, while many of the older colonies have increased so rapidly as to menace all the surrounding country. In 1896 many trees were stripped in two localities on the borders of the metropolitan park reservation. Most of the men working in that section of the infested region were concentrated in these woods during the first of the autumn before the leaves had fallen from the trees, and again in December, when the snow fall made the inspection of outer towns and careful cleaning work there unprofitable. During the winter of 1896-97 the work should be pushed to the utmost in these woods, otherwise there is danger that considerable injury may be done in the metro-

politan park reservation next summer, and that the moths may be scattered abroad by means of vehicles driving through the many roads which have been recently opened by the Metropolitan Park Commission.

A Summary of the Present Condition of the Infested Region.

An arbitrary line can now be drawn, enclosing the region most infested, which will leave outside of it and surrounding the centre about two-thirds of the region formerly known as infested. This outer region is nearly, if not entirely, cleared of the moth. If sufficient resources are promptly provided another year, I believe the moth can be cleared from all this outer region in a year's time. In the central region there are now only two large centres badly infested in the woodland, in place of three of about one thousand acres each which were reported to the Legislature on Jan. 1, 1896. The tract, comprising the woods of south-western Woburn, eastern Lexington and western Winchester, is now in much better condition than last year. This gain is offset by the fact that the great tracts of woodland in Medford and Saugus are now in a worse condition than ever before, though all has been done there that could be done with the delayed and reduced appropriation. This unfavorable condition of affairs requires a word of explanation.

When the work of extermination was begun by the Board of Agriculture, in 1891, there were many infested localities in the woodland in the outer towns. These colonies were particularly dangerous as moth-distributing centres, both on account of their situation near the borders of the infested region and on lines of traffic and travel to non-infested towns, and because of the character and extent of the woodland in which they were situated. In 1891 and until within two years some of these outer colonies were much more infested than those in the central woodlands. Attention therefore had first to be given to preventing the moths in these colonies from occupying a larger area in these remote woodlands, from which it would be difficult to exterminate them. Furthermore, the work of exterminating these

colonies in the outer towns had to be done, if the spread of the moth into towns outside the infested region was to be prevented. But, while the work has been so well done in these outer woodland colonies that the moth has been exterminated from most of them, it has been impossible, with the means at hand, to provide at the same time for the extermination of the moth in the colonies in the inner towns. It has been simply a case of choosing the greater of two evils to combat. The dangers of this enforced neglect have been realized, and the steady increase of the moth in the central woodlands has been known, and, as you are aware, has been repeatedly pointed out.

While some of the colonies in the outer towns were at first much to be feared as centres of moth dissemination, this danger has now been largely eliminated by the success of the work of extermination in those towns. Yet a new danger of distribution now overshadows all others. The facilities for the distribution of the moth from the central woodlands have greatly increased within the last six years, or since the work of exterminating the gypsy moth was begun. Streets have been cut through many of them, and building begun. The Metropolitan Park Commission has opened driveways and built boulevards, all of which form a network through the Middlesex Fells region; and people from all the region round about drive over these roads and boulevards during the summer months, when the caterpillars are spinning down from the trees. Electric car lines have been opened along roads through the woods, connecting the eastern cities with the central towns and cities, one line going as far as Lowell.

There are now in the woods of these central towns probably one million egg-clusters; and, if by any delay of the appropriation for the work of 1897, these egg-clusters are allowed to hatch, they will probably produce from one hundred million to five hundred million caterpillars. We have, therefore, good grounds to fear that, should the caterpillars be allowed to hatch out in the spring, they will be spread abroad, reinfesting those towns already cleared or nearly so, and necessitating much of the work of the past five years to be done over again. This great danger can be averted

and the moth stamped out in these woodlands only by the immediate provision of ample means, which will insure the destruction of the eggs before May 1, 1897.

The condition of the towns which are or have been infested may be quickly seen by a glance at the following list. Brookline is not included in this list, as the first inspection of this place is not yet finished.

Places formerly infested, not found infested in 1896. — Beverly, Charlestown, Danvers, Nahant, Reading.

Places in which only One Locality has been found infested in 1896. — Roxbury, South Boston.

Other places in which the Moth appears to be nearly exterminated. — Brighton, Burlington, Chelsea, Marblehead, Somerville, Swampscott, Wakefield, Waltham, Watertown, Winthrop.

Places in which the Moth is now found only in Limited Areas. — Boston, East Boston, Lexington, Lynn, Lynnfield, Peabody.

Places Large Portions of which have been cleared from the Moth. — Cambridge, Revere, Salem, Saugus, Stoneham.

Places more or less generally infested. — Arlington, Belmont, Everett, Malden, Medford, Winchester.

Number of Employees in 1896.

The figures given below do not fully represent the number of employees enrolled on the pay roll, which at the height of the season considerably exceeded three hundred, but give the number of those actually at work each week. There are always some absentees, on account of sickness or leave of absence.

Jan. 1–Jan. 4,	141	Feb. 24–Feb. 29,	134
Jan. 6–Jan. 11,	137	March 2–March 7,	135
Jan. 13–Jan. 18,	133	March 9–March 16,	136
Jan. 20–Jan. 25,	133	March 17–March 21,	48
Jan. 27–Feb. 1,	133	March 23–March 28,	65
Feb. 3 Feb. 8,	133	March 30–April 4,	134
Feb. 10 Feb. 15,	135	April 6–April 11,	136
Feb. 17 Feb. 22,	135	April 13 April 18,	135

April 20-April 25,	136	Aug. 31-Sept. 5,	234
April 27-May 2,	135	Sept. 7-Sept. 12,	221
May 4-May 9,	132	Sept. 14-Sept. 19,	209
May 11-May 16,	131	Sept. 21-Sept 26,	193
May 18-May 23,	130	Sept. 28-Oct. 3,	177
May 25-May 30,	132	Oct. 5-Oct. 10,	174
June 1-June 6,	140	Oct. 12-Oct. 17,	179
June 8-June 13,	196	Oct. 19-Oct. 24,	173
June 15 June 20,	236	Oct. 26-Oct. 31,	175
June 22-June 27,	248	Nov. 2-Nov. 7,	173
June 29-July 4,	293	Nov. 9-Nov. 14,	171
July 6-July 11,	304	Nov. 16-Nov. 21,	141
July 13-July 18,	306	Nov. 23-Nov. 28,	135
July 20-July 25,	299	Nov. 30-Dec. 5,	132
July 27-Aug. 1,	281	Dec. 7-Dec. 12,	139
Aug. 3-Aug. 8,	271	Dec. 14-Dec. 19,	139
Aug. 10-Aug. 15,	268	Dec. 21-Dec. 26,	139
Aug. 17-Aug. 22,	253	Dec. 28-Dec. 31,	29
Aug. 24-Aug. 29,	244		

Summary of the Year's Work.

The figures given annually in the table of the number of each form of the moth destroyed are such as pertain only to the results of hand labor. These may be misleading, as it is quite probable that more moths have been destroyed by burning and spraying than by hand. Therefore, records of the hand work done each year do not accurately indicate the number of the different forms of the moth destroyed by all methods during each year. The other figures give only such results of labor as from their nature can be accurately reported and tabulated.

Some difference in the figures from year to year is due to the fact that, owing to the lack of adequate appropriations, only a part of the territory can be examined and worked over each year. Certain towns, for instance, are entirely inspected one year, and the inspection is necessarily omitted the next.

Work Done.

Trees (fruit, shade and forest): —

Inspected,	10,718,836
Found to be infested with caterpillars pupæ, moths or eggs,	57,723
In which cavities have been cemented or covered,	3,408

Burlapped,	567,025
Sprayed,	4,327
Trimmed,	90,820
Scraped,	929
Cut,	132,391
Acres of brushland and woodland cut and burned over,	477
Buildings: —	
Inspected,	24,764
Found to be infested,	815
Wooden fences: —	
Inspected,	43,917
Found to be infested,	1,318
Stone walls: —	
Inspected (rods),	18,997
Found to be infested,	633
Number of each form of the moth destroyed during the year by hand: —	
Caterpillars,	1,808,105
Pupæ,	441,899
Moths,	44,291
Hatched or infertile egg-clusters,	31,501
Unhatched and probably fertile egg-clusters,	884,928

The number of trees reported as inspected is not so large as the number reported in 1895. This may be accounted for by the reduction of the appropriation and the late date at which it was granted, both of which made a thorough inspection impossible in 1896. The number of trees found infested in 1896 (57,723) is considerably less than the number found infested in 1895 (76,794). Yet the reduction in the number of infested trees in the region is more apparent than real, for, as it has been impossible to inspect thoroughly as large a portion of the field as was last year examined, there are undoubtedly many trees in the woodland of the central towns on which eggs have been laid during the summer or fall of 1896, which have not yet been examined and are therefore not recorded. There has been, however, a considerable gain, in that most of the infested places in the outer towns have been cleared; and, although the number of trees actually infested this year may possibly be as large as the number infested last year, they are mostly in fewer localities, nearer the centre of the region, so that they can be cleared at less expense than if they were scattered through the outer towns.

The number of trees sprayed in 1896 is much larger than the number sprayed in 1895, for it had been demonstrated beyond all doubt that arsenate of lead could be relied upon to destroy the moth. Also, much of the spring work having been left undone, the numbers of newly hatched caterpillars made spraying necessary in many cases where it would not have been done had the hatching been prevented. Again, much of the spraying with arsenate of lead was done in wooded localities, where there were many trees to be sprayed.

While the number of caterpillars destroyed by burlapping during 1895 was greater than the number killed in this way in 1896, the numbers of pupæ and moths destroyed in 1896 more closely approached the figures of 1895, while the number of egg-clusters destroyed in 1896 is greater than the number of those destroyed in 1895. On account of the lateness of the appropriation, it was impossible to burlap all the trees, and, on account of the reduction in the size of the appropriation, very little in the way of killing caterpillars could be done in the summer in most of the territory comprised in those towns where no burlap was put on. Therefore, more moths matured and more eggs were consequently laid in 1896 than in 1895. This accounts for the difference between the figures of the two years. Although a greater number of egg-clusters has been destroyed this year than last year, the number now existing in the woodland of the central towns is greater than the number reported destroyed.

False Alarms.

During 1896, as in former years, reports of the presence of supposed gypsy moths or of injury caused by them have been received, both from towns within the infested region and from other towns in the State; but in no such case has any evidence of the moth been found by our investigations outside the region previously known to be infested except in Brookline, which adjoins the infested region. Reports have also been received from other States. These have all been investigated, and no evidence of the gypsy moth has been found.

A view showing trees stripped by the Gypsy Moth in Saugus woods.
From a photograph taken July 10, 1896.

Towns and Cities that have been falsely reported as infested by the Gypsy Moth in 1896.

Massachusetts.		*Maine.*
Ayer,	Marion,	Jay.
Bedford,	Milton,	
Concord,	Newton,	*New Hampshire.*
Easton,	Oakham,	Derry.
Framingham,	Quincy,	
Foxborough,	Rochester,	*Texas.*
Grafton,	Royalston,	Galveston.
Groton,	Stoughton,	
Haverhill,	Tyngsborough,	*California.*
Lawrence,	Wellesley,	Fresno.
Leominster,	West Bridgewater,	
Lincoln,	Weymouth.	

The Gypsy Moth as a Forest Pest.

The gypsy moth has long been known as a destroyer of the foliage of both coniferous and deciduous trees, shrubbery and foliage plants. Instances are on record where, in European countries, it has not only destroyed the foliage and fruitage, but caused the death of trees. Several cases are cited in the somewhat voluminous report published in 1896 by the Board of Agriculture.* This report also gives many instances where trees, shrubs and garden crops in Medford, Mass., were destroyed by the caterpillars of the gypsy moth. It is also stated that vast areas of forest have been infested in Russia and other countries.

When the Board of Agriculture first began work in the woodlands of the infested district in 1891, many dead and dying trees were found in localities where defoliation had occurred for one or more years. These trees were cut and burned. It was then impossible to determine to a certainty the cause of their death. Since that time there has been no opportunity to observe the effect of the defoliation of trees for even two successive seasons until 1896. This year the delay in the appropriation allowed the moths to obtain

* "The Gypsy Moth," E. H. Forbush and C. H. Fernald. Issued by the Massachusetts State Board of Agriculture, 1896.

sufficient headway in some woodlands, which were defoliated in 1895, so that the trees were again stripped in 1896.

So far as observed, all pines which have been defoliated for even one year have died, and some which have not been entirely defoliated are dying. Where oaks have been defoliated two years in succession, a large proportion of them are now either dead or dying. In one locality in the large forest park, controlled by the Lynn municipality, and known as the "Lynn woods," where a small area of young trees, mostly oaks, was stripped in 1896, many of them are either dead or dying. In several localities in Saugus, where the trees have been stripped for two years in succession, we find the same condition. There are several other localities where trees appear to have been killed by total defoliation one season and partial defoliation the next. One of these where the greatest injury was done was in the Lexington woods. Thus we have demonstrated the fact, which has been hitherto denied by some, that defoliation by Lepidopterous insects may weaken and destroy deciduous trees.

The trees appear to die from the tops. The defoliated limbs apparently suffer from sun-burn or sun-scald, and this condition is closely followed by the attacks of bark borers, *Scolytidæ*, which still further weaken the tree. It is well known that these insects frequently follow the leaf-eaters, and they soon complete the destruction of the tree.

Judging by the foregoing observations, the danger to our forest and park reservations appears to be great. Should the insect be allowed to increase and spread, the great cost of protecting the forest growth would preclude any effort in that direction by the great majority of land owners.

Unless the work of destroying the eggs of the moth in the woodlands of Medford, Saugus and other towns is promptly provided for, much serious injury may be done, especially in the Middlesex Fells reservation, during the coming year.

Methods used in Forest Work.

It is not extremely difficult to exterminate the gypsy moth from shade or fruit trees or from open or cultivated lands. Although the danger of a distribution of the moth to a dis-

tance is not under ordinary circumstances as great in woodland centres, remote from human habitations, as it is where the moths are numerous in cultivated lands or in centres of population, the cost of exterminative work in woodlands is greater and more time is required for extermination. If woodland colonies are not "nipped in the bud," the increase of the moth and its limited distribution go steadily on, even though it be held in check by repressive measures, so that it does not do any appreciable injury. This comparatively slow but sure distribution over a large woodland area greatly increases the ultimate cost of the work of extermination. It is more economical to expend, if necessary, a thousand dollars at once in stamping out a woodland moth colony while it is confined within narrow limits, than to expend a smaller sum and allow the moth to spread (which it will do even if its increase is partially checked), so that an expenditure of thousands of dollars will be required year after year, annually increasing, to merely hold it in check.

Where a small isolated colony is found in the woods, the quickest way to dispose of it is to cut all trees and burn the underbrush and rubbish in the fall or winter. The ground should then be burned over with crude oil once or twice in the spring, about the time the young caterpillars hatch out. Within the past two seasons an experiment of this kind has been tried on a large scale on a wooded hillside, on the estate of Mr. W. H. Winning, in Woburn. The moths appeared in the summer of 1895 in numbers sufficient to strip the foliage from the trees on two tracts of an acre or more each. A careful examination of the surrounding woods showed that the moths had scattered over some fifteen acres in the immediate vicinity. The growth was largely oak and the trees were from forty to sixty feet in height. All the trees and undergrowth on an area of about ten acres were burned and on the rest the wood was cut and marketed. The leaves were raked up and burned in the fall of 1895, and in the spring of 1896 the ground was burned over.

Although the first burning in the spring swept the land so that very little remained except stumps and ashes, a few caterpillars appeared later around the edges of the burned tract and fed for a time on the sprouts which sprang up after

the fire. Here the ground was again burned over and the moth was no doubt exterminated on this tract.

As much of the forest land now infested has been reserved for water or park purposes, it has not been deemed expedient to use this method elsewhere, except in small colonies, or in sproutland where the wood is of little value. Considerable burning, however, has been done in connection with clearing waste land and in destroying the moth in certain situations where other means of destruction are of less avail.

In badly infested localities in the woodlands which are cleared to destroy the eggs, there is usually much débris on the ground in the shape of dead leaves, broken pieces of decayed branches, decayed stumps, bark, etc., on and among which the eggs of the moth have been deposited by the moths themselves, or scattered by other causes. Therefore, even if the eggs on the trees are destroyed, the task is not complete, for in such localities many scattered eggs will remain upon the ground, and, if they are unmolested until hatching time, the young caterpillars will ascend the trees, and injury, which varies according to circumstances, results. If, however, before hatching time the underbrush is cut, piled and burned, the dry leaves and other débris raked together and burned, and if afterward the ground is burned over with oil, most of the scattered eggs will be destroyed. Even then, however, some may escape the burning, and caterpillars will usually be found in the locality another season.

A more successful method is as follows: The eggs upon the trees are treated with creosote or petroleum, and thus destroyed early in the fall. The undergrowth is cut away and the dead limbs burned. The colony is then left for the winter. Just before the caterpillars hatch in the spring, the trees are banded with "Raupenleim" or some other substance which will prevent the caterpillars ascending. As they hatch out they feed on whatever may be available on the ground, and when all the eggs have done hatching, the ground is burned over with the cyclone burner. This has proved the speediest way to exterminate the moth in the woods where the trees are left standing; but examining the trees and burning over the ground are very expensive

methods. Although in open and cultivated lands the destruction of eggs is considered one of the most efficacious and practical methods of dealing with the moth, this is not the case in badly infested woodlands, where, unless fire is also used, all that can be done by egg-killing, even at a great expense, is to partially check the evil. Yet in badly infested localities all the eggs possible must be destroyed to prevent a great increase and dissemination of the caterpillars, for their expansive energy increases in proportion to their numbers.

There are two methods of coping with woodland colonies, which, under certain conditions, have proved more effectual than egg-killing. These are spraying with arsenate of lead, previously mentioned, and banding the trees with burlap. Neither of these methods alone, however, can be depended upon to exterminate, but either will dispose of most of the moths. To secure extermination either of these methods must be supplemented by others, such as egg-killing, cutting, burning, etc., as circumstances may require.

It is well known that in 1891 spraying with Paris green for the gypsy moth proved to be a partial failure, and very little spraying was thereafter done until the discovery and successful use of arsenate of lead. Spraying, however, has its disadvantages, and cannot be used over a large extent of territory with results proportionate to the expense required.

There is only about one month of the year during which the most effective spraying for the gypsy moth can be done. This period is from about the 15th of May, when the larger proportion of the caterpillars have hatched out and the foliage has reached a certain size, to about the 15th of June, when all the caterpillars have appeared, and most of them have reached an age when they will cluster under the burlap. If within this short spraying season there are two or three weeks of rainy weather, very little effective spraying can be done, as the poison will not stay on the leaves unless they are dry when it is sprayed on. Therefore, although spraying may be very effective in certain localities and in certain seasons, it cannot always be depended upon. The short season also makes necessary a great expenditure for spraying apparatus, if the work is to be carried on over a large area. Furthermore, spraying must be done by com-

petent men and carefully watched, and it is difficult to secure, for a month only, a sufficient number of workmen and foremen competent to conduct a great amount of this work.

When the caterpillars begin to cluster, burlapping may be done to advantage and it is certainly very effectual. In order that the burlaps may attract the largest number of caterpillars, it is necessary to at least remove the undergrowth and dead limbs from the ground. This should be done, whatever method is adopted, for the undergrowth facilitates the escape and distribution of the caterpillars. In order to secure extermination in the woodland colonies, the dead branches and loose bark must be removed from certain trees, cavities must be closed, and a careful search for eggs in the fall must follow burlapping or spraying. This search will then be a comparatively light task, for, if the burlaps are put on early and carefully attended, or if the trees have been successfully sprayed, comparatively few moths will be left to deposit eggs. To guard against caterpillars, resulting from possible scattered eggs, the trees must be burlapped the following year.

All these methods may be used in woodland, as circumstances require, and by a proper combination of them the best results may be secured at the least expense. To secure extermination, however, the work must be preceded and supplemented by a thorough and careful search for eggs, pupæ, moths and caterpillars in their season, and it is by this search that the final extermination of the moth in wood colonies has been secured and verified.

Birds which feed on the Gypsy Moth.

During the past few years observations which have been made on our native bird enemies of the gypsy moth have given us a list of birds all of which are more or less useful in destroying the moth in some of its forms. The list of birds observed to feed upon the moth has been increased from year to year, as the moth has appeared in different localities. Wherever the moth swarms, some birds will be found to feed upon it. When it appears in the woods, more

wood birds feed upon it; when it appears in the orchards, orchard birds will be found most useful. In the vicinity of swamps or meadows about lakes or streams some of the birds which frequent these localities are found feeding on it.

Where the moths are unusually numerous, the limited number of birds cannot keep pace with the moths' increase, and therefore can destroy only a small proportion of them; but when the moths are reduced in number by man, the birds are of great assistance in the work of extermination.

Lists of birds found feeding on the gypsy moth have been given in my annual reports from year to year. The list published in the last report is the most complete, and contains the names of thirty-eight birds.*

Beside the species contained in this list, the red-winged black-bird (*Agelaius phœniceus*, Linn.) and several species of sparrows not identified have been seen feeding on the moth. Most of the birds named in the list feed upon the caterpillars. This is rather surprising, and does not agree with the generally accepted theory that birds do not eat hairy caterpillars. Were our birds sufficiently protected, they might become numerous enough to check materially the increase of the moth. Unfortunately, however, the most useful birds are so persecuted that they are few in numbers and consequently of little assistance. In this country no birds have been seen to eat the eggs of the moth, and careful observations and experiments indicate that none of our native birds will destroy them. This must remain a serious drawback to the usefulness of native birds, unless they learn that the eggs are good for food. We also lack the larger species of ground-frequenting birds, the unfledged young of which feed largely on insect larvæ. The prairie chicken, wild turkey and passenger pigeon have long since been exterminated from Massachusetts, and the larger wading birds are not common in the worst infested region. Although there are a few grouse and quail, they are so persecuted by gunners that they are not numerous enough to be of much assistance in destroying the caterpillars, even if they eat them at all. Although the caterpillars are exposed to the attacks of their bird enemies upon the trees, only a few birds, like the tow-

* "The Gypsy Moth," Forbush and Fernald, pages 207-208.

hee, brown thrush and some of the sparrows, seek for the moths on the ground in the woods, where they are enabled to conceal themselves and their eggs among the dead leaves. I would recommend that an attempt be made to protect and foster native birds in the Middlesex Fells reservation, and that careful observations be made of the effect of this policy on the gypsy moth and other injurious insects.

It has been suggested that European birds might be imported to destroy the eggs on the trees as well as the caterpillars upon the ground. I should not advise that this be done, in the present state of our knowledge of the subject. At a session of the Congress of the American Ornithologists' Union, held at Cambridge, Nov. 12, 1896, this suggestion was the subject of discussion. Among the members of the union are the most eminent ornithologists in the country. Dr. J. A. Allen of the American Museum of Natural History, New York, said there was very little accurate information to be obtained on the question of the introduction of birds, for no careful study had been made of the subject. As a matter of opinion, however, he believed it unwise to attempt the importation of birds for the purpose. He thought the importation of the titmice, which are said to eat the eggs of the gypsy moth in Europe, would probably result in failure.

Dr. Elliot Coues of Washington said that experience had demonstrated that the importation of animals from foreign countries had been either costly failures or costly successes. Such animals when introduced had become pests in the new country, and he was strongly opposed to any attempt at introducing birds.

Other members followed in the same strain. It seemed to be the general opinion that either the imported species would die out, or that, if it became numerous enough to be of any assistance, it might become so numerous as to prove a nuisance in some way.

Should any study of the enemies and parasites of the gypsy moth be made abroad, it would be well to investigate there the influence exerted by birds on the increase of the moth, and to observe carefully the habits of such birds as may be found to feed upon the moths' eggs. In this way we

might determine whether the usefulness of foreign birds in this respect has been exaggerated or underestimated, and form some judgment of the desirability of attempting their importation.

A species of Mongolian pheasant (*Phasianus torquatus*) has already been introduced under the auspices of the Fish and Game Commission of Massachusetts, and the chairman of the commission, Hon. E. A. Brackett, has been engaged in propagating them for a year. Many are now at liberty, and have been seen in the infested region. If they winter well, there seems to be little doubt that the introduction will be successful.

Mr. Brackett has observed that the young pheasants destroy the caterpillars of the gypsy moth, and, in fact, all insects within the enclosure in which they are confined. He has offered to place at our disposal a few of the pheasants and to furnish eggs for hatching another year, so that experiments may be made with the birds. This bird was introduced years ago into Oregon, Washington and British Columbia. It is said to do very little harm, and as the young, like the young of most land birds, are said to feed almost entirely on insects, and as the bird is protected by law, it may help to fill the gap among the enemies of injurious insects which has been made by the wanton destruction of our native gallinaceous birds.

The Co-operation of Property Owners.

During the past six years a disposition to co-operate with the agents of the State Board of Agriculture in the work of exterminating the gypsy moth has steadily increased among property owners. In some localities where the moths have done considerable damage in the past, the property owners or residents have assisted by killing caterpillars under the burlaps during the summer months, and some have assisted in other ways. Notable among these are Gen. S. C. Lawrence and Mr. Walter Wright, both of Medford; Messrs. Samuel and Richard Hawkes of Saugus; and Mr. Barthold Schlesinger of Brookline. General Lawrence, who owns a sixty-acre farm and a large tract of woodland near the Middlesex Fells

reservation, has year after year employed men in trimming out the undergrowth in the infested woods and destroying the caterpillars by burning, burlapping and spraying. He has also destroyed a great number of eggs. During the past summer several men in his employ have been engaged on his estate in killing caterpillars under burlaps in infested woodland, and have much reduced the number of caterpillars in these localities. Mr. Walter Wright, whose estate is neither so large nor so much infested as that of General Lawrence, has treated many egg-clusters upon both his home and woodland property, and has burlapped the trees, employing a man in killing caterpillars under the burlap. Mr. Samuel Hawkes, who owns a large tract of infested woodland in Saugus, has spent much time in searching for the gypsy moth in these woodlands, and has cut some tracts of infested trees. He has also given the agents of the Board information which has been of assistance to them in their work. Mr. Schlesinger, who owns a large estate in Brookline, on which a colony of moths was found this year, has directed his gardener and the men under him to assist the agents of the Board in every way possible, and these men destroyed many of the different forms of the moth and assisted in other ways. The gentlemen who have given most assistance, as described above, are owners of large property, and are better able to protect their estates from the ravages of the moth than are most of our farmers and other owners of smaller or less valuable holdings. The poor man who rents or owns a small place has neither time nor means to check the ravages of the moth; and a farmer with an orchard, garden and many acres of woodland would better give up his home at once than spend his substance in fighting the gypsy moth.

Respectfully submitted,

E. H. FORBUSH.

APPENDIX.

Notes on Predaceous Insects which attack the Gypsy Moth.

The following papers on predaceous insects were prepared by my assistants from studies and observations which were made both in the field and in the insectary during the summer of 1896.

C. H. FERNALD.

Notes on the Life History and Habits of Certain Predaceous Heteroptera.

A. H. Kirkland, M.S., Assistant Entomologist to the Committee on the Gypsy Moth, Insects and Birds.

Podisus placidus (Uhl.).

This interesting little Hemipteron, whose predaceous habits were first recorded by Saunders,* has been repeatedly taken during the past year while feeding upon the larvæ and occasionally pupæ of the gypsy moth. In habits and in the appearance of the early stages this insect closely resembles *P. serieventris*, whose life history we have given elsewhere.† During the summer months of the past year specimens of *P. placidus* were taken on a great variety of trees and bushes, their distribution in this respect being governed by the presence or absence of the insects on which they feed. The imagoes of the fall brood hibernate and in this region make their appearance about the middle of May. At this time the males considerably outnumber the females. In common with *P. serieventris* this species is a formidable enemy of the tent caterpillar (*Clisiocampa americana*), and this latter insect generally furnishes the first food supply of the season for these bugs. *P. placidus* shows a greater proclivity for entering the webs of the tent caterpillar than does *P. serieventris*, possibly because the shape of its body renders it better able to force an entrance into the web, since the humeral processes do not project to such a degree as in the latter species.

A fortnight or more is spent in feeding before the eggs are laid, although the sexes are frequently found in coitu soon after emerging from hibernation. Egg-laying takes

* Can. Ent., Vol. 2, pp. 15-95. Report Entomological Society, Ontario, 1871, p. 31.
† "The Gypsy Moth," Forbush and Fernald, 1896, p. 395.

place in from three to ten days after pairing, depending upon the temperature, warm weather hastening and cold weather retarding this process. Each female deposits from two to four egg-clusters at intervals ranging from a few hours to three days.

The Egg. — The general appearance of the egg (Plate 1, Fig. 1) so closely resembles that of *P. serieventris*, both in size and markings, that the separation of the species in this stage is extremely difficult. The eggs are deposited in clusters composed of a single layer. From ten to thirty-five eggs are placed in a cluster, each egg resting on its smaller end, and connected with the adjacent eggs by means of a varnish-like cement. The form of the egg is nearly ellipsoidal, slightly tapering toward the lower end, but not as caldron-shaped as in *P. serieventris*. Length, 1 mm.; width, .8 mm. Top slightly flattened, and surrounded by a row of ten or twelve capitate spines, arranged around the margin of a circular cap. The surface of the egg is covered with minute spiny projections, not abundant at the lower end of the egg. When first laid the eggs have a pearly white color which soon changes to a deep bronze. The period of incubation extends over eight or ten days, according to the temperature. The circular cap at the top of the egg is pushed off by the young bug at the time of hatching, but usually remains attached at one point.

First Stage. — The newly hatched bug (Plate 1, Fig. 2) is 1.7 mm. in length. Form ovate. Head and thorax dark seal brown, abdomen vermilion. The head is much wider than long, closely appressed to the prothorax, and bears large compound eyes, which, from their relative size, are quite conspicuous. Antennæ four jointed, basal joint stout, nearly concealed beneath the margin of the head. Second joint cylindrical, three times as long as basal joint; third joint cylindrical, three-fourths as long as second joint; fourth joint one-half longer than second joint and considerably dilated; all the joints bear scattering hairs. The terminal joint is seal brown in color, the other joints being copper colored.

The thorax is dark brown with a faint median sulcus. The posterior margin of the meta-thorax is tinged with red. Immediately behind the posterior angles of the thorax, on each side, is a small dark-brown wedge-shaped spot, arising from the outer margin of the abdomen. Following this spot and extending on either side to the anus there is a border of semi-elliptical spots of similar color, one spot on each segment. At the anus there are three small markings of the same color. On some specimens, bordering the interior margins of the dark-brown spots, there is a faint undulating white line extending around the abdomen. On the dorsum of the abdomen, about equi-distant from each other and the posterior margins, are two transverse copper-colored spots. Between the anterior of these spots and the thorax there are two narrow transverse markings of similar color. Under surface of the abdomen reddish brown; legs of similar color, but somewhat darker. Tarsi two jointed. Beak extending to hind coxæ, of same color as legs. In this stage these insects are in general phyllophagous. The first molt takes place in about seven or eight days.

Second Stage. — (Plate 1, Fig. 3.) Length, 3 mm. General form same as in preceding stage, except that the head is quadrate and the abdomen larger in proportion to the size of the head and thorax. These latter are pitchy black in this stage. With the exception of the terminal joint, which is shorter, much darker and less dilated, the joints of the antennæ retain their relative length.

The abdomen is dark red. Marginal spots black and bordered on the inner margin with white. Behind the thorax on the dorsum of the abdomen are two large transverse dark-brown spots, which in some specimens are nearly fused together. Posterior to these spots are two smaller transverse markings of similar color. Under surface of head and thorax dark brown. Legs and beak of the same color. Abdomen same color as upper surface. In this stage the insect develops predaceous habits. The second molt takes place in about twelve days.

Third Stage. — (Plate 1, Fig. 4.) Length, 5 mm. General form of body as in preceding stage, but the head

is not quite as large in proportion to the rest of the body. Head black, eyes quite prominent. Antennæ black, basal joint stout, projecting about one-third of its length beyond the margin of the head. Second joint four times as long as basal joint, cylindrical, slightly dilated at the outer end. Third and fourth joints about two-thirds as long as second joint. Fourth joint slightly dilated, but not as much as in the preceding stage.

Thorax entirely black, margined by a distinct white or cream-white line. The color of the thorax and the white margin distinguishes the insect in this stage from the corresponding stage of *P. serieventris*. Abdomen of same color and with similar markings as in preceding stage, except that of the four dorsal spots the two middle ones are the largest, the anterior and posterior spots being narrowed transversely. Colors of under surface and legs as in preceding stage. In this stage, as well as those which follow, the insect is almost entirely predaceous.

Fourth Stage. — (Plate 1, Fig. 5.) Length, 7 mm. Head, thorax, wing-pads and scutellum intense pitchy black. Joints of antennæ as in third stage; basal and second joints seal brown, third and fourth joints black. Thorax margined with white, as in preceding stage. Both the marginal and dorsal spots of the abdomen are closely appressed. Across the dark-red ground color of the abdomen fine white transverse lines connect the lateral and dorsal spots. The same variation in color observed in *P. serieventris* also occurs here, and in some specimens the white lines predominate to such an extent as to give the abdomen a light striped appearance. Under surface of body yellowish brown. On the median line near the end of the abdomen are three small, somewhat circular black spots. Femora straw colored, marked longitudinally with brown; tibiæ of same color at junction with femora, shading downward to a dark seal brown. Tarsi dark brown varying to black.

In this stage the insects feed voraciously. The fourth and last molt, in specimens under observation, took place in about twenty-two days from the preceding molt, but I

think under natural conditions the period spent in this stage would be somewhat shorter.

I have been unable to find in the literature at my disposal any description of the imago of this species, and it seems doubtful if such a description has been heretofore published. At my request Prof. P. R. Uhler has kindly prepared, for publication in this connection, the following characterization of the species : —

Podisus placidus Uhler. — (Plate 1, Fig. 6.) "Of a narrower and more oval form than *P. serieventris*, with a head somewhat tapering anteriorly, and rounded at tip instead of being truncated, and with the humeral angles rounded off and very moderately prominent. Color pale testaceous, stained with pale brown and punctate with darker brown. Head much longer than wide, depressed, remotely punctate, the edge reflexed, brown; each side of tylus is a slender brown line which is triangularly expanded on the base of the vertex; occipital margin dark brown in the middle, pale and narrowly callous each side; a pale callous line extends back from each ocellus; throat whitish testaceous; cheeks with a slender black line before each eye; eyes brown, bordered with testaceous behind; antennæ pale brown, paler at base and on the two last joints; the basal joint testaceous, very short, the second longest, third scarcely more than half the length of the second, fourth about three-fourths as long as the second, fifth a little shorter than the fourth; rostrum stout, pale testaceous, reaching upon the posterior coxæ, the apical joint narrow, about as long as the preceding one, brown. Pronotum with the sides straighter than usual, the lateral margin narrowly callous, pale ivory yellow, and with a few indented points and small teeth before the middle; the submargin with a brown line, surface with wavy, transverse pale lines between the pale brown marbling, more generally brown behind the middle; posthumeral margins slightly sinuated; anterior margin callous, having a small group of coarse punctures behind each eye; punctures sunken, brown, mostly not close together in the transverse series; posterior margin truncate. Scutellum long, bluntly rounded and margined with white at tip, punctures in short transverse series, grouped in about three spots at base. Corium slenderly bordered with pale testaceous, more broadly covered with brown at base and on the disk, the veins posteriorly yellow; membrane pale bronze. Legs minutely speckled with red, the tibiæ and tarsi a little stained with brown. Under side finely punctate, the sternum with two series

of black points. Connexivum depressed, punctate, the outer edge ivory white, callous and marked with two black points at each incisure of the segments; the upper surface yellow, with the black points more linear. Length to end of abdomen, 8½ to 10½ mm. Width of pronotum, 4⅔ to 6 mm.

"Through the kindness of many friends, I have had the opportunity to examine specimens from the provinces of Quebec, Ontario and Columbia, in British America, from nearly all of the New England States, besides Illinois, Iowa, Michigan and Colorado. The genital segment of the male is deeply excavated, and with two short processes on the middle. The tergum is often bright red, which color becomes brownish in more mature specimens. The humeral angle is usually more or less black. In some specimens there is a series of minute black dots each side of the venter, and a few obscure spots distributed over the ventral surface."

There are undoubtedly two annual broods of the insect in this locality, and it seems probable that in especially favorable seasons there may be three broods.

The nymphs and imagoes of this species fraternize with those of *P. serieventris*, although this appears to be wholly accidental, and depending upon food supply. I have found *P. placidus* feeding upon the larvæ of *Euvanessa antiopa*, *Hyphantria cunea*, *Orgyia leucostigma*, *O. definita*, *Clisiocampa americana* (previously mentioned), *C. disstria* and a small, undetermined saw-fly larva common on oaks.

One must note with regret that this decidedly beneficial little insect, which destroys so many injurious species, is preyed upon by two spiders which are common occupants of tent caterpillar webs, *Epeira strix* Hentz and *Phidippus multiformis* Em.*

Dendrocoris humeralis† (Uhl.) (Plate 2, Fig. 8).

This small Pentatomid was originally described by Prof. P. R. Uhler (Bulletin United States Geological Survey, Art. XIV., page 399) under the genus *Liotropis*. According to Montandon, this generic name is preoccupied (Uhler in litt.), and the insect should be placed in the genus *Dendrocoris*. The specimens from which the original

* These spiders were kindly identified by Mr. J. H. Emerton.

† Identified by Prof. P. R. Uhler.

description was prepared were taken in Massachusetts, New Jersey, Maryland and Colorado, and from its wide distribution and occurrence on many plants the opinion was expressed that the species was predaceous in habits. That such is the case our observations of the past two years afford ample evidence. We have repeatedly found this diminutive Hemipteron engaged in destroying tent caterpillars, and on several occasions have taken it in the act of feeding upon gypsy moth larvæ.

While as yet we have been unable to rear this species through its transformations, the dates of our captures of nymphs and imagoes lead us to the opinion that the insect is double-brooded, and doubtless hibernates in the imago state.

Description of Full-grown Nymph. — (Plate 2, Fig. 7.) Length, 5 to 6 mm. Body broad, very compact. Head somewhat sunken in prothorax, deeply cleft in front, thickly dotted with reddish brown and margined with black. A very short and very blunt spine projects laterally in front of either eye. Eyes dark brown, bordered posteriorly with sordid yellow. Prothorax thickly punctured with dark brown except at lateral margins, which are of a pale yellow color. At the humeral angles the dots are aggregated into a dark brown or black spot. Scutellum and wing-pads of the same color as prothorax, except that the outer anterior part of each wing-pad is marked with reddish yellow. Abdomen pale yellow, heavily dotted with vermilion. On the lateral margins of each abdominal segment there is a semi-elliptical black spot, which is divided by a narrow yellow band extending parallel to the margin. On the dorsum are five transverse black spots, each of the three anterior being divided transversely by a yellow line. The spot immediately behind the scutellum is quite narrow; the second and third spots are large and prominent; the fourth and fifth scarcely more than short transverse black lines.

Under surface of head and thorax amber yellow, heavily bordered with black. There is a small white spot at the base of each antenna. Abdomen of the same general color as upper surface. Antennæ dark brown throughout; first

joint stout, scarcely reaching the margin of the head; second joint over three times as long as basal joint; third and fourth joints each about one-half as long as second joint. Legs pale amber, darkening to brown on tibiæ; tarsi dark brown.

This species is widely distributed throughout the region infested by the gypsy moth, but does not occur in such numbers as do its allies in the genus *Podisus*. I have taken specimens in Medford, Malden, Saugus and Revere, while Professor Uhler records it from Andover, Lynn and Charlestown.

Euschistus politus Uhl. (Plate 2, Fig. 12).

A rare member of our heteropterous fauna is a small *Euschistus*, which, previous to the past summer, had been occasionally taken under such circumstances as to give the impression that it possesses predatory habits. Specimens of the insect submitted to Prof. P. R. Uhler were considered by him to be new to science, and at my request he has very kindly prepared the following description: —

Euschistus politus. New sp. — "Pale dull fulvous, or rufo-fulvous, suboval, with the humeral angles almost rounded and very moderately prominent. Head narrow, as in *E. tristigmus* Say, deeply and finely punctate, the tylus prominent at tip and a little longer than the lateral lobes, the lateral lobes deeply sinuated, with the outer margin blackish. A black line extends from the eye to base of antennæ; antennæ (Plate 2, Fig. 13) clay yellowish; the basal joint short, hardly reaching the apex of head, marked with a few black points; second joint longer; third a little longer than the second; fourth longer, dusky at tip; fifth a little longer than the fourth, fusiform, blackish excepting at base; rostrum pale testaceous, slender, with the setæ piceous, reaching to the posterior coxæ. Pronotum much wider than long, polished, closely and finely punctate with brown; the lateral margins very slightly sinuated, smooth, ivory white; the submargins blackish; humeral angles triangularly rounded; posthumeral margins almost straight. An obsolete, callous, imperfect curved line extends between the humeral angles. Scutellum narrow and bluntly rounded at tip, where it is also slenderly margined with white; the surface is less densely punctate in small spots. Wing-covers (Plate 2, Fig. 14) closely punctate; membrane a little brownish,

the veins and numerous dots darker brown. Legs pale yellow, remotely dotted with brown. Beneath pale greenish, finely punctate, highly polished, the pleuræ with a row of fine black dots, and an extra dot outwardly; connexivum acute, the intersegmental sutures indented and marked with a black dot. Tergum black, the sutures, exteriorly, with a double black spot. Length to end of abdomen, 9 to 10 mm. Width of pronotum, 5½ to 6 mm. A pair of these insects taken in Massachusetts have been kindly given to me by Mr. A. H. Kirkland. Other specimens have been sent to me for examination from Rhode Island, Pennsylvania and the District of Columbia. I have found it once, July 4, in a sandy pine woods district in southern Maryland. Only a few specimens have thus far been reported. It seems to be of rather uncommon occurrence."

A female of this species, confined in a small breeding cage with larvæ of *Porthetria dispar* (L.) and a number of oak leaves, deposited a cluster of thirteen eggs upon the under side of a leaf, June 21, 1896. The eggs were placed in a single layer. Very unfortunately they proved unfertile, so that I was disappointed in my anticipation of being able to carry the species through its early stages. The egg (Plate 2, Fig. 11) may be described as follows: —

Color, pearly white. Length, 1 mm.; width, .8 mm. Form, nearly cylindrical, the upper and lower ends being abruptly flattened. Around the cap at the upper end of the egg is a row of delicate, elongated, club-shaped spines. The surface of the egg is covered with small single blunt spines, between which are numerous similar spines of microscopic dimensions.

During the past summer I have been able to establish the fact that this species is predaceous upon the larvæ of the gypsy moth, thus making an addition to the list of the natural enemies of this insect. As an enemy of the gypsy moth it is of only minor importance, and from the slender structure of the beak I am led to believe that the insect is more of a plant feeder than an insect destroyer.

Diplodus luridus * (Stål).

The members of the group of insects to which this species belongs possess such marked predaceous habits that they have received the very appropriate name of "assassin bugs." The species under consideration is one of the most rapacious of our predaceous bugs, and, while occurring in but limited numbers, its great activity and almost abnormal appetite render it a formidable enemy to several forms of insect life.

On May 12, 1896, I took a nearly full-grown nymph in the act of feeding upon a partly grown tent caterpillar. An inspection of the tree in the vicinity of the web showed several other nymphs engaged in the work of destroying the caterpillars. The nymphs did not enter the webs of this caterpillar, as do some of our predaceous Pentatomids, but devoted their attentions to such larvæ as were more or less isolated and at some distance from the web. One of these nymphs was reared upon tent caterpillars until May 18, when it assumed the mature form.

Later in the season several imagoes of this species were found attacking gypsy moth larvæ, as well as those of *Clisiocampa americana*. From a female confined in a breeding cage with a male imago from June 5 to 10 I obtained June 12 a cluster of thirty-four eggs, which were laid in a compact mass (Plate 2, Fig. 1) shaped like the frustum of a cone.† The eggs were closely cemented together and to the surface on which they were deposited, and could only be separated with difficulty. The eggs (Plate 2, Fig. 2) may be described as follows: —

Length, 1.9 mm.; width at base, .4 mm.; at top, .3 mm.; somewhat curved, widest and rounded at the base, truncate at the top. The eggs forming the outer layer are of a burnt sienna color, those on the inside being of a pale amber. The upper end of the eggs is of a pale yellowish color, and bears immediately within the circumference a

* For the identification of the species I am indebted to the kindness of Prof. P. R. Uhler.

† Mr. Robert A. Cooley, assistant entomologist, Massachusetts Hatch Experiment Station, informs me that he has found the eggs of this insect attached to the under surface of leaves of *Ostrya virginica* and *Betula lenta*.

narrow, circular, dark-brown band, while at the centre there is a small dark-brown dot. The areas covered by the circle and dot are depressed. Embryonic development was apparent June 22, and on June 29 the eggs hatched.

First Stage. — (Plate 2, Fig. 3.) The newly hatched bug, with legs and antennæ much longer than the body, presents indeed a most unique appearance. In this stage the nymph feeds readily on aphids, and does not hesitate to attack insects considerably larger than itself. Length of body, 2 mm.; of antennæ, 4 mm.; general color pale amber, darkening after the insect has taken food. Head large in proportion to the rest of the body, projecting between the antennæ. A transverse groove crosses the head behind the dark-red eyes. Beak reaching to the anterior coxæ. Basal joint of the filiform antennæ as long as the three outer joints. These latter are of nearly equal length. Thorax somewhat longer than either head or abdomen, with lateral projections on each segment. Legs long and very slender. Abdomen compact, sparsely hairy, with well-defined segmentation.

The young bugs were reared on aphids found on *Corydalis glauca* and *Hammamelis virginana*. On July 3 nearly all had passed the first molt.

Second Stage. — Length, 2.6 mm. General color darker than in preceding stage. Form similar, but abdomen much longer in proportion to the rest of the body than in first stage. Most unfortunately all the nymphs died soon after passing the first molt. In this stage the nymphs first showed the habit so common to the imago, of raising the fore legs above the head upon the slightest disturbance. The insects were apparently able to walk as well with but four legs as with six.

Full-grown Nymph: Fourth (?) Stage. — (Plate 2, Fig. 4.) Length, 11 mm. Body slender, elongated; color light green, faintly marked with brown. Head narrow, widest at the eyes, the latter being of a brick-red color. Behind the eyes the head is shaded with reddish brown. Thorax

short, with well-developed scutellum. Wing-pads extending about one-third the length of abdomen. Abdomen widened at the middle with lateral flanges developing with the approach of maturity. Near the posterior margins of the dorsum of each abdominal segment there is a faint reddish-brown spot, from which a light line extends forward on either side to the anterior margin, then bends at an acute angle and runs backward to the posterior angles of the segment. Antennæ filiform. Legs slender, anterior pair the stoutest; tarsi brown; claws dark brown.

Imago. — This species, along with a number of Mexican Hemiptera, was originally described by Stål in 1862 (Stettiner Entomologische Zeitung, 23 jahrgang, page 452) as *Zelus luridus*, from Carolinian examples. Uhler, in his check list of the Hemiptera Heteroptera of North America (1886), places the species in the genus *Diplodus*, as established by Amyot and Serville in their "Hemipteres" (1843), page 370. Lethierry and Severin, in their "Catalogue general des Hemipteres" (1896), have replaced the species in the genus *Zelus*. The sexual dimorphism existing in this species is worthy of note; unless otherwise informed, one might readily believe that the sexes of this insect represent different species.

Male. — (Plate 2, Fig. 5.) Length, 13 mm. Body nearly linear, dark brown, varying to black on the upper surface. Head narrow, elongated, and projecting to a blunt point between the bases of the filiform antennæ. First joint of the antennæ dilated at base, slender, and of about the same length as that of the head and thorax taken together; second joint one-third as long as first; third joint over two-thirds as long as first; fourth joint about the same length as second. Eyes prominent, dark reddish brown; ocelli large, in rear of the eyes on slight prominences of the head, which is widened at this place. Base of head smooth and shining. Prothorax dark brown, varying to black, rounded posteriorly and with a very small blunt black spine at the posterior angles. Two semi-lunar depressions extend inward from indentations in the sides of

the prothorax and meet at the dorsal line, whence a similar depression leads forward to the anterior margin. The areas thus included are slightly raised. Scutellum dark brown or black, tipped with pale yellow. Wings dark brown.

Under side of head and thorax and tip of abdomen pale sulphur yellow. Remainder of abdomen sordid yellow, darkest anteriorly. Beak yellow, brown at tip, reaching nearly to anterior coxæ. Legs slender; coxæ of same color as thorax; femora of same color at base, darkening outwardly. A narrow dark-brown band encircles the femora near their junction with the tibiæ. Tibiæ and tarsi dark brown.

Female. — (Plate 2, Fig. 6.) Length, 15 mm. Body much lighter and stouter than the male. Head pale brown in front of the eyes, but darker posteriorly. Thorax, scutellum and wings light yellowish brown. Posterior thoracic angles acute, tipped with a stout black spine. Under surface as in male. Antennæ pale brown, darker at joints. Legs pale brown; femora without bands; tarsi dark brown.

Notes on Certain Coleoptera known to attack the Gypsy Moth.*

A. F. Burgess, B.S.

Among the natural insect enemies of the gypsy moth in this country, next to certain Hemiptera, the predaceous Coleoptera should undoubtedly be given a place; and, although the latter species are not as beneficial as the Hymenopterous and Dipterous parasites in controlling some of our common injurious insects, their work with reference to the gypsy moth seems to warrant their occupying this prominent position. The most important of the beetles known to attack the gypsy moth are members of the family Carabidæ belonging to the genera *Calosoma* and *Harpalus*, and, on account of their voracity, size and rapid movements, have long been recognized as formidable enemies to Lepidopterous larvæ. They grasp their prey with the sharp mandibles, the favorite place being along some of the dorsal segments, and, after tearing away the integument, suck up the internal contents. As a rule they do not seem to show any particular preference as to their food, since almost all our injurious caterpillars, cut-worms, etc., are attacked by them to a greater or less extent, as is abundantly shown by reports on beneficial insects.

Another factor which makes the work of these beetles especially important is the predaceous habits of their larvæ, which have been known to feed on both the eggs and the young caterpillars of the gypsy moth. Previous to 1896 the following beetles had been found attacking the gypsy moth larvæ in the field: —

* The studies forming the basis of this paper were made at the experiment station and insectary of the gypsy moth committee during the summer of 1896. The description of the different stages and the drawings illustrating the same were completed at the entomological laboratory of the Massachusetts Agricultural College, under the direction of Prof. C. H. Fernald, entomologist to the committee.

Calosoma scrutator (Fab.), *Calosoma frigidum* Kirby, *Calosoma calidum* (Fab.), *Harpalus caliginosus* Say., *Harpalus pennsylvanicus* (DeG.), *Cicindela 6-guttata* Fab.* The larvæ of two species of *Harpalus* have been reported by Mr. C. H. Rowe as feeding on young gypsy moth caterpillars. *Platynus limbatus* (Say.) has been found feeding on the pupæ in the field, *Dermestes lardarius* Linn., reared from pupæ, and *Ptinus brunneus* Duft., reared from the egg-clusters. Several undetermined beetle larvæ have also been found feeding on the eggs.†

No new species have been found this year attacking the gypsy moth, but the life histories and habits of some of the more important of these beneficial insects have been investigated, with a view to obtaining a more accurate knowledge of the conditions favorable to their multiplication. The following pages contain the points of interest learned concerning these beetles, together with notes on the life histories of *Calosoma frigidum* and *C. calidum*.

Distribution. — The species of *Calosoma* and *Harpalus* above mentioned are as a rule quite generally distributed throughout the infested district, although they occur chiefly in sections to which, by reason of their peculiar habits, they are particularly adapted. Of these species, *Calosoma scrutator* is the least common, no doubt, for the reason that its large size, brilliant color and clumsy movements render it more susceptible to the attacks of its various enemies. Its occurrence is limited chiefly to wood and brush land. I am informed that the *Calosomas*, especially *scrutator* and *calidum*, are very abundant in brushland near the salt water at Belmont, N. J., so much so that it is very common for visitors to catch the brilliantly colored *scrutator* and wear it as an ornament. The occurrence of this species, in eastern Massachusetts at least, is more limited, and it is considered by many local collectors as a very rare beetle.

Calosoma frigidum is much more common, and is found in orchards where the grass has not been cut, in wood and

* Reported by Mr. Samuel Henshaw, Bulletin No. 26, U. S. Dept. Agri. Div. Ent., page 75.

† "The Gypsy Moth," Forbush and Fernald, pages 381 and 385.

brush land; and I have taken specimens in the early summer (June 4) on the trunks of the large street elms in the city of Medford. Seven specimens of this insect were also taken by Mr. C. E. Bailey and myself in a small orchard in the same city. These latter were running about at the roots of the tall grass at some little distance from the trees. Judging from the experience this season, it would seem that, although this species is much more abundant than *scrutator*, its distribution is local rather than general, as is the case with *calidum*. The latter, popularly known as the fiery caterpillar hunter, is the most common species, and is very frequently found in thickly populated sections.

The two species of *Harpalus* are common in cultivated land, and are often found under stones or rubbish in pastures and to a more limited extent in woodland. The members of the group Carabidæ occur in localities where there is either natural or artificial protection. This is especially noticeable in wooded areas, where there is good forest cover and a moderate amount of moisture. A stone wall often furnishes them an excellent place of shelter, and it is not uncommon to find them when tearing down walls in the early spring.

One very significant fact has been noted this year, viz., that in localities where the beetles had been very common in previous years, no traces of any could be found even after careful search. This may perhaps be explained by the fact that the brush and rubbish which had served for their hiding places had been cleared up by the employees of the department, causing them to migrate to more suitable quarters.

Habits of the Beetles. — Many observations tend to show that the members of the genus *Calosoma* are nocturnal as well as diurnal in their habits. While sugaring for moths at Amherst in June, 1893, I took two specimens of *Calosoma calidum*. They were very active, and had climbed up one of the trees to the sugar band, a distance of five feet. Mr. A. H. Kirkland has also taken a specimen of this same species at Amherst, running about at 10 P.M., apparently in search of food. The stomachs of several toads which were

captured late in the evening, upon examination by Mr. Kirkland were found to contain specimens of *Calosoma calidum* intact, they having undoubtedly been swallowed only a short time previous. *Calosoma frigidum* observed in confinement has been found to feed at night as well as during the day. These facts show that the members of this genus under observation accomplish a great amount of good by their nightly raids against injurious insects.

Bearing in mind the fact that the gypsy moth caterpillars feed at night and seek shelter during the day, and that these beetles are active, climbing the trees at night, and are also busy searching out food in sheltered places during the day, we are led to believe that they are most valuable allies. The feeding habits of the different species vary somewhat, although all have been taken on the trunks of trees and under burlaps during the day. As a rule the number of gypsy moth larvæ killed on the trees depends upon the size and agility of the beetles. In point of efficiency they rank in the following order: *frigidum*, *calidum* and *scrutator; frigidum* is most skilful in this respect, and has been observed not only to feed on a vertical surface but to support itself and feed on the under side of a horizontal branch. A rise in temperature seems to stimulate their activity and the desire for food. Specimens of *Calosoma frigidum* observed in confinement during very hot weather were more active, ate more and laid a greater number of eggs than when the weather was cooler. When the temperature fell still lower they sought the ground, ate very little and seldom laid eggs. As far as observed, the members of this group depend entirely on their well-developed legs as a means of locomotion, although both sexes of *frigidum* have been observed to vibrate their hind wings in confinement, but when thrown in the air they do not make the slightest effort to fly.

Specimens of *C. frigidum* while confined in cages have been fed, in addition to the gypsy moth larvæ, pupæ and imagoes, the following caterpillars, which they ate freely: —

Euvanessa antiopa, *Grapta progne* (?), *Protoparce celeus*, *Hyphantria cunea*, *Euchætes egle*, *Halesidota caryæ*, *H. maculata*, *Orgyia definita* (pupa also), *O. leucostigma*

(pupa also), *Datana ministra*, *D. major*, *D. integerrima*, *Œdemasia concinna*, *Attacus promethea*, *A. cecropia*, *Clisiocampa americana*, *C. disstria*, *Acronycta* sp., *Rhynchagrotis alternata*, *Noctua c-nigrum*, *Leucania unipuncta*, *Pyrophila pyramidoides*, and *Catocala* sp.

Method of rearing Predaceous Coleoptera. — From the fact that the adult beetles not only spend part of their time in the ground, but that the eggs are laid in the soil and the young grubs are beneath the surface the greater part of their existence, accurate observations on the early stages are rendered quite difficult.

As a preliminary to the study of the early stages and habits of these insects, the limited literature upon the subject was carefully sought out and examined, although but little assistance was thus obtained; and active operations were commenced in the spring of 1896, as soon as living imagoes became available.

In order to compare results, the work was begun along two lines, both with a view to approaching as nearly as possible to natural conditions. One set of observations was made on beetles in breeding cages, out of doors, while the other set was made on a limited number of beetles confined in small glass jars, where they could be more closely watched.

For the first purpose, use was made of the cages devised by Mr. Kirkland in 1895, for studying the feeding habits of the imagoes. These were attached to trees near the insectary. They were made of wire netting, bent into a nearly cylindrical form. The edges were fastened to the two sides of the tree trunk, the lower end extending down into the ground and the upper end covered by a piece of cloth, one side of which was secured to the tree, the other covering the top of the wire screen cage and held in place by a rubber strap, the ends of which were fastened to the trunk of the tree.*

In one of these cages two males of *C. frigidum* were placed June 6, but at the end of ten days both had died. The beetles of the same species which were placed in the

* "The Gypsy Moth," Forbush and Fernald, page 384.

other cages escaped in some unknown way, and, as the chance of finding the eggs in such cages was very small, further attempts along this line were abandoned.

For the other line of investigation, common jelly tumblers, containing about two inches of earth, were used, the tops of the jars being covered with pieces of muslin which were held in place by rubber bands. A pair of beetles were placed in each jar, with gypsy moth larvæ for food and with fresh leaves to serve as food for the larvæ. At first the jars were kept in the insectary, but when the weather became excessively hot it was thought best to place them out of doors, and a large box with a screen cover was selected for the purpose. The jars were examined daily, and when eggs were found in the earth the beetles were changed to other jars, those formerly occupied not being disturbed until the eggs hatched, when the earth was examined and the number of young larvæ carefully noted. Great care had to be exercised in not allowing the grubs to remain together too long, as under these conditions they soon develop cannibal tendencies, and readily devour each other.

During the extremely warm weather, about the middle of July, many of the grubs which had heretofore seemed healthy began rapidly to sicken and die. Thinking that perhaps more natural conditions could be obtained, I made a cage consisting of a box twenty-four inches long and five inches square, the lower end being covered with a wire screen. The box was sunk in the ground and nearly covered with soil, the top being covered with muslin held in place by an elastic band. Although great care was taken to feed and watch the grubs, at the end of eight days all had died. Later more young grubs were placed in the cages, but the results were very unsatisfactory. On account of these discouraging results, careful attention was given to the insects confined in the jars. Later in the season a number of eggs of *C. frigidum* and *C. calidum* were thus obtained, and, upon hatching, the young larvæ were isolated. A part of these larvæ remained healthy, and with great care I was able to rear a few through their successive stages.

Life History of Calosoma frigidum Kirby.

Oviposition. — The eggs are laid at intervals of a few days from early June until about the first of September, the length of this period depending somewhat on the weather. Soon after pairing, which takes from one to two and one-half minutes, the female beetle seeks the ground. The eggs are deposited from one-eighth to two inches below the surface, and are often laid at night. They are dropped separately, without any regularity of arrangement. The greatest number of eggs deposited by a single female in twenty-four hours was seventeen.

The following table shows the record of the pairing and egg-laying of nine female imagoes of *C. frigidum*. The jars in which the beetles were confined were examined daily, but the days when no eggs were found have been omitted from the table. The figures indicate the number of eggs found; the sign "×" indicates that the beetles were observed to copulate; the "?" indicates that a greater number of eggs than are here recorded were doubtless originally deposited in the jar, but that upon hatching a part of the young grubs were probably consumed by the older larvæ. The figures in these cases give the number of larvæ actually found in the jars at the time of examination.

DATE.	No. 2.	No. 3.	No. 5.	No. 6.*	No. 7.†	No. 8.‡	No. 9.	No. 10.§	No. 11.‖
June 4, . .	×	×	-	-	-	-	-	-	-
5, . .	17	1	-	-	-	-	-	-	-
6, . .	-	1	6	14	-	-	-	-	-
7, . .	-	-	4	2	-	-	-	-	-
8, . .	-	×1	-	-	-	-	-	-	-
9, . .	-	-	-	8	-	-	-	-	-
10, . .	-	-	×	-	-	-	-	-	-
11, . .	-	1	-	-	-	-	-	-	-
12, . .	-	-	-	12	-	-	-	-	-

* Laid well while the weather was hot and food plenty.
† No eggs laid after male died.
‡ Although seven weeks together no eggs were laid.
§ No eggs laid until male was received.
‖ Male feeble when put in.

DATE.	No. 2.	No. 3.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.
June 17, . .	–	–	×	–	Put in June 19.	Put in June 19.	–	–	–
21, . .	–	–	×	–	–	–	–	–	–
26, . .	–	–	1	–	–	–	Put in June 26.	Put in June 27.	Put in June 27.
July 11, . .	–	Female died.	–	–	–	–	–	Male receiv'd from No. 3.	–
13, . .	–	–	Male died.	14	–	–	–	2	–
14, . .	–	–	–	5	×	–	–	9	–
15, . .	–	–	–	–	–	–	–	7	–
16, . .	–	–	–	4	2	–	–	–	–
17, . .	–	–	–	2	–	–	–	–	–
18, . .	–	–	–	–	1	–	–	–	–
20, . .	–	–	–	5	–	–	–	–	–
21, . .	–	–	–	2×	–	–	–	–	–
22, . .	–	–	–	6	Male died.	–	–	–	–
23, . .	–	–	–	×	–	–	–	–	–
24, . .	–	–	–	10×	–	–	–	–	–
26, . .	–	–	–	12	–	–	–	–	–
27, . .	–	–	–	6×	–	–	–	4	–
28, . .	–	–	–	6	–	–	–	–	–
29, . .	–	–	Female died.	–	–	–	–	–	–
31, . .	–	–	–	11	–	–	–	–	–
Aug. 1, . .	–	–	–	13	–	–	–	–	–
4, . .	–	–	–	2?	–	–	–	–	–
5, . .	–	–	–	4?	–	–	–	–	–
6, . .	–	–	–	10?×	–	–	–	–	–
7, . .	–	–	–	10	–	Female died.	Male receiv'd from No. 8.	–	Male put in.
8, . .	–	–	–	7?	–	–	–	–	–
10, . .	–	–	–	9	–	–	–	–	Male died.
11, . .	–	–	–	2	–	–	–	–	–
13, . .	–	–	–	8	–	–	–	–	–
15, . .	–	–	–	–	–	–	–	1	–
19, . .	–	–	–	2	–	–	–	–	–
	17	4	11	186	3	–	–	23	–

As will be seen by the table, the beetles show a great difference as regards the number of eggs laid; but the fact is also noticeable that no eggs were deposited by any female which had not paired. There were very few cases where the eggs failed to hatch, and these I think were due to the injuries the eggs may have received while removing the beetles from the jars. Probably the number laid by female No. 6 is the nearest typical, though doubtless under favorable natural conditions the number would be materially increased.

The Egg. — (Plate 3, Fig. 1.) The eggs are somewhat elliptical in form, but slightly larger at one end. Although subject to variation, they measure 4 mm. in length and 1.9 mm. in diameter, and are of a light straw-yellow color. With a lens or low power of the microscope the surface of the egg looks perfectly smooth, but if the contents are removed and the shell placed under a high power it is found to be very finely reticulated. These markings (Fig. 2) are pentangular in form, and may be readily observed on shells mounted in glycerine jelly. Sometimes the eggs change their form and become slightly kidney-shaped before hatching. The color, however, does not change. The time spent in this stage is from four to ten days.

First Larval Stage. — (Plate 3, Fig. 3.) At the time of hatching the young larva is of the same color as the egg, but gradually grows darker, until in about ten hours it is of a deep shining brown. After remaining in the cavity occupied by the egg for about twenty-four hours, the larva comes to the surface of the ground in search of food. At this time the length is 8 mm., including the caudal appendages, which measure 1 mm.; the width at the middle of the first thoracic segment is 1.7 mm., from which point the body tapers gradually to the last segment. The head is large in proportion to the body, longer than wide, somewhat flattened, and truncate behind. The clypeus is separated from the epicranium by a well-defined suture, which extends to the base of the antennæ, dividing the raised portions from which they arise. The front edge of the clypeus is emarginate,

and bears a prominent hair at each anterior angle. There are also three pairs of hairs situated on the forward part of the clypeus and two pairs directly between the eyes, one pair being on the clypeus and one on the epicranium. Antennæ setaceous, four jointed and ferruginous. Eyes conspicuous, and situated in groups of six each, on slight elevations just behind the antennæ. The mandibles are dark brown in color, long, simple, stout at base, but quite pointed at the tip, the left mandible often folded over the right. The maxillæ and labium are small, ferruginous and provided with well-developed palpi. Prothorax large, as long as the meso- and meta-thorax, slightly contracted and rounded posteriorly. Meso-thorax slightly rounded posteriorly; meta-thorax truncate. Lateral edges of the body segments slightly produced. Dorsal line prominent on all the segments except the last. On the dorsum of each thoracic segment there are ten short hairs, one on the anterior part of each lateral margin, one at each angle of the segment and one on each side of the dorsal line at the anterior and posterior margins. Abdominal segments, nine in number, with the exception of the last, truncate behind, the last segment being rounded posteriorly and bearing a pair of caudal appendages. Each segment except the last bears six hairs, one on each lateral margin and two on each side of the dorsal line at the posterior margin. The last abdominal segment bears a pair of hairs on each lateral margin, but none on the dorsum. The caudal appendages are entire, although probably jointed at the base, and bear numerous hairs. The spiracles are situated just below the dorsal plates. The ventral portion of the body is of a yellowish white except the portions which are strengthened by chitinous plates. These are of the same color as the dorsal part of the body. Legs well developed, provided with stout spines which are especially prominent at the joints, the tarsi bearing two claws. The last body segment bears on the posterior ventral portion an appendage which serves as a proleg and aids in locomotion. The larva remains in this stage about four days. Molting is accomplished by a splitting of the thoracic plates along the dorsal line; the head, mouth parts and legs are then withdrawn and the exuviæ forced back

over the posterior end of the body. The newly molted larva is of a pale straw color.

Second Stage. — (Plate 3, Fig. 4.) Length, 15 mm.; width, 3 mm. Form somewhat stouter than in the preceding stage. Head relatively smaller, flattened, as wide as long; eyes less prominent. Clypeus deeply emarginate in front and feebly incised at the middle. Antennæ and mouth parts relatively the same as in the last stage; the body, however, is of a somewhat paler brown color. All the body segments except the last are truncate behind, and bear a well-defined dorsal line. The first thoracic segment is broadest posteriorly and gradually narrows toward the head, but is not quite as wide as the two succeeding segments. The hairs are arranged the same as in the first stage, except that two pairs of hairs arise on the lateral edges of each segment up to the last, which bears only one pair. The caudal appendages are entire but not quite as prominent as in the previous stage, and the legs are a little more slender. The time spent in this stage varies from four to eleven days.

Third Stage. — (Plate 3, Fig. 5.) After molting the larva measures 22 mm. in length and 4 mm. in width, and is of a light mahogany-brown color, which soon changes to a dark seal brown. The mandibles are stout, and bear a prominent carina. The clypeus is deeply bilobed in front, the hinder border separated from the epicranium by a somewhat indistinct suture. Prothorax narrowed in front and much wider behind. Caudal appendages each provided with a blunt spine, which is thickened at the base and arises from the dorsal surface. When full grown (Plate 4, Fig. 1) the larva is very stout, and measures 32 mm. in length and 6 mm. in width. A detailed description of the full-grown larva follows: —

The head is of medium size, slightly flattened and of the same color as the body. Clypeus somewhat shield shaped. A faint line separates the clypeus from the epicranium and reaches to the base of the mandibles, but does not divide the raised portions which bear the antennæ. Front edge

of clypeus strongly bilobed, each anterior angle bearing a prominent spine; top of the clypeus slightly hollowed toward the dorsal line. The spines are the same in number and arrangement as in the previous stages. Eyes near base of antennæ, not prominent. The antennæ (Plate 3, Fig. 6) are setaceous, short, four jointed, and arise from an elevation at the base of the mandibles. First joint short, cylindrical and naked; second joint nearly twice as long, slightly clavate and bearing a short hair near the middle of the outer margin; third joint a little shorter than the second, somewhat clavate and having one anterior angle slightly produced, and bearing three spines, which arise near the outer angles; last joint as long as the first, nearly cylindrical and bearing three spines at the apex. Mandibles large, stout at base, with a prominent dorsal carina. A strong, simple, blunt tooth (Fig. 9) arises near the base. The mandible gradually tapers from the outermost insertion of this tooth to a somewhat chisel-shaped point. The maxillæ (Fig. 8) are small, ferruginous in color, and are densely covered with hairs and spines. They bear four-jointed, naked palpi, which are nearly as long as the antennæ. The three inner segments of the maxillary palpus are short, stout, truncate and of nearly equal length; the terminal joint is slightly longer than the two preceding joints, oblong ovate in form and truncate at the tip. The galea or inner lobe is naked, two jointed and as long as the three basal joints of the palpus. Lacinia prominent and bearing a spine at its apex. Labium (Fig. 7) small, somewhat halbert shaped, with numerous spines arranged in an oval row on the inner side. Palpi two jointed; outer joint the longer and truncate at tip.

The dorsal thoracic plates are large, and nearly cover the lateral thoracic walls, while the dorsal abdominal plates, with the exception of the last, are smaller, and allow the lateral walls of the abdomen to protrude. Dorsal line not prominent. Each abdominal plate except the last bears, near the posterior margin, a very feeble transverse carina. Spines are arranged as in the preceding stage. The last segment (Plate 4, Fig. 4) is relatively small, nearly truncate behind; the caudal appendages of moderate length, and

each bears on the upper surface a large, blunt, horn-like protuberance, which is terminated with a bristle. Numerous other hairs occur on these caudal appendages. The ventral portion of the body is yellowish white except the parts which are strengthened by chitinous plates.

Spiracles seal brown, nine on each side, borne in shallow depressions just below the lateral edges of the dorsal plate, on the meso-thorax and on each abdominal segment except the last. Those on the abdominal segments are small and circular, while the thoracic spiracles are decidedly larger and elliptical in outline. Legs (Fig. 7) small, very muscular and spiny. Coxæ very stout, dark brown; trochanters, femora and tibiæ slender, reddish brown; tarsi of same color, one jointed and bearing two simple claws. The anal proleg is slender, tapering and bears a number of short spines. This appendage serves the double function of acting as an organ of locomotion and also containing the cavity into which the rectum discharges. General color of under surface sordid white, varying to light gray, variously marked with light seal-brown patches. Head and anterior part of prothorax seal brown. Two lateral rows of elongated markings of similar color extend along the body beneath the spiracles. The upper row terminates on the penultimate segment, the lower row on the last segment.

The markings forming the upper row are single and entire on the first two thoracic segments; on the meta-thorax there are two spots, the anterior being the smaller. On the abdominal segments the markings are somewhat circular, two to each segment, a large orbicular marking being followed posteriorly by a smaller one of similar shape. The markings composing the lower row are in general elliptical, and occur singly on the segments stated. On both the meso- and meta-thorax there is a single small brown spot on the median line. In a corresponding position on each of the following segments except the last two, and near the anterior margin, there is a large elliptical, transverse, seal-brown spot. Posterior to this marking on each of the segments mentioned there is a transverse row of four small spots of similar color. On the last two segments the median spot is quite large and somewhat pentagonal in out-

line. The transverse row of small spots occurring on the preceding segments is here absent.

After the last molt the larva feeds for about three weeks, during which time it grows very rapidly. It then ceases feeding, burrows a little distance below the surface of the ground and makes a small chamber. The body shortens somewhat, and in less than a week pupation takes place, and is accomplished in the same way as the molting in the previous stages. In several instances the larvæ have molted three times before pupating.

Pupa. — (Plate 5, Figs. 1, 3.) Eighteen mm. long, 6.4 mm. wide at the first abdominal segment. Oblong, somewhat elliptical and flattened. General color of the body pale amber. Head medium, somewhat flattened in front and strongly depressed beneath the thoracic segments. Eyes prominent, seal brown in color. Antennæ and mouth parts free, translucent. Prothorax broader than long, considerably narrowed behind; meso-thorax emarginate in front and two-thirds as long as the meta-thorax; all separated by well-defined sutures. Wing-covers translucent and extending beyond the third abdominal segment. Abdominal segments nine in number, the sides of the body protruding beyond the dorsal portions. The lateral edges of abdominal segments two to six are produced to a blunt point, within which is a slight depression. Penultimate segment slightly depressed; last segment greatly depressed beneath the body, and bearing on the posterior margin a pair of small anal stylets. Each of the first five abdominal segments bears a narrow brush of erect brown hairs, which extends two-thirds of the distance across the segment (not shown in Fig. 1). The nine pairs of spiracles are light chestnut brown, and are situated in the same relative position as those of the larva; they are larger, however, and elliptical in outline, those on the meta-thorax being the largest. Legs free, translucent and nearly surrounded by the wing-covers.

Unfortunately all the larvæ reared to pupæ died before emerging, hence I am unable to give the length of the period spent in this stage.

*Imago.** — Length, 18 to 22 mm. General color metallic black above and greenish black below. Thorax and elytra bordered with a more or less greenish band. Head medium in size, profusely punctured. Mandibles (Fig. 5) large and prominent. Third joint of antennæ (Fig. 4) slightly compressed. Prothorax small, narrowed posteriorly, the lateral edges slightly produced.

The posterior two-thirds of segment bears a quite prominent impressed dorsal line. Thorax with granular punctures. Elytra striate, each bearing three rows of small impressed greenish dots. Under side of the body somewhat wrinkled and punctured. Fore tarsi of the female (Fig. 6) simple. Fore tarsi of male (Figs. 7, 8) have the first four joints hairy beneath; this character is not only of value as a means of determining the sexes, but is also of specific importance.

Calosoma calidum (Fab.).

A male and female *Calosoma calidum*, which were taken early in September, 1896, were immediately placed in a breeding jar. On September 3 they were observed to copulate, and on the following day fourteen eggs were found in the jar. Three of these eggs were preserved for study, but, owing to the death of a number of the larvæ during the early stages, only four pupated. From these survivors the following brief notes on the life history of this species were prepared: —

Egg. — (Plate 4, Fig. 2.) Length, 4 mm.; width, 1.7 mm. Form similar to that of *C. frigidum*, but tapering somewhat more toward the lower end. Color, light amber. Hatching took place in seven days from the date of oviposition.

First Stage. — Length, 8 mm.; width, 2 mm. at third thoracic segment. Form ellipsoidal, tapering more gradually toward the last segment than in the corresponding stage of *C. frigidum*. General color of the body and

* For figure of imago see "The Gypsy Moth," Forbush and Fernald, Plate 53, Fig. 1, 1896.

mouth parts dull black, not shining. Head large, as long as wide, dorsal surface flattened; palpi prominent, longer than antennæ. Posterior margin of the head somewhat emarginate at the centre. First thoracic segment as long as the two following, slightly wider than the head and edges produced laterally. All the body segments except the last are truncate behind, and bear a prominent impressed dorsal line. Caudal appendages present, simple and provided with numerous spines.

Ventral portion of the body nearly pure white, but is profusely covered with small black chitinous plates. Spiracles nine, black, circular and arranged just below the lateral edges of the dorsal plates. Anal proleg moderately stout. After feeding for a week the larvæ molted.

Second Stage. — Soon after molting the larvæ became black and measured 18 mm. in length. Body somewhat stouter than in preceding stage. Head longer than wide, emarginate behind. Prothorax wider than the head. Dorsal line quite prominent. Abdominal segments truncate and slightly produced laterally. The second molt occurred at the end of a week.

Third Stage. — The following description was not made until the larva was almost ready to pupate. Length, 30 mm. Color, dull black. Head of medium size, flattened, truncate behind. Clypeus slightly broader in front than in *C. frigidum*. Strongly bilobed. Suture between clypeus and epicranium sub-obsolete. Mandibles stout, the large tooth (Plate 3, Fig. 10) near the base being deeply cleft on the inner margin. Prothorax longer than the head, the hind angles slightly curved. Meso- and meta-thorax smaller, but similar in shape, each thoracic segment bearing four pairs of hairs on the dorsal plate. The abdominal plates one to seven of the same form and bearing a moderate carina near the posterior edge of the segment. Eighth segment a little larger, slightly wider, and also bearing a carina, lateral edges of each abdominal segment bearing three short hairs. The last segment (Plate 4, Figs. 5, 6) small, posterior angles produced backward, but hind edge

of segment truncate; caudal appendages long, blunt, spiny, slightly depressed, and bearing on the upper surface a hump-like protuberance provided with a few spines. The spiracles are nine in number, and are arranged the same as in *C. frigidum;* the color, however, is black. Legs small and spiny, tarsi bearing two claws. The anal proleg is stout and covered with numerous short hairs. The under surface is of a purer white than in *C. frigidum*, but bears similar markings. The latter resemble those of the preceding species in form and arrangement, but are slightly darker in color. The spots composing the first lateral row are more elongated, and all the ventral spots are somewhat larger than in the preceding species. The time spent in this stage is about one month, of which about three weeks are passed in feeding. When full grown the larva burrows into the ground to a depth of several inches, and after preparing a cavity throws off its skin and goes into the pupa stage.

Pupa. — (Plate 5, Fig. 2.) The pupa resembles that of *C. frigidum* very closely, but is stouter and less compressed at the anterior and posterior ends. Other differences occur in the shape of the prothorax, which is not nearly as rounded in front as in *C. frigidum*. The anterior margin of the meso-thorax is transverse; the lateral projections of the dorsal abdominal segments are not as marked as in *C. frigidum*. Anal stylets larger, more prominent. Brushes of hairs present on the first five abdominal segments. The figure shows a part pushed out from beneath the last abdominal segment. All the pupæ died before spring.

Habits of the Larvæ. — The larvæ of this genus of beetles are called indiscriminately by the common names of "cut-worm lion," "corn grub killer," etc., although these names have been referred more particularly to the larva of *C. calidum*. The reason for such names is very apparent, since the larvæ are often found in gardens, and do a great amount of good in killing cut-worms and other injurious caterpillars. They have also been reported as feeding on the Colorado potato beetle larva (*Doryphora decemlineata*),

canker worms (*Paleacrita vernata*), May beetle (*Lachnosterna fusca*), eggs of the Rocky Mountain locust and numerous cut-worms.

Mr. F. H. Mosher informs me that he has found these larvæ quite numerous during the past summer under burlaps on an estate in Brookline which was quite badly infested by the gypsy moth. Without doubt these insects would do a great amount of good by killing the gypsy moth larvæ which would seek shelter below the burlap. If this habit of hiding in concealed places on trees, as under loose bark, etc., is constant among these beetle larvæ, a great many of the caterpillars as well as eggs of the gypsy moth must be destroyed every season. In confinement I have found that larvæ of *C. frigidum* will feed quite freely on the gypsy moth egg-clusters.

The amount of food consumed by a larva of *C. frigidum* in confinement was as follows: during the first stage one small cut-worm, three second-molt gypsy moth larvæ and one third-molt gypsy moth larva; second stage, two fall web worms (*Hyphantria cunea*), one larva of *Datana ministra*, one army worm (*Leucania unipuncta*) and one-half of a gypsy moth egg-cluster; third stage, two *Datana integerrima*, two *D. ministra*, one *Attacus promethea* and six army worms.

Under natural conditions this amount would be probably somewhat increased. The larvæ also ate gypsy moth pupæ quite readily, especially directly after pupation, before the bodies had become hard, the most favorable place for attack on the hardened pupæ being a point at the base of the wing-covers.

The larvæ are very ferocious, and do not hesitate to attack a caterpillar on account of its size or strength. They commonly grasp the victim by some of the ventral segments, and cling with great tenacity until the caterpillar succumbs. If perchance the little larva is shaken off, he persistently renews his attack with greater zeal than before. After succeeding in cutting a hole through the integument with his sharp mandibles, he sucks in the viscera of his prey and often becomes gorged almost to the point of bursting. He next repairs as rapidly as his condition will allow to a place of shelter, for which loose leaves, rubbish or

something of this description serves his purpose. Here he remains dormant for a short time, when he is ready to start out again in search of more prey.

Wintering or Hibernation of Carabidæ. — During the winter and early spring occasional trips were made to different parts of the infested district in order to learn, if possible, how this group of insects spends the winter. Species from the following genera were collected: *Pterostichus*, *Amara*, *Platynus*, *Lebia*, *Dromius*, *Pinacodera*, *Brachynus*, *Harpalus*, *Anisodactylus*. Mr. W. S. Blackley reports in Psyche 217 species of Carabidæ collected in the winter in Virgo County, Indiana.

There can be little doubt of the fact that many of this family spend the winter in the adult stage.

On March 22, 1896, I received from Mr. W. C. Colt a specimen of *Cychrus lecontei* (Dej.), which he found on the trunk of a tree in Medford on the previous day. Doubtless this insect hibernated as an adult.

In addition to the foregoing, the fact that *Calosoma calidum* was taken less than a month later leads to the conclusion that the Calosomas as a rule hibernate as adults, although it is possible that they may pass the winter in some other stage.

Natural Enemies. — Many natural influences conspire to limit the numbers of these beneficial insects. From their large size and conspicuous colors they cannot be otherwise than an attractive article of diet for some of our larger insectivorous birds. The pungent odor given off by these beetles would seem to be in a measure a means of defence; yet it is a well-known fact that some birds, like the crow, appear to prefer such malodorous insects.* In this connection it may be of interest to record that the fluid producing the characteristic odor of *C. calidum* is ejected by the beetle as a fine spray.

On one occasion, while examining the earth in a jar containing a female *Calosoma calidum*, on touching the back of the beetle with a brush a fine spray struck my face, which was about eight inches distant from the beetle. It

* See "The Common Crow," Bulletin Division of Ornithology and Mammalogy, Barrows-Schwarz, page 59, 1895.

had a very pungent odor, and produced a stinging sensation on the skin. Some that struck in the corner of my eye was very painful until the eye was washed with water. The fluid is probably expelled from anal glands, as in the case of the allied genus, *Brachynus*. Undoubtedly the insectivorous birds are the chief agency in checking the increase of these insects, although the terrestrial habits of the beetles render them an easy prey to the ever-watchful toad, while in woodlands many are probably destroyed by skunks. I have been unable to observe any of our common birds feeding upon these beetles, yet it seems probable that they may be devoured by the majority of those insectivorous species known to seek a part of their food upon the ground. In this class Gentry * gives the following as feeding upon the Carabidæ: the crow, blue jay, king bird, black-billed cuckoo, yellow-billed cuckoo, hairy woodpecker, downy woodpecker. Forbes records the robin,† cat bird and several thrushes as attacking Carabidæ, while Beal ‡ states that thirteen per cent of the food of the purple grackle consists of carabids. The same author § notes the occurrence of *Calosoma calidum* in the stomach of a red-headed woodpecker, while Schwarz ‖ found that this species is commonly devoured by the crow.

One would hardly expect that so ferocious and strongly chitinized an insect as *C. calidum* would suffer from the attacks of parasites, yet that such is sometimes the case is evident from the fact that on June 6, 1896, I took a specimen of this species which bore on the side of the prothorax a cluster of nine Dipterous eggs. After keeping the beetle a few days in confinement he became sluggish and finally died June 12. On the 28th seven flies had emerged, and on opening the beetle the empty puparia were found within. The flies were sent to Prof. L. O. Howard, Washington, D. C., and were referred to Mr. D. W. Coquillett, who kindly identified them as *Pseudotrætocera calosomæ* Coq., a species that he has bred in California from *Calosoma peregrinator*.

* "Birds of Eastern Pennsylvania," 1877.

† Bulletin 3, Illinois State Laboratory of National History, 1880.

‡ Year Book, United States Department of Agriculture, 1891, page 240.

§ Bulletin No. 7, United States Department of Agriculture, Division of Ornithology and Mammalogy, page 21, 1895.

‖ "The Common Crow," page 59.

EXPLANATION OF PLATES.

PLATE 1: Fig. 1, egg of *Podisus placidus* Uhl., ... × 13
2, first stage of *P. placidus*, ... × 9
3, second stage of *P. placidus*, ... × 6
4, third stage of *P. placidus*, ... × 4
5, fourth stage of *P. placidus*, ... × 3
6, imago of *P. placidus*, ... × 3
7, male genitalia of *P. placidus*, greatly enlarged.
8, female genitalia of *P. placidus*, greatly enlarged.

PLATE 2: Fig. 1, egg-mass of *Diplodus luridus* (Stål), enlarged.
2, single egg of *D. luridus*, greatly enlarged.
3, first stage of *D. luridus*, greatly enlarged.
4, full-grown nymph of *D luridus*, . . . × 2
5, male imago of *D. luridus*, ... × 2
6, female imago of *D. luridus*, ... × 2
7. full-grown nymph of *Dendrocoris humeralis* (Uhl.), ... × $3\frac{1}{2}$
8, imago of *D. humeralis*, ... × $2\frac{1}{2}$
9, head of imago of *D. humeralis*, greatly enlarged.
10, antenna of *D. humeralis*, greatly enlarged.
11, egg of *Euschistus politus* Uhl., greatly enlarged.
12, imago of *E. politus*, ... × $2\frac{2}{3}$
13, antenna of *E. politus*, greatly enlarged.
14, wing-cases of *E. politus*, greatly enlarged.

PLATE 3: Fig. 1, egg of *Calosoma frigidum*, ... × $4\frac{1}{2}$
2, reticulations on egg shell, ... × 300
3, first laval stage of *C. frigidum*, . . . × 6
4, second larval stage of *C. frigidum*, . . × 4
5, third larval stage of *C. frigidum*, . . . × $3\frac{1}{5}$
6, antenna of larva of *C. frigidum*, . . . × 20
7, labium of larva of *C. frigidum*, . . . × 20
8, maxilla of larva of *C. frigidum*, . . . × 20
9, mandible of larva of *C. frigidum*, . . . × 20
10, mandible of larva of *C. calidum*, . . . × 20

PLATE 4: Fig. 1, full-grown larva of *C. frigidum*, . . . × $2\frac{1}{2}$
2, egg of *C. calidum*, ... × $4\frac{1}{2}$
3, full-grown larva of *C. calidum*, . . . × $2\frac{1}{2}$

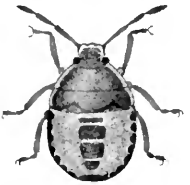
PLATE 4: Fig. 4, last abdominal segment of larva of *C. frigidum*, × 5
5, last abdominal segment of larva of *C. calidum*, × 5
6, last abdominal segment of larva of *C. calidum*, showing cavity in anal proleg, . . . × 5
7, larval leg of *C. frigidum*, ... × 12
8, labium of *C. frigidum* (imago), . . . × 10
9, maxilla of *C. frigidum* (imago), . . . × 10

PLATE 5: Fig. 1, pupa of *C. frigidum* (dorsal view), . . × 3½
2, pupa of *C. calidum* (dorsal view), . . . × 3½
3, pupa of *C. frigidum* (lateral view), . . × 3½
4, antenna of *C. frigidum* (imago), . . . × 5
5, mandible of *C. frigidum* (imago), . . . × 10
6, fore leg of female *C. frigidum*, . . . × 4
7, fore leg of male *C. frigidum*, ... × 4
8, fore tarsus of male *C. frigidum* (under surface), ... × 4

1

8

2



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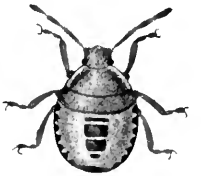

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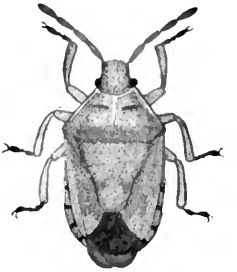

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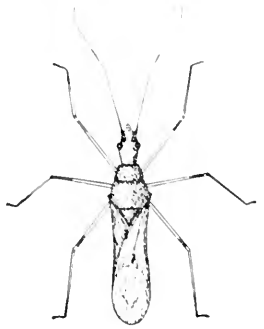

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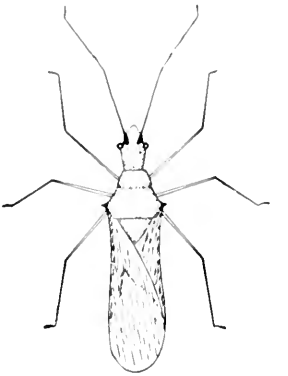

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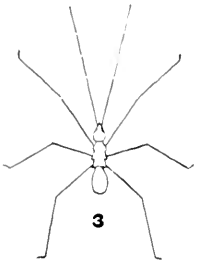

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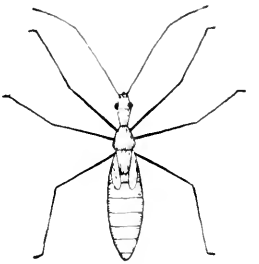

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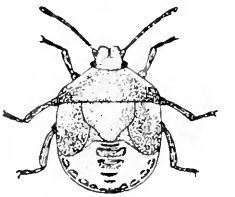

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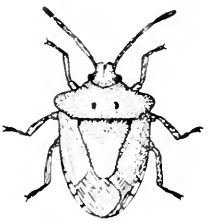

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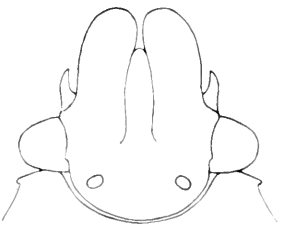

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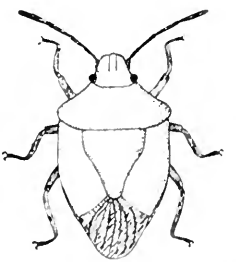

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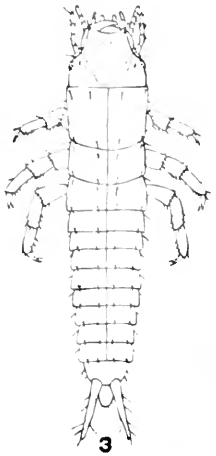

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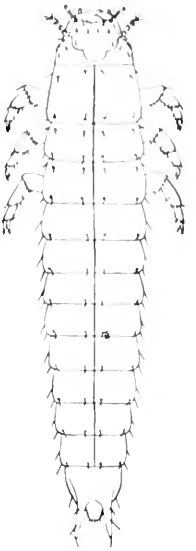

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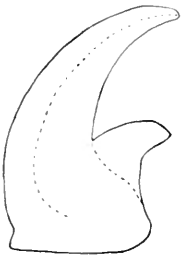

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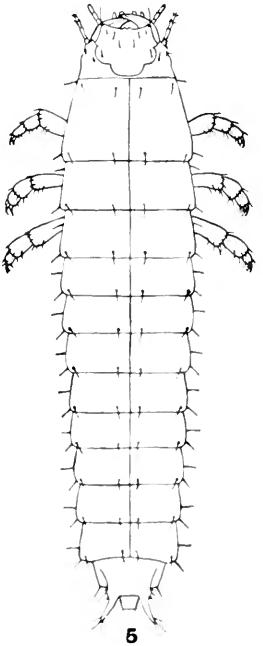

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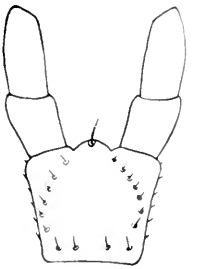

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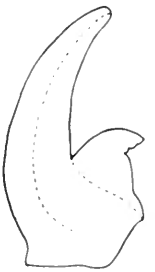

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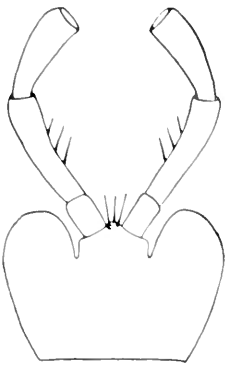

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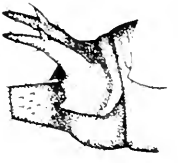

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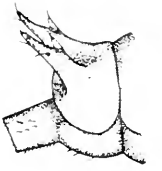

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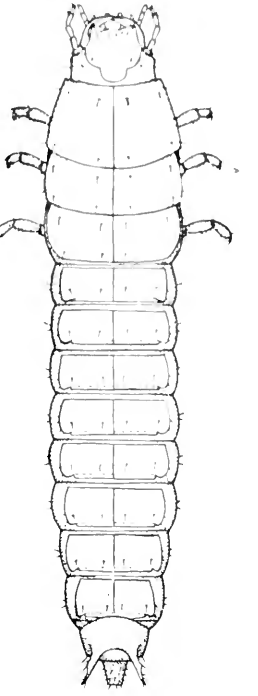

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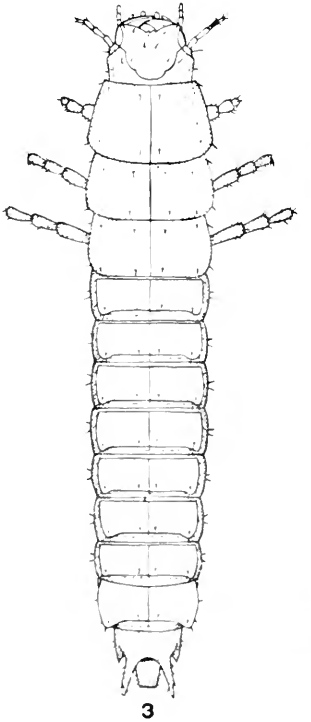

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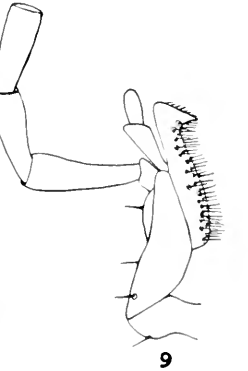

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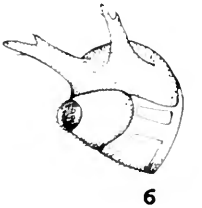

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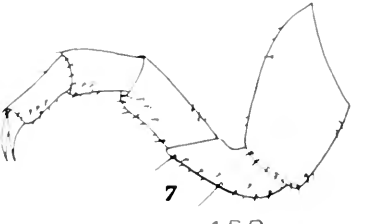

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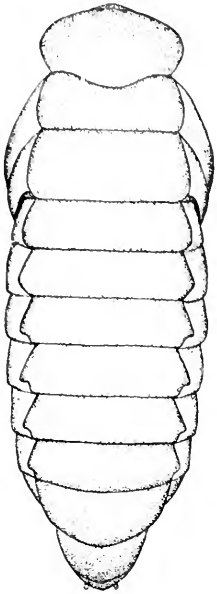

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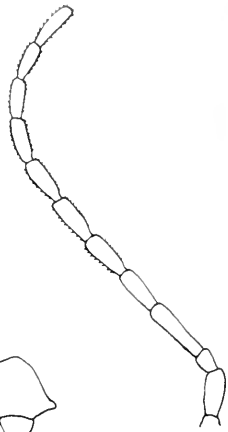

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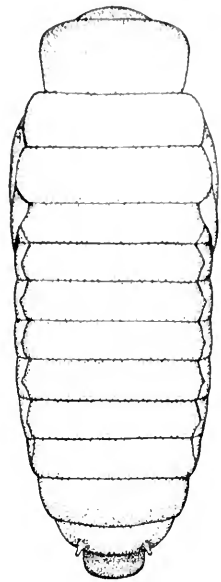

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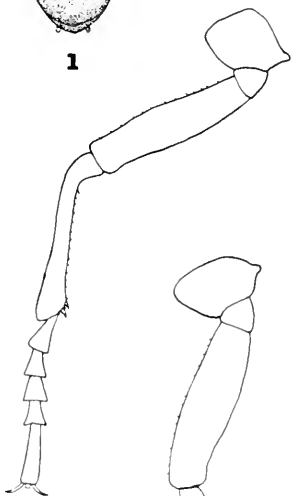

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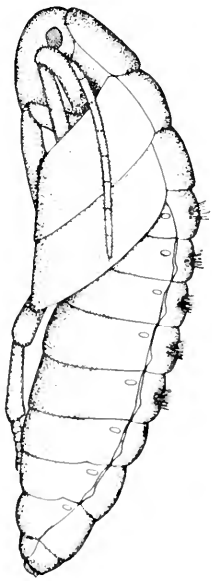

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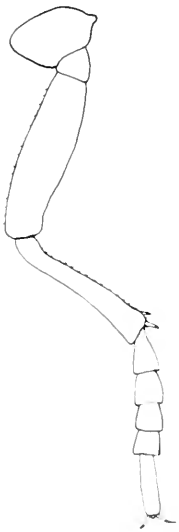

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