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INSECTS AFFECTING PARK AND WOODLAND TREES

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PREFACE

This work was begun a number of years ago by the writer studying various insects depredating on shade trees, and from that it was very natural to give attention to those affecting forest trees. It assembles in one volume the results of our studies for a series of years, together with a summary of the more important literature relating to the subject. It is not expected that this memoir will supersede the exceedingly valuable work by Dr Packard on *Forest and Shade Tree Insects*, 5th Report of the United States Entomological Commission, but rather that it will be supplementary thereto. It is hoped that the arrangement adopted will facilitate the identification of the different species and aid materially in making the information accessible to the general public. The writer at this time wishes to acknowledge his indebtedness to the assistants who have been associated with him during the past six years, all of whom have aided more or less in the preparation of this work. Particular mention should be made of the work of Mr D. B. Young, now assistant entomologist, who during the last three years, by collecting and otherwise, has secured much valuable data which has been incorporated in this work. Through the courtesy of Dr L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture, a number of species were kindly determined by Drs Hopkins and Ashmead. The former named most of the bark borers or Scolytids and also generously gave the writer the benefit of his extended experience in the study of forest insects. Dr Ashmead is responsible for the determination of most of the parasitic Hymenoptera, a group in which he is a well recognized authority. The value of the work is also greatly enhanced by the large series of original drawings by Mr L. H. Joutel of New York.

This publication is essentially practical or economic in nature, and as such, gives special attention to the more injurious species depredating on shade and forest trees. A somewhat radical, though we hope none the less valuable, departure from the ordinary treatment in economic literature is found in the summarized accounts of some of the more interesting groups one meets in the study of forest entomology. These latter are of special value in giving a general knowledge of the subject, something which appeals strongly to those having a comparatively slight knowledge of entomology, yet desirous of following in a general way, the manifestations of insect life. Some original morphologic studies are also included in the volume, since they are almost essential to the adequate identification of certain very injurious species.

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INSECTS AFFECTING PARK AND WOODLAND TREES

INTRODUCTION

The welfare of the human race is closely connected with that of our trees, and any work looking to their better protection makes for the advancement of mankind. The value of our street and park trees is much greater than the cost of their production, and a city or village blessed with such has treasure which should be most jealously guarded, since these magnificent growths have an important influence in modifying climatic conditions, besides adding materially to the beauty of the surroundings. This is not only true in cities and villages but also in the country at large, particularly in such resorts as the Adirondacks, where thousands go for recreation and health. The trees in such places not only afford most agreeable shelter from wind and sun, but the evaporation from the immense leaf areas modifies the temperature and the exhalations from the coniferous needles undoubtedly aid very much in healing diseased lung tissues.

The protection of shade trees is a serious problem, largely due to the introduction into this country of certain very destructive species, such as the gipsy moth, the elm leaf beetle, the elm bark louse, the leopard moth and the San José scale, all exceedingly injurious and all, except the gipsy moth, well established in New York State. It is only a question of time before the latter crosses our borders. The above are a few of the important exotic species which aid such destructive native forms as the white marked tussock moth, the bagworm, the fall webworm, the scurfy and oyster scales and the cottony maple scale in their nefarious work.

Injuries caused by insects. It is very difficult for most persons to form an adequate idea of the great economic importance of this group. They are willing to admit that some injury is caused, but have no adequate conception of the enormous losses inflicted. For example, during 1854 to 1857, the wheat midge, Diplosis tritici Fitch, caused an estimated damage in New York, Ohio and Canada of at least $80,000,000. The chinch bug, Blissus leucopterus Say, between 1850 and 1887, was responsible for losses amounting to $350,000,000, while grasshoppers, between 1874 and 1875, destroyed crops valued at $571,000,000. The cotton worm, Alabama argillacea Hübn., caused an estimated annual loss of $15,000,000 during the 14 years following the Civil War according to Dr Packard, that for 1873 being placed at $25,000,000. These records afford only an approximate idea of the damage caused by insect depredations. Several authorities have attempted to estimate the total loss in the United States due to such causes and have placed the amount at from three hundred to four hundred million dollars annually. This estimate is probably a fair approximation of the amount of damage.

Dr A. S. Packard has placed on record a statement that every spruce tree west of the Penobscot was killed by insects in 1818, and that in 1874 the forests of spruce and fir in Maine, New Hampshire and New York began to be destroyed by the wholesale,[1] which in large part was due to the depredations of bark borers.

Prof. C. H. Peck, now state botanist, observed extensive injuries to the spruce forests of the Adirondacks in 1876 by the spruce bark beetle, Dendroctonus piceaperda Hopk. The trouble was so serious in some places that in 1883 a correspondent of *Nation* stated that in one large tract in Essex county he was unable to find 1 tree in 20 alive.[2] The comparatively recent outbreak of Dendroctonus frontalis Zimm. in 1891–92 covered an area of something over 50,000 square miles in West Virginia, Maryland, Pennsylvania and probably New Jersey, as estimated by Dr A. D. Hopkins, who has made a special study of this insect. The infested area in West Virginia alone was estimated by him at 15,000 square miles. There was in 1897 a serious outbreak of a bark beetle, identified as Dendroctonus piceaperda, in northern New Hampshire and in adjacent territory in Vermont, Maine and Canada, as reported by Dr C. M. Weed.

[1] U. S. Ent. Com. 5th Rep't. 1890. p. 811, 817.

The above figures make the following estimates prepared several years ago by Dr Hopkins appear quite reasonable. He placed the annual loss on timber as follows: bark beetles to pine and spruce, $5,000,000; bark and timber beetles causing defective wood in felled timber, $1,000,000; insects in timber injured by fires and other causes, $1,000,000; the Columbian timber beetle to standing and living timber, $1,000,000; timber and carpenter worms in oak, $2,000,000; chestnut worm, $1,000,000; long-horned wood borers to standing timber, $2,000,000; the same to felled timber and saw logs, $2,000,000; other wood borers to standing and felled timber, $2,000,000; foliage-infesting insects to forests and shade trees, $3,000,000; white pine weevil, plant lice, scale insects, etc. to young growth, $1,000,000; powder post beetle to dry manufactured wood, $1,000,000; miscellaneous insects not included in the above, $3,000,000, making an enormous total of $25,000,000. To this should be added losses in working up and disposing of defective wood, losses caused by use of the same, and indirect losses caused by diminished forest area due to insect ravages, all of which, could it be estimated in dollars and cents, might be placed at $75,000,000, making a grand total of $100,000,000 annually on forests and forest products alone.

Shade trees and adjacent property affected. Aside from direct losses to forest trees and their products, very great damage is inflicted by insects on shade and ornamental trees throughout the country. This loss can not be estimated in financial terms, since a tree destroyed can not be replaced for a number of years, and its effect on the value of adjacent property is quite variable. The loss occasioned by the destruction of trees is usually underestimated. To give an idea of the extensive damage caused in this way, we would call attention to the depredations of the elm leaf beetle, Galerucella luteola Müll., a species which is well established in most cities and villages along the Hudson river and bids fair to become destructive in many other places in the State. It has caused the death of several thousand trees in Albany and Troy alone since 1898, besides seriously would not many others. The leopard moth, Zeuzera pyrina Fabr., is a very serious borer which has become established about New York city, and has killed hundreds of trees and seriously damaged thousands. The cottony maple scale, Pulvinaria innumerabilis Rathv., is another very destructive pest affecting soft maples in particular, and the elm bark louse, Gossyparia spuria Mod., is almost as injurious to elms. In addition to these there is the San José scale, Aspidiotus perniciosus Comst., a pest which thrives on a great number of trees and is a serious menace to ornamentals. The gypsy moth, Porthetria dispar Linn., has become well established in Massachusetts and in the course of time will probably become a pest of prime importance in New York State.

It is interesting in this connection to call attention to the fact that some of the most destructive species have come to us from abroad, and this is as true of those infesting shade trees as of the pests feeding on our fruit trees and other cultivated crops. It is only necessary to recall that the elm leaf beetle, leopard moth, the elm bark louse, the mottled willow borer, San José scale and others of that character have come to us from abroad. The obvious deduction is that every possible precaution should be exercised to prevent the introduction of other species which may become equally injurious.

Definitions and classification. An insect may be defined as a six legged, tracheate animal, with the principal body divisions, namely, head, thorax and abdomen, separate. They may be distinguished from the closely related spiders, by the latter having eight legs in the adult condition and the head and thorax being fused into a compound cephalothorax. The mites are normally eight legged when adult, and may be recognized by the unsegmented abdomen being fused with the thorax. The large number of legs possessed by the centipede and the millipede, together with their elongate form, should prevent their being confused with insects proper.

The head of the insect bears the principal sense organs — the eyes and the antennae — and also those for the prehension and mastication of food. These latter consist of the mandibles, the maxillae with their palpi, and the lower lip or labium, which is also provided with a pair of palpi. The thorax bears the principal organs of locomotion: the wings and the legs. The former may be absent in some cases, as in the lowest order, the Thysanura, in certain sexes and in some species of the higher orders. The hind wings may be reduced to mere vestiges known as halteres or balancers, as in the flies. The wings may be covered by protective shields, the elytra of beetles, or partly thickened, like the anterior wings of the Heteroptera, and to a still less extent of certain Orthoptera. The modifications existing in these organs are of great aid in classification. The vestiture or absence thereof, relative length, number of veins, location of veins, arrangement of cells and other differences are of great service to the systematist.

The legs are normally six in number, though occasionally there are species which have but four, the anterior two in some butterflies being reduced to mere rudiments. The principal parts of the leg are the trochanter, femur, tibia and tarsus. The first is the small segment close to the body, the femur and tibia are usually of nearly equal length, the femur being decidedly stouter, while the tarsus is rather slender and usually consist of from three to five segments, the terminal one bearing a pair of claws or a sucking disk or both. There are considerable modifications in each of these parts, and their relative development, length, clothing, color etc. afford good characters for the separation of important groups and species.

The abdomen has 10 or fewer segments and is usually considerably longer than the harder, more complex thorax. It is composed of a series of very similar segments, the terminal ones bearing the sexual organs, which are very diverse in different orders, families, and sometimes great differences occur between species.

The larvae of insects present marked divergences from the normal structure and occasionally appear to lack important organs. The head is usually present, the eyes are simple, sometimes absent, the antennae are often very minute, the wings are wanting, as are also the true legs in many families. The abdomen is relatively much longer, and in certain groups at least is provided with false legs or prolegs, which are of material service in locomotion. It may be stated as a general rule, that the larvae of some of the highest developed insects are the most helpless, degraded forms, being dependent on the mother to place the egg where food is of easy access, or else they can attain maturity only with paternal aid, which in some instances is bestowed by a nurse form. Larvae of the more lowly organized insects are better able to provide for themselves, and those of many species are relatively well equipped to meet the struggle for existence, some being much more powerful in the immature than in the adult condition. This is particularly true of the May flies, some species of which develop into a very short lived, weakly organized adult.

Important groups of insects affecting forest trees. A great many insects occur on or in our different native trees and shrubs, though comparatively few of them are of much economic importance, and these in turn belong to still fewer important groups which have certain distinguishing features.

The bee family or four winged insects, known as Hymenoptera, contribute two important groups, namely, the four winged gallflies or Cynipidae, and the sawflies or Tenthredinidae. The former are not easily distinguished as adults, though the deformities they produce in various plant tissues can be confused only with those caused by certain other groups, and then, after a little experience, the galls of one group can easily be separated from those of another. The sawflies are, many of them, leaf feeders and some, gall makers. They may be readily distinguished in the larval stage because of the many legs, having in addition to the 6 thoracic or true legs, 12 to 16 abdominal prolegs. Several sawfly larvae are very voracious and defoliate large areas; for example, the well known larch sawfly of the Adirondacks.

The two winged flies or Diptera include comparatively few species which are injurious to forest or shade trees, and most of these are of slight importance. The gall-making midges, Cecidomyidae, cause deformities in various plants, but ordinarily they are of little commercial importance. They are easily distinguished from other galls, if they contain inhabitants, by the peculiar jumping larvae which by bringing the extremities together and then suddenly straightening, propel themselves an inch or more.

The beetles or Coleoptera are a group which includes some of the most important and destructive enemies of trees. The flattened, metallic Buprestidae are frequently met with in bright daylight, and their legless, white larvae are easily recognized by the enormous, flattened head and the more or less flattened body segments. They usually make wavy, irregular galleries.

The long-horned borers or Cerambycidae, are generally rather large beetles, somewhat cylindric in shape and with long antennae; in some cases they are enormously developed. The white larvae are normally legless, usually rounded, and with the head only slightly flattened, and as a rule they make well defined galleries more or less circular in section. This family includes a large number of very destructive borers.

The leaf feeders or Chrysomelidae are relatively abundant on various trees, and some species are exceedingly numerous. The beetles present a somewhat variable appearance both in color and shape, and the larvae are equally diverse. The latter, normally, have six legs, with rounded body, and frequently there is an anal proleg; as a rule they are leaf feeders.

The weevils or Curculionidae may be easily recognized by the distinct snout and hard shell or exoskeleton. The wood-boring grubs belonging to this family are legless, curled and thickened anteriorly, and may work either in bark or wood.

The bark or wood borers, Scolytidae, are all small species, usually somewhat cylindric in shape and brown or black in color. Their wood-boring larvae are legless, round, slightly thickened anteriorly and frequently smaller than the grubs of weevils.

The butterfly and moth family, Lepidoptera, contributes some injurious groups, and in addition there are in certain families a number of destructive species with no equally injurious close relatives.

The old group Bombycidae included some of our most destructive leaf feeders, such as the white marked tussock moth, the fall webworm, the imported gipsy moth and others.

The Cossidae are wood borers and include several rather destructive forms, specially the carpenter worm and the leopard moth.

The Sesiidae are also a family of borers, some of which are rather injurious to forest trees.

Certain species of the true bugs or Hemiptera are of considerable importance because of their depredations on trees and shrubs. Possibly the most injurious, though not usually considered so, are the plant lice, which year after year make drafts on the vital fluids of various plants and some seasons cause very great injury. This was particularly true in 1898 and 1903. The scale insects belong here, and some of them cause serious damage, not only weakening trees but in some instances killing them. This is true of the cottony maple scale, Pulvinaria innumerabilis Rathv., and also of the San José scale, Aspidiotus perniciosus Comst., which latter is very destructive to certain ornamentals.

Certain of the other orders contain species of some economic importance, though most of them may be disregarded in this connection.

Literature. The American literature relating to forest entomology is not very abundant. The pioneer in this work was undoubtedly Dr Asa Fitch, practically the first state entomologist, who gave considerable space to the subject in both his fourth and fifth reports, thereby leaving records of great value. These publications were followed by Bulletin 7 of the United States Entomological Commission, prepared by Dr Packard, who in 1890 extended that into the voluminous and valuable fifth report of the commission, a work which is a veritable storehouse full of information. A number of later writers have treated of certain phases of the subject, particularly Dr Hopkins, who is easily the American authority on the Scolytidae. Several valuable biologic monographs treating of groups specially injurious to trees have appeared, besides a number of bulletins giving accounts of from one to several insects attacking various trees. The following are some of the principal references to this group, particular attention being given to New York State publications:

1857 **Fitch, Asa.** Insects Infesting Evergreen Forest Trees. Ins. N. Y. 4th Rep't, p. 5–67.

1858 ——— Insects Infesting Deciduous Forest Trees. Ins. N. Y. 5th Rep't, p. 1–74.

1881 **Packard, A. S.** Insects Injurious to Forest and Shade Trees. U. S. Ent. Com. Bul. 7, p. 1–275.

1890 ——— Insects Injurious to Forest and Shade Trees. U. S. Ent. Com. 5th Rep't, p. 1–945.

1893 **Hopkins, A. D.** Catalogue of West Virginia Scolytidae and their Enemies. W. Va. Agric. Exp. Sta. Bul. 31, p. 121–68.

1893 ——— Catalogue of West Virginia Forest and Shade Tree Insects. W. Va. Agric. Exp. Sta. Bul. 32, p. 171–251.

1895 **Packard, A. S.** First Memoir on the Bombycine Moths. Nat. Acad. Sci. 7: 291.

1896 **Marlatt, C. L.** Revision of the Nematinae of North America. U. S. Dep't Agric. Div. Ent. Tech. ser. 3, p. 1–135.

1898 **Felt, E. P.** Insects Injurious to Maple Trees. Forest, Fish and Game Com. 4th Rep't, p. 367–95.

1899 ——— Insects Injurious to Elm Trees. Forest, Fish and Game Com. 5th Rep't, p. 351–79

1901 **Beutenmuller, William.** Monograph of the Sesiidae of America North of Mexico. Am. Mus. Nat. Hist. Mem. 6, p. 217–352.

1901 **Hopkins, A. D.** Insect Enemies of the Spruce in the Northeast. U. S. Dep't Agric. Div. Ent. Bul. 28, n. s., p. 1–48.

1903 **Felt, E. P.** Insects Affecting Forest Trees. Forest, Fish and Game Com. 7th Rep't, p. 479–534.

Transformations of insects. The wonderful changes accompanying the development of insects add much to the interest attaching to their study, and the great diversity between the different stages renders recognition of a species in its various forms exceedingly difficult. The transformations of insects are of interest not only to the biologist, but also to the economic entomologist who seeks some method of controlling injurious species. A knowledge of the life history and habits of an insect pest is almost essential to a person attempting to control it, because there is usually some weak point in its life history which may be taken advantage of in devising a practical method of keeping it in check. The habits of insects are consequently of great practical importance.

Egg. All insects develop from eggs which present widely variable forms in different species and are frequently of exceedingly beautiful design. They may be placed in clusters, bunches or singly; on or in leaves, bark, food products, etc.; tucked in all manner of crevices, dropped at random in the grass, or buried in the soil. They may be arranged in single or double rows, placed in bands about a twig, left unprotected or covered with hairs or scales or sheltered by a gummy secretion. A great many eggs are nearly smooth and globular, but those of many butterflies and some moths are somewhat elongated, delicately ribbed and with the surface broken into innumerable smaller areas by minor ridges. The eggs of a number of true bugs are nearly barrel-shaped and are crowned with a ring of small spines. Certain minute fruit flies (Drosophila) deposit theirs in decaying fruit and were it not for the curious appendages extending on the surface of the semiliquid nidus, the embryo would probably suffocate for want of air. The lace-winged fly (Chrysopa) is of interest because of her peculiar stalked eggs [pl. 20, fig. 18*b*] placed in clusters on leaf or twig. This curious arrangement is believed to be for the purpose of preventing earlier hatching individuals from devouring their undeveloped relatives. The eggs of a Californian red spider, Tetranychus mytilaspidis, are remarkable[1] for the umbrella handlelike stem projecting in the air, from the tip of which strands of silk radiate and are attached at a little distance to the supporting surface. This device probably affords more security on account of the elastic fastening. Many insect eggs are deposited in masses and their form is frequently modified by the supporting surface or surrounding eggs. Some species, like the tussock moth and the tent caterpillar, protect their

[1] 1902 Woodworth, C. W. Cal. Agric. Exp. Sta. Bul. 145, p. 5

ova with cementlike secretions. Others, like the gipsy moth and the brown tail moth, cover theirs with scales or hairs from the body, and still others depend on a protective resemblance and either oviposit in conspicuous places or lay them so flatly, as in the case of the nearly transparent eggs of some species of leaf rollers, that they escape all but the sharpest scrutiny, even when on the exposed surface of a leaf. Those interested in ingenious devices for concealing or protecting these delicate objects, or who are attracted by beauty of form and sculpture, will find the study of insect eggs a fascinating one. In certain cases the ova or eggs hatch within the body of the parent, while from others young appear about nine months after deposition. The larvae of a few species of insects are known to possess the somewhat anomalous power of producing young under certain conditions.

No metamorphosis. Members of the very lowest or simplest order of insects, the Thysanura, which includes forms such as snow fleas, slides or silver fish and their allies undergo no transformation, i. e. there is very little or no difference, except in size, between recently hatched young and adults.

Incomplete metamorphosis. Grasshoppers and other related insects have what is known as an incomplete metamorphosis or transformation, which means that there is a gradual development through a succession of active stages to the adult. The immature individuals are frequently spoken of as nymphs, and our best authorities confine this term to the young of forms having an incomplete metamorphosis. The young grasshopper, as it emerges from the egg, is a curious wingless little creature, bearing a general resemblance to the adult, and one which can easily be recognized as a grasshopper. The little fellow increases in size, and from time to time casts its skin because the comparative inelasticity of the epidermis, or exoskeleton permits of only a limited expansion. The wing pads become longer with each molt, and in the final change the wing cases are slipped off and the organs of flight are at liberty to perform their proper functions. The wing pads may be nearly as long as the fully developed wings in the stage preceding the full grown condition, but the two may easily be separated by the position of these organs. The fore wings of the adult fold over and conceal the hind ones, while in the immature grasshopper the hind wing pads are outside of the fore ones. Many insects like the cockroaches, walking sticks, true bugs and dragon flies develop in this manner, though the earlier stages of all do not resemble the adult so closely as do those of grasshoppers. There are more marked differences between the nymphal stage of the dragon fly and the adult than obtain in many insects having an incomplete metamorphosis, and these insects are grouped with the others because there is no resting period accompanied by marked changes such as occurs in most insects undergoing a complete metamorphosis.

Complete metamorphosis. The most marked changes in development are seen in insects such as moths, butterflies, flies, beetles etc., which undergo what is known as a complete metamorphosis or transformation. Comparatively few understand the relations existing between the voracious caterpillar, the quiet pupa or brightly colored chrysalis and the beautiful moth or butterfly.

Larva. It is very convenient to distinguish between the young of those insects having a complete and an incomplete metamorphosis and this term is frequently limited to the young of the former class, which are commonly known as grubs, maggots, caterpillars and frequently, though improperly, as worms. The young caterpillar emerges from the egg and at once begins feeding. This is the period of growth and most injurious insects commit their depredations when urged by the voracious appetite of adolescence and the several molts occurring during this period are largely to permit increase of size. An impending molt is indicated by the caterpillar appearing dumpish, neglecting its food, followed later by a retraction of the head from its old case and a consequent swelling of the thoracic segments. Soon the old integument splits over the newly developed head case, the caterpillar slowly emerges from its old skin, leaving it in a collapsed, shriveled condition. One of the readiest methods of ascertaining if a molt has taken place is to look for the empty head case or to measure the width of the head, since a marked increase in size usually indicates a molt. Dr H. G. Dyar[1] has shown that a nearly constant ratio exists between the widths of the head of a caterpillar in its various stages. It is interesting to note in this connection that some species of female lepidopterous larvae have an additional molt. Ecdysis in forms having an incomplete metamorphosis is practically the same as that described for a caterpillar except that it is usually accompanied by a greater change in form or a nearer approach to the external appearance of the adult.

The larvae belonging to one order present many diversities of structure but they may all be considered as developments from a more simple or generalized form. A comparison of those belonging to various orders will reveal certain analogies and it will be seen that those less highly developed possess many features in common with the lowest or simplest insects, the Thysanura. They all have, generally speaking, a distinct head, well developed mouth parts, simple eyes, 6 thoracic legs and an abdomen destitute of true legs. The membranous prolegs of hymenopterous, coleopterous and lepidopterous larvae are secondary developments to meet the necessities of existence and vary in number from a large anal one among many beetles to 16 in some sawflies. The same is also true of other structures, such as spines, hairs and tubercles, for while these modify the appearance of the bearer very much, they are of secondary importance.

The larvae of some of the more highly developed insects, such as bees and flies, are legless, and have a very small head and poorly developed mouth parts. The explanation of this may be found in the fact that these larvae are not compelled to make any effort to obtain food. The young of bees are fed by their parents and those of flesh flies and of many parasites find themselves surrounded by sustenance. The same is true of species living in decaying vegetable matter or in many vegetable galls. One of nature's laws is that useless organs must eventually disappear and the degraded or apparently undeveloped condition of these larvae must be regarded as the result of their manner of living. Bearing in mind this law,

[1] Psyche. 1890. 5: 420.

it is easy to see how these legless, degraded forms could have been derived from the more common type through a reduction of their various organs.

The larval stage is frequently of prime importance to the economic entomologist because it is while in this form that many insects commit their greatest depredations. The young of our sawflies may be recognized by their usually cylindric form and by their having 18 to 22 legs including the 6 true or thoracic legs, while caterpillars or larvae of butterflies and moths are usually provided with from 8 to 16. The young of the more highly developed bees and flies, as previously stated, are footless, maggot-like creatures and the young of most beetles possess the 6 thoracic legs and are often provided with a fleshy appendage at the posterior extremity, though in some, such as snout beetles and many wood borers, all the usual locomotive appendages are wanting.

The larval stage of insects, like the others, may be met with under very diverse conditions and in all seasons of the year, though its duration in each species is usually somewhat closely limited. The caterpillar [pl. 7, fig. 1] sheds its skin when full grown and changes to a pupa, a stage which is frequently subconical and often of a brownish inconspicuous color.

Pupa. The assumption of this stage is usually preceded by the larva betaking itself to some sheltered place where a protective cocoon or cell may be prepared. The cocoon may be very delicate and netlike as in the clover leaf weevil, Phytonomus punctatus Fabr. or with an outer net and inner close woven cocoon as in Climacia or a more or less homogeneous silken covering as in the common silkworm. Some native species incorporate leaves or portions of them in their cocoons like the promethea moth. The larvae of many moths construct very perfect earthern cells in which to undergo their final transformations while others depend on the partial shelter of a crevice or curled leaf. Many butterflies undergo transformations in exposed situations and their chrysalids present some interesting adaptations to surrounding objects. The angular protectively colored chrysalis of the spiny elm caterpillar [pl. 10, fig. 10] is an exceedingly interesting object and the daintily colored one of the monarch butterfly, though conspicuous when removed from its natural surroundings, is not often detected in the field. The pupa is usually conical or subconical in form with the rudimentary antennae, wings and legs closely appressed to the breast. It may be conceal d by the last larval skin which usually turns brown, hardens and then is known as the puparium, as in many flies. The unsheltered pupae of many beetles are protectively colored or rendered inconspicuous by morphologic resemblances. This stage is specially a period of transformation and reorganization.

Adult. The comparatively simple caterpillar changes into the delicate highly organized moth or butterfly, which in due time emerges from the shroudlike pupal case. This last stage, contrary to popular belief, is not marked by growth. Flies of various sizes belong to different species; the larger are not parents of the smaller. Some species take no food in the adult condition. A few moths are wingless and simply emerge, deposit their eggs in a few days and die, but the majority consume enough to sustain life for a longer period and not a few winter in this stage. The main object of the adult existence is to provide for the perpetuation of the species and death usually follows soon after.

This stage is marked by great diversity of form and the study of perfect insects in particular and the relation of one to another forms the basis of systematic entomology. The elaborate classification now recognized is not the work of one man or even of a single generation, but represents the combined efforts of many students from the time of Linnaeus and others to the present.

Hibernation. The winter is a period of comparative quiet and few insects are seen in this latitude. The first inference is that most of them have died or disappeared somewhere and the rigors of our climate undoubtedly kill many, yet vast numbers pass the winter in safety and are readily found after a little searching. Some species, as previously stated, hibernate in the egg stage. The tent caterpillars, the white marked tussock moths and certain predaceous bugs are familiar examples of this method of winterm. The half grown caterpillars or larvae of certain moths hibernate in a dormant condition in the sheltering grass and in the spring resume feeding and complete their growth. The partly grown bud moth in its cleverly concealed silken case, sheltered by a protuberance on the twig, and the firmly attached shelters of case bearers with their tiny occupants, are familiar examples of insects wintering in the caterpillar or larval stage. Many species, possibly the majority, hibernate in the pupal stage, which, usually passed in a secure and well hidden retreat, naturally affords much protection from the elements, and as a consequence, hibernation in this form involves less risk than wintering in some other. A large number of insects pass the winter as adults in various sheltered places. Examples of these are many bugs, beetles and even delicate moths and butterflies can withstand the extreme cold of our climate, and some forms are apparently able to survive the winter in either the larval, pupal or adult condition. It is not the degree of cold that is fatal to insects so much as repeated thawings and freezings or a sudden change from one to the other. It is a well known fact that caterpillars may be frozen stiff and revived, but they perish after this is repeated several times.

Parasitic and predaceous insects. These two groups of insects are exceedingly important in controlling insect outbreaks, and occasionally they may be the principal agents in reducing the numbers of a serious insect enemy.

The studies of Dr L. O. Howard[1] have thrown a flood of light on the intricate relations which may exist between a notorious pest and its insect enemies. The white marked tussock moth, Hemerocampa leucostigma Abb. & Sm., was exceedingly abundant in Washington and the opportunity was seized by Dr Howard to make the above mentioned study. He succeeded in rearing from this insect 15 species of primary hymenopterous parasites and listed three others as probably having the same habits. He also bred six primary dipterous parasites from this insect, making a total of 21 and probably 24 species, which depend to a greater or less extent on

[1] 1897 U. S. Dep't Agric. Div. Ent. Tech. Ser. 5, p. 1-57

this leaf feeder for their sustenance. The relations existing between this insect and its parasites were further complicated by the presence of 14 species of hyperparasites, some of which live on their associates, and were therefore parasites of hyperparasites.

This study also resulted in the breeding of 11 species of flies from cocoon masses of this pest. Insect enemies of this species were so abundant in Washington in the autumn of 1895 that they destroyed about 90% of the larvae, as estimated by Dr Howard.

The efficiency of the parasites of the forest tent caterpillar, Malacosoma disstria Hübn. has been brought to the writer's attention on several occasions in recent years. In one instance he found that from 90 to 95% of the caterpillars in one locality had been killed by insect enemies. These two illustrations, and others might be cited, give some idea of the importance of these forms. Insect enemies are also noticed in the following accounts in connection with the species on which they prey, and the reader, by consulting them, may easily note the number of species preying on an injurious form, and in most cases gain some idea of their habits. The great value of insect enemies makes it very desirable to become somewhat familiar with the general characteristics of the more important of these groups.

Parasites. True parasites are distinguished from the predaceous insect by differences in habits. The parasites, in many instances, work internally and are comparatively easy to breed from their hosts, while our evidence regarding the value of predaceous forms rests very largely on their being found in association with a species, or on their being observed depredating on the pest. The true parasites belong to several families of Hymenoptera and to one in the Diptera. Many of our largest and most important true parasites, such for example as species of Pimpla, Ophion, Thalessa, and others, belong to the Ichneumonidae, a very large family, the members of which are distinguished by their wasplike appearance and by their having the abdomen usually flattened as though by pressure from above, and with the first abdominal segment bent at nearly right angles.

The Braconidae include some very important parasites, specially of wood-boring larvae and of a number of leaf feeders. This group may be best recognized by such species as Bracon simplex Cress., a form which is well known to live on a number of borers, and also by the tiny Microgasters, minute species which frequently occur in immense numbers in our larger leaf feeders, and when maturity is attained, make their way out through the body wall of their hosts and spin tiny, nearly cylindric, snow white cocoons on the body of the victim, as represented at plate 44, figure 2.

The Evaniidae or ensign flies, as they are termed by Professor Comstock, constitute a parasitic group which may be easily recognized by the peculiar manner in which the abdomen is carried. The latter is quite slender, attached to the dorsum of the metathorax, and is carried in an elevated position resembling a flag or ensign.

The Chalcididae comprise an immense number of very small parasites, some of which are exceedingly valuable agents in controlling our native insects. A number of species are noticed in connection with their hosts and the general characteristics of the group may be learned by reference to subsequent pages.

The Proctotrypidae in spite of the long family name, are smaller insects than the preceding and a number of them are well known as important egg parasites of some of our more injurious species.

Practically all of the dipterous parasites belong to the Tachinidae, a large family which comprises forms having much the appearance of the common house fly. These insects are more general in their food habits than most of the hymenopterous parasites and frequently attack insects belonging to very different groups. Occasionally members of this family are exceedingly abundant and have a very important part in reducing the numbers of some insect pest. This is particularly true of the notorious army worm, Heliophila unipuncta Haw. It has been recorded in connection with this latter insect that its parasites are sometimes so abundant as to appear in swarms about their victims and it is by no means uncommon to meet with an army worm bearing from 6 to 7 or even more pearly white oval eggs, which are usually deposited just behind the head of the victim. It was formerly considered that such larvae were doomed, but more careful investigations have shown that if the eggs are laid shortly before the bearer molts, the skin may be shed before the grubs can hatch and penetrate the body of their prey.

Predaceous insects. These are also valuable allies in controlling some of our more important insect pests. The large social wasps are known to prey to some extent upon the forest tent caterpillar, Malacosoma disstria Hubn., and the solitary wasps, Eumenidae, also attack various forms. A large group of beetles, known as the Carabidae or ground beetles, are almost entirely predaceous in habit, and undoubtedly aid to a considerable extent in reducing the number of various insects, particularly of those species which descend to the ground at sometime during their existence. These beetles are very voracious and some of them are credited with destroying many more insects than they can possibly devour.

The Cleridae or checkered beetles are exceedingly valuable allies of the lumbermen, since they occur very commonly on forest trees, particularly on those infested with various bark and wood borers. It is by no means uncommon to find their reddish, brown-headed larvae in the burrows of such beetles as Tomicus and related genera, and considerable numbers of adults may be observed on logs and trees badly infested with these insects. Both adults and larvae are exceedingly voracious and undoubtedly accomplish much in controlling borers.

The lady beetles, or Coccinellidae, constitute another exceedingly valuable group. The adults and the larvae are quite voracious, and are notable for their fondness for various species of plant lice and scale insects. The abundance of any members of these two groups is usually followed shortly thereafter by the presence of a great many lady beetles and their young, which feed on adults and young of the pests, and not infrequently do very much toward reducing their numbers.

There are a few of the darkling beetles, Tenebrionidae, credited with being predaceous in habit and as these are found in decaying wood, it is very likely that they may render some service in checking the work of injurious species in such situations.

Another group of predaceous insects which is of considerable importance, is the dipterous family of flower flies, Syrphidae. This contains a large number of species and some are known to be exceedingly valuable on account of their larvae preying on plant lice. The eggs are laid by the female among prosperous colonies of these little insects and the young hatching therefrom proceed to devour their victims, and when the flies are at all abundant, the little pests are soon reduced to harmless numbers.

Certain Hemiptera belonging to the family Pentatomidae, are well known because of their fondness for other insects. The species of Podisus and Euschistus, popularly known as soldier bugs, are sometimes present in considerable numbers and undoubtedly render material aid in controlling some injurious forms. The writer has observed Podisus placidus Uhl., numerous in and about the nests of the apple tent caterpillar, Malacosoma americana Fabr. These little bugs were seen to attack caterpillars five times their size and slay them. As many as six or seven were found within one nest and a number in the near vicinity. The presence of this or related species in such large numbers means the destruction of a great many caterpillars.

There are some other predaceous insects in the north of less importance than those mentioned above. A number of species belonging to the Hemipterous family Reduviidae are well known on account of their living on other insects, and several members of this family have come into prominence because of occasional bites inflicted on man. Several members of the grasshopper order, Orthoptera, are beneficial on account of their destroying various insects. The white flower crickets are common members of this family and while the adults are injurious because of the punctures they make in canes and small twigs, and holes in certain fruits, they possess the valuable habit of devouring a great many small insects.

The southern praying mantis, Stagmomantis carolina Linn., is a well known southern species which preys on a great many insects, and the related European mantis, Mantis religiosa Linn., which has recently become established in New York State, and has been distributed to several localities through the efforts of the writer, may occupy a similar position in the northern states, should it prove able to withstand the severities of our winters and become somewhat abundant, as appears very probable.

GENERAL PREVENTIVE MEASURES

The control of insects, particularly in forests, must be effected very largely through the activity of natural agents, which should be encouraged in every possible way. It is ordinarily impractical to attempt much in either a preventive or a remedial way, in the forests of the United States.

Birds. Among repressive measures perhaps nothing is so effective in forest entomology, as encouraging or protecting the natural enemies of insects depredating on the trees, chief among which may be ranked our native insectivorous birds. Considerable has been written on this subject in recent years, and while it is undoubtedly true that there are two sides to the question, it is quite certain that birds are exceedingly useful checks on some of our more destructive insects. The recent widespread and disastrous outbreaks of the forest tent caterpillar, Malacosoma disstria Hübn., in New York may be charged, in part at least, to the abnormal scarcity of birds. The investigations of Dr William T. Hornaday of the New York Zoological Society, show that in this State there has been a decrease of about 48% in the number of our birds during the past 15 years. These figures, taken in connection with the enormous number of insects our feathered friends devour, are very significant.

The following observations from Mr E. H. Forbush,[1] ornithologist to the Massachusetts State Board of Agriculture, give an excellent idea of the voracity of birds

Birds are remarkably active and energetic creatures, requiring a tremendous amount of food to sustain them in their efforts and to repair the waste of the tissues.

Some of the smaller birds require only half an hour to an hour and

[1] 1904 N. J. State Bd. Agric. 31st Rep't 1903. p. 192–93

one half to completely digest a full meal, and the stomach is filled many times each day. The rapidly growing young need far more food in proportion to their size than the old birds. An adult crow will eat about eight ounces of food daily. A young crow nearly fledged requires at least 10 ounces.

Professor Treadwell found that a young robin needed one half its own weight in solid beef or 48% more than its own weight in worms daily, to secure its healthy growth and development. It is now well known that to these remarkable appetites we owe the repression of many of our insect enemies. The smaller land birds feed largely upon insects. Where insects are numerous birds eat them with almost incredible rapidity. My assistant, Mr E. H. Mosher, saw a pair of tanagers eat 35 newly hatched caterpillars in a minute. They continued eating these minute insects at this rate for 18 minutes; so that, if Mr Mosher's count is correct, they must have eaten in this short time 630 of the little creatures. This would not make them a full meal, as the entire number would hardly be equal in bulk to one full grown caterpillar.

By carefully watching two Maryland yellowthroats and counting the plant lice they ate, he estimated that they destroyed 7000 within an hour, a thing almost incredible, but still possible, when we consider the exceedingly small size of the insects at the time, their swarming numbers, the activity of this warbler and its remarkably rapid digestion. Dr Judd speaks of a letter received from Mr Robert H. Coleman, in which he says of a palm warbler, that it must have killed 9500 insects in about 4 hours. These may be extreme cases, but even if we halve the numbers given, they will still serve to show the bird's possibilities for good.

The remarkable appetites of the young birds keep their parents very busy. The old birds usually carry to the young from 1 to 12 insects at each visit to the nest, although some visits are made for other purposes. A pair of vireos visited the nest 125 times in 10 hours. A pair of chippies made nearly 200 visits to their young in a day. Martins have been seen to visit their young 312 times in 14 hours. Rose-breasted grosbeaks made 436 calls at the nest in 11 hours. House wrens have been seen to enter the nest from 30 to 71 times an hour.

In view of these facts we may, in time, come to give credit to the statement of Professor Wood that the daily food of a robin is equal in bulk to an earth worm 14 feet in length. He tells us that were a man possessed of proportionate food capacity he could consume each day 67 feet of a sausage 9 inches in circumference.

The following facts recorded by Messrs Mosher and Kirkland[1] working under the direction of Mr Forbush, are of great interest, since they give

[1] 1899 Mass. Crop Rep't Sep. p. 31–32

detailed information concerning the voracity of certain birds feeding upon gipsy moth caterpillars, a species of much importance not only to Massachusetts but to the entire northeastern United States.

GIPSY MOTH CATERPILLARS EATEN BY BIRDS

May 12	A yellow warbler ate 15 caterpillars in less than 5 minutes.
May 12	A Nashville warbler ate 42 caterpillars in ½ hour, in the meantime taking many more.
May 18	A scarlet tanager ate upwards of 30 caterpillars within 5 minutes.
May 18	Two scarlet tanagers together ate small caterpillars at the rate of 35 a minute for 18 minutes.
May 20	A crow blackbird ate 40 caterpillars in a little over 3 minutes.
May 26	A Maryland yellowthroat ate 52 caterpillars while moving in and out among trees. Time not taken.
May 26	A redstart ate 31 caterpillars while moving about. Time not taken.
	A red-eyed vireo ate, in four brief visits to an infested tree, 37 caterpillars.
July 13	A yellow-billed cuckoo ate 1 every 2 minutes for 36 minutes.
	A red-eyed vireo ate 73 in 40 minutes.
July 14	A yellow-billed cuckoo ate 81 in 48 minutes.
July 15	A towhee ate 7 pupae and 2 caterpillars in a very short time. Exact time not noted.

These facts indicate that birds must be exceedingly effective checks on outbreaks of such leaf feeders. This record is by no means exceptional as may be seen in the following paragraph by Mr E. H. Forbush:[1]

As showing the large numbers of these caterpillars eaten by birds, a few notes from Mr Mosher's observations will be of interest. A black-billed cuckoo was seen to eat 36 forest tent caterpillars within 5 minutes. Red-eyed vireos (probably a pair) took 92 forest tent caterpillars from a tree within an hour. They were also eating span worms and other larvae and plant lice. A male Baltimore oriole went into a tree infested by these caterpillars, where he stayed 4 minutes, killing 18 caterpillars in that time; coming a little later he stayed 7 minutes, and took 26 caterpillars. A pair of blue jays came to the tree 24 times during 3 hours, taking 2 or 3 caterpillars at each visit.

Those not familiar with bird life will be surprised to know how many species prey on injurious insects. Mr Forbush has recently published a

[1] 1900 Mass. Crop Rep't. July. p. 29

list of 30 species known to feed on the gipsy moth, Porthetria dispar Linn. He has found 25 feeding on the imported brown tail moth caterpillar, Euproctis chrysorrhoea Linn., 25 feeding on the forest tent caterpillar, Malacosoma disstria Hübn., 32 feeding on the apple tent caterpillar, Malacosoma americana Fabr., and 51 feeding on cankerworms. Dr A. D. Hopkins in a recent bulletin states that woodpeckers "are the most important enemies of spruce bark beetles, and appear to be of inestimable value to the spruce timber interests of the Northeast." Of many hundreds of infested trees examined by him, he is confident that at least one half of the beetles and their young had been destroyed by the birds, and in many cases it was evident that even a greater proportion had perished from this cause alone. He adds that estimating 100 beetles to the square foot of bark, and an average of 60 square feet of infested bark, it is possible for each tree to yield an average of 6000 individuals; 100 trees, 600,000, and so on. It is therefore plain, that if one half or two thirds are destroyed by the birds and other enemies, the amount of timber the remainder kills will be much lessened; specially is this true because the beetles must be present in great numbers before they can overcome the natural resistance of the living trees to injury.

He also gives a list of the common and scientific names of the woodpeckers of northern New England, prepared for him by Dr C. Hart Merriam, chief of the Biological Survey, United States Department of Agriculture. It is to these birds that Dr Hopkins refers, though no evidence was obtained at that time as to which species was to be credited with the larger part of the beneficial work. The list follows:

Hairy woodpecker - -	Dryobates villosus
Downy woodpecker - -	Dryobates pubescens medianus
Arctic three-toed woodpecker	Picoides arcticus
Banded three-toed woodpecker	Picoides americanus
Yellow-bellied woodpecker -	Sphyrapicus varius

19[illegible] Mass. Crop Rep't, July p. 34.

1901 U. S. Dep't Agric., Div. Ent. Bul. 28, n. s. p. 25-26.

Red-headed woodpecker Melanerpes erythrocephalus
Flicker - - - - - Colaptes auratus luteus
Pileated woodpecker - - Ceophloeus pileatus abietorum

The activity and efficiency of some of our native woodpeckers is strikingly shown by the following notes published by Mr E. H. Forbush.[1] He states that his friend, Mr C. E. Bailey observed a downy woodpecker Mar. 28, 1899, make 26 excavations for food between 9.40 a. m., and 12.15 p. m. The bird during this time climbed over and inspected in a greater or less degree 181 trees. Most of these excavations exposed galleries in trunks or high branches in which ants were hibernating, and examination of the stomach of this bird disclosed one spider, one unidentified beetle, two scolytid larvae, 22 ants, and a mass of partly digested material which could not be identified. Mr Forbush continues the record and states that another downy woodpecker was observed Mar. 31 taking larva and beetles from beneath the bark of oak trees. He adds that the birds seem to know the exact spot to drill for each larva as it always cuts a small hole directly over the insect and invariably finds the prey. The splintered, bare piece of plum shown in figure 1, only a portion of several limbs, yards in length, also illustrates well the industry of these birds.

Fig. 1 Work of woodpeckers on plumtree infested by fruit tree bark beetle

Mr E. H. Forbush,[2] in connection with various assistants, has given considerable attention in recent years to the economic value of a number of our native birds, and has prepared a brief summary of the relative value of certain families. His estimates are so valuable that they are given here in the hopes that more may be led to recognize the importance of these forms as checks on injurious insects, particularly in forests. The work had special reference to the value of birds as checks on the gipsy moth and other hairy caterpillars. His summary is practically as follows:

[1] 1900 Mass. Crop Rep't. July, p. 31.
[2] 1899 Mass. Crop Rep't. Sep. p. 34-36.

CUCULIDAE

Cuckoos

It is generally acknowledged that the cuckoos are an exception to the usual rule that birds do not eat hairy caterpillars. There is no question as to their value in this respect, and they feed mainly on medium sized and larger caterpillars. The two common American species seem to prefer hairy caterpillars to smooth ones, and their diet sometimes results in their stomachs becoming lined with prickly hairs, the ends of which are imbedded in the stomach walls. This, however, does not appear to inconvenience the birds. Whether there is any other family that is as useful in this respect as the cuckoos is still an open question. Our observations show that great numbers are eaten by other birds.

PICIDAE

Woodpeckers

Woodpeckers certainly do not destroy as many hairy caterpillars as the cuckoos. They appear to take them only when they come in their way, frequently maiming and killing without eating.

TYRANNIDAE

Flycatchers

The flycatchers eat very few hairy caterpillars but destroy a great many imagos of the diurnal species, two kingbirds having been observed to kill about 250 male moths of Porthetria dispar in less than three hours, and many female moths as well. Many moths are destroyed on the wing by flycatchers.

CORVIDAE

Crows, jays etc.

This family is represented by the blue jay and crow, both species being among the most useful in the destruction of medium sized and full grown caterpillars. The observations on these birds made within the last three years prove them to be more useful in this respect than was suspected. They are continually feeding where outbreaks of hairy caterpillars occur, eating both the caterpillars and pupae, and feeding them to their young. These birds, because of their size and voracity, destroy large numbers of larvae. Crows destroy fully as many pupae as larvae.

ICTERIDAE

Orioles

The Baltimore oriole and crow blackbird are exceedingly useful. As the feeding habits of these birds have become better known their usefulness in destroying hairy caterpillars has been recognized. They eat mainly medium sized and larger larvae.

FRINGILLIDAE

Finch and sparrow family

The finch and sparrow family is represented in Massachusetts by many species, several of which do not appear in the list of those attacking hairy caterpillars, but probably most sparrows eat such caterpillars to some extent. The chipping sparrow, song sparrow, towhee and rose-breasted grosbeak habitually feed on them. Several observers have seen the indigo bunting attacking them. The sparrows eat both large and small caterpillars.

TANAGRIDAE

Tanagers

The tanagers are potent enemies of hairy caterpillars wherever they appear in numbers in the woods, feeding quite constantly on them. Our later observations indicate that no bird is more useful in woodlands.

VIREONIDAE

Vireos

The vireos or warbling flycatchers are persistent caterpillar hunters and destroy many of these creatures. They do not feed so readily on the full grown caterpillars as on the smaller, but none are safe from their attacks.

MNIOTILTIDAE

Warblers

It was not till 1899 that the value of the warblers as caterpillar eaters was fully established. As they are small birds and feed mainly on smaller larvae, it is very difficult to determine by observation exactly what they are feeding on.

A special effort was made during 1899 to secure accurate data in regard to the destruction of the smaller hairy caterpillars by warblers. The result has demonstrated that warblers are certainly among the most useful birds in this respect, specially during the early part of the season, when most larvae are small. They appear so fond of these larvae that they will even climb about on the trunks of the trees to get them.

MIMINAE (subfamily)

Mocking thrushes

Represented by the catbird and brown thrasher. They are certainly among the most useful birds. The catbird eats hairy caterpillars greedily, destroying even those covered with spines, like the Euvanessa antiopa, and feeds many caterpillars to its young. It eats full grown caterpillars about as readily as cuckoos, taking mainly those that have, perhaps, escaped more arboreal birds by remaining in the shrubbery near the ground.

TROGLODYTIDAE

Wrens

The house wren is the only species that has been seen by our observers to eat hairy caterpillars. It can hardly be called a common bird, and it has only occasionally been seen to eat these caterpillars.

PARIDAE

Nuthatches and titmice

The chickadee, the common representative of the titmouse family, and one of the most useful of all birds, is a great destroyer of hairy caterpillars. Not only does it eat caterpillars of all sizes, feeding them to its young, but it destroys all forms of these insects, except, perhaps, the eggs of some species. Too much can not be said in favor of this most useful and harmless bird. Both species of nuthatch take these larvae only as they come in their way on the trunks of trees, and not always even then.

TURDIDAE

Thrushes

While the thrushes eat hairy caterpillars when they come in their way, they do not, with the exception of the robin, appear to search them out. The robin seems to be in this way the most useful of all thrushes. The wood thrush and Wilson's thrush occasionally visit localities infested by the caterpillars and eat a few, but the robin visits them frequently and eats many. The thrushes eat mainly the larger caterpillars.

The bluebird is useful in destroying most forms of these insects, but as bluebirds are not plentiful in the infested region the opportunity for observation has not been so good as in the case of some other species.

Prof. S. A. Forbes, state entomologist of Illinois, has made an extended study of the food habits of different birds and he estimates that there are about 10,000 insects per acre over the entire state, and on this basis concludes that if the operations of birds were suspended entirely for a period of seven years, the entire state would be carpeted with insects, one to the square inch. Professor Forbes gives this as an illustration, by no means as a prediction, and it certainly is a graphic way of stating the high value he places on bird life as a means of checking the depredations of insect pests. Professor Forbes has estimated that should the people of the state apply appropriate measures to increase the efficiency of bird life in destroying insects, even if it was no more than 1%, the agriculturists of that state would be saved $76,000 a year at the lowest, and probably five times that amount.

Mr E. H. Forbush in a recent publication[1] has made some recommendations which, if adopted, should result in increasing the number of useful birds in woodlands:

Some practical lessons have been learned from studying the food of wood birds. As birds go where they find food most abundant, many birds of the swamp, field and orchard go from their usual haunts, ½ mile or more, to the woods to feed on insects plentiful there. Thus the bobolink in the meadow goes to the woods for aphids, and the oriole in the orchard and the blackbird in the marsh go there for caterpillars. On the other hand, the chickadee, blue jay, tanager and the warblers go from the woods to the orchards and gardens for caterpillars. In an orchard near the woods we noticed that the wood birds came frequently to those trees nearest the woods, and by adding their work to that of those living in the orchard, soon cleared the cankerworms from the trees nearest the woods.

All our experience thus far goes to show that a well watered country, where the woodland is kept mainly in detached patches, with the rest of the land more open, much of it well cultivated, with an occasional marsh or swamp, is the best calculated to encourage the increase of the largest number of species of birds. In such a country vegetation should therefore receive better protection from birds than elsewhere. In view of these facts, it is possible for a man owning from 30 to 100 acres of land to so select his land and control the growth of vegetation upon it as to obtain conditions attractive to an abundance and variety of birds. The first requisite is a plenty of suitable food, and for this a variety of vegetation is desirable. This provides not only a variety of fruit and seeds, but furnishes food for a large variety of insects, which will attract the birds. It is especially desirable to have both wild and cultivated cherries and grapes, and if the birds take too large a proportion of the cultivated species, the earlier wild berries, like the Russian mulberry, and the shadberry, should be planted to draw the bird's attention from the cultivated fruit. Winter food may be furnished birds by planting mountain ash, sumach, bayberry and other berries which cling to the trees or shrubs bearing them during the winter months. The winter birds may be induced to remain in some numbers by hanging bones, suet or portions of any carcass in sheltered places on the trees. These will furnish food for them when the trees are covered with ice, and will keep them in the neighborhood during the coldest weather. Sunflower seeds, broken nuts and grain will sometimes attract winter birds.

Having secured food the birds must have shelter from the elements and their enemies. This may be provided by planting thick evergreen trees in groups and allowing a deciduous thicket here and there. Nesting boxes should be provided for those birds which will use them and such

[1] 1900 Mass. Crop Rep't, July, p. 38–39

boxes will shelter many a bird from winter storms. Nesting material, such as straw, feathers, waste string etc., should be hung on limbs during the nesting season. It will soon be utilized. Having made a locality attractive to birds they must be protected and fostered. Birds soon learn to love a place where they receive a measure of protection from their enemies. We may protect them:

1 By doing away with cats, so far as possible
2 By stopping promiscuous gunning
3 By suppressing bird-egging boys
4 By keeping hawks, crows and jays within bounds.

It is well not only to have a variety of trees in your woodland, but also to have portions of it in different stages of growth. A small patch of ground covered with young sprouts furnishes a desirable breeding place for such birds as the indigo bird, brown thrasher, towhee and several warblers, all of which may be very useful in adjoining woodland. If each farm, wooded or otherwise, could be ideally situated and cultivated, with the protection and accommodation of birds always in view, it is doubtful if paris green and other insecticides would find a ready market in the commonwealth, except, perhaps, in such cases as that of the gypsy moth, where a man disturbs the balance of nature by introducing a new pest from a foreign shore.

REMEDIAL MEASURES

The conditions under which trees grow along our streets and in our parks are so very different from those obtaining in nature that methods of value in one place could not be tolerated in the other. The comparatively high value of individual trees in streets and parks warrants much larger expenditures or more labor than could be advised in the forest.

Street and park trees

The following paragraphs apply in particular to the more highly prized trees of our roadsides, lawns and parks and the recommendations are not intended for the forester.

Methods against biting and sucking insects. Practical considerations compel the recognition of two classes of insects, the biting or devouring and the sucking species. The work of the former is characterized by the removal of more or less tissue from the part attacked, while the latter never do this, though they frequently cause wilting and discoloring in the immediate vicinity of the injury. Generally speaking, biting insects can be controlled by spraying infested plants with arsenate of lead, paris green, london purple or other arsenical poisons. The aim of such treatment is to cover the plant so thoroughly with the substances used that it will be practically impossible for the pest to feed without also consuming the deadly insecticide. Experiments have shown more than once that caterpillars will not feed on foliage sprayed with poison till forced to do so by hunger, while those placed on untreated leaves, with all other conditions the same, manifest no such hesitancy. Thus it is pretty safe to assume that insects will not eat poisoned leaves unless obliged to do so or go hungry, and that only the most thorough spraying will produce satisfactory results. Measures of value against leaf devourers may not have the slightest effect on those species which obtain their nourishment by sucking, through a slender beak, the fluids from the underlying plant tissues. Particles of paris green or other such poison lying on the surface of the plant will not affect them and as it is practically impossible to so change the vegetable fluids that an insect will not or can not feed upon them and yet not damage the plant, we must depend to a great extent on contact insecticides in fighting these pests. The most satisfactory method of killing such insects as aphids or plant lice, scale insects, etc. is by spraying them with kerosene emulsion, whale oil soap solution or similar substances, which operate either by closing or choking the breathing pores or spiracles along the sides of the insect or they may exert a paralyzing influence through these orifices. The applications must be made directly to the insects themselves and the effectiveness of the treatment will be proportional to the number actually hit. In short, when fighting leaf-devouring insects, aim to cover the portions of the plant liable to attack with some arsenical poison, while in controlling sucking forms, it is essential to throw a substance, which will kill by contact, on the insects themselves.

The foregoing are general directions subject to many modifications. Some pests are very resistant to poisons and require large doses before succumbing, but as a rule the trouble is more apt to be lack of thoroughness in the treatment than weakness of the insecticide. Many biting insects, like leaf miners, twig, bark and wood borers operate in places where it is impracticable to put the poison. Others feed underground on roots and must be fought in special ways. Sucking insects also present exceptional difficulties. Some are cased with so resistant armor that it is nearly impossible to kill them with substances that will not at the same time injure the plant. The attacks of many plant lice cause the leaves to curl so that it is very difficult to hit them with a spray. Small leaf hoppers sometimes occur in such large numbers that, owing to their activity and resistance to insecticides, they are very difficult to control. Others, like biting forms, may work beneath the surface of the soil, and are therefore nearly inaccessible. Study has shown that in the case of almost every injurious insect there is some point in its life history where it is comparatively easy to keep the pest in check. A little difference in cultural methods will sometimes accomplish much. As a general rule, the wholesale destruction of insect life by the use of deadly sprays is to be avoided. Prevention is the most successful method of anticipating insect depredations. That is, avoid, so far as possible, offering conditions favorable for the development of insects in large numbers. Suppression and control, rather than extermination, should be the aim. The latter is impossible, generally speaking, while the former is frequently our only hope.

Useless remedies. Avoid patent remedial preparations, specially those that are advertised to kill most, if not all insects, and act as a fertilizer in addition. A large corps of trained workers in experiment stations and other public positions are at present engaged in searching for new insecticides and in determining the best methods of applying them. Recommendations from such sources can usually be relied on. Some of the preparations sold in the markets are undoubtedly of value, but they almost invariably owe their efficacy to well known substances and not to secret compounds. The great objection to this class of insecticides is that the consumer pays several times the value of the article, because it is in a disguised form, and he is usually ignorant of its nature. There are other so called remedies which are totally worthless, having no intrinsic value of themselves. One of the most persistently advertised of these is the old trick of plugging a tree with sulfur or other substance in order to render the sap distasteful to insects of all kinds. This is a fascinating theory, but has absolutely no basis in fact. The safest way is to disregard all innovations till they have been duly tested at experiment stations or are recommended by well known authorities.

Need of experiment. The following formulas comprise what are regarded as the most reliable, but must be modified under varying conditions, to meet the demands of the occasion. It should be borne in mind that in many cases it is not so much the insecticide used as the manner of its application, though in some cases the difference is due to a variation in composition.

Formulas for arsenical preparations. Arsenate of lead may be prepared as follows: Dissolve 11 ounces of acetate of lead (sugar of lead) in four quarts of water and four ounces of arsenate of soda (50% purity) in two quarts of water, each lot in a wooden pail, and then add the solutions to the required amount of water, which for most leaf-eating insects will be about 50 gallons. This substance can be used in much greater strength without danger of injuring the plants, provided it is properly prepared, and though this poison does not act so rapidly as paris green and its allies, it possesses superior adhesive powers, can be applied in much greater quantities and its white color renders its detection on foliage very easy. It is of special value against the elm leaf beetle because of its adhesiveness — it frequently remains on the foliage nearly an entire season in spite of many rains — and for this insect it is better to use the amounts given above in but 30 gallons of water. This poison has also been placed on the market in a paste form ready for dilution with water. Thus prepared it has all the good properties of the freshly made material and may be used with confidence. The crystalline arsenate of lead can not be recommended as it is heavier and does not adhere to the foliage as well as the other form.

Paris green or london purple, and also certain other arsenical preparations, are used with great success in combating leaf feeders. One pound of either of these poisons to 100 to 150 gallons of water is the proportion usually advised. It is also well to employ an equal amount of recently slaked lime (mix with considerable water and strain before adding) in order to lessen the danger of burning the foliage. It is essential that either of the above mixtures be kept well stirred in order to secure uniform results, as the latter named poisons, in particular, sink rapidly to the bottom of the tank.

Formulas for contact insecticides. Kerosene emulsion is one of the most important contact insecticides, that is, those which must be actually thrown on the insect in order to secure results. It may be prepared as follows: dissolve one half pound of hard soap in a gallon of boiling water and while it is still hot add two gallons of kerosene, and emulsify either by stirring rapidly or by repeatedly forcing it through a pump and fine nozzle. A white, uniform creamy mass which does not break up into oil and water should be obtained and this can then readily be diluted with water, the usual amount being nine parts water to one of the emulsion. A sour milk emulsion should be used in limestone regions, two gallons of kerosene to one gallon of sour milk, emulsify as described above and dilute. The 10% mechanical kerosene emulsion can be used in a similar manner, provided the pump can be depended on to give reliable proportions, which is not often the case. One pound of whale oil soap to four gallons of water is the strongest that can be used safely on foliage and one pound to six gallons is usually as effectual as the kerosene emulsion for similar purposes.

The above formulas are to be used on trees in foliage and can be depended on to kill only the more tender insects. The abundance of certain scale insects in recent years has shown the need of something more effective and what are known as winter washes have been devised. These are more penetrating corrosive or alkaline substances which can be applied with safety to trees only while they are dormant, and are therefore more fatal to insect life. The whale oil soap solution, 2 pounds to a gallon, comes under this head and it may be applied either in the fall or spring for the destruction of certain scale insects. It has been used[1] very successfully against the San José scale, Aspidiotus perniciosus Comst.

This material has been found injurious to fruit buds of peach when applied in the fall, and it is very likely that it might kill the more tender buds of some other trees when used in similar way. Early spring applications, however, do not affect buds of our fruit trees and this is probably true of ornamentals. This soap appears to be giving way to the more effective and much cheaper lime-sulfur washes.

The lime-sulfur wash, or as it is more generally known, the lime-sulfur-salt wash is rapidly becoming a favorite remedy for scale insects in the Eastern states. It may be prepared in a number of different ways with very diverse proportions of the various ingredients, and still be effectual. An old and very good formula consists of 40 lb lime, 20 lb sulfur and 15 lb of ordinary salt to 60 gal. of water. Another calls for 15 lb each of lime, salt and sulfur to 50 gal. water. Later experiments have shown that these can probably be modified to considerable advantage and the salt omitted. A very satisfactory combination is made by using 20 lb lime and 15 lb sulfur to 50 gal. of water. The lime should be added to a little hot water in a kettle, and as soon as slaking begins, put in the sulfur and boil vigorously for at least 30 minutes, stirring constantly in order to get a smooth mixture. Combination between the lime and sulfur is facilitated by the use of an alkali such as caustic soda, and recent experiments have shown that sal soda, 10 lb to the above named amounts, makes a very good wash and obviates the necessity of boiling. Several pails of hot water are put into a barrel, the lime is added, quickly followed by the sulfur, then the sal soda, and the entire mixture is stirred vigorously till the reaction has ceased sufficiently so as to allow the covering of the barrel with burlap, and the mixture is then allowed to stand for at least 30 minutes, strained and diluted with cold water to the requisite amount. It is sometimes necessary to add a little cold water to prevent the compound from boiling over and care should be taken not to stir so much as to hinder the chemical reaction. This latter formula, while very promising, is still in the experimental stage.

Fumigation. Scale insects can also be controlled very successfully by fumigation with hydrocyanic acid gas. This treatment should be given in the winter time when the trees are dormant and is of particular value where a large number of small trees must be treated. The tents necessary for fumigation are too expensive for moderate or large size trees. The process consists in covering the tree with a canvas tent and generating the gas underneath it by applying diluted sulfuric acid to potassium cyanid. This method is extensively used in California on citrus trees and has been employed to some extent in the east. There are a number of different tents which have been designed for this purpose by various investigators, and those wishing to treat their trees may find it advantageous to consult Professor Johnson's *Fumigation Methods*.[1] Those who have only a few trees and wish to employ the gas in a small way may find the following directions of service. The trees should be exposed to the action of the gas for 35 minutes at least, and one ounce of the cyanid (98% purity) should be used to every 75 cubic feet of space together with an equal amount, by liquid measure, of the best commercial sulfuric acid (specific gravity 1.83) and three times that amount of water. Professor Johnson has advised using $1\frac{1}{2}$ ounces of acid to $2\frac{1}{4}$ ounces of water to each ounce of cyanid. The cyanid should be placed in an earthenware crock near the trunk of the tree, as distant as possible from the tent, and when everything has been prepared, the diluted acid (which is prepared by turning the acid slowly into the water, stirring constantly in the meantime) should be emptied into the crock containing the necessary amount of cyanid and the tent quickly made tight all around. These materials are extremely dangerous to handle, the acid will burn almost anything and causes very bad sores, while the cyanid is one of the most deadly poisons known. The fumigated trees should be covered with a tight tent which is usually made of 8 ounce cotton ducking thoroughly coated with boiled linseed oil, paint or other material in order to make it gas tight. The tent may be bell-shaped or rectangular and supported by a frame or may even consist of a large sheet thrown over the tree. The form supported by the frame is the better because of the ease

[1] Orange Judd Co. 1902.

with which the cubic contents may be calculated. Several box tents covered with canvas or even roofing paper have been devised. These are provided with frames and either constructed with a flexible hood so that they can be dropped entire over trees or else with a removable side which can be quickly and tightly clamped to the frame.

Directions for spraying. In order to spray trees successfully, certain rules must be observed. Apply the poison at the time the insects begin to feed and where they must eat it if the tree is attacked. Early spraying not only prevents much injury to foliage but it is likely to be fully as effective because young caterpillars as a rule succumb more easily to poisons. In the case of certain insects, it is best to throw the spray on the under surface of the leaves so far as possible, as some young caterpillars and elm leaf beetle grubs in particular, prefer the tender lower epidermis. Do thorough work, that is, try to cover every leaf with the mixture and spray till the tree begins to drip, but no more. The finer the spray, the better, as a more even distribution is insured. The poisonous mixture must be kept agitated while spraying is in progress. Good work can be accomplished with hand pumps, though a power spraying apparatus is the best and plenty of hose is essential, as a fine spray can not be thrown far and it is therefore usually necessary to do more or less climbing. Remember that very much depends on the man at the nozzle and insist on having one who can be relied on. It is the poorest economy possible to put a cheap man in this responsible and somewhat disagreeable position. It is comparatively easy to give directions but the man who faithfully and intelligently carries them out is not often found, and he who will temper his work with judgment is a rarity.

Cost of spraying trees. Several years ago we took some pains to ascertain the precise cost of spraying in the hope of encouraging those to whom the expense seems a serious item, and it is pleasant to record that it is much lower than had at first been supposed. Dr Smith, of the New Jersey agricultural experiment station, kindly supplied the following data in 1898. The elms on the college campus at New Brunswick are 5? to 75 feet high and were sprayed at odd times by the janitors, about an hour being required by two men with force pump, tank and ladders to treat one tree. The poison necessary for each spraying was worth about 6c. It will thus be seen that the cost for each tree would be between 36c and 50c, varying with the price of labor. In New Brunswick, N. J., the trees were sprayed at a contract price of $1 for the season, the understanding being that they were to receive three treatments if necessary. The contractor prepared the outfit, furnished the material, did the spraying at the price mentioned and had a neat margin remaining.

The cost of spraying elms in Albany in 1898, aside from wear and tear of the apparatus, was about 15c a tree for each spraying. This average was based on one or two days work and probably would not hold for the season. It is very likely that it would have paid to give each tree a little more time, which would have brought the average cost up somewhat. The elms of Albany range from 20 to about 70 feet in hight, though most of them are over 50.

The average cost of one spraying in Albany in 1900 was about 22c a tree. The spraying was done with apparatus to be described later, and under civil service regulations, which require men to work but eight hours a day. Two power spraying outfits under one foreman's direction constituted the force. It would be possible in private work to reduce the force somewhat and have one man serve both as motorman and driver. A little more selection could also be exercised and possibly more efficient men secured than can usually be obtained for such work under civil service regulations.

Mr H. W. Gordinier of Troy found that in contract work in the village of Lansingburg, where he sprayed all the trees, the average cost a tree for each spraying was 23c. This figure, however, was raised considerably in his work in Troy where the trees were sprayed at the expense of private parties and there was necessarily much running hither and thither; under these conditions it ranged from 50c to 60c a tree, the cost depending on the size and the number in one locality. Large maples have been sprayed at a cost of only 17¼ cents per application, as stated below.

The saving in cost shown by the above figures, not to mention the greater benefit to the public, particularly in the poorer sections of a city where shade trees are most needed and where they are usually neglected, is a strong argument in favor of such spraying operations being done by villages and municipalities. The more general and thorough the work, the more satisfactory are the results.

Proper apparatus. In order to do this work successfully one must possess a force pump capable of throwing a stream some distance, a number of feet of hose and a nozzle that will discharge a rather fine spray. There must also be something to hold the poisonous mixture and a ladder facilitates the work of application greatly.

One of the best arrangements for hand work is most probably found in a spraying outfit on wheels that can be readily moved from place to place [pl. 21]. In most cases this takes the form of a box or barrel to which a force pump is firmly attached, and is either provided with wheels or designed to be placed in a wagon. It is necessary to have 25 to 50 or more feet of $\frac{1}{4}$ or $\frac{1}{2}$ inch hose when spraying tall trees, while the addition of a 10 to 25 foot metal extension adds materially to the value of the apparatus. It is essential to have a nozzle that will produce a fine spray, not clog, and which can be quickly adjusted to throw a coarse spray some distance if desirable. Such an outfit is of great service to any individual having considerable spraying to do and it could undoubtedly be used to advantage by those desiring to make a business of spraying in a small way, as for example the treating of trees here and there for those in cities wishing their trees sprayed and not willing to purchase the necessary apparatus.

In the extended work against insects, specially the elm leaf beetle, conducted by cities and villages, it is desirable to have apparatus that will admit of more rapid work. This at first led to the refitting of retired fire engines and the designing of more or less cumbersome outfits for the purpose. In all cases these makeshifts have been successful, though they are not so satisfactory in operation as those specially adapted to the purpose. One of the best forms of apparatus yet designed for spraying trees is that constructed under the direction of Dr E. B. Southwick, entomologist of the department of public parks of the city of New York. This is the form used in Albany. The whole outfit is represented on plate 21. It consists of a Daimler gasoline motor operating a Gould force pump. The motor and pump, weighing but 300 pounds, can be placed in the bottom of a spring wagon along with the 100 gallon tank containing the poisonous mixture. This motor has the advantage of being almost noiseless in operation and is scarcely noticed by passing horses. It is very inexpensive to operate, as a gallon of gasoline is sufficient for a day, and it requires so little attention that a tyro can run it. The smallest size Gould three-piston pump is the one used with the motor, though Dr Southwick now recommends a larger one in order to utilize the power more fully. A complete power spraying outfit, aside from horse and wagon, should not cost over $500, the price naturally varying with market conditions and quality of materials used. Four lines of hose can easily be supplied, though in most places in Albany not more than two can be used to advantage.

Some other apparatus in addition to that usually supplied with spraying outfits is necessary. Several ladders or some convenient arrangement for getting up into trees is almost essential unless the spraying wagon has one of the elevating platforms such as are used by electric car companies on repair outfits. Two power spraying outfits constructed for the village of Saratoga in 1899 were provided with these elevating towers and they were found to be very effective and economical. The cost of spraying for the forest tent caterpillar which, by the way, need not be done so carefully as for the elm leaf beetle, was but $17\frac{1}{4}$c a tree, and considerable of this saving was attributed to the elevating towers. In this instance 5667 large maple trees were sprayed and practically all in the village were treated, thus enabling the operators to save time in every possible manner.

Hand collecting, etc. Hand collecting appears very slow, laborious, and not at all adapted to present conditions. This is true in a great many instances and yet there are cases where hand picking is one of the most economical methods of controlling certain injurious species. The white marked tussock moth, Hemerocampa leucostigma Abb. & Sm., is a form which can be controlled as readily by collecting its white egg masses as by spraying. These latter are easily gathered, and the tree once cleaned, will remain so for some time, or until the caterpillars can make their way from adjacent trees. Several cities in New York State have found it an exceedingly good investment to pay children a nominal amount for collecting the egg masses. The weakness of this method is that it is apt to be spasmodic and the rewards are offered only during times when the caterpillars are exceptionally injurious, hence the insect is allowed to increase at intervals and periodically inflicts considerable damage. The city of New York pays an entomologist connected with the park department, who makes a practice of collecting the egg masses of this insect. This should be done in other cities where this species is a pest. This method can also be applied in a measure to the collection of the cocoons of our larger moths, such as the promethea moth, Callosamia promethea Drury and the Cynthia moth, Philosamia cynthia Drury and others.

Borers. Hand labor is practically the only method of dealing with certain borers. Dr E. B. Southwick of New York city has met with considerable success in controlling the notorious leopard moth, Zeuzera pyrina Linn., a species which has become well distributed throughout that city and which infests practically all kinds of trees. His men inject carbon bisulphid, carried in an engineer's oil can, into all holes which give any indication of being inhabited. The orifices are then closed with putty and other scars on the trees are carefully treated. This method has also been applied with a little variation in details in the case of the carpenter worm, Prionoxystus robiniae Peck, in the Buffalo parks by the late M. F. Adams, who preferred to stop the entrances with soap.

Prevention of attack by the application of a deterrent wash is frequently advised against these insects. The treatment consists in applying a wash to parts liable to attack just before the egg-laying period, for the purpose of driving the females away before they deposit eggs. One of the best formulas is the following: 1 pt. of crude carbolic acid (½ pt. refined), 1 gal. soft soap, thin with 1 gal. hot water, stir in acid, let it set over night, then add 8 gal. soft water. Or to a saturated solution of washing soda add soft soap to make a thick paint; this is improved by 1 pt. of crude carbolic acid and ½ lb paris green to 10 gal. of wash. Or in 6 gal. of saturated solution of washing soda, dissolve 1 gal. of soft soap, add 1 pt. of carbolic acid, mix thoroughly, slack enough lime in 4 gal. of water, so that when added, a thick whitewash will result, then add ½ lb of paris green, mix thoroughly. The latter is probably the best. Valuable only to prevent egg-laying on bark.

SELECTION AND PLANTING OF TREES

Something can be done along this line, in the case of shade trees, toward preventing serious depredations by some pests. Rapidly growing trees have vigor enough to withstand the attacks of some insects and apparently they are not able to thrive on such trees. This result can be obtained only by providing the right conditions. Trees should be set in congenial soil and placed where they will have no difficulty in securing an adequate amount of nourishment, water and sufficient light. Requisite space should be provided or crowding, followed by lowered vitality and insect attack will probably result.

The abundance of serious insect enemies in the eastern United States makes it advisable to consider the resistance of certain trees to insect injury before setting them out. Some are very subject to such attacks and while there are other important factors to be taken into account, this should not be overlooked. Dr L. O. Howard in connection with some estimates prepared by Dr B. E. Fernow, then chief of the division of forestry in the United States Department of Agriculture, prepared a rating representing the comparative resistance of our more important shade trees to insect enemies. Dr Howard, as entomologist of the federal government, necessarily considered the value of these species in all parts of the country, and the following is a revision of a local comparative rating of our more important shade trees prepared by the writer at the request of Mr Frederick Shonnard of Yonkers N. Y. It varies little from a similar estimate prepared by Dr Howard, and has been modified to represent more nearly our estimate of the relative resistance of these trees to insect attack in New York State, specially in the Hudson river valley. The figure 3 has been placed opposite trees which are practically immune from insect injury, 2.5 indicates some damage. Trees having one somewhat serious enemy are rated at 2, and those having at least one notorious insect pest at 1.5. Greater likelihood of injuries is indicated by 1 and still more by .5. The species are arranged according to the comparative injury and the list follows:

Tulip tree	3	Red maple	2
*Tree of Heaven	3	Honey locust	2
Hardy catalpa	3	European linden	1.5
Gingko	3	American linden	1.5
Red oak	2.5	Horse-chestnut	1.5
Scarlet oak	2.5	Soft or silver maple	1.5
Yellow oak	2.5	American elm	1
Oriental plane tree	2.5	*Hackberry	1
American plane tree	2.5	European elm	.5
Sycamore maple	2.5	Scotch elm	.5
Norway maple	2	Cottonwood	.5
Sugar maple	2	Balm of Gilead	.5
White oak	2	Black locust	.5
Bur oak	2		

Those that are starred have been seen only in parks or in such small numbers that the rating can be regarded as provisional only.

Massing of trees. It is not only advantageous to select trees possessing relative immunity from insect enemies but it is also advisable to avoid planting too many of one variety together. It is a well recognized principle among agriculturists that large areas devoted to a single crop, specially for a series of years, increase the danger from insect enemies and the same applies in the case of shade trees set in parks and along our streets. It would be much better could different varieties be alternated on the same street or at least set in small groups, so that in case a few became badly infested by such a species as the white marked tussock moth, Hemerocampa leucostigma Abb. & Sm., or a scale insect like the elm bark louse, Gossyparia spuria Mod., the pest would experience difficulty in finding other trees to its liking. An alternation such as sugar and soft maples is very desirable because while the former finds a serious enemy in the forest tent caterpillar, Malacosoma disstria Hübn., the latter is comparatively exempt from its attacks, and wandering caterpillars would therefore not find an abundance of food near at hand, as would be the case where an entire row was composed of hard maples. Maples and elms alternated would prove of service in checking the rapid distribution of such a species as the elm leaf beetle, Galerucella luteola Müll., and would be an advantge even in the case of an outbreak of the spiny elm caterpillar, Euvanessa antiopa Linn. A number of other instances could be mentioned. Care should be taken in setting trees not only to have species side by side which are rarely affected by the same insect enemies, but also varieties which wil! grow harmoniously and afford a pleasing combination.

The following table of some of the principal insect enemies of our shade trees should prove of considerable service in avoiding undesirable combination from the standpoint of the economic entomologist.

Common shade trees and their principal insect enemies

	SUGAR MAPLE	SOFT MAPLE	NORWAY MAPLE	AMERICAN ELM	SCOTCH ELM	ENGLISH ELM	HORSE-CHESTNUT	EUROPEAN LINDEN	RED OAK	LINDEN	LOCUST	WILLOWS	POPLARS
Hyphantria textor				Sometimes badly inj.		Seriously injured		Suffers much at times				Seriously injured at times	
Malacosoma disstria	Defoliated at times			Rarely defoliated									
Euvanessa antiopa				Rather seriously injured								Defoliated	Defoliated
Galerucella luteola				Frequently badly inj	Very badly injured	Very badly injured							
Porthetria dispar	Often seriously inj			Seriously injured					Very seriously inj.				
Thyridopteryx ephemeraeformis		Seriously injured		Seriously injured	Seriously injured	Seriously injured		Seriously injured					
Hemerocampa leucostigma		Sometimes injured		Sometimes badly inj.			Frequently defoliated	Frequently defoliated					
Xylina antennata		Rarely defoliated											
Zeuzera pyrina		Seriously injured	Injured	Seriously injured			Badly injured	Badly injured		Injured			Badly injured
Prionoxystus robiniae	Seriously injured								Seriously injured		Badly infested		
Plagionotus speciosus	Generally injured												
Saperda tridentata				Occasionally badly injured									
Saperda calcarata													Badly infested
Saperda vestita								Occasionally badly injured					
Cryptorhynchus lapathi												Seriously injured	Seriously injured
Elaphidion villosum	Inj. occasionally			Infested somewhat					Injured frequently				
Magdalis barbita & M. armicollis				Occasionally badly injured									
Sesia acerni	Inj. occasionally	Badly injured occasionally											
Cyllene robiniae											Badly infested		
Pulvinaria innumerabilis	Rarely injured	Very badly injured		Very rarely inj									
Gossyparia spuria				Occasionally badly injured	Frequently very badly injured								
Eulecanium nigrofasciatum	Infested in some localities	Very badly infested in places											
Lepidosaphes ulmi													Badly infested at times
Chaitophorus aceris			Badly infested										
Phenacoccus acericola	Occasionally badly inj.												

MORE IMPORTANT SHADE TREE PESTS

It is exceedingly difficult to draw a sharp line between insects of prime economic importance and others. An attempt has been made to do this simply for the purpose of making the contents of this work more accessible to the general reader. Some of the species listed under this head could almost with equal propriety be included with those affecting forest trees, and as a matter of fact no sharp line can be drawn between the two, though there are insects which are much more destructive by reason of their depredations upon certain forest trees used to adorn our streets and parks rather than because of their injuries to the same species in a wild state.

DESTRUCTIVE BORERS

This includes a number of borers affecting some of our more valuable shade trees, and the different species may be identified by aid of the following tabular statement.

Key to destructive borers

Affecting living sugar maples only, making broad, shallow galleries in sapwood just under the bark; a large, fleshy, legless grub
Sugar maple borer, Plagionotus speciosus, p. 51

Affecting hard and soft maples, causing deformities in the trunk and many small, brownish, powdery borings about the places injured... Maple sesian, Sesia acerni, p. 56

Boring in small twigs of maple and oaks, causing the tips of the branches to fall, the broken ends having a large proportion smoothly cut
Maple and oak twig pruner, Elaphidion villosum, p. 59

Diseased or nearly dead maple, elm and other trees having medium, pencil-sized borings, with frequently many galleries coming out at nearly right angles to the bark
Pigeon tremex, Tremex columba, p. 61

A dark brown or black, rather stout, cylindric beetle about 1/8 inch long makes circular sometimes spiral galleries in the roots of underground stems of sugar maple, huckleberry and a number of shrubs
Sugar maple timber beetle, Corthylus punctatissimus, p. 65

American elms with dead and dying limbs, usually with the sapwood badly scored by rather large, flat, legless borers.......... Elm borer, Saperda tridentata, p. 67

A small, reddish beetle about [illegible] of an inch long and prettily marked with three yellow, nearly transverse lines on each wing cover, may be bred from wood infested by the elm borer.................... Neoclytus erythrocephalus, p. 71

American elms having much the same character as mentioned above, but with short, curled, legless grubs in the smaller limbs

Black elm snout beetle, Magdalis barbita, p. 73

The reddish elm snout beetle, Magdalis armicollis is frequently associated with the above .... p. 74

Dead limbs projecting above leafy branches or broken and hanging in the midst of otherwise healthy trees .... Leopard moth, Zeuzera pyrina, p. 75

Very large, round, irregular borings in the trunk of different kinds of oak, maple and locust .... Carpenter worm, Prionoxystus robiniae, p. 79

A legless, flattened, white grub boring at the very base of thornapple, mountain ash, shadbush and fruit trees .... Round-headed apple borer, Saperda candida, p. 84

A large-headed, flattened, legless, white grub making shallow galleries in various trees

Flat-headed borer, Chrysobothris femorata, p. 86

Dead stumps or timbers in houses etc. may be irregularly mined by ants

White ants, Termes flavipes, p. 87

Large black carpenter ant, Camponotus herculaneus, p. 90

Lindens frequently have large, irregular galleries at the base of the tree

Linden borer, Saperda vestita, p. 91

Ash trees sometimes have moderate-sized galleries in the trunks, the work of a white, sparsely haired caterpillar .... Ash borer, Podosesia fraxina, p. 92

Our common native black locust is sometimes badly riddled by moderate-sized galleries,

Locust borer, Cyllene robiniae, p. 93

Very large galleries in this tree

Carpenter worm, Prionoxystus robiniae, p. 79

Poplars are very subject to the attack of a legless, white grub which makes large, irregular galleries, and in midsummer piles of excelsiorlike shavings may be seen at the base of infested trees .... Poplar borer, Saperda calcarata, p. 98

Willows and poplars are frequently severely injured by medium-sized, transverse galleries, usually at the base .... Mottled willow borer, Cryptorhynchus lapathi, p. 100

Lilac stems are frequently tunneled by a white, sparsely haired caterpillar, the branches above wilting in midsummer .... Lilac borer, Podosesia syringae, p. 124

Sugar maple borer

Plagionotus speciosus Say

Dead limbs among leafy branches or transverse ridges and dead areas on branches or trunks of sugar maples are the most characteristic signs of the work of the large fleshy, footless grub belonging to this species.

Sugar maples along the roadsides in the State of New York probably have no more serious insect enemy than this pernicious borer. The attacks of other insects on our maples, specially the depredations of the so called maple worm or forest tent caterpillar, Malacosoma disstria Hübn., are from time to time pictured in most glowing colors, and while these other pests undoubtedly cause much injury, the fact remains that the sugar maple borer is quietly and unobtrusively carrying on its deadly work and in a series of years probably kills more of these popular shade trees than any other insect pest. In almost every city and village where sugar maples adorn the roadsides, evidences of the work of this borer are very apparent and in many of these places dead or nearly ruined trees are by no means scarce. The unthrifty condition of these maples is frequently attributed to drought, fungous diseases, leaking gas, pavements impervious to water, etc., whereas, in fact, the true depredators are gnawing within the trees.

Character of the injury. Unlike many borers, this insect attacks trees in full vigor. The powerful, legless grub confines its operations largely to the inner bark and sapwood, and as it runs a burrow several feet long in one season, and as one borer will frequently work transversely half around a tree some 18 inches in diameter, the dangerous character of this pest is at once apparent. The bark over the burrow, be it either a longitudinal or a transverse one, dies and the growing tissues forming underneath in the natural process of healing push the dead bark out, cause it to break and in the course of a year or two an ugly, naked scar is produced. A large patch of bark may be killed by several borers working near each other or possibly by one doubling back and forth, and the result is a large, unsightly area of exposed wood. The injury produced by a transverse burrow is shown at figure 2, and a blasted area resulting from the doubling of a borer or of the work of several near together is shown at figure 3. Two or three borers in the same trunk are very likely to nearly girdle a tree, if they do not kill it outright. Infested maples frequently have one or more large branches killed by this pest. The base of the limb is girdled in the same way as the trunk, the first intimation of trouble in this manner usually being a sudden wilting of the foliage, followed by the leaves drying up and falling. This borer displays a marked preference for the base of large limbs and adjacent portions of the trunk.

Description. The parent insect is a beautiful stout beetle about one inch long. It is black, brilliantly marked with yellow, as represented at figure 4 of plate 2. The borer or larva is a whitish, flattened, footless grub with brownish mouth parts. Small ones [pl. 2, fig. 2], about 1/2 inch long, are found in September just under the bark and come from eggs laid the same season. The nearly full grown borer [pl. 2, fig. 3] is about 2 inches

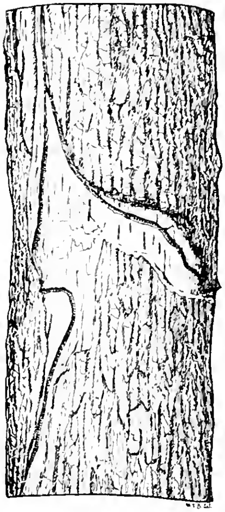

Fig. 2 Injury produced by a transverse burrow in a sugar maple about 18 inches in diameter

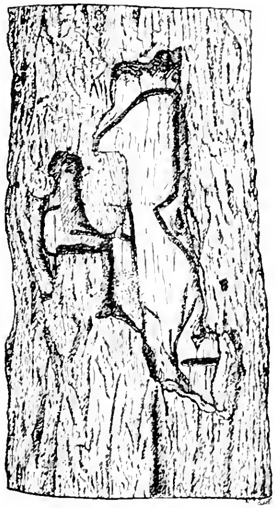

Fig. 3 Large dead area produced by the intersection of several burrows. Tree about 15 inches in diameter

long, white, with some rosy tints and in other respects closely resembles the smaller ones.

Life history and habits. The parent insects or beetles occur from the latter part of June till into August. Most of the eggs are probably laid during the latter two months. The place of oviposition [pl. 2, fig. 1, 1*a*] may be recognized by the irregular discoloration of the bark, caused in part by the sap flowing from the wound and partly from the expelled frass or excrement, the latter often hanging in small masses from the point of entrance. We have found burrows about 30 feet from the ground, but most of them occur in the trunk or near the base of the larger limbs. The latter seems to be a favorite place for the deposition of eggs. The young borer passes the winter in a rather shallow excavation in the sapwood, the following spring renewing operations with increased vigor. The boring of the second season is largely just under the bark, the burrows being about $\frac{1}{2}$ inch in width and $\frac{1}{3}$ inch in depth, and running in almost any direction, though usually longitudinally or obliquely upward and partly around the tree. Sometime during its life, probably in the second fall when the borer is about 16 months old, a deep burrow is made, usually penetrating about 4 inches in an upward, oblique direction toward the heart of the tree and then running some distance parallel with the grain of the wood, as represented in figure 4, which was drawn from a photograph. The larva transforms to a pupa and from that to a beetle at the end of this deep burrow, the beautiful adult emerging from the trunk through an oval hole [pl. 2, fig. 5] about $\frac{3}{8}$ by $\frac{5}{8}$ inch in diameter.

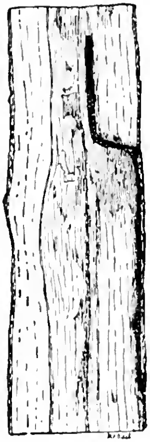

Fig. 4 Deep burrow in which the grub transforms to the beetle

The only natural enemies observed preying on this insect are woodpeckers. Dr Packard records having seen them at work. Mr A. H. Kirkland has seen the hairy woodpecker, the downy woodpecker and the flicker feeding on white larvae taken from beneath the bark of infested trees.

Associated insects. As previously pointed out, the sugar maple borer attacks trees in their prime. It is well known to students of nature that an enfeebled plant invites insect injury by presenting favorable conditions for their multiplication. Trees suffering to any extent from the attack of the sugar maple borer are usually infested with the pigeon tremex, T r e m e x c o l u m b a Linn., a species which assists materially in the destruction begun by the beetle and which is noticed on page 59.

Remedies. Very badly infested trees should be cut and burned before the following June in order to prevent the maturing of any insects they may contain. It may be possible to prevent oviposition if the trunks of shade trees are treated early in June with the carbolic soap wash described on another page. This is simply a deterrent and is employed to render the trunks so distasteful that the insects will not attempt to deposit eggs therein. The most successful method of checking this insect, in case of valued trees, is by careful examinations each fall and spring for characteristic signs of borings. These are familiarly known as sawdust, and small comminuted particles of wood or bark at the base of the tree or in bark crevices should lead to a careful examination for their source. It will usually be found in a burrow near the base of the limbs or in the adjacent trunk, and wherever such injury occurs the borers should be carefully dug out, even though it means much cutting, because the borers make extensive drafts on the sap of the tree, on which they appear to live to a considerable extent. The galleries are usually under perfectly smooth, apparently healthy bark and within $\frac{1}{4}$ to $\frac{1}{2}$ an inch of the surface. They should be followed carefully, and if a wire is used it may be possible to trace the gallery by cutting in here and there without exposing its entire length, something of particular importance when the boring has a transverse or oblique direction. It should in any case be followed to its end and the offender destroyed. This may seem like an extreme recommendation, but it should be remembered that if the borer is not killed, the nefarious work will continue and much more injury probably result than from the cutting, since in most instances the bark immediately over the gallery soon dies and after a term of years we have exposed wood and subsequent decay. The writer has seen a case where extensive borings by this insect were carefully cut out and the grubs killed. Several of the galleries had an oblique direction and it looked as though the cutting would cause much injury to the tree, which was in a sickly condition and the owner feared it was going to die. It is sufficient to state that the tree began to recover immediately after the operation and nearly three years later was the picture of health (though not so large as uninjured associates) in spite of the severe scars left after exposing the galleries, see pl. 22, 23]. One of these galleries was partly transverse, extending about 1/4 of the distance around the trunk. This injury could probably be helped by bridge grafting. In any event it is advisable to cover such wounds with grafting wax or even fill the galleries with mortar, grafting wax, or some other material to protect the wood from the elements. Occasionally much digging can be saved by injecting a little carbon bisulfid into an inhabited gallery, but the objection to this procedure is that one can never be certain of destroying the grub. We consider it better to expose the gallery far enough, so that a sharp wire can be inserted and the borer killed. A wound or two with such an instrument means its death and there is no necessity of securing the grub itself.

Wounds made either by the borer or by a person looking for it, should be cleaned and plastered with a cement of fresh cow dung and lime, in order to hasten their healing.

In sugar maple groves, Mr Kirkland advises that the underbrush be left as much as possible, as he has observed that the clearing up of the shrubbery has repeatedly been followed by severe injury from this borer. The beetles are known to be sun-loving insects and it is very probable that they would place their eggs where the conditions were most attractive.

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Maple sesian

Sesia acerni Clem.

Deformed and frequently enlarged trunks of maples showing brownish powdery borings near the surface, with here and there a small circular orifice, indicate the work of this insect.

The riddling of new tissues around healing wounds on maples is usually the work of this borer. The round holes through the injured bark and the brownish, powdery borings are very characteristic of this caterpillar. It has a special fondness for the tissues growing over wounds, though occasionally it may be found operating on comparatively smooth trunks. It is generally distributed over the State and evidences of its work occur in many localities. Trees wounded from any cause find great difficulty in the comparatively simple process of covering exposed wood with bark, after being attacked by this insect. Thus relatively insignificant wounds result in scars constantly increasing in size and finally in a badly disfigured, gnarled maple. These creatures, when abundant, may nearly girdle a tree. Very serious complaints regarding this pest have been made in Michigan, Missouri, and even in Buffalo N. Y., and it has been stated that this borer annually causes much damage to hard maples. The distribution of this insect has been given by Mr Beutenmuller as Canada, New England and Middle States and westward to Nebraska.

Description. These beautiful, wasplike, red-tailed moths [pl. 4, fig. 16] are not often seen by the casual observer. An infested tree frequently presents the appearance represented on plate 4. Near a partly healed wound there may be found a number of round holes [pl. 4, fig. 12] and considerable brownish, powdery matter [pl. 4, fig. 17], the excrement or frass of the borers. Empty pupal cases may frequently be seen in early fall projecting from the trunk as represented at plate 4, figure 14. On cutting into the injured wood, a whitish, brown-headed caterpillar [pl. 4, fig. 18] about ½ inch long may be found in the latter part of the summer. In the early spring the silken frass-covered cocoons [pl. 4, fig. 15] occur in the burrows.

Life history and habits. The moths are most abundant at Buffalo N. Y., from May 20 to June 15, according to the observations of the late Dr D. S. Kellicott. The males have been seen by Mr L. H. Joutel flying up and down the trunks of infested trees looking for a partner in much the same way as do the males of the lunate long sting, Thalessa lunator Fabr. The eggs are deposited on the bark of both soft and sugar maples, the female preferring as a rule to place them on roughened areas, specially in the vicinity of wounds, if one may judge from the injury inflicted. The eggs soon hatch and the young borers commence operations in the bark and sapwood. In the fall most of the caterpillars are about ½ inch long and can easily be found in their burrows. The cavities made by the borers are nearly filled with frass. The caterpillar completes its growth in the spring, eats its way nearly through the bark [pl. 4, fig. 13], then retires into its burrow, spins a loose silken cocoon and changes to a pupa. Shortly before the adult emerges, the pupa works its way partly out of the burrow, rupturing the thin piece of bark covering the outlet of its retreat in the operation, and the moth escapes, leaving the pupal case as represented on plate 4, figure 14.

This pest attacks both hard and soft maples. In some localities it is reported as most injurious to the former, in others to the latter. In Albany its work is most evident on soft maples. Woodpeckers are efficient aids in keeping this pest in check in forests, according to the late Dr Kellicott.

Remedies. As the parent moth shows a marked inclination to deposit eggs on rough bark, the trees should be protected from injury by horses, boys and other agencies and the trunks kept as smooth as possible. The caterpillars bore near the surface and are easily dug out and destroyed. Infested trees should be inspected the latter part of the summer and the borers killed. The wounds in the trees should be carefully covered with grafting wax, paint or other protective substance. A plaster made of fresh cow dung and lime has been used for this purpose with excellent results. The deposition of eggs could probably be prevented to considerable extent by treating the trunks of the trees about the middle of May with a wash prepared as follows: thin 1 gal. of soft soap with an equal amount of hot water and stir in 1 pt. of crude carbolic acid (1½ pt. refined), let it set over night and then add 8 gal. of soft water. Apply thoroughly to the trunk, specially about all crevices and wounds, from the ground to about 6 or 8 feet high, and renew if necessary before the middle of June.

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Maple and oak twig pruner

Elaphidion villosum Fabr.

Small, cleanly cut twigs of oak or maple falling during the summer are signs of this insect's work.

This insect probably attracts more attention than any other species causing the same amount of damage. As a general rule it is not very injurious, except possibly to shade trees on lawns and along roadsides where symmetry and beauty are very desirable. Aside from damage to the trees, the falling twigs are a source of annoyance and form the one sign of the insect's presence most commonly noted.

Description. This species, like some others, is most easily recognized in connection with its work. A fallen twig is found to have its larger end nearly eaten off, as represented on plate 2, the cutting being nearly as smooth as that of a sharp chisel. The central burrow is plugged with sawdust and if the twig be whittled, a large proportion of its interior will be found eaten away and somewhere in the burrow there is usually a whitish grub with brown jaws [pl. 2, fig. 7], our carpenter. The beetle is a rather slender, grayish brown insect [pl. 2, fig. 9].

Life history and habits. The adult is said to deposit an egg in July in one of the smaller twigs. The young larva feeds for a time on the softer tissues under the bark, packing its burrow with castings and working toward the base of the twig. Later it bores along the center of the limb, making a more or less oval channel. In the early fall our borer quietly eats away a large portion of the woody fiber, plugs the end of its burrow with castings and waits for a high wind to break off the nearly severed branch. In this manner the larva reaches the ground in safety. Late in the fall or in the early spring the change to the pupa takes place and the transformation to the perfect insect occurs in the spring, the beetles emerging from the limbs in June and continuing abroad till September. Occasionally the insect completes its changes in the portion of the limb remaining on the tree; it as a rule drops with the severed branch.

The reason for cutting off the limbs has been accounted for in different ways by several writers. Professor Peck thought it was cut so as to permit of the insect's retreat being kept moist, as it would be if it lay on the ground amid leaves and snow. This can hardly be the reason since it is well known that this species is easily reared from very dry limbs. Mr Chittenden has suggested the following, which appears to us to be the most reasonable explanation. He states that most of the larvae in hard wood cut their way nearly out before the final transformations take place. The small portion of the bark remaining is left to protect the insect from birds and other enemies. There are some species that have well developed, strong mandibles in the adult condition and these can make their way through solid wood, as for example Monohammus. Many others, and among them this species, are not thus favored and they would be utterly unable with their weaker mouth parts to make their way through solid wood. These exit channels are very frequently run at an angle to the axis of the wood, as is well known, and since this twig girdler works in such small limbs that this method of escape would be impracticable, the cutting off of the limb and plugging of the free end with borings seems to be the easiest and most natural way of getting around the difficulty. Dr Fitch gives considerable space to discussing the infallibility of this larva in cutting off the limbs but such is hardly borne out by facts. Mr Chittenden states that this can hardly be true and cites Dr Fitch who observed that at least $\frac{3}{4}$ of the fallen limbs contained no grub and an examination of these showed that the insect must have perished at the time the limb was severed or before it had excavated any burrow upward in its center.

The life cycle of this species is probably completed under natural conditions in one year, though when breeding in dry twigs the period may be considerably extended. Dr Hamilton states that in some cases 3 and probably 4 years are required to complete the life cycle, and the writer is inclined to agree with Mr Chittenden in accounting for this extended period by the retarding influence of undue drying which may easily obtain in breeding cages. The writer has reared a number of the beetles and failed to observe any such prolonged life cycle.

Natural enemies. Mr F. H. Mosher, as stated by Mr Kirkland, records the downy woodpecker, the blue jay and the chickadee as preying on this borer. Mr Kirkland adds to this list a spider, Theridium tepidariorum C. Koch, which he found feeding on the beetles.

Food plants. This twig pruner not only attacks maple and oak, two of its favorite food plants, but has also been recorded from a number of others. A few of the more important are: apple, pear, plum, peach, grape, quince, orange, osage orange, hickory, chestnut, locust, sassafras and sumac.

Remedies. The fallen branches usually contain the larva and should therefore be collected and burned sometime during the winter.

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Pigeon tremex

Tremex columba Linn.

A number of round holes, the size of a medium lead pencil, in the diseased trunk of maple, elm and other trees are quite characteristic of this insect's presence. The large grub works near the center of the trunk and may be recognized by its prominent spine on the posterior extremity.

This interesting insect attacks a number of forest and shade trees, but so far as observed, its operations are confined almost entirely to diseased or dying trees. It is a very common insect in or about Albany where it breeds in the elms which have been weakened by successive attacks of the elm leaf beetle, Galerucella luteola Müll., and it also occurs in many sugar maples which have been seriously injured by the sugar maple borer, Plagionotus speciosus Say.

Description. The pigeon tremex is a magnificent four-winged fly about 2 inches long, a wing spread of 2½ inches and with a prominent horn at the extremity of the abdomen. This latter appendage give rise to the common name of horn tail, which is frequently applied to this insect and its allies. This species may be recognized by its cylindric dark brown abdomen with yellowish markings as seen in figure 5. The larva or grub producing the pigeon tremex may be recognized by its cylindric form, the possession of 6 legs on the three anterior segments and by the prominent horn at its caudal extremity.

Life history and habits. Very little has been recorded concerning the life history and habits of this conspicuous insect. The adults make their way out of the trunk through a hole about the size of a common lead

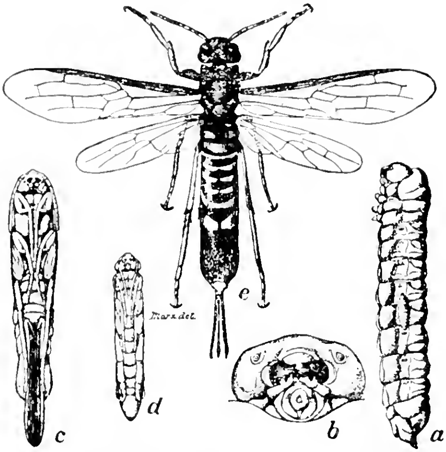

Fig. Pigeon tremex: *a*, larva showing the Thalessa larva fastened to its side; *b*, head of larva; *c*, pupa of female; *d*, male pupa; *e*, adult female; all slightly enlarged. (After Riley, Ins. Life, 1, U. S. Dep't Agric.)

pencil, and during the summer months they are frequently found on diseased maples and elms, sometimes with the stout ovipositor bent at right angles to the body as the female inserts it with a wriggling motion. She is often unable to withdraw her ovipositor and perishes on the tree. Occasionally, the remains of a considerable number may be found about a single trunk. A number of eggs are apparently deposited near together as the writer has uncovered groups of young larvae quite near each other. It is also well known that this species usually occurs in some numbers, if at all, in an infested tree. The eggs have been described by Harris as oblong oval, pointed at each end and rather less than $\frac{1}{20}$ of an inch in length. It is very probable that the life cycle is completed within 12 months, though no observations on this point have been recorded to our knowledge.

Parasites. This large borer is a common prey of an exceedingly interesting parasite known as the lunate long sting, Thalessa lunator Fabr., which is a slender brown and yellow, wasplike insect about $1\frac{1}{2}$ inches long and with a delicate tail or ovipositor about 3 inches long, whence its common name of long sting. This beneficial parasite is very conspicuous and may be frequently seen with its long ovipositor arched over the back and the membrane of the terminal segments of its abdomen distended as it forces its slender tool deep in the wood, in an effort to place its eggs in the vicinity of a borer. The male is a much smaller insect than the female. On splitting open a log containing numerous larvae, the white legless maggots of this parasite may be found with mouth parts inserted and sucking the life fluids of its hapless prey. These parasites emerge from the trunk of the tree through holes of a slightly smaller size than a common lead pencil. The various stages of this insect are well shown in figure 6.

Food plants. This insect works more commonly in maples and elms in New York, probably because there are more of these trees offering conditions favorable for its development. It has also been recorded as attacking apple, pear, beech, oak and sycamore.

Distribution. This species has been recorded from Canada, and the northern Middle States and Missouri by Norton.

Remedial measures. This insect is so rarely injurious in the United States that active remedial measures will hardly ever be needed. It should suffice in most instances if the trees are kept in vigorous condition. It is also advisable on the score of economy and beauty, if on no other account, to cut and burn all trees badly infested by this insect.

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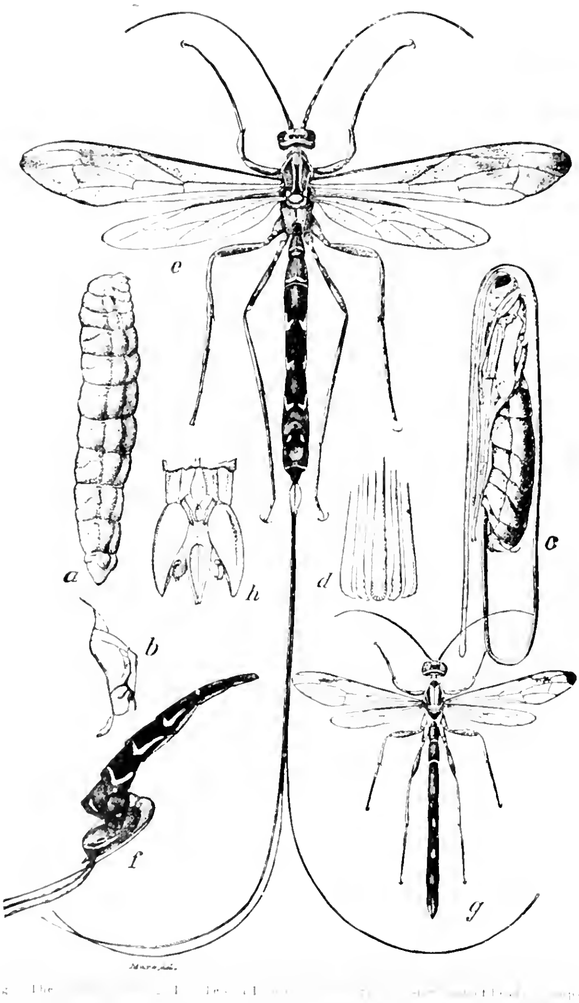

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Sugar maple timber beetle

Corthylus punctatissimus Zimm.

A dark brown or black, rather stout, cylindric beetle about 1/8 inch long, makes circular sometimes spiral galleries in the roots of underground stems of sugar maple, huckleberry and a number of shrubs.

This species was met with by Dr C. H. Merriam in 1882, at which time it caused very serious injuries to the undergrowth of sugar maples in Lewis county, New York. He states that a large per cent of the young trees appeared to be dying, the leaves drooped, withered and finally shriveled and dried, though they still clung to the branches. The majority of the trees affected were from 3/16 to about 3/8 inch in diameter and averaged from 3 to 6 feet in hight. On pulling up the affected trees they almost invariably broke off at the level of the ground, and the ruptured portion showed that it was perforated both vertically and horizontally by the peculiar channels of this wood borer. During September and October Dr Merriam was surprised to find that fully 10% of the apparently healthy young maples were infested by this beetle, and he concluded that they would all die during the coming winter or next spring, so that hundreds of thousands of young trees in Lewis county perished from the ravages of this borer during the summer of 1882.

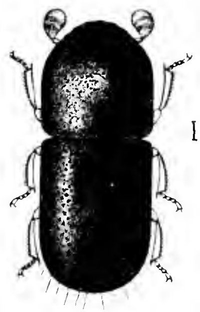

Fig. 7 Corthylus punctatissimus. (After Hubbard, U. S. Dep't Agric. Div. Ent. Bul. 7, n. s. p. [illegible]

Description. The beetle is a dark brown or black, cylindric, rather stout insect about 1/8 inch long. It may be recognized on comparison with figure 7 and particularly by its characteristic work shown at figure 9. The galleries of this insect consist of a series of circular, nearly horizontal borings just within the sapwood of the affected tree. The different galleries are connected either by vertical or nearly vertical passages as illustrated in figure 9.

Life history. The life history of this insect in huckleberry, has been carefully studied by Dr Schwarz.

He states that the entrance hole leads into a circular gallery, the farthest end of which is always a little above or below the point of attack. From this circular burrow a varying number of straight, short galleries lead perpendicularly either upward or downward. Sometimes the beetle excavates below from the point of entrance and at other times above; in some cases there may be as many as three circular galleries one above the other, and in almost every instance they are at or below the surface of the ground. Dr Schwarz calls attention to a novel feature in that this insect sometimes constructs a straight gallery through the core or heart of the root, beginning at the top of the honeycombed portion and carrying it upward, sometimes above the surface of the soil. This is believed to be a hibernating gallery which the insects make in order to secure a dry place, where they can spend the winter. The small diameter of huckleberry roots as compared with those of maple, makes it very difficult for the insect to follow the usual plan, and as a consequence the galleries are more or less irregular, having windings similar to those of a corkscrew. The circular galleries in any event have opening from them a number of shorter brood chambers or grooves in which the young are reared.

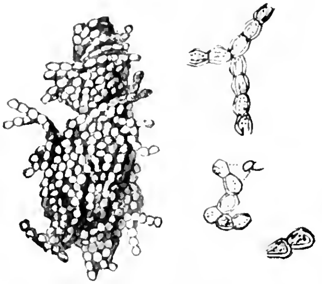

Fig. 8 Ambrosia of Corthylus punctatissimus. A detached dumb-bell-shaped pair of cells, greatly enlarged (After Hubbard, U. S. Dep't Agric. Div. Ent. Bul. 7, n. s. p. 97)

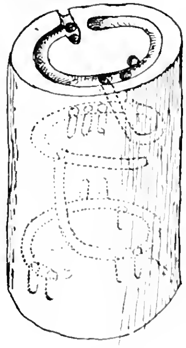

Fig. 9 Galleries of Corthylus punctatissimus in huckleberry roots, enlarged. (After Hubbard, U. S. Dep't Agric. Div. Ent. Bul. 7, n. s. p. 97)

This species, like other timber beetles, feeds on ambrosia, a fungus grown in the galleries. Mr Hubbard states that this fungus consists of a confused mass of rather large conidia heaped together like fish roe. He states that the cells lose some of their spheric shape by pressure. The general form and structure of this fungus is illustrated at figure 8.

Dr Schwarz states that this species is quite local in habitat and apparently has a decided preference for shaded localities where the plants grow on a decayed log, or where the soil is covered with a thick layer of leaves. He believes that this species is largely subterranean in habit, since it is rarely met with except in its food plant, and he has observed that the beetles appear to be perfectly at home in the soil, digging through it with astonishing rapidity. All stages of this insect were met with by Dr Hopkins Aug. 18, in Wisconsin.

Food plants. This insect was first discovered on sugar maple and later found in considerable numbers in huckleberry roots, Gaylussacia resinosa. Dr Schwarz states that he failed to find it in the two allied species, Vaccinium stamineum and V. corymbosum. Dr Hopkins further records numerous hazel, sassafras and species of dogwood at Dells Wis., which had been killed or were dying from the attacks of this timber beetle, and adds that he has met with specimens in living sassafras saplings over 2 inches in diameter, near Morgantown, two annual growths having been formed over the entrance, showing that this species does not always kill its food plant. Dr Hopkins has also taken this species in water beech, Carpinus caroliniana and ironwood, Ostrya virginica.

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Elm borer

Saperda tridentata Olivier

The unthrifty condition indicated by dead limbs or by dying limbs and diseased or dying areas of bark on the trunk of American elms is the most frequent sign of the presence of this insect. Most of the injury is caused by the white footless grubs working under the bark.

This beetle is sometimes as injurious to the beautiful white elm as the sugar maple borer, Plagionotus speciosus Say, is to the sugar maple, and in places where this elm pest has become well established even greater damage may result from its attacks. This is probably due to the greater prolificacy of the elm pest, which sometimes occurs abundantly beneath the bark, while the maple borer is usually present in much smaller numbers. The infested elms are also attacked by other insects, as will be shown in a subsequent paragraph, and the ultimate result is very disastrous to the trees.

Early history. The earliest record of injury by this insect is that given by Dr Harris[1] in his report on insects injurious to vegetation. He states that the trees on Boston common were found to have suffered considerably from the ravages of this insect, several of them had already been cut down as past recovery; others were in a dying state, and that all of them were more or less affected with disease or premature decay. Prof. S. A. Forbes,[2] state entomologist of Illinois, records the rapid progress which this pest has made among the elm trees within the last two or three years. He states that it seems extremely likely that it will totally exterminate the elms unless it be checked by general action. Dr J. A. Lintner, late state entomologist of New York, in writing of this insect in 1893, characterized it as being destructive throughout the state, and as one worthy of serious attention, if it were to be prevented from causing serious injury. Prof. H. Garman, entomologist of the Kentucky Agricultural Experiment Station, records a case of serious injury by this pest to elms at Frankfort. Several trees were diseased and a number of other valuable elms dying; those affected being among the largest and finest in the State. A more recent outbreak at Berlin Mass. was brought to the writer's attention in 1898. Several rows of young elms were seriously injured by this insect, the associated Magdalis armicollis Say and M. barbita Say, and a number of trees were killed [*see* pl. 26]. It is probable that the two latter species were not unimportant factors in making the trouble, though the elm borers were generally present, and undoubtedly caused considerable injury. More recently, Prof. A. F. Burgess has recorded serious damage by this insect to the elms of Columbus O.

[1] 1862 Harris, T. W. Insects Injurious to Vegetation. Ed. 3, p. 111–13

[2] 1885 Forbes, S. A. Ill. State Ent. 14th Rep't, p. 112–14

Distribution. This species has been recorded from the following localities: Canada, Vermont, Massachusetts, New Jersey, Pennsylvania, Ohio, Michigan, Wisconsin, Illinois, and Iowa. It has in all probability a general distribution at least throughout the northeastern United States.

Characteristics of attack. It is difficult to detect this insect till it has become well established and the first signs are usually seen in the lighter, thinner foliage followed by a limb dying here and there. Soon indications of boring are apparent in the dark sawdust collected in crevices of the bark and after the attack has progressed for some time, large portions of the bark can be easily pulled from the tree, revealing a condition beneath very much like that represented at figure 3 on plate 3. The inner bark and sapwood are sometimes badly scored [pl. 27], and if the work has not gone too far, numerous whitish, flattened, legless grubs may be found in the channels they have eaten out. Mr L. H. Joutel is of the opinion that this species normally works in dead or badly diseased tissues and from them may invade the living bark. This is undoubtedly true in some cases, at least, and in others it certainly appears as though this species was the prime cause of the trouble. The observations of Mr M. F. Adams on a large number of injured trees in the vicinity of Buffalo led him to blame the primary injury on this species.

Description. The parent insect is a modest gray beetle about ½ inch long and marked with red lines and black spots, as shown at figure 4 of plate 3. The specimen represented is an unusually well colored individual, the dotting with black and portions of the red lines being frequently quite indistinct. The flattened, legless, whitish grub is shown curled in its burrow at figure 1 and the same extended at figure 1*a*. The pupa, within its elongated pupal cell, is represented at figure 2. It is yellowish white, about ½ inch long, and with slender antennae curled along either side and bent back over the breast.

Life history. The time necessary for this insect to complete its life cycle is unknown but after rearing it seems probable that it is one and perhaps two years. The larvae that are to transform to beetles in one season change to pupae sometime about the middle of May or earlier, and the beetles begin to appear the latter part of that month and continue to emerge for some time, examples having been taken as late as Aug 24. The eggs are deposited on the bark in June, according to the observations of Dr Fitch, but it would seem very probable that oviposition may occur much later, as the beetles are abroad till into August. The attack usually begins at the base of the tree. The young grub works its way under the bark and begins feeding on the tissues, making a serpentine burrow. The boring increases in size with the growth of the larva and in the course of time the tree may be completely girdled and then it must soon die. Dr Packard, writing in 1870, calls attention to finding three sizes of larvae and the writer has found it comparatively easy to separate those taken from a badly infested piece of limb in a similar manner.

Food plants. This insect appears to infest the white elm almost exclusively, though Dr Fitch records it as breeding in the slippery elm. No indications of its attacking either the English or Scotch elms have been seen in Albany. There is a record of this species having been reared from maple, but it would seem that the infestation must have been accidental.

Associated insects. Two species of curculionid or snout beetles may frequently be observed working in elms attacked by this pest, but they appear to follow and not to initiate an attack. Magdalis armicollis Say and M. barbita Say are both small beetles a little over 1/4 inch long, the former reddish, and the other black [pl. 3, fig. 5, 6, 6*a*] and are treated of on pages 71-73. The cocoons of a parasite, Melanobracon simplex Cress., occurred in numbers under the bark where Saperda larvae were abundant, on which the ichneumon preys.

Another ally of Saperda, Neoclytus erythrocephalus Fabr., is less common than the two species of Magdalis. This is a small reddish beetle about 3/8 inch long and prettily marked with three yellowish, nearly transverse lines on each wing cover. It usually follows Saperda attack in much the same way as does Magdalis.

Remedies. Badly infested trees should be cut and burned before the beetles have had an opportunity to emerge in the spring, that is before the latter part of May, in the latitude of New York. And in a like manner infested portions of others should be cut away and burned. This latter treatment was given a lot of 1500 elms at Buffalo N. Y., by Mr M. F. Adams, who reports that the trees were benefited in a most gratifying manner.

Protecting the trees during the period of oviposition with a carbolic acid wash has been frequently recommended but it is of doubtful utility. Where this insect is very abundant and its injuries correspondingly serious, it would do no harm to try the effects of a wash. One of the best may be prepared as follows: thin a gallon of soft soap with an equal amount of hot water and then stir in 1 pt. of crude carbolic acid, or $\frac{1}{2}$ pt. of the refined, and allow it to set over night. The next day add 8 gal. of soft water and apply to the parts to be protected, which in the case of this insect would be the trunk and base of the lower limbs. The bark should be kept moist with this substance from the latter part of May through to the end of July.

Removing portions of the bark has also been recommended. The badly infested portion should be cut away and the grubs destroyed and where a few are working in living bark, it might be well to remove the upper layers till the grubs are nearly exposed and then brush over the shaven surface with strong kerosene emulsion or whale oil soap solution, finally covering the wound with a paste formed of a mixture of fresh cow dung and lime or with a coat of cheap, red paint.

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Neoclytus erythrocephalus Fabr.

A small, reddish beetle about [illegible] inch long and prettily marked with three yellow, nearly transverse lines on each wing cover, is rather frequently bred from elm, hickory and some other woods affected by borers.

This species is probably not injurious as a rule, though the larvae undoubtedly hasten decay by running their galleries in dead and dying wood. It is often associated with the much more injurious elm borer, Saperda tridentata Oliv., and probably follows this species. It has been bred by Dr Lintner, from elms infested by Saperda, 11 examples emerging between April 20 and May 12, from a piece 3 inches long and 6 inches in diameter, and more were obtained from other sections on June 23, and thereafter to July 1. He has also reared it from hickory, locust and pear twigs infested with Xyleborus dispar Fabr. Dr LeConte has reared it from hickory logs infested by Sinoxylon basilare Say., and states that its borings are much coarser than the last named species, and that it exhibits a decided preference for the softer portions of the wood. The exit gallery of the adult may be distinguished from that of Sinoxylon, according to him, by its gradually approaching the surface instead of at right angles as in the case of the latter. Mr Chittenden regards this insect as having no favorite food plant, since he has obtained numerous specimens in about equal abundance, from trunk and branch of Cornus floridus, tulip (Liriodendron tulipifera), locust (Robinia pseudacacia), Cercis canadensis, hickory and grapevine. He has observed the adults common on appletrees, usually pairing and in such abundance that there was little doubt but what they bred in the trees. The beetles occur in Washington from the last of April till toward the end of July. Individuals were reared by him from locust twigs kept indoors two years. He states that the larval galleries are very extensive in dogwood, the young evidently passing a considerable portion of its time under the bark, afterward penetrating the solid wood, which is still more extensively bored. The pupal cell is often in the center of a large twig, and the exit is excavated before the final transformations occur.

We have bred this insect several times from elm limbs infested by the elm snout beetles, Magdalis armicollis Say., and M. barbita Say., and Mr Hubbard has had a similar experience. Dr Riley records finding a a gravid female near the root of a rosebush at Washington, and Mr Adams

Tolman of Concord, states that he took two specimens on pine. We are inclined to believe that this latter was merely an accidental occurrence. A small parasite, Bracon agrilli Ashm., has been reared from cocoons, frequently occurring in the galleries and pupal chambers made by this insect in hickory.

Black elm snout beetle

Magdalis barbita Say

Dying or dead limbs with the inner bark infested by short, white, curved, legless grubs, or with the outer bark showing circular exit holes, are usually caused by the work of this little black beetle.

This small insect represented on plate 3, figure 6, is only about 1/4 inch long, and together with the closely allied M. armicollis Say., has been reared from elm in considerable numbers. The adult of this species is easily recognized by its jet-black color in connection with its occurrence in elm. The difference between the other stages of this and related forms, if any, are very slight. The method of work of this species is shown on plate 3.

Life history. The larvae of this beetle transform to pupae in May, and adults begin to appear, according to Mr M. F. Adams of Buffalo, about the 21st, and from the 23d to the 30th, he obtained them in large numbers, a few emerging as late as June 9. The beetles feed to some extent on the foliage, as the writer took a specimen on the underside of a young elm leaf where it had skeletonized a small patch. This species apparently requires but one year to complete its life cycle. The burrows of the grubs are about 1 1/2 inches long, running generally with the grain, and are confined very largely to the inner layers of the bark. The final transformations to the adult occur in oval cells just beneath its surface.

Food habits. This insect has been recorded by Mr W. H. Harrington, as feeding on the bark of dead or felled hickories. He states that the grubs live in great numbers between the bark and wood. Dr J. B. Smith, state entomologist of New Jersey, records it from shell bark hickory and as breeding in fallen hickories. It seems very probable that the above reports are based on mistaken determinations, and that in reality they belong to a very similar species, M. olyra Hbst. This elm borer was reared by us in abundance from American elms growing at Berlin Mass., and in small numbers by Mr M. F. Adams and the writer, from American elms in the vicinity of Buffalo. These insects enter trees very shortly after injury, and there are facts which go far toward showing that occasionally they may attack trees in practically normal condition. It is sometimes very difficult to decide whether this species or the elm borer, Saperda tridentata Oliv., is the primary cause of the death of shade trees. It seems probable that in most cases at least, the elms became sickly before being seriously injured by either insect.

Distribution. The existence of this species in Canada, Pennsylvania, Georgia and South Dakota, has been recorded by Dr Horn, and the records given above show that it occurs in Massachusetts, New York and New Jersey. This species probably has a somewhat general distribution over the northeastern United States and southeastern Canada.

Parasites. Several species were reared from trees badly infested by this borer, and smaller numbers of M. armicollis Say and by Saperda tridentata Oliv. The following parasites were in all probability obtained from this borer: Brachistes magdalis Cress., Entelus onerati Fitch, Smicra microgaster Say, a pteromalid and a small fly, Limosina crassimana Hal., all being determined by Messrs Ashmead and Coquillett through the courtesy of Dr Howard.

Remedial measures. The most effective method of checking the devastations of this insect and its allies, is found in cutting the infested limbs and burning them before the appearance of the beetles in May. Thorough work along this line will so reduce the numbers of the insect that they will cause very little or no trouble. Prof. Pettit has suggested that in the case of valuable shade trees, it might be well to cut poles of green elm and set them nearby for the purpose of attracting the beetles. These poles should be set the last of May and removed and burned sometime in July, provided they are infested by the grubs. This method has been successfully employed in Germany, for the control of beetles possessing similar habits.

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Reddish elm snout beetle

Magdalis armicollis Say

This beetle may be distinguished from the preceding by its reddish color. It has been reared in small numbers by the writer from American elms growing at Berlin Mass., and in larger numbers from the same wood received through Mr M. F. Adams of Buffalo. It has also been obtained from elms by several other entomologists. Dr Horn states that this form occurs with the preceding and this accords with experience of other entomologists. Its life history, so far as known, is practically the same as that of M. barbita Say, and the remedial measures of value against the preceding species would doubtless prove of equal service in the case of this insect.

Leopard moth

Zeuzera pyrina Fabr.

Dead limbs, projecting above leafy branches or broken and hanging in the midst of otherwise healthy trees are the most conspicuous signs of this insect's work.

Dead limbs may frequently be seen projecting above the leafy masses of many trees in New York city and vicinity. These and the sudden wilting of living ones are, in many cases, the effects of the destructive work of the leopard moth caterpillar. This is probably the worst insect enemy of shade trees in the vicinity of New York city. It not only bores in slender twigs, but as the caterpillar increases in size, it enters larger limbs and before attaining its growth frequently inflicts serious injury on the trunk.

Description. This insect is most easily recognized in connection with its work. Boring within the smaller twigs, there may be found a pinkish or white caterpillar about 3/8 inch long, with numerous well defined, darker spots or tubercles on its body, a brown head and thoracic shield and an anal shield of nearly the same color. Short hairs grow from the tubercles and are also found about the head and posterior extremity. The burrows in the larger limbs and trunk may contain caterpillars over 3 inches long, nearly white, and with larger, more distinct spots or tubercles than in the earlier stages [pl. 4, fig. 4]. The beautiful white moths marked with blue and black are well represented, the female, with wings folded at 2 and the male with them expanded at 3, on plate 4. The salmon colored eggs are about the size of a common pin head and in captivity are deposited in a large mass. This borer's work is shown on plates 28, 29.

History and distribution in America. This insect is another of the bad pests accidentally introduced within recent years. The earliest authentic record of its presence in America is the brief note given by Jacob Doll in *Papilio* for February 1882, stating that he had taken a living example in a spider's web the preceding June at Hoboken N. J. Its destructive work was observed in 1884 by Dr E. B. Southwick in Central Park, New York city. It was taken in 1887 at Newark N. J., and in 1889 at Arlington and Orange N. J. Colonel Pike, in 1892, after describing the widespread ravages of the insect in Brooklyn, reported it as present at Astoria, New Rochelle, Jamaica, New Lots and Flatbush, and at a later date stated that the pest had made its way to almost all parts of Long Island and had extended into Connecticut. In 1894, Dr Southwick characterized this pest as "one of the worst insects we have to contend with." Mr L. H. Joutel of New York informed me recently that this species was present at Kensico, Westchester county, some 25 miles north of New York city. It appears to be confined very largely to cities and villages and apparently does not thrive in the country. As this insect occurs in southern and central Europe and possibly in southern Sweden, we may expect the pest to make its way farther north. On this account, the last American locality given has exceptional interest, showing, as it does, that this borer is working northward. It is yet early to state how fast the pest will spread. At present the rate appears to be slow, but it will certainly do no harm to keep on the watch for the appearance of the insect in new localities in the State. Searching for indications of the borer's presence along the Hudson River, specially in cities and villages, may result in its detection in several new localities.

Life history and habits. Moths may be taken from early June till the latter part of September. European authorities state that the female places her eggs in crevices of the bark in branches as well as the trunk. Since the young caterpillars frequently enter the twigs at the base of a bud [pl. 4, fig. 11*a*], it seems quite probable that many of the oval, salmon colored eggs may be thrust between the stem and bud or under a bud scale. Several observers have noted the deposition of about 300 eggs by the female in confinement and some writers estimate that she may deposit as many as 1000 eggs. When a young caterpillar enters a twig, it usually tunnels along the pith, eating away the wood here and there almost to the bark. The expelled frass at the base of the bud indicates the point of entry. As the caterpillar works along the twig, it occasionally makes an opening for the expulsion of its frass [see pl. 4, fig. 8]. These orifices, after they have served their purpose, are closed by a web of silk, as represented at figure 7 on plate 4. This singular habit of closing these holes when no longer needed, probably affords considerable protection from insect parasites and it would also tend to prevent birds from finding the caterpillars so readily. The smaller twigs frequently wilt and break as a result of the work of this borer. The latter part of September caterpillars 3/8 inch long were found, having probably hatched from eggs laid the latter part of the summer, and the larger borers, about one inch long, from eggs deposited earlier in the season. These creatures have a habit of leaving their burrows, wandering to another part of the limb or even to other branches, and commencing operations anew. As they increase in size, larger limbs are attacked and nearly full grown caterpillars are frequently found in the trunk. In the larger limbs and in the trunk, these borers make very bad work. Sometimes a caterpillar will nearly girdle a tree with a burrow just under the bark. Frequently several burrows run side by side, as represented in figure 10, plate 4. Many of the caterpillars will keep gnawing away just under the bark till an irregular chamber the size of a man's hand has been made. The bark covering these large wounds soon dies, breaks away and the following season there is an ugly scar, as represented at figure 9, on plate 4. In a short time small trees harboring several of these creatures are quickly girdled. Two years are required to complete the life cycle, according to most authorities. The first winter is passed by the small caterpillar, usually less than an inch long, in its burrow. The second winter it is nearly full grown [pl. 4, fig. 4]. The transformation to the quiescent pupa [pl. 4, fig. 5] takes place in the burrow, the bark having previously been eaten nearly through by the caterpillar. Before the adult appears, the pupa works itself partly out of the burrow [pl. 4, fig. 6] and the moth emerges, leaving the empty pupal case as represented at figure 1, plate 4.

This pernicious borer has been recorded as attacking 83 species of trees and shrubs. According to the observations of Dr E. B. Southwick, entomologist to the department of public parks of New York, the elms and maples are most subject to attack, the horse-chestnut, Ohio buckeye (Aesculus glabra), beeches, birches, dogwood, hickories, oaks, and walnuts suffering in the order named. Almost every species of tree and shrub in Central Park, except evergreens, was injured to some extent.

Remedies. Something can be accomplished by the destruction of the rather sluggish females before eggs are deposited. This is of most value where there are only a few small trees. In localities where this insect occurs, trees should be examined three or four times a year. The wilting of smaller twigs and the strings of expelled frass indicate the presence of this borer. Smaller infested branches can be cut off and burned, and as the caterpillars leave their burrows on slight provocation, their destruction should not be delayed long after cutting. Limbs broken off by storms should be collected and burned, as they frequently contain caterpillars of this pest. The borers in larger branches or in the trunks should be cut out and destroyed whenever possible. In some cases they may be killed in their burrows with a flexible wire. Dr E. B. Southwick, who has had considerable experience in fighting the pest in Central Park, New York, has found that it pays to use carbon bisulfid on the more valuable trees. The insecticide is carried in an oil can and when a caterpillar can be located, the chemical is injected in the burrow and the hole sealed with putty. The deadly fumes soon make their way to the borer and kill it with little or no injury to the tree. As the carbon bisulfid is very volatile, its vapor inflammable and explosive, great care must be taken to keep it from all fire. Mr M. F. Adams of Buffalo N. Y., who has tried some experiments in fighting borers, recommends the use of newly made hard soap in the place of putty for plugging the holes after the carbon bisulfid has been inserted.

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Carpenter worm

Prionoxystus robiniae Peck

A large reddish white caterpillar boring large holes in the solid wood of different kinds of oak, maple and locust belongs to this species.

This insect is a serious enemy of several of our native trees, though it rarely causes their death because its operations are confined very largely to the heartwood. It frequently produces serious deformities and thus renders unsightly trees which should be an ornament to the landscape. The writer's attention was called to this insect in 1900 by Miss Mary B. Sherman of Ogdensburg N. Y. Two pupal cases were sent June 16, with the statement that they were projecting from the trunk of a maple tree which was full of burrows, and July 2, a moth of this species was taken on one of the infested trees. Examples of this insect's work were subsequently sent from Ogdensburg, and $\frac{1}{3}$ of the section of a tree about 15 inches in diameter was riddled with the large burrows of this wood borer. Miss Sherman stated that it was so abundant as to ruin a number of fine maples in that locality, over 20 of these caterpillars being taken from a single trunk. About this time Mr M. F. Adams reported this insect as quite injurious to ash trees in the parks at Buffalo, and through his courtesy the writer was enabled to examine a number of trees infested by this species.

Early history. The work of this caterpillar was first brought to public notice by Prof. W. D. Peck in 1818, when the insect was briefly described, and its injuries to locust trees in the vicinity of Cambridge Mass., recorded. Professor Peck also states that he met with this species in black oak. Dr Harris mentions the borer under the name of Xyleutes, and Dr Fitch gave a detailed account of its work in 1858. He characterizes this species as by far the most pernicious wood-boring insect, and adds that it wounds the trees most cruelly. He observes that the stateliest oaks in our forest are mined and probably ruined in every instance "where one of these borers obtains lodgment in their trunks. It perforates a hole the size of a half inch auger, large enough to admit the little finger and requiring 3 or 4 years for the bark to close over it." These holes run inward to the heart of the tree, and admit the water from every shower, which causes the wood to decay and soon ruins the trees. Dr Riley, writing of this insect in 1870, characterizes it as a serious enemy to the locust in Iowa, and states that it aids the locust borer, Cyllene robiniae Forst., in destroying locust groves throughout the country. Prof. C. W. Johnson in 1896 records this species as very injurious to black oak at Bellville, Mifflin co., Pa., and gives an instance of its killing many trees in that neighborhood. This insect has also been noticed by a number of later writers. Professor Lugger states that this borer is not uncommon in Minnesota, and that it is frequently attracted to electric lights. Professor Hillman records it as common in Nevada in locust, elm and poplars. It is stated by Professor Buffum to be the species which attacks cottonwoods in Wyoming, and Professor Gillette states that it is confined almost exclusively to cottonwoods in Colorado.

Life history and habits. The moth may be found abroad in New York during the greater part of June, and Dr Fitch states that it occurs in the early part of July. This species was bred June 8, 1900, from infested ash logs received from Mr M. F. Adams of Buffalo, and many more appeared between the 20th and 22d, and one the 28th. Several moths were bred from the same ash log the following spring, showing that the insect can live for a considerable period in the dead, nearly dry tissues. This insect is said to be a most prolific one by Dr Fitch, who obtained upwards of 300 eggs from one female within a few hours after its capture. The discharge of this large number was followed by a reduction in the bulk of the abdomen of about 1/2. A good sized female was dissected by the writer who found 269 well formed eggs and about 133 partly developed, making a total of 402. This large number filled the entire abdominal cavity, and more could be developed only in the case of a somewhat prolonged adult stage during which enough food must be taken to permit the development of the ova. Dr Fitch states that more than 1000 eggs have been found on dissection in the case of an allied European insect, and he concludes that a single one of these insects is capable of ruining a whole forest of oak trees. Dr Fitch's observations led to the belief that in New York State at least this species is more commonly met with in the oaks than in the locust, and this conclusion is justified by the writer's observations in more recent years. The eggs of this insect are apparently stuck in crevices in the tree, and in the case of a captive female, she did not hesitate to tuck a number in the deserted burrow of the mottled willow borer, Cryptorhynchus lapathi Linn. The eggs are covered by glutinous matter which causes them to adhere to any surface with which they come in contact and in the case of the captive referred to above, they were carefully packed away in what evidently appeared to be a suitable crevice. Examination of infested trees seems to indicate that the eggs are deposited by preference in the vicinity of some wound or scar, and after the insect has once obtained an entrance, this place is a favorite point for the deposition of eggs in later years. Dr J. B. Smith expresses the opinion that the eggs are laid about such places, and that the young larvae continue the old burrows in the heartwood, and that in time a series of galleries may be the work of several generations, all entering at nearly the same point. The writer's observations would appear to bear out the statement of Dr Smith. The habit of the larva has been described by Dr Fitch as follows: it feeds at first on the soft inner bark, later penetrating the harder sapwood and finally resorts to the solid heartwood, residing mostly in and around the center of the trunk, boring the wood in a longitudinal direction, and moving backward and forward in its burrows enlarging them as it increases in size. The entire excavation is therefore of a nearly uniform diameter. Dr Fitch records meeting fully grown and others but half grown in one tree, and adds that the same oak had been extensively mined by preceding generations of this insect, and was decayed. The writer has met with at least two very different sizes of larvae in one tree at the same time. Dr Fitch records the fact that none of the caterpillars were in decaying wood, but all were working in tissues which were still sound, and adds that the insect evidently prefers the healthy tree. Mr L. H. Joutel recently found two young larvae of this species feeding on the pupae of Cyllene robiniae Forst. and another about to devour a pupa, indicating a willingness on the part of these caterpillars to vary their diet. The life cycle of this species is believed to occupy three years, and certainly extends over two at the very least. The transformation to the pupal state occurs in oval cells made at the extremity of the galleries. The free end of the burrow is packed with borings [pl. 5, fig. 6]. The appearance of the adult is preceded by the pupa working itself along the gallery and partly out of the entrance to the burrows [pl. 5, fig. 5]. This permits the disclosure of the moth in the open air, and thus avoids her being injured by crawling through rough and devious galleries. The duration of the pupal stage has been given by Dr Fitch as probably two weeks or longer. See plate 30 for this borer's work.

Description. The adult insect is a magnificent, grayish moth having a wing spread in the female of about 3 inches. Her general color is a dark gray mottled with a very light gray, and with traces of yellowish on the hind wings. The males are considerably smaller, with a wing spread of about 2 inches, and they may be quickly recognized by the large orange red marking on the hind wing. The male is darker than the female, the forewings being a very dark gray with a few light gray mottlings. The anterior portion of the hind wings is nearly black, and there is a large reddish blotch covering most of the posterior portion. The abdomen is coal-black. The male may also be recognized by its more pectinate antennae.

The pupa is about $1\frac{1}{2}$ inches in length, brownish in color, and with the dorsal surface of the abdominal segments ornamented with conspicuous rows of toothlike processes, as represented in plate 5, figure 6. The anterior row on each of the segments having two is much stouter than the posterior. The three terminal segments have but a single row in the female, while in the male there is a second row on all except the last two. This sexual character was first brought to attention by Dr Lintner in his 2d report as state entomologist.

The full grown larva is a large white caterpillar about $2\frac{1}{2}$ inches long. The head is brownish, with mouth parts a very dark brown, and the well developed thoracic shield is dark brown along its anterior margin. The white body is frequently suffused with rose red, and bears on each segment several minute brownish tubercles from each of which there springs a hair. The spiracles are brownish. The young larvae resemble the nearly matured ones very closely.

The eggs have a broadly oval form, and are about one half the size of a grain of wheat, being $\frac{1}{10}$ inch in length, and about $\frac{3}{4}$ that in diameter. They are of a dirty whitish color, with one of the ends black, and when highly magnified, the surface is seen to be finely reticulated or marked by rows of slightly impressed dots [pl. 5, fig. 4*a*].

Distribution. This insect is a rather common borer in Massachusetts, New York and New Jersey, and has been recorded from as far south as Texas. It is also regarded as quite injurious in the Western States. It would thus appear that the insect has a general distribution in the states east of the Rocky mountains, at least.

Food plants. The describer of this insect, Professor Peck, met with it first in black locust, and subsequently observed the same species in black oak. The insect is also known to attack ash and maples, which are injured very seriously in New York at least, and in the Western States it is regarded as a dangerous enemy of cottonwood. Dr J. B. Smith records this insect as working in willow, poplars, and chestnut in addition to those given above, and he adds that infested trees are of little value for any other purpose than fuel.

Remedial measures. This moth's habit of depositing eggs in crevices, particularly about injuries caused by earlier attacks or possibly by other borers, may be taken advantage of to protect trees to some extent by keeping the trunks smooth. Rough, wounded places should be carefully dressed and in the case of a serious injury by earlier borings, it would pay to cement and otherwise close these points of entrance, and in some instances the insects might be killed by injecting carbon bisulfid.

It is very possible that this could be done even after the attack has been in progress for some years and a serious wound made. A considerable amount of the insecticide should be used in such cases, and all the orifices at the point of entrance covered and sealed with cement, putty, or soap, so as to prevent the rapid escape of the fumes. The employment of this insecticide might advantageously accompany the use of cement in many cases.

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Round-headed apple borer

Saperda candida Fabr.

A round-headed, white, legless grub infests thorn apple, mountain ash and shadbush as well as fruit trees, making large tunnels at the base of the trunk and frequently killing the trees.

There is no insect so well known as this species, which has become notorious on account of its severe injuries to fruit trees, many of which are killed before they have been in the ground more than three or four years, and thousands are rendered comparatively worthless when not killed outright.

Life history. The life history of this insect may be summarized as follows. The young borer on the approach of winter, descends as near the ground as its gallery will allow and remains inactive till the following spring, when it renews operations, and on the approach of the second winter it is about half grown and still living in the sapwood. The most damage is done at this period, because where four or five occur in a single tree they almost girdle it. The next summer, when it has become about three fourths grown, it cuts a cylindric passage upward into the solid wood and having completed its larval growth, continues this passage to the bark, sometimes cutting entirely through a tree to the opposite side and occasionally turning back at a different angle. The injury is so severe that several borers in a tree may fairly riddle its base. The upper end of the gallery is stuffed with fine borings and the lower part filled with long wood fibers. The larva remains unchanged in this cell through the winter, transforming to a pupa the following spring, and the beetle appears sometime during the summer, escaping through a circular exit hole.

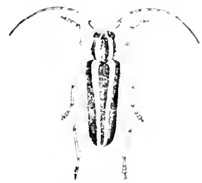

Fig. 11 Round-headed apple borer, beetle

Distribution. This species is a common pest in southern Canada and the Eastern, Middle and Western States. It does not appear to have been listed from the Pacific slope.

Description. The beetle is about $\frac{3}{4}$ inch long and may be easily recognized by its brownish color with two white bands joined at the front and extending to the tip of the wing covers. The underside and front of the head, white, and the antennae are light gray with legs lighter.

Natural enemies. A small parasite known as Cenocoelius populator Say, has been reared from this insect, and the downy woodpecker and the great golden woodpecker have been observed in infested orchards. These two birds and probably others are undoubtedly of considerable value in destroying the grubs of this pernicious borer.

Remedial measures. These are practicable only in the case of highly valued trees, and consist in cutting out the borers or else in recourse to protective bandages or offensive washes, the former making it impossible to deposit eggs where the parent insect desires, and the latter rendering the base of the trunk unattractive to the insects.

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Common flat-headed borer

Chrysobothris femorata Fabr.

A somewhat inconspicuous, metallic, grayish, flattened beetle about 1/2 to 5/8 inch long, occurs on various trees, and its legless, flat-headed grub makes shallow galleries in the wood.

This, the common flat-headed borer of the appletree, infests a number of forest trees, and the term apple borer is hardly characteristic.

Description. The beetle ranges from 1/2 to about 5/8 inch in length, and is of an obscure metallic color. It may be recognized, according to Dr LeConte, by the serrulate margin of the last ventral segment, the irregular surface of the thorax, the acute median notch of the clypeus and its somewhat circular outline on each side. The anterior tibiae of the male are slightly dilated at the tip and with the inner side denticulate.

The grub is a slender-bodied, legless creature, with an enormously dilated, flattened head.

Life history. The beetles appear from the end to the middle of May, and may often be seen resting on the trunks of trees or flying around them during the daytime. The eggs are deposited on the bark, probably in a crevice. The young grub makes its way under the bark, and during its early stages feeds on the sapwood immediately beneath. As it increases in size, it gnaws into the more solid heartwood, forming somewhat dilated, irregular flattened burrows quite distinct from the nearly cylindric ones made by some of the long-horned borers. The winter is passed at some depth within the wood. The larvae work toward the surface in the spring, where the pupal cell is excavated and the adults emerge from the somewhat elliptic burrow.

Food plants. This insect affects a number of trees, it having been recorded from mountain ash, horse-chestnut, linden, box elder, beech, apple, pear, plum, cherry, peach, oak, sycamore, chestnut, hickory and soft maple, and we have taken specimens on spruce and hemlock.

Distribution. This species has a very wide distribution. Dr Hopkins states that it occurs in Canada and in every state and territory in the United States and extends into Mexico. He adds that the species is quite variable, though in a large series, the specific identity of all forms is easily demonstrated. He comments briefly on some six forms which have been characterized.

Natural enemies. Several natural enemies have been reared from the larvae. Dr Riley records obtaining Bracon charus Riley and Cryptus grallator Say, besides a chalcid fly.

Remedial measures. Comparatively little can be done for any except the more valuable fruit and shade trees. Some protection undoubtedly results from coating the trunk and larger limbs of the tree with a repellant wash such as the carbolic soap wash, frequently used against the round-headed apple borer, Saperda candida Fabr. Repeated inspections in July and August should result in the detection of the borers, and it is then comparatively easy to dig them out before much injury has been caused.

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White ants

Termes flavipes Kollar

White, wingless antlike creatures, occurring in dead stumps or in decaying or other timbers of houses, are familiar to most people.

This species is an enemy of timber in houses, particularly in the Southern States, and in the North it occasionally causes considerable injury. This pest is met with somewhat commonly in hard pine stumps and dead trunks are sometimes riddled by the insect. One small dead hard pine had been tunneled by this species to the hight of 4 feet from the ground. It was a somewhat common species in decaying hard pine

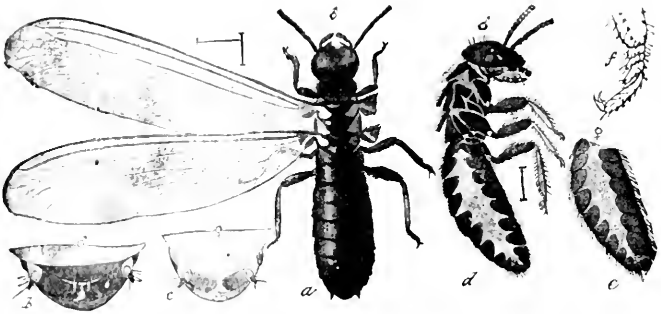

Fig. 11 Termes flavipes: a, adult male; b, terminal abdominal segment of same from below; c, same of female; d, female with abdomen somewhat inflated; e, side view of abdomen of female; f, tarsus showing segments and claw; a, d, e are enlarged; b, c, f are greatly enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4, n. s. 1896)

stumps near Manor L. I., in 1900. The principal effect the species has in these situations is to hasten decay, and in the forest this can hardly be counted undesirable. The insects, however, may make their way from

Fig. 12 Termes flavipes: a, dorsal view of head of winged female; b, ventral aspect of same, with mouth parts open, greatly enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4, n. s. 1896)

decaying stumps outdoors into dwellings and their presence in such places may be followed by serious injuries. Professor Webster has recorded this species as quite injurious in Ohio, not only to buildings, but also to small trees, and the writer has received several complaints in recent years of their annoying operations in dwellings in Albany and vicinity. Dr A. S. Packard has recorded this species as injuring a wounded elm tree at Salem Mass., and Dr Hagen cites an instance where it attacked living maple trees. He states that three trees more than 60 feet high and 2 feet in diameter and apparently in good condition, except for a splitting of the bark in some places, were infested. On removing portions of the bark, living white ants were found and proved to belong to this species. Observations revealed the presence of small open gangways, covered

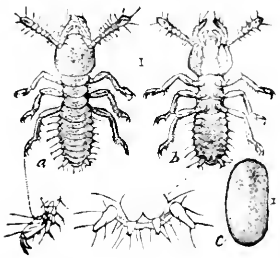

Fig. 13 Termes flavipes: *a* dorsal view of newly hatched larva; *b* ventral aspect of same; *c*=egg, all enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

outside by the split bark, which ran along the tree to a hight of 30 feet or more. There were no old rotten stumps near by, except on some of the adjacent estates. The infested trees were remarkable for their abnormally small leaves and an examination showed that the bark in the vicinity of the gangway had been extensively bored by these miners. The general facts concerning the life history of this insect and the different forms the species assumes are so well known that detailed descriptions of them in this connection seem hardly necessary.

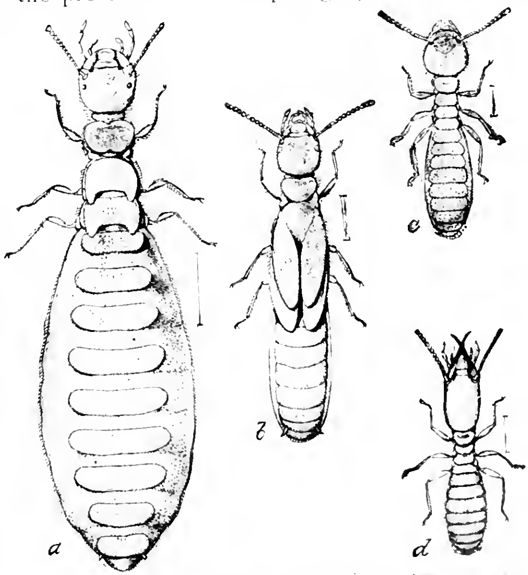

Fig. 14 Termes flavipes: *a*, queen; *b* [illegible] of winged [illegible] *d*, soldier, all enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4 [illegible] 1896)

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Large black carpenter ant

Camponotus herculaneus Linn.

A large black ant may be observed running in and out of diseased trees and on examination it may be found that a considerable proportion of the interior has been honeycombed.

These insects are apparently unable to enter a sound tree and only where a wound lays bare the wood are they apt to effect an entrance. This is specially true when the diseased area is near the ground. Plate 31, figure 2 illustrates how thoroughly this species can honeycomb the interior of an elm tree. The irregular method of work is probably to be explained by the fibers of this tree interlacing so closely that there is very little or no difference in the texture of the wood made in the different seasons of the year. Plate 31, figure 1, illustrates the work of the same species in balsam, and it will be seen that the method of operation is entirely different. The wood has been excavated along well defined lines, and that which is allowed to remain forms portions of large lamina. An examination of the specimens revealed the fact that the ants had eaten out the softer portion of the wood and left the harder parts formed towards the end of the season, when growth was comparatively slow and the wood correspondingly firmer. The work of this species in balsam was observed by the writer in 1900 at several localities in the Adirondacks. In one or two instances the trees were so honeycombed that they broke in heavy winds and fell. One balsam, which at the time of observation, was badly infested with Tomicus balsameus Lec., had been entered by these ants in large numbers and their galleries continued to a hight of 4 or 5 feet, rendering that portion of the tree worthless for anything else but firewood.

Linden borer

Saperda vestita Say

Large, irregular galleries at the base of the tree, inhabited by a white, legless borer, are very likely the work of this species.

This insect is a rather common borer of the linden and is occasionally quite injurious. It not only attacks full grown trees used for ornamental purposes but sometimes occurs in the nursery, where it may cause considerable injury.

Life history. The beetles appear toward the end of the summer and feed on the bark and leaf stems and also the larger veins on the underside of the leaves and on the green bark of the growing shoots, often killing the tips of the branches. The injury by them is quite noticeable when the insects are abundant. A female may contain as many as 90 eggs, which are deposited two or three in a place on the trunk or branches, specially about the forks in slight incisions and punctures made for their reception with her strong jaws. The larvae mine the bark for a distance of 6 to 8 inches from the place where they hatch and often penetrate the wood to a considerable extent, according to Dr Packard, who states that this insect works at the base of young lindens, gouging two parallel rings around the trunk and forming annular swellings. We have seldom found the work of this species more than 12 inches above the ground, and in our experience it occurs very largely in exposed roots and subterranean parts, though it has been taken from the lower limbs of large trees [*see* pl. 6]. Nothing is known concerning the time required to complete the life cycle.

Food plants. We doubt if this insect infests other than lindens, though it has been recorded by some writers from poplar, elm and in apple.

Description. The beetle is black and so densely covered by an olive-yellow pubescence, that, as a rule, only a few black spots are observable near the middle of the wing covers [pl. 6, fig. 16].

Distribution. This species has been recorded from Canada south to Pennsylvania and westward to Iowa. It is probably generally distributed in the eastern United States, at least.

Remedies. It is impossible to control this insect on other than valuable trees, and for such, digging out the borers, with possibly recourse to the use of repellant washes is about all that can be done, and in the majority of cases should afford considerable protection.

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Ash borer

Podosesia fraxini Lugger

Boring ash trunks, a white, sparsely haired caterpillar.

This species is very closely allied to P. syringae and according to Dr Lugger, its describer, is very common in the prairie regions of Minnesota and South Dakota. It also occurs in Montana. It seriously injures the ash and attacks that tree when it is grown for wind-breaks. It is so destructive that, as a general rule, the trees are unable to attain a large size before they begin to break down. All parts of the trees are infested though the borers are more commonly found just below the surface of the soil. The young trees succumb easily while larger ones may survive the attack for many years.

Description. *Male.* Head black between the eyes; face dirty whitish; palpi dull orange, mixed with some black hairs; collar reddish orange in front, yellow behind. Antennae rufous. Thorax blackish, with the patagia becoming yellow posteriorly; transverse mark at base of thorax yellow. Abdomen black, with a yellow band at the posterior end of each segment, or the last four segments are wholly yellow, or are marked with orange at the sides, sometimes extending almost over the whole surface of the last three. Fore wings opaque except a short transparent and orange brown basal streak, with the discal mark heavier, veins at base sometimes stained with red; underside golden yellow. Hind wings transparent, margin and veins yellowish brown, underside stained with yellow.

Female. Similar to the male, but more robust and larger. Expanse: male, 25–30 mm; female, 30–35 mm. *Beutenmuller*

Locust borer

Cyllene robiniae Forst.

Irregular ugly scars opening into burrows about 1/4 inch in diameter are very common on our native black locust. This is the work of a black beetle, less than 3/4 inch long, very prettily marked with golden yellow. May be found in considerable numbers in the fall on golden-rod.

The work of this insect is very common on black locust trees in New York State, and the beetle occurs in considerable numbers each year. The species is such a pretty one that it is not infrequently submitted to the entomologist with an inquiry as to its name and habits. Its depredations are so serious in some sections of the State as to mar the beauty of our locust trees. Almost every row of any size may be recognized at a distance by the large number of dead limbs projecting above the leafy branches, an appearance which in most cases must be attributed to the work of this borer. Its operations lower down, particularly in the case of small trees, produce very unsightly scars which admit moisture and promote decay.

Early history. This species was observed by Dr Harris in Massachusetts, who characterizes the pest as a most destructive insect. Dr Fitch, in 1858, states that this borer is the greatest obstacle to the cultivation of the locust tree with which the growers have to contend. He records an instance in the city of Utica where one of the principal thoroughfares, early planted with locusts, had been invaded by this borer, and the magnificent trees either killed outright or totally ruined. He states that Micheaux records this species as so destructive 50 years before that many were prevented from planting the locust. Dr Fitch adds that heretofore, this borer appeared to have been a pest in the older settled section of our country and that no doubt in time it will become equally destructive in the newer districts. He considers this a native species though some of the earlier writers thought it was an introduced form. It was noticed by Mr S. S. Rathvon in 1861, who records this species as one of the most common and destructive to this tree, and incidentally he confuses this insect with the hickory borer, Clytus pictus Drury.

This species was noticed in 1866 by Dr Walsh who states that till 20 years before it was unknown in Illinois; shortly after it commenced its depredations in Chicago, spread to the south, southwest or west through the state, sweeping the locust before it. In 1860 it had destroyed most of these trees in central Illinois, and in 1863 it was present in immense numbers in Rock Island, and in the two following years nearly destroyed the locust in that section. He states that it had crossed the river into Iowa in 1865, and in a note the following year records it from Lawrence Kan., where it had been observed by a correspondent in 1865.

Dr Walsh clearly distinguished between this species and the hickory borer, Clytus pictus Drury. Dr Fitch in 1858, states in reference to the report that the insect had not yet made its appearance west of the Mississippi, that he had received specimens year after year from Indian Territory west of Arkansas, and that in all probability the species occurs all over that portion of the country in which the locust grows.

This statement of Dr Fitch's is confirmed by Messrs Walsh and Riley receiving this borer from Omaha Neb., in 1868. Rev. C. J. S. Bethune writing of this insect in 1877, states that it was first recorded in Canada in 1855, when some locust trees at Montreal were attacked and in 1862 it began to be very destructive to these trees in Toronto, and was for several years excessively abundant. He adds that it appeared in enormous numbers at London Can. in 1873, and at the time of writing it appeared to be generally distributed throughout the province. Dr A. D. Hopkins states that many trees in and about Morgantown were in 1891 nearly killed or dead as a result of this insect's work. The bettles were brought to Prof. M. E. Webster in 1888 by a florist who stated that they were in a greenhouse eating rose leaves and that in no case were they observed to molest other plants. This observation has been questioned by Messrs Riley and Howard.

Mr Philip Laurent has recorded injurious work by this borer in and about Philadelphia in 1893. He states that in a grove of young trees varying from 1 to 6 inches in diameter, there was not one of them that did not show the destructive work of this insect. Many of the trees were completely honeycombed by the larvae.

Description. The adult insect is cylindric and ranges in length from a trifle over 1/2 to about 3/4 inch. It is a dull black color, brightly marked with golden yellow, as shown in plate 5, figure 3. The antennae and legs are a dull yellowish.

The pupa is nearly 3/4 inch long, stout, flattened, yellowish and with the dorsum of the head and anterior six abdominal segments dotted with irregularly arranged chitinous points. There are two clusters, one on each side of the median line, of three to six small hooks on the dorsum of the seventh abdominal segment. A slightly larger hook occurs behind each of these clusters and on the posterior half there is a transverse row of about 10 hooks. The eighth segment bears a smaller transverse row of about 5 hooks. The antennae extend to the second abdominal segment and the wings and legs are appressed to the breast.

The larva is six or seven tenths of an inch long, somewhat flattened, club-shaped, the thoracic segments being considerably broader than the abdominal ones, but at the same time distinctly flattened above and below. The head when extracted from the thorax appears almost circular and narrower than the prothorax. The latter is twice broader than long, rounded anteriorly, flattened above and below, brownish yellow, covered, especially on the sides and below, with a short golden pubescence. A deep, longitudinal sinuated furrow is visible on each side, a short transverse furrow crosses its posterior end. The upper disk is inclosed between two furrows beginning at the posterior margin, and not reaching the anterior one; a transverse furrow parallel to the posterior margin, separates a narrow fleshy fold. The anterior portion of this upper disk is irregularly punctured and wrinkled, although shining; in some specimens it has an indistinct,elongated, somewhat oblique brownish spot on each side, about the middle; the posterior portion of the disk is opaque, covered with dense longitudinal wrinkles, among which a straight impressed line is apparent in the middle. The ventral side is irregularly punctured on the sides, and has a depression in the middle which is less apparent in some specimens.

The other two thoracic as well as the two first abdominal segments have, above and below, a transverse flattened opaque disk, limited on each side by a furrow, and showing some indistinct furrows on its surface; the other abdominal segments have the usual protuberances, on the dorsal as well as the ventral side, marked with wrinkles. The last segment is short and divided in two halves by a transverse fold; the latter half has the anal opening at the tip. All these segments are beset with short golden hairs on the sides. There are no feet, as in the Lamii. *Osten Sacken*

The borings of this pest are very characteristic and are usually indicated externally by irregular areas of exposed dead wood, more or less riddled by galleries about 1/4 inch in diameter. The inner portion of the trunk of an infested tree is frequently nearly honeycombed by the larvae. The galleries for the most part run longitudinally in the heartwood. The galleries are terminated in some cases by a very characteristic upward broad curve which extends down to the exit hole [pl. 5].

Life history and habits. The life history and habits of this insect have been very well described by Dr Harris as follows:

In the month of September these beetles gather on the locust trees, where they may be seen glittering in the sunbeams with their gorgeous livery of black velvet and gold, coursing up and down the trunks in pursuit of their mates, or to drive away their rivals, and stopping every now and then to salute those they meet with a rapid bowing of the shoulders, acompanied by a creaking sound, indicative of recognition or defiance. Having paired, the female, attended by her partner creeps over the bark, searching the crevices with her antennae, and dropping therein her snow white eggs, in clusters of seven or eight together, and at intervals of five or six minutes, till her whole stock is safely stored. The eggs are soon hatched, and the grubs immediately burrow into the bark, devouring the soft inner substance that suffices for their nourishment till the approach of winter, during which they remain at rest in a torpid state. In the spring they bore through the sapwood, more or less deeply into the trunk, the general course of their winding and irregular passages being in an upward direction from the place of their entrance. For a time they cast their chips out of their holes as fast as they are made, but after a while the passage becomes clogged and the burrow more or less filled with the coarse and fibrous fragments of wood, to get rid of which the grubs are often obliged to open new holes through the bark. The seat of their operations is known by the oozing of the sap and the dropping of the sawdust from the holes. The bark around the part attacked begins to swell, and in a few years the trunks and limbs will become disfigured and weakened by large porous tumors, caused by the efforts of the trees to repair the injuries they have suffered. According to the observations of Gen. H. A. S. Dearborn, who has given an excellent account of this insect, the grubs attain their full size by the 20th of July, soon become pupae, and are changed to beetles and all leave the tree early in September. Thus the existence of this species is limited to one year.

This insect resembles the painted hickory borer very closely indeed, and the two can be distinguished more easily by their food plants, and by the locust borer occurring in the fall, and the species affecting hickory in the spring, than by any structural characteristics or details in coloration. The male of the hickory insect may also be recognized by its antennae being longer than the body and quite stout, and by the wing covers being indented at the base and tapering toward their tip, so that the two together equal the basal width of one of them, as stated by Dr Walsh.

Destructiveness in New York State. Dr J. B. Smith includes this insect in his list of species found in New Jersey and states that its presence renders it impossible to raise decent trees in most localities. This seems to be exactly the condition which prevails in many sections of New York State. The locust tree is a rapid, vigorous grower and therefore does not show the operations of a borer so quickly as do some others. It is a rare thing to meet with uninjured trees and not infrequently many rows of locust trees are from one quarter to two thirds dead as the result of this insect's work. Mr M. F. Adams in a recent communication, attributes the destruction of nearly all the locust trees in the city of Buffalo to the work of this species and the carpenter worm, Prionoxystus robiniae Peck, and in 1899, the writer received from Poughkeepsie the trunk of a young locust which had been literally riddled by this borer.

Remedial measures. Ordinarily it is impossible to do much to control this species as the tree is hardly worth the attendant expense. Writers, however, suggest applying to the trunks a repellant wash in the early fall to prevent deposition of eggs, and this would probably help considerably in avoiding infestation. It is also advisable to cut and burn badly infested trees which may be done at any time during the winter. This species is a sun-loving beetle and it appears to have a preference for trees with trunks and branches exposed to the sun. Thick groves would therefore be more likely to escape injury

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Poplar borer

Saperda calcarata Say

Large, blackened, swollen scars on the surface of the trunk and limbs are very likely the work of this insect.

This, the largest native species belonging to this genus, is of considerable economic importance on account of the serious injuries inflicted on the trunks and larger limbs of poplars. These trees rarely attain any size in New York State before showing the operations of this insect, and in not a few instances very great damage is inflicted. This applies not only to neglected trees along roadsides and in forests but also to magnificent specimens grown for ornamental purposes. The poplars in Washington Park, Albany, have been recently damaged to a considerable extent by large numbers of these borers. Similar injury has also been observed in New York city and Brooklyn.

The lombardy poplars in the vicinity of Cambridge Mass., were nearly destroyed by this insect in the early 40's, according to Dr Harris' classic report on insects injurious to vegetation. It was recorded as very injurious to poplars along the shores of Casco bay, Maine, in 1884, by Dr Packard, and it had inflicted great damage on the silver poplars of Cincinnati O., in 1892, according to Charles Dury. Professor Riley, in his early writings, states that this insect has been universally destructive to cottonwoods and poplars in the Western States and Professor Bruner considers it as by far the most destructive enemy of poplars and cottonwoods in the West, and adds that it is almost impossible to obtain trees of any size in cities and towns of Nebraska, away from the friendly care of birds and parasitic enemies.

Description. The parent insect is a magnificent beetle about 1 1/4 inches long, grayish, diversified with patches of yellow [pl. 6, fig. 2]. There is an entirely brown variety of this species. The general characters of the pupa and larva, together with the latter's method of work, are so well depicted on plate 6, figures 1–6, 26 that lengthy descriptions are unnecessary.

Life history. Comparatively little has been published regarding the life history of this insect. The beetles occur on the trunks and branches of various poplars in August and September. The most obvious signs of infestation are the numerous blackened, swollen scars on the trunk and limbs. These are sometimes open and in early summer large quantities of borings are expelled from the galleries and frequently occur in considerable amounts about the base of the tree. This is very evident during the latter part of May and in early June. Pupae were found in large numbers about Albany in early June, and adults appeared early the following month and continued to emerge throughout July and were probably abroad during August and into September. Full grown larvae were also met with in early June, indicating that there was not much uniformity in the time of pupation. The pupal stage probably lasts three or four weeks, and the chamber where the final transformations take place, is invariably located near the center of the smaller limbs and at some distance from the surface in trunks. The top is smoothly excavated, the other end is closely packed with coarse fibers which are attached at one end to the side of the galleries and the portion next to the pupa is packed with much finer borings and then coated with very fine sawdust. This pupal chamber is probably made the previous season, but final transformations do not occur till spring. The young larva works in the inner bark and outer sapwood for a short time and before the approach of cold weather sinks its burrow to a greater depth. The galleries of the second year are very largely in the interior of the wood, and during this stage the limb or trunk may be honeycombed with very large, somewhat irregular galleries. The nearly full grown larvae not infrequently excavate large, shallow galleries in the sapwood and inner bark, and appear to subsist to a considerable extent on the sap collected in such cavities. Three years are probably required to complete the life cycle.

Food plants. This species appears to infest practically all poplars, and it has been recorded from the lombardy poplar, the cottonwood and the common aspen besides other species or varieties.

Distribution. This borer ranges from Canada south to Texas and entirely across the United States. It appears to be somewhat common in most localities.

Remedies. It is manifestly impossible to control this insect on other than valuable trees, and in such situations digging out the borers in early fall, with possibly recourse to the use of repellant washes is about all that can be done, and in the majority of instances should afford considerable protection.

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Mottled willow borer

Cryptorhynchus lapathi Linn.

Willows and poplars are frequently severely injured by a footless, fleshy, white grub which transforms in midsummer to a dark colored snout beetle, about ¼ inch long, with the posterior third of the wing covers a pinkish white.

The presence of this imported insect was first brought to public notice by Mr Juelich,[1] who records finding the beetle near West Bergen N. J., and states that five years before he took a specimen of this insect on willows near Williams bridge, at least 12 miles from the first named locality. Mr Juelich expressed the opinion in the above notice that the species might become a great scourge to the willow, and apparently his prediction is being fulfilled.

History and distribution in New York State. Mr Ottomar Dietz found this species on Staten Island in 1886 and it was next taken in New York State by Mr Ottomar Reinecke in the vicinity of Buffalo in 1896. It was brought to the writer's attention in 1898, by Mr M. F. Adams of Buffalo, who reported it as seriously injuring willows and poplars in that city. It occurs about New York city and Albany in willow, and the writer has taken it at Westfield N. Y., and received specimens from Newark and Rochester; in the two latter places it has caused considerable damage to nursery stock.

[1] 1887 Juelich, William. Entomologica Americana. 3: 123.

Its reception the same year from Pike N. Y. indicates a general distribution in New York State, at least.

Work in Massachusetts. This species was studied by Mr J. G. Jack, who stated in 1897, that it had been known to occur in Cambridge, Boston, and vicinity for many years, and that for several it had proved destructive to almost all species of willows growing in the Arnold arboretum. Mr A. H. Kirkland, writing of this insect in 1899, states that in Massachusetts it appears to be most injurious to the balm of Gilead. It had become so abundant in Winthrop and Revere that there was hardly a sound balm of Gilead at the time of his writing. He also found that the insect bred in nearly all species of poplars and willows and had observed serious injuries in many of the larger nurseries in eastern Massachusetts.

Distribution. This species, as stated by Professor Webster, is common in Europe, ranging over Siberia and Japan, but whether it extends farther south into Central Asia is not known. It occurs in the United States from New Jersey, where it already had obtained a considerable distribution, to Massachusetts and westward, through New York into Ohio, it doubtless having made its way along the southern shore of Lake Erie. Later it was found in Minnesota whither it had been shipped in nursery stock.

Description. The adult beetle or curculio is about 1/3 to 3/8 inch in length. Its body is a dull black, with little spots or tufts of jet-black scales or hairs on the thorax and wing covers. The posterior third of the wing covers, the sides of the thorax, the base of the anterior femora and portions of the middle and posterior femora are a pinkish white. The beetle is represented on plate 10, figure 8. The delicate pupa is white, about 3/8 inch in length, with a long snout, and when nearly mature begins to show the coloration of the beetle. The full grown larva is about 1/2 inch in length, fleshy, white and footless. The egg has been described by Professor Webster as oval, pale yellowish white and from 1.5 to .8 mm wide.

Life history. The adult beetles appear in midsummer. They have been observed by Mr M. F. Adams at Buffalo N. Y., July 5, [illegible]. Mr A. H. Kirkland records their occurrence in infested sticks July 28, [illegible], and states that they were emerging freely on the 31st. July 30, 1898, he found them abundant at Springfield Mass., feeding on cottonwood along the Connecticut river. Adults were numerous at Winthrop as late as September 21. Professor Webster states that one adult was found by Professor Burgess at Ashtabula O. ovipositing Oct. 5, 1901, which is in all probability exceptionally late. The beetles may be said to occur from early in July through August and into September to some extent. Oviposition presumably extends over a considerable period, and in most instances, the eggs are probably laid at the base of the buds, or small branches.

Mr Burgess has observed this process and states that the female excavates quite a cavity in the corky bark, the process occupying about 40 minutes, and then deposits the egg, which appears to be protected by a mucilaginous secretion. The burrows of the young grubs occur around buds and at the base of small limbs, and frequently partly girdle the stem. The nearly full grown grubs or borers make galleries about 1/8 inch in diameter, and in the case of small trees it may frequently be carried nearly half way around. The injury is indicated externally on willows by a purplish discoloration of the bark on either side of the burrows, and by the drying and shrinking of the thin bark directly over the gallery. The full grown larva bores into the center of small stems, frequently for a distance of 3 or 4 inches. The pupal cell is found near the extremity of this burrow, the pupa always being headed toward the exit. An examination of infested nursery trees in April, 1900, showed that most of the grubs were in the central part of the burrow, and apparently were full grown. There were other small grubs working around the base of the buds and these probably produce the late appearing beetles. The work of this species is represented on plate 16, fig. 8, 9 and on plate 32. Mr M. F. Adams observed nearly the same thing May 23–25, 1900, taking many larvae; the smallest being less than 1/25 inch long, and the largest 5 times that size. The burrows of these smaller grubs, as observed by us frequently nearly encircle the bud, and produce a brownish discoloration, different from the purple color seen near the larger galleries. Infested twigs collected at this time and placed in breeding cages were bored to a considerable extent by the grubs, most of the galleries being in the central portion of the twigs. No adults were obtained from this material, but a later sending received July 18, contained a number of beetles within their burrows, and subsequently many emerged. The duration of the pupal stage has been determined by Mr Kirkland as about 18 days.

Food plants. This species has been recorded by various European authors as attacking willows, alders, and birches. It has proved specially injurious to willows and poplars in this country. Mr M. F. Adams of Buffalo, states that he has taken this species from balsam poplar, balm of Gilead, Carolina poplar, Lombardy poplar, Babylonian willow, heart-leaved willow, Kilmarnock willow, and from the trunk of the new American weeping willow. He states further that he has never taken it from the golden barked willow, laurel-leaved willow, silver poplar, or bollean poplar, though a great many of these varieties were growing in the vicinity of infested trees. Mr Kirkland has recorded it as occurring in the cottonwood (Populus) and in the silver or bollean poplar.

Remedial measures. This insect, like many borers, is comparatively inaccessible, and the most practical method of checking its ravages appears to be cutting and burning all seriously infested wood in early spring. The burrows of the larger grubs, at least, can easily be distinguished at this time and probably the preceding fall. The work of the young grubs is very difficult to detect, but with careful examination it should be possible to recognize most of the infested wood.

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Lilac borer

Podosesia syringae Harris

B[illegible] stems and ash trunks. A white, sparsely haired caterpillar

This species is one of the more common pests of the lilac and its work may frequently be seen in stems of this shrub a sign of its presence in midsummer being the sudden wilting of a shoot. It has been found at work in ashtrees in Brooklyn by the late Rev. G. B. Hulst and Prof. Herbert Osborn observed it working in the young shoots of species of ash at Ames Ia. The late Dr Kellicott of Buffalo states that it lives under the bark of old trees, he having watched 20 or more issue from a single tree in one day and found that often there were more than one hundred in one tree.

Professor Thomas, in writing of its work in Illinois, states that it may be found during the latter part of the summer making its galleries through both sap and heart wood of limbs even an inch in diameter. Moths were bred at Carbondale Aug. 10 and cocoons were spun the following season about the middle of May. The late Dr Kellicott found this species also boring in mountain ash. Its recorded distribution has been given as New England, Middle States westward to California and southward to Texas.

Description. *Male.* Head black, palpi chestnut red, black beneath. Collar edged with chestnut in front. Antennae rufous, black above. Thorax deep brown more or less marked with bright chestnut red. Abdomen black, or marked with chestnut brown, sometimes with a small yellow spot on each side of the fourth segment, or with the segments banded with yellow. Femora black, anterior pair of tibiae orange, tarsi yellow; middle and hind tibiae black with an orange band. Tarsi yellow, hind pair with a black band above. Fore wings opaque, deep brown, with a violaceous luster, usually with a rusty red dash at the outer part of the wing below the costa. At the base is a short transparent streak, and marked with red on the costa and inner margin. Underside washed with orange and yellow. Hind wings transparent, yellowish, with an opalescent luster, veins, discal mark, and margin deep brown, sometimes tinged with red; underside marked with red.

Female. Similar to the male, but more robust and larger. Expanse: male 25–30 mm; female 30–36 mm. *Beutenmuller*

DESTRUCTIVE LEAF FEEDERS

Certain species of leaf feeders have been exceedingly destructive to shade trees in New York State in recent years, and in making selections for this group it is probable that some will be omitted, which, in the course of a few years will attract notice on account of their depredations.

Key to destructive leaf feeders

Blue-headed caterpillars with a line of silvery diamond-shaped spots down the middle of the back, rest in masses on the sides of branches and trunks and defoliate maple and other trees in midsummer.. Forest tent caterpillar, Malacosoma disstria, p. 106

Brownish caterpillars with blue and reddish warts, occur in masses on the sides of branches and trunks of many trees in early summer
Gipsy moth, Porthetria dispar, p. 116

Curious baglike shelters containing caterpillars, occur in early summer on various trees and shrubs in the vicinity of New York city
Bag worm, Thyridopteryx ephemeraeformis, p. 123

Light green, white marked caterpillars about 2 inches long sometimes occur in immense numbers on soft maples in early summer........... Xylina antennata, p. 129

Red-headed, yellow and black tufted caterpillars defoliate in early summer horse-chestnut, linden, maple and other trees
White marked tussock moth, Hemerocampa leucostigma, p. 132

Conspicuous web tents in July and August, inclosing foliage at the tips of branches, which is soon skeletonized and turns brown
Fall webworm, Hyphantria textor, p. 142

Irregular, circular holes in elm leaves, particularly of European species, followed by skeletonizing of the under surface of the foliage by grubs
Elm leaf beetle, Galerucella luteola, p. 146

Cylindric, coiled, yellowish white worms with a black line down the middle of the back, occur in midsummer on willow, elm, poplars and other trees
Elm sawfly, Cimbex americana, p. 155

Large, black, red-marked, spiny caterpillars 2 inches long, occur in June and August in clusters and defoliate terminal branches of elm, willow, poplar and other trees
Spiny elm caterpillar, Euvanessa antiopa, p. 158

Circular, somewhat irregular mines occur in considerable numbers in the leaves of European and American elms.....Elm leaf miner, Kaliosysphinga ulmi, p. 162

Small web tents on tips of trees in midwinter
Brown tail moth, Euproctis chrysorrhoea, p. [illegible]

[illegible] somewhat flattened cases on mined leaves of English and Scotch elm

Elm case bearer, Coleophora limosipennella, p. 167

[illegible] folded in August or September, containing a long, tapering, blackish [illegible], with the adjacent tissues on the underside skeletonized

Maple trumpet skeletonizer, Thiodia signatana, p. 168

Yellowish or brown larch needles with hollow apex and small circular hole on one side

Larch case bearer, Coleophora laricella, p. 170

Forest tent caterpillar: maple worm

Malacosoma disstria Hübn.

Blue-headed caterpillars with a line of silvery diamond-shaped spots down the middle of the back, frequently defoliate maple and other trees in early summer, and when not feeding assemble in clusters on the sides of the larger limbs and trunks.

Stripping a large proportion of the foliage from maples has been a marked characteristic of this species for the last four or five years in many sections of New York, the climax being reached in 1898 and 1899. The sugar maples of Delaware, Greene and Otsego counties suffered most severely from the attacks of this pest in 1897 and 1898, large areas being left with hardly a green leaf. The destructive work of this caterpillar in 1899 was more general than in the preceding two years, there having been complaints received from about half the counties in the State, and in some sections the depredations were worse than ever. This species appeared in force in many cities and villages, threatening thousands of handsome shade trees with defoliation, and had it not been for most energetic efforts on the part of local authorities and private individuals, many maples along streets and in parks would have been stripped of leaves. This native species is generally distributed and its comparative abundance in a locality is therefore due to natural causes, favorable or otherwise, and very rarely can it be said that the insect has migrated to any extent, except in a very local and restricted sense.

Early history in New York State. The earliest record of injury in this State appears to be that of Dr Riley, who reported the species as being quite destructive in certain parts of western New York in 1857. Peter Ferris 10 years later, states that this insect had been troublesome in western

New York for 12 or more years. A serious outbreak at Kingsbury, Washington co., was brought to the attention of Dr Lintner in 1889. About 10 acres were defoliated at that time. These depredations, however, are insignificant compared with those occurring in 1897 and following years. Prof. John Mickleborough states that this species was very destructive to maple and other forest trees at Jewett, Greene co. in 1897. The depredations of this species at Andes, Delaware co., were complained of, but the most serious damage occurred in the vicinity of Margaretville in the same county where the pest was abundant enough to defoliate large areas. It not only attacked the hard maple, but turned its attention to apple, pear, plum, beech, birch, poplar and other trees. The ravages of 1897 were continued in 1898, and considerable areas in St Lawrence, Oneida, Otsego, Greene and Warren counties were seriously injured. In not a few instances, hundreds of acres were stripped of their leaves, and this outbreak was followed in 1899 by some very serious injuries. This was specially true in certain cities and villages, and the local authorities of the infested places adopted vigorous measures in many cases and offered rewards for the collection of caterpillars and cocoons. The pest was so abundant in portions of Otsego county as to interfere with the operation of railroad trains. One correspondent reports that a train was stopped three times in passing between two stations 8 miles apart. This pest caused less injury in 1900, though it was very abundant in som: orchards in Greene and Columbia counties, and in 1901, the injury was still less, though far from being inconspicuous.

Extensive depredations in other localities. This insect has been extremely injurious in a number of other states, in some instances defoliating hundreds of square miles. One of the earliest accounts is the record of Abbot, whom Dr Riley quotes, stating that it "is sometimes so plentiful in Virginia as to strip the oak-trees bare." In his 3d report [*see* citation], Dr Riley credits this species with completely stripping the "over-cup timber" on the overflow bottoms near Des Arc Ark., and records extensive injuries by it in many parts of Missouri. In the 8th *Report on the Insects of Missouri*, it is stated that this species stripped oak forests over hundreds of square miles in the Southern States, and that in the vicinity of Memphis, in 1862, the larvae were so abundant as to frequently stop trains going in and out of the city. In 1889 another instance of trains being stopped was brought to the notice of the division of entomology, United States Department of Agriculture [*Insect Life*. 1889. 2:58]. This time the trouble was in Maine and was accompanied by serious injury to forests and orchards. Two years later trains were stopped on the Carolina Central Railroad near Lumberton [*Insect Life*. 1891. 3:477], and hindrance to travel was accompanied by the defoliation of many trees over large areas. This species was excessively injurious in the vicinity of London Ont. in 1877, as recorded by William Saunders in the following words: "There were millions upon millions of them, and so enormous were their numbers and so persistent their attacks, that after fighting them bravely for a week or two, many gave up the contest in despair, weary of the slaughter. Many an orchard was rendered bare and leafless and in some instances the woods were so void of foliage as to remind one of winter." In southern Illinois this insect "made a frightful inroad upon the apple orchard, absolutely defoliating every tree in large districts in 1883." The damage of the last few years in New York State has been duplicated to a great extent in Vermont and New Hampshire.

The caterpillars committed very extensive ravages in 1897 along the Ottawa river, stripping the aspen groves of every leaf and seriously injuring other trees [*Ottawa Naturalist*. 1898. 12:13].

Distribution. The numerous records of serious injury by this insect in the eastern United States and Canada indicate that it is widely and generally distributed. It has been reported from Mississippi north into Canada and from Maine westward to California. Dr Dyar states that M. disstria extends throughout the range of M. americana and M. pluvialis and also into California.

Description. This insect can be distinguished at once from the commonly injurious tent caterpillar, Malacosoma americana Fabr., by the fact that no conspicuous web tent is spun. This caterpillar [pl. 7, fig. 13] has a row of somewhat diamond-shaped whitish spots down the middle of the back, while its close relative possesses a narrow whitish stripe in place of the dots. The egg belts [pl. 7, fig. 12] encircling the more slender twigs, are smaller, usually with one or two wrinkles or depressions in the brownish, protective covering, and the ends of the belts are more abrupt than are those of the species usually found on appletrees. An average sized egg belt, collected in Albany, of the forest tent caterpillar contained about 150 eggs. If an egg is opened in September or later, a well developed, nearly black caterpillar with a few whitish hairs may be seen. The recently hatched caterpillars are nearly black with whitish hairs and are found clustered together or traveling along certain silk-lined paths. After the second molt, the characteristic row of whitish spots along the back appears and as the caterpillars increase in size, the colors become brighter and more distinct. The white or yellowish white cocoons [pl. 7, fig. 14] are spun in leaves on the tree or lying on the ground, in crevices of the bark, under stones, in fence corners and under almost any convenient shelter. Within the cocoon is found the dark brown pupa [pl. 7, fig. 15]. The moths are light, buff colored, active creatures [pl. 7, fig. 10, 11]. The male may be recognized by his richer coloring, smaller size, and feathery antennae [pl. 7, fig. 11].

Life history and habits. The winter is passed by the well developed larvae within the eggshell. On the appearance of warm weather, the young caterpillars begin to emerge and if no food is at hand, await the unfolding of the leaves. From eggs received in early spring, young caterpillars emerged Ap. 17. There is considerable latitude in the time of hatching, even in one locality, about a month as reported by the late Prof. V. H. Lowe, and there is a corresponding variation in the time the caterpillars attain maturity. As the young increase in size, they molt from time to time, leaving their cast skins in small clusters on the bark [pl. 7, fig. 10]. When not feeding, the larvae may be found in clusters on the limbs. They also resort to such places when about to molt, an operation requiring at least a day or two. A wind or jarring causes these creatures when small to drop and suspend themselves with a silken thread, a position very annoying to persons obliged to pass under an infested tree, and as many shade trees were attacked recently, this feature was painfully apparent. If the shock is sudden, the caterpillars drop without spinning a web. As they become about half grown, they frequently form good sized clusters on the larger limbs and trunk of an infested tree. If the creatures are very abundant, they may strip the tree before full growth is attained and then be forced by hunger to invade neighboring orchards. The maple trees represented on plate 32 show well the work of this insect. Ordinarily, as the caterpillars approach maturity, many of them forsake the tree and crawl in all directions. Thus in obedience to a natural impulse, they may crawl in numbers over walks, piazzas and swarm on sides of houses. This wandering, prior to pupation, occurs about June 1, the transformation to the pupa taking place from about the middle to the last of June. The insect remains in the pupa state about two weeks, the moths appearing the latter part of June and during July, mostly in the latter month. The eggs are deposited during July, a large proportion of them being laid on the lower twigs, but many are found over 20 feet from the ground and numbers even in the tops of tall trees.

Food plants. Like the common tent caterpillar, this insect can subsist on a large variety of plants. Its favorite species of oak in the Southern States, as given by the late Dr Riley, are those belonging to the same group as the black oak. In New York and adjoining states this insect is reported more frequently as defoliating the sugar maple than any other tree. This may be owing to the fact that large sugar orchards afford the most favorable conditions for the caterpillars in the north, and as the maples are of greater value than forest trees, complaints of attack are more frequent. The caterpillars have been reported by various writers as feeding on the following trees and shrubs: linden, maples, locust, peach, plum, cherry, rose, strawberry, apple, sweet gum (Liquidambar styraciflua), dogwood, "black gum," sour gum (Nyssa sylvatica), ash, elm, black walnut, hickory, walnut, oak, black oak, post oak, white birch, gray birch, willow and poplar.

Natural enemies. Like its associates, this species has a number of important natural enemies. A fungous disease is known to attack this caterpillar, but at present little has been done in attempting to disseminate it. One of the most fruitful methods of keeping the pest in check through the aid of its natural enemies, will probably be found in encouraging and protecting the native birds known to feed on it. Robins, orioles, chipping sparrows, catbirds, cuckoos, the red-eyed, white-eyed, and warbling vireos, cedar birds and nuthatches have been observed feeding on forest tent caterpillars by Miss Caroline G. Soule who writes: "The nuthatches would stand by a patch of larvae lying close together below a tar band on a tree and eat so voraciously and with such an entire abandonment of self-consciousness that I could go close and put my hand on them before they would fly. This experience was repeated several times." Mr William Saunders gives an instance in which a black-billed cuckoo was brought to him with its crop filled with caterpillars. Mr E. H. Forbush, ornithologist to the Massachusetts State Board of Agriculture, has kindly supplied me with the following list of native birds observed by him feeding on forest tent caterpillars: Baltimore oriole, black-billed cuckoo, yellow-billed cuckoo, crow, blue jay, American redstart, white-breasted nuthatch, wood thrush, chewink, black and white creeper, red-eyed vireo, flicker and scarlet tanager. He has since published a list including the following additional species: yellow-bellied sapsucker, bronzed grackle or crow blackbird, chipping sparrow, towhee, English sparrow, warbling vireo, white-eyed vireo, black and white warbler, yellow warbler, catbird, chickadee, American robin and cedar waxwing. Prof. V. H. Lowe has observed the black-capped chickadee feeding on the eggs besides others mentioned above. Prof. C. M. Weed states that the robin, chipping sparrow, yellow bird and English sparrow feed on the moths.

The value of birds in keeping other pests under control is also strikingly shown in the experiment conducted by Mr Forbush. In a typical orchard at Medford Mass., a little trouble was taken to attract the native birds, the nests of the English or house sparrow being destroyed. The results were greatly in favor of protecting our indigenous forms. In the neighboring orchards it was evident that cankerworms and tent caterpillars were very numerous, but in the orchard in question, the trees were seriously injured in only one or two instances, though no attempt was made to control the insects by spraying or other artificial means. The common toad has been recorded by Mr Kirkland as feeding on this species, though from this batrachian being confined to the ground and presumably occurring more abundantly in cultivated fields, it is hardly probable that as a rule it devours many caterpillars.

Parasites. Relatively few true parasites have been bred from this insect. Dr Riley records the rearing of Limneria fugitiva Say, and

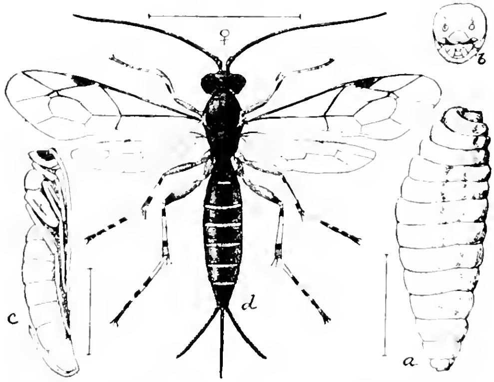

Fig. 1. Pimpla conquisitor: a, larva; b, head of same; c, pupa; d, adult female (all enlarged). Lines beside figures represent natural size. (After Howard, U. S. Dept Agric. Div. Ent. Tech. Ser. 5. 1897)

Mr Saunders states that Pimpla pedalis Cress preys on this species. Pimpla conquisitor Say was reared from several pupae collected in Delaware county in 1897, the large proportion of the cocoons parasitized indicated that it was very valuable in controlling this caterpillar. This species was extensively parasitized about Albany in 1900, Pimpla inquisitor Say, being the most efficient in many localities. Theronia fulvescens Brullé, recorded as a secondary parasite of Pimplas, was common at Slingerlands, and a considerable number were reared from cocoons. Anomalon exile Prov. was reared in small numbers from cocoons received from Lyons Falls and Glens Falls. Pteromalus vanessae How. was also obtained from the latter place. The following dipterous parasites have been recorded by Mr Coquillett: Euphorocera claripennis Macq., Frontina frenchii Will., Tachina mella Walk. This latter species was reared by us in sufficient numbers in 1900 to show that it was of considerable importance in a number of localities. Several predaceous insects prey on the caterpillars. One of great value is Calosoma scrutator Fabr., a species which Dr Riley characterized as most efficient. The beautiful and equally ferocious Calosoma calidum Fabr., is another valuable enemy, as stated by William Saunders. Mr Burgess records that Calosoma wilcoxi LeC. fed readily in confinement on the larvae of this insect. Two predaceous hemiptera, Podisus placidus Uhler and P. serieventris Uhler, as stated by Kirkland, feed on the caterpillars. A mite, ? Trombidium sp., was discovered by William Saunders destroying many clusters of eggs.

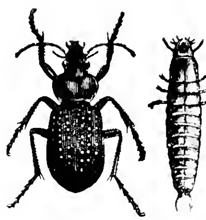

Fig. 16 Fiery ground beetle, Calosoma calidum. (After Riley)

Whenever cocoons of the forest tent caterpiller are collected, they should be placed in a box and covered with a rather coarse wire netting, about 3/16 inch mesh, so as to confine the moths but allow the beneficial parasites to escape.

Remedies. As a large proportion of the eggs of this species occur on twigs within 20 or 30 feet of the ground, something can be accomplished in winter by cutting off the infested twigs and burning the egg clusters, specially if the trees are not very large. But in the case of good sized maples, it is very doubtful if this could be done to advantage, and even with moderate sized trees there would probably be enough inaccessible egg belts near the top to stock the trees with a host of leaf consumers. At best, the collection of eggs can hardly be regarded as more than one of several repressive methods, no one of which can be depended on by itself to prevent serious injury. The egg belts can be seen best on a bright day and if there is snow on the ground, it will be easier to find all cut twigs dropped to the ground. The collection and burning of the eggs is necessary in order to insure thorough work. A long handled pruning hook is of great service in cutting off the infested twigs.

As soon as the presence of the young caterpillars (indicated by the thinness of the foliage on the upper branches) is detected, much can be accomplished by crushing them as they collect on the limbs or by dislodging them with a brush or torch. If the latter is used, care must be exercised not to injure the tree. Many caterpillars can be jarred from trees by using a padded mallet, or even violent shaking will cause some to drop. Ridding the trees of caterpillars by jarring or otherwise, must be followed up by some means of preventing their ascent. A band of cotton batting 8 to 10 inches wide tied tightly in the middle around a tree and the upper portion turned down over the string and allowed to hang loosely, is a difficult obstacle for caterpillars to surmount, so long as it remains dry. Wide bands of paper coated with tar or of sticky fly paper will also prevent the pests from ascending for a time. A band composed of equal parts of lard and sulfur is said to be an effective barrier. In one locality bands of cottolene were used to prevent the caterpillars from climbing the trees. It is safer to put lard, cottolene and similar oily preparations on close fitting paper bands rather than to apply them direct to the trunk. When the pests are very abundant it will not do to depend entirely on shaking and bands, the dropping creatures must be collected on sheets spread under the trees before they are jarred, and then killed, or crushed as they collect under the bands. Nothing but the most vigorous measures will protect a badly infested tree from severe injury. The masses of caterpillars found on the larger limbs and trunk can be crushed in large numbers with a stiff broom or thickly gloved hands. A more agreeable method is spraying these clusters with kerosene emulsion, whale oil soap solution (1 pound to 4 gallons) — a tobacco whale oil soap is better — or pouring boiling water over them. For methods of preparing kerosene emulsion see page 30.

Thorough spraying with any one of the poisons described on a preceding page and in the manner directed will kill these caterpillars very quickly. If they are nearly full grown and many are crawling to the sprayed trees from others, it is perfectly possible that all the foliage may be devoured before the caterpillars have eaten enough poison to kill them, but under most circumstances there need be little fear of the arsenical spray proving ineffective. The cost attendant on this method will lead people to depend largely on other means. Even a hand spraying outfit requires some outlay, while if many trees are to be sprayed a power outfit, described on a preceding page, is the most economical in the long run.

After the damage has been done, many of the insects are within man's power and can be killed in their cocoons. From about the middle to the last of June thousands of cocoons can be collected with little labor, and if this is done, opportunity should be given the parasites to escape before the cocoons are destroyed, as stated on a preceding page. Every healthy female pupa killed means one less egg mass to produce its approximately 150 hungry caterpillars another spring. During the summer of 1899, many hundreds of cocoons were collected and destroyed. Local authorities in Glens Falls, Saratoga Springs and several other villages offered the school children 10 cents a quart for these cocoons. Glens Falls paid for 1350 quarts, Saratoga Springs 744, Mohawk 450 and other communities took similar action.

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Gipsy moth

Porthetria dispar Linn.

Numerous brownish caterpillars with blue and reddish warts occur in large numbers on the sides of branches and trunks of many trees in the early summer. The egg masses are conspicuous and covered with buff colored hairs. An introduced species which works very locally.

This species has attracted more attention in America in all probability than any other imported insect with the exception of the now notorious San José scale and the cotton boll weevil. This is somewhat remarkable considering its restricted range in this country, and yet it is not very surprising when due credit is given to the scientists charged with safeguarding the interests of the country. The presence of this insect in enormous numbers at Medford Mass., was brought to the attention of Prof. C. H. Fernald in 1889, and a special bulletin calling attention to this dangerous pest was issued by the agricultural experiment station at Amherst Mass., in November of that year. A study of the situation convinced Professor Fernald that it was not only possible but practicable to exterminate this species. The closing decade of the last century witnessed a wonderful struggle between man and nature, and, had the work received the support it should, there is no doubt as to what the outcome would have been.

Not in New York. There is no occasion for extreme alarm. This pest does not occur within the borders of New York State to our knowledge; but as the commonwealth of Massachusetts has not only declined to do more toward exterminating the pest but puts no efficient checks on its distribution, it is only a question of time when the insect will invade our borders. It is impossible to say just when this insect will succeed in establishing itself in New York State. Favoring circumstances may bring about its introduction within a year or two or it may not occur for a number of years. Forewarned is forearmed and while the extermination of the pest in America may now be placed among the impossibilities, it is of greatest importance that it be kept under control, as it spreads over the country.

History in America. This species was introduced into Medford Mass., in 1868 or 1869 by Leopold Trouvelot, who imported it in the course of some experiments on silkworms. Justice to Mr Trouvelot compels the statement that the insect escaped from him by accident, and that he did all in his power to repair the mischief. Very little was seen of the pests for about 10 years, and then the caterpillars began to be abundant about the place where they had become established, and from then on their numbers increased till 1889, when Medford and vicinity were literally overrun with hordes of voracious caterpillars. The infestation bordered closely on a plague. An act was passed in the winter of 1890 providing for the appointment of a special commission and placing at its disposal $25,000, which sum was subsequently increased by an equal amount. The work of that year showed the insect to be present over a much larger territory than had been supposed. A farther appropriation of $50,000 was made in 1891, and from then till 1899 the appropriations ranged from $75,000 to $190,000 annually for the purpose of exterminating this species, the total amount disbursed by the commonwealth of Massachusetts for work against the gipsy moth being $1,155,000. This is a large amount of money to be expended in exterminating an insect, but it is very small compared to the loss we may reasonably expect from the devastations of this pest. The work was hindered from time to time by delayed appropriations, and yet, in spite of this and other obstacles, good progress was being made in the work of extermination. Its abandonment in 1900 can hardly be regarded as other than a grave misfortune. Personal examination of the infested territory in July 1904 showed that the insect had increased so greatly in parts of Malden, Medford and Melrose as to completely defoliate the trees over considerable areas. Previous to this the general results were most striking to a visitor. Places, where in 1891 defoliated trees, crawling caterpillars and signs of desolation had been prominent features, were in 1895 and 1898 seen to be comparatively free from the pests, and the injuries to vegetation slight or none. The checking of the insect over a large area was so thorough as to lead many to forget its earlier destructiveness and to despise its powers. At the close of 1899 the gipsy moth was known to be present in 34 cities and towns in Massachusetts. Its presence in large numbers at Providence R. I., was discovered in 1901 and other infested localities may be reported from time to time.

Description. It is exceedingly important that residents of this State should know something about the appearance of this insect and what to expect. Do not jump at conclusions and consider the specimen some form of gipsy moth because it bears a general resemblance to the illustrations given herewith. It is much better to send the specimen to an entomologist and secure an authentic determination. Generally speaking, the statement from a nonscientific person that the object in hand is a gipsy moth is of little or no value and is quite apt to be incorrect.

The eggs of this insect are deposited usually in round or oval patches [pl. 9, fig. 15] on a piece of bark and then covered with the buff-colored scales from the underside of the female's abdomen. A completed egg mass looks very much like a small piece of sponge. The eggs may be found on stones, in tin cans and in fact on almost any fixed object near at hand, preferably on the undersurface, particularly of limbs and fence rails. The nearly globular, pale yellowish or salmon-colored eggs are about 1/20 inch in diameter, and there are usually 400 to 500 eggs in a cluster, though occasionally 1000 may be found in an egg mass.

The young caterpillar is slightly over 1/10 inch long just after it emerges from the egg. It has a black head, the body is brownish yellow and well clothed with long hairs. There is a prominent hairy tubercle on either side of the segment next the head; this gives the caterpillar a peculiar broad headed appearance, specially in its early stages. The markings become plainer as it increases in size, and when full grown it is from 2 to 2 1/2 inches long. This caterpillar has a double row of conspicuous warts or tubercles down its back, the eight anterior blue, the 12 remaining red, not counting the four blue ones just behind the head. Similar tubercles also occur on the sides [pl. 9, fig. 16].

The somewhat conical, dark brown pupa ranges from 3/4 to 1 1/2 inches long and is well represented in figure 17 on plate 9. It is usually found lying among a few threads and securely attached to them by its terminal spine.

The male and female moths differ markedly. The former, a slender olive brown, black marked creature with featherlike antennae and having a wing spread of about 1½ inches, may be seen flying in the late afternoon and early evening in considerable numbers. It is represented with wings expanded at figure 13, plate 9. The female is much heavier and lighter colored. She has a wing spread of about 2 inches and is a white or buff white color with more or less distinct black markings. The abdomen is tipped with buff. The female in her characteristic resting position is well shown at figure 14 on plate 9. The female moth does not fly though she apparently has well developed wings.

Life history. The winter is passed in the egg mass, which is remarkably resistant to atmospheric and other agencies. Experiments have shown that even when the egg clusters were broken up and freely exposed to the elements, the eggs were apparently not harmed, and a normal proportion of the caterpillars appeared at the usual time, which in the vicinity of Boston is from the last of April to the middle of June. The feeding period extends from the first of May to about the middle of July, a caterpillar requiring from about 9 to 11 weeks to complete its growth and enter the pupal stage. The young caterpillars remain on the egg clusters from one to five or more days and then commence feeding on the leaf hairs. Soon they eat out small holes in the leaves and, after the third or fourth molt, about as many feed on the edge of the leaf as eat out holes. The caterpillars are largely nocturnal, remaining in clusters on limbs and trunk or hiding in some crevice during the day, and beginning between 7 and 8 o'clock in the evening leisurely to ascend the tree, where they feed on the foliage at intervals during the night, descending about 3 o'clock in the morning. Many of our farmers are familiar with the masses of forest tent caterpillars so abundant in sections of New York the past two or three years. The gipsy moth caterpillars assemble in just such masses, and on badly infested trees they are as destructive as our native species.

The larvae transform to pupae during the month of June, the moths appearing from the latter part of June till the latter part of July. In exceptional cases these dates may be considerably extended. Males emerge in advance of the opposite sex, and shortly after the females appear, pairing takes place and egg deposition begins. The embryos are frequently well developed within the egg in two or three weeks after oviposition, but as a rule the caterpillars do not emerge till the next spring. A case is on record of eggs hatching in early September of 1895 at Woburn Mass., but the round of life was not completed, and in this northern latitude at least, there need be little fear of two generations annually.

Food plants. One of the most dangerous features of the gipsy moth is the exceedingly large number of plants on which its caterpillars thrive. They will eat without hesitation almost all our native shrubs and trees and, when hard pushed, they can subsist for a time, at least, on a number of herbaceous plants. The common fruit trees, the elms, maples and oaks are all eaten most readily, and, even were the list no greater, the pest would be a most serious one to combat. It feeds on many other plants, as the list of 536, given in the exhaustive report on this insect in 1896, attests. It is very true that the caterpillar feeds on some of these only when compelled by starvation, and that it can not be considered an enemy of a number of others, but, even after making most liberal allowance for these, the list is still a very formidable one.

Destructiveness. Countless instances of serious injury by this pest could be given, even if we did not go outside of America. It is well known as a grievous pest in many parts of Europe, and its operations in this country, when unhindered by man, have been appalling. Personal observation of the infested area since 1891 leads me to consider this pest a much worse insect enemy than the forest tent caterpillar. It defoliates forest and other trees just as completely as Malacosoma disstria, and a series of disturbances such as those caused by this native pest may be expected when the insect becomes well established in New York State.

Means of dispersal. One of the redeeming features about the gipsy moth is the fact, previously noted, that the female moth does not fly. This compels the insect to rely on other agencies to a great extent for its distribution over the country, because, though the partly grown caterpillars are good travelers, they can not, relying on their own efforts, cover great distances. Experience with the insect has shown that people and vehicles constantly passing from an infested area to a clean one are among the most efficient carriers of the pest in the caterpillar stage. The insect can be conveyed long distances in the egg, and it is rather surprising that such has not occurred more frequently. Any hard object allowed to remain near an infested tree during July, while oviposition is in progress, is very likely to be infested with one or more clusters of eggs. The intelligent, energetic officials, who were in charge of the work against the gipsy moth, took special pains to prevent such dissemination, and now that nothing is done, there is great danger of the insect being carried with household effects to most distant points, specially if packed in boxes and barrels which have been allowed to lie where females could deposit eggs on them. Fortunately for New York State, this pest is most abundant north and northwest of Boston, and with this area we have less direct railroad communication. Still as the badly infested area becomes greater along the line of the Fitchburg railroad and extends to include the terminus of the Boston and Albany line, the chances of the insect being brought into the State will be very largely increased. This dangerous condition was emphasized by finding egg masses in the summer of 1904 on freight cars and while in many cases cars are not left where young caterpillars would readily find suitable food, in some places this is true and no one can predict where the pest will appear next.

Natural enemies. This insect has a number of natural enemies in this country, but unfortunately none of them are aggressive enough to warrant the placing of much dependence on them, though they should be encouraged by all possible means.

Mr Forbush states that about a dozen native song birds are very useful in devouring one stage or another of this moth and that about 20 other species will feed on it to a slight extent, or more largely when their usual food is rather scarce. The most useful birds are the yellow and black-billed cuckoos, Baltimore oriole, catbird, chickadee, blue jay, chipping sparrow, robin, red-eyed and yellow-throated vireos and crow.

A number of predaceous and parasitic insects have either been reared from this insect or observed preying on it, but none of them are of sufficient importance to warrant special mention in this connection.

Recommendations. Investigate anything that arouses a suspicion that it may be the gipsy moth, but be in no undue haste to identify the insect. It will be much more satisfactory to submit the specimens to an entomologist than to arouse unnecessary fears. There have already been several false alarms occasioned by persons with more enthusiasm than discretion, who have attempted to identify an insect with which they were unacquainted.

It would undoubtedly pay to exterminate a small colony, but in the course of time this will be impracticable. We must learn to control it on our own land. The inability of the female to fly and the conspicuousness of the egg masses make this task relatively easy, unless the pest is allowed to escape to the woods. There a private individual could hardly cope with the insect. The point of establishment in this state is almost bound to be near some dwelling, and therefore the species need not be allowed to establish itself in wild land, at least for some years.

One of the most effective methods of keeping this pest under control is the careful collection and burning of the conspicuous egg masses. This can be done most effectually in the fall, during the winter and in early spring. No ordinary fire running over the ground can be relied on to kill the eggs. The only safe way is to put them in a stove or similar fire and burn them up. Creosote oil applied to the egg mass will soak in and kill the eggs. The following preparation was used in the work against the gipsy moth: Creosote oil, 50%; carbolic acid, 20%; spirits of turpentine, 20%, and 10% of coal tar. The latter was added to color the compound and thus show at a glance what clusters had been treated.

The caterpillars prefer to hide during the daytime, and advantage may be taken of this habit to tie burlap bands in the middle around the tree trunks and then turn the upper portion of the burlap down over the string. The bands can be lifted daily and the caterpillars beneath killed. This method proved of such great value in the work against the gipsy moth that thousands of trees were banded during the latter part of the caterpillar season.

The larva is quite resistant to arsenical poisons, and it requires a large dose to kill it, specially when the caterpillar is nearly grown. There is probably no better poison for this pest than arsenate of lead, using at least 5 pounds to every 50 gallons. The application should be made as soon as the leaves are well grown, and then the caterpillars will be poisoned while young and most susceptible to the insecticide.

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A very complete and exhaustive account of this insect in America may be found in the *Gipsy Moth, a report of the work of destroying this insect in the commonwealth of Massachusetts, together with an account of its history and habits both in Massachusetts and Europe*, by E. H. Forbush and C. H. Fernald. Many of the facts given in the above account, which was published in the writer's 16th report,[1] have been taken from this valuable work, which also contains a very complete bibliography of the insect. This work renders a bibliography unnecessary in connection with the above brief notice.

Bag or basket worm

Thyridopteryx ephemeraeformis Haworth

Small caterpillars in curious baglike shelters are frequently found in early summer defoliating trees and shrubs in the vicinity of New York city and further south. They are particularly injurious to arbor vitae and other evergreens.

This insect is limited in our State to the southern portion of the Hudson river valley and to the islands about New York. It has been recorded as far north as Yonkers and Mt Vernon. It is a species of considerable economic importance to us despite its limited range in the State,

[1] 1901 Felt, E. P. State Ent. 16th Rep't, N. Y. State Mus. Bul. 36, p. 955–62.

and in New York city and vicinity it finds ample opportunity to inflict considerable damage on valuable trees. It manifests a great liking for certain evergreens and as these are usually killed with one defoliation, there is need of watching them closely. A study of the insect shows it to be one of the most interesting forms in our native fauna.

The conspicuous larval cases or bags reveal the identity of the depredator or excite the wonder of the curious, and examples of these are received yearly, some with accounts of serious injury, and others with a query as to the nature and origin of the curious structures.

Description. The larval case or bag of this insect is usually the first to attract notice. It is a fusiform structure from 1½ to 2½ inches long and in fall and winter it is firmly attached to a twig by a broad band of silk, as shown at figure 10 on plate 8. The form of the bag is quite characteristic but as this shelter is covered with particles of bark, pieces of leaves, leaf stems, etc., from the tree on which the larva feeds, its appearance may vary considerably. A female case cut open in late fall or winter presents the appearance shown at figure 11, plate 8. Within is the black pupal case and inside that there is a soft yellowish down and a large number of yellowish eggs, a few of which are shown enlarged on the same plate at figure 12. The appearance of the young larva and the cases formed a little later are exceedingly well shown at figures 13, 14 and 15 on plate 8. Special attention should be called to the harmony in color existing between the small cases and the portion of the twig on which they occur, due as determined by Mr Joutel, to the larva gnawing particles from the bark to attach to its tiny case. The full grown larva removed from its protecting bag is shown at figure 16 and the creature's method of carrying its apparently cumbersome retreat is represented at figure 17. The pupal cases of the two sexes are shown at figures 18 and 21 and the wide difference between the adult insects at figures 19 and 20. The female is almost legless, wingless and nearly helpless, while the male is a small black moth with well developed wings and beautiful feathery antennae.

Life history. The eggs survive the winter within the larval and pupal cases of the female. A large number may be deposited by one female, as 1284 were taken from one bag collected at Jericho L. I. and 523 occurred in one received from Everett Pa.; while Mr A. Girault states that he has obtained as many as 2000 and 3000 eggs from individual females. The young appear sometime in May or early in June and begin by eating the softer portions of the leaf. They repair to the stems when not feeding and here it is that they sometimes cover their interesting shelters by biting off pieces of the bark and attaching them to the case. This habit was brought to my notice by Mr Joutel who, in the course of his studies of the insect, found many tiny brown cases on the older bark, green ones on the younger bark and occasionally party-colored ones. The gnawed condition of the bark showed where the color had been obtained. This is not the first record of this interesting habit for the same thing was observed by Mr S. S. Rathvon in 1867. He also mentions an instance of the young larvae of this insect hatching in his office and in the absence of food escaping to the floor where they proceeded to attach to their cases pieces of paper, leather, straw matting and even scales of lime, in fact taking anything at hand. The cases may also be constructed on the leaves. Dr Riley's exceedingly graphic account of this operation is as follows:

The way in which this bag is prepared is curious [fig. 17]. The young larva crawls on a leaf and, gnawing little bits from the surface, fastens these together with fine silk spun from its mouth. Continually adding to the mass, the larva finally produces a narrow, elongated band, which is then

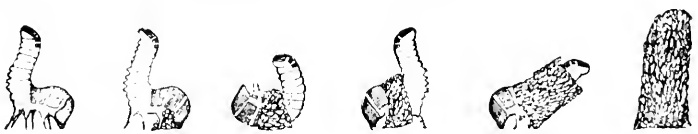


Fig. 17 Young caterpillar [illegible] caterpillar under strip [illegible] turning [illegible] case more enlarged [illegible] plete (After Riley U. S. Dept Agr. Div. Ent. Bul. [illegible])

fastened at both ends onto the surface of the leaf by silky threads. Having secured itself from falling down by some threads, it now straddles this band and, bending its head downward [fig. 17 *b*], makes a dive under it, turns a complete somersault and lies on its back, held down by the band [fig. 17 *c*]. By a quick turning movement the larva regains its feet, the band now extending across its neck [fig. 17 *d*]. It then adds to the band at each end till the two ends meet, and they are then fastened together so as to form a kind of narrow collar which encircles the neck of the worm. Far from resting, it now busies itself by adding row after row to the anterior or lower end of the collar, which thus rapidly grows in girth and is pushed further and further over the maker [fig. 17 *e*]. The inside of this bag is now carefully lined with an additional layer of silk, and the larva now marches off, carrying the bag in an upright position.

The case is carried in an upright position for a time but as it becomes heavier it is allowed to hang down [pl. 8, fig. 17]. Holes are eaten out of the leaves [pl. 8, fig. 15] as the larvae increase in size and pieces therefrom are attached to their protective covering. The cases are enlarged from time to time to meet the requirements of the growing caterpillar. The peculiar, ragged appearance produced by half grown bag worms is shown on the leaf just below figure 22, plate 8. The caterpillars attain their full size in July or August and in early September they become restless and wander to other trees and shrubs. Next the bags are securely fastened to twigs (sometimes the males attach their bags to leaves) by broad bands of silk [pl. 8, fig. 10], and the caterpillars then transform to pupae and about three weeks later assume the adult form. The males are on the wing during September and October. Their appearance is preceded by the male pupa wriggling itself partly out of the larval case, thus permitting the occupant to escape direct from his pupal case to the free air [*see* pl. 8, fig. 22]. The female does not leave hers till after ovipositing but works out of her case far enough to permit pairing, returns, oviposits and then escapes from the case and dies. The posterior portion of the pupal shell, which is the upper part as it hangs, is filled with eggs, and the anterior or lower part with the yellowish downy substance which is also intermixed with the eggs to some extent. The eggs may be found the latter part of October and the winter is passed in this form, as previously stated.

Food plants. This caterpillar feeds on a number of trees and shrubs. It is most injurious to evergreens on account of their not withstanding defoliation during the growing season. This is specially true of arbor vitae and red cedar. It has been recorded on the following trees, beside those previously mentioned: apple, pear, plum, cherry, chokecherry, apricot, quince, linden, catalpa, maple, locust, oak, elm, poplar, sycamore, osage orange, willow, spruce, hemlock, larch and white pine.

Distribution in the United States. This species is stated by Dr Riley to occur in the more southern portions of the middle states and in the southern states, though it appears to be absent from the peninsula of Florida. It occurs within these limits from the Atlantic to Texas and reaches the less timbered regions west of the Mississippi. Professor Webster has recently shown that this insect has established itself in Ohio within 25 miles of Lake Erie.

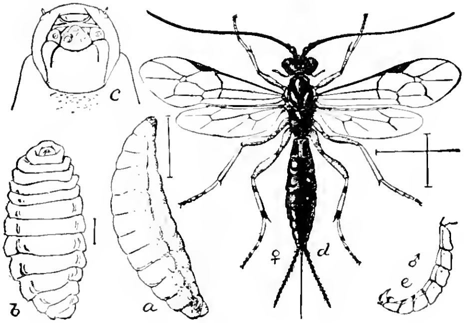
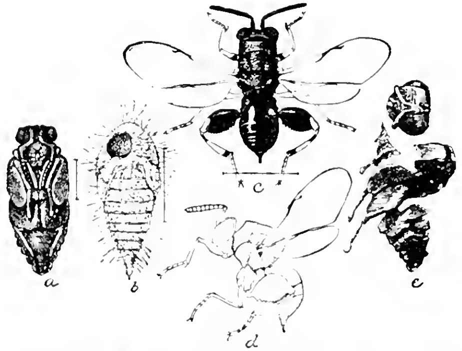


Fig. 18 Pimpla inquisitor: *a* full grown summer larva; *b* hibernating larva; *c* mouth parts of larva; *d* adult female; *e* abdomen of male from side—all enlarged; *c* greatly enlarged. (After Howard U. S. Dep't Agric. Div. Ent. Tech. Ser. 5. 1897)

Natural enemies. This species is subject to attack by several natural enemies. Pimpla inquisitor Say, P. conquisitor Say, and Hemiteles thyridopterigis Riley, are among the more important ichneumon parasites. The last named is more abundant than the two preceding, and unfortunately, it is probably a hyperparasite preying on the beneficial Pimplas. Chalcis ovata Say is a minute, four winged fly which was reared from this species by Dr Lintner. Dibrachys boucheanus Ratz., a common hyperparasite, was also reared from this insect by Dr Lintner.

Remedies. The spread of this insect is dependent almost wholly on the wandering of the larvae, which must be very limited on account of their cumbersome load. This, in connection with the eggs being deposited in a stout, conspicuous case, which remains on the trees all winter and is easily removed, renders the control of the insect by collecting the bags at this time and burning them, comparatively easy. This caterpillar is a leaf feeder and yields readily to arsenical poisons. Evergreens are quite susceptible to arsenic and therefore the arsenate of lead has been recommended.



[illegible] a, pupa; [illegible] parasitic [illegible] *[illegible]* [illegible] same from side; [illegible] pupal exuviae [illegible] enlarged [illegible] (After Howard, U. S. Dep't Agric. Div. Ent. Tech. Ser. [illegible])

Dr Smith advises the use of at least 15 ounces of the arsenate to 40 gallons of water for the purpose of securing the prompt destruction of the pests.

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Xylina antennata Walker

Light green, white marked caterpillars about 2 inches long sometimes occur in immense numbers on soft maples in the early summer.

The extensive defoliation of soft maples in 1898 by the larvae of this species at Schenectady and presumably at other places in the State, is another instance of how destructive comparatively unknown species may become provided conditions are favorable.

Recent injuries. The numerous soft maples at Schenectady were practically stripped of their foliage by hordes of light green caterpillars. On June 20, many were to be seen on the affected trees, not infrequently 50 to 100 on a single trunk. On the sidewalks, along the curbing and in the roadway, larvae were crawling hither and thither. Even were one deprived of sight, the peculiar odor arising from the thousands of larvae gave ample evidence of their presence, and the abundance of the caterpillars called to mind forcibly the numerous fields swarming with army worms in 1896. At Albany, only 17 miles distant, there was no sign of injury to the soft maples. A search at that time was not rewarded by a single caterpillar. As far west as Herkimer, on the Mohawk river, on the Raquette river in St Lawrence county, and in Schoharie county, many soft maples were defoliated. In some cases this was probably the work of Xylina larvae, though the forest tent caterpillar, Malacosoma disstria Hubn., was abundant and may have caused the mischief. In Massachusetts a green larva was quite destructive to soft maples, as stated by Mr R. H. Cooley. This depredator may be the same species that proved so destructive in New York. In a letter referring the larvae to Xylina, Dr Dyar states that in 1897 they were quite common on maples at Bellport L. I., and less abundant though plenty the following season.

Comparatively unknown. An examination of the literature relating to this insect shows that it is comparatively unknown to economic entomology, specially as a defoliator of maple or other trees, though Dr Riley, in his 3d report on the insects of Missouri, states that for several years he had known the larvae to be common on apple, poplar, hickory and some other trees, the leaves of which they devour. This species, in conjunction with Xylina laticinerea Grote and X. grotei Riley, was reported in 1896 by Professor Slingerland of the Cornell Agricultural Experiment Station, as quite injurious to fruits in the State, more specially in the western part. Extensive injuries to apples in Orleans county, N. Y., were also reported to Dr Howard the same year. Previous to that, there had been but one record of injuries in New York by this species and that was in 1877. In other States there have been a few instances of these insects attacking fruits. In 1870, Dr Riley received several complaints of injury by the larvae of this insect to peaches and apples. In 1888, it was somewhat injurious to apples and a bulletin by Prof. F. H. Hillman, of the Nevada Agricultural Experiment Station, records serious injuries in 1890 to roses by the same insect.

Description. The larvae of this species are stout, smooth, light green, cutworm-like caterpillars measuring from 1 to 1½ inches in length when full grown. The head is pale yellowish green. There is a rather broad yellowish white or white dorsal stripe along the body, a narrower white subdorsal stripe, a broken, faint lateral stripe of the same color and an irregular white stigmatal stripe. The tubercles are rather large and white, and the skin is minutely spotted with the same color. Professor Slingerland [see citation] states that in the larvae of X. grotei both edges of the stigmatal stripe are well defined, while in those of X. antennata the upper edge is much broken or indented. He finds that the subdorsal stripe is more continuous in the latter, it being composed of three or four irregular spots on each segment in X. grotei. He separates the larvae of X. laticinerea from those of X. antennata by the position of the stigmatal stripe, which is just above the spiracles, except the one at each extremity, in the former species, while in the latter it is mostly below the spiracles.

The moth [pl. 43, fig. 6] is ashy gray with indistinct, rather variable markings. Sometimes it resembles X. laticinerea so closely that only an authority on the family can separate the species. So close is the resemblance between these forms, that at first the larvae depredating on the maples were referred by Dr Dyar to X. grotei and X. laticinerea, the determination being based on examples named by Dr Smith some years ago. The subsequent studies of the latter have somewhat modified his views as to the limitation of these species, and have led to a renaming of those at the United States National Museum. These forms are undoubtedly very close to each other, though Professor Slingerland has found differences in the male genitalia of X. antennata and X. grotei.

Life history. Usually the larvae are not observed till May or June. They complete their growth by the middle of the latter month, enter the ground and pupate an inch or more below the surface. They remain in the quiescent stage till September, when most of them emerge. Though some hibernate as pupae, the majority pass the winter as adults. It has been stated that in the south, the eggs are deposited on the under surface of the leaves. No record of the oviposition in the north has been made.

Food habits. Though comparatively little is known about the food habits of this species, it is probably a somewhat general feeder. Dr Riley records attacks by the larvae of X. antennata on apples, peaches, oak galls, hickory leaves and those of other forest trees. Their feeding upon rosebuds and maple foliage has already been mentioned. The extensive defoliation of the soft maples would indicate, however, that the species becomes abundant only when climatic and other conditions favor its rapid development on some favorite food plant like the soft maple. In his bulletin, Professor Slingerland adds peas, plums, currants and quinces to the list of fruits injured and states that one grower had to watch the buds on grafted pears to prevent their being destroyed. Further observations may greatly extend the list of known food plants.

Natural enemies. Two hymenoptera, Mesochorus agilis Cres. and Meteorus hyphantriae Riley, were reared from X. laticinerea by Professor Slingerland. They would probably attack X. antennata with equal readiness. The latter parasite is a very efficient enemy of the fall web worm, Hyphantria textor Harr. In addition to these, the writer has reared examples of the red-tailed tachina fly, **Winthemia 4-pustulata** Fabr., a species which has frequently rendered most valuable aid in controlling the army worm, **Heliophila unipuncta** Haw.

Remedies. Parasites and native birds will keep this species under control in most cases. The outbreak chronicled in the preceding pages is out of the usual order and may not occur again for years. In such event, spraying the infested trees with one of the arsenical poisons is our best remedial measure. If the application is made before the caterpillars are more than half grown, serious injury to the trees may be averted. Many of the descending caterpillars can be killed by inclosing the trunks of the infested trees with a low overhanging barricade and then treating the collected larvae with hot water, kerosene emulsion or other contact insecticide wherever spraying is impracticable. Small trees can be protected by jarring the caterpillars from them, and if sticky bands are placed around the trunk and properly guarded no larvae can ascend to continue their destructive work.

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White marked tussock moth

Hemerocampa leucostigma Abb. and Sm.

Red headed, yellow and black tufted caterpillars may frequently be observed in early summer defoliating horse-chestnut, linden, maple, elm and other trees.

This insect appears to thrive best in cities and villages and some seasons proves a veritable scourge in certain localities. In Albany and Troy, the horse-chestnuts are usually partly defoliated each spring and occasionally stripped of all their leaves by the voracious caterpillars of this moth. The lindens frequently suffer nearly as much, and the maples and elms come in for a goodly share of attention from year to year. The above is probably true to a great extent of most of the cities and larger villages in the State. The summer of 1898 was marked by the abundant presence of this insect, and the extensive defoliations which occurred at the time aroused the people to the necessity of fighting the pest. This was done so effectively that very little trouble with this caterpillar was reported in 1899.

Early history. This species was regarded in earlier years as a serious enemy to appletrees in Ontario, for Rev. C. J. S. Bethune, writing in 1871, stated that it was a serious pest and that in the Western States it had defoliated some of the orchards, and even attacked the fruit. The late Dr Lintner, in his second report, records several instances of severe injury to fruit trees by this species. Serious depredations have also been reported by Professor Lowe, entomologist of the State Agricultural Experiment Station. He received many complaints in 1895, specially from Yates and Ontario counties, where the caterpillars not only devoured foliage, but attacked the fruit. He states in his report that one fruit grower estimated the loss on his apple crop at 25 per cent.

A city pest. This insect is widely distributed over the country, but it is one of those forms which are much more destructive in the cities and towns than in the country. The cause for this is probably found largely in the protection afforded by the English sparrow. It not only fails to feed on this caterpillar but drives away many native birds that would. Dr J. L. Le Conte has placed on record an interesting instance of the effect this bird may have on our local fauna. He states that the English sparrow was imported for the purpose of keeping in check the snow white linden moth, Ennomos subsignarius Hubn., and that in Philadelphia, after the sparrows had destroyed the Ennomos larvae, the white marked tussock moth caterpillars found abundant food, and being unmolested by the sparrow on account of their irritating hairs, they soon became even worse pests than the other species.

Other forms of Hemerocampa. There are several other species in the country belonging to this genus, one of which, H. definita Packard, has frequently been confused with H. leucostigma. As an aid to the ready identification of these interesting larvae, the following table by Dr Dyar is reproduced.

Synopsis of the larvae of Hemerocampa

Head yellow, colors in general pale.................................. definita
Head red
    A distinct yellow subdorsal band.............................. leucostigma
    Gray marks predominate, the yellow band not noticeable.......... inornata
Head black
    Warts crimson, brushlike tufts dark along the crest, the yellow lines along the sides broken into spots
        One black tuft in young larva.................................. vetusta
        Two black tufts in young larva................................ var. cana

Description. The full grown caterpillar has a coral red head, a pair of long black plumes just over it, a single one at the opposite extremity of the body, four delicate yellowish or white brushlike tufts on its back and just behind them, separated only by a segment, two small, retractile, red elevations. Along the back, except for the tubercles and tufts, there is a broad black band bordered by yellowish subdorsal stripes. Each side is dark gray, except the yellowish tubercles. A black line indicates the position of the spiracles or breathing pores, and below this latter line it is yellow, the legs usually being paler [pl. 7, fig. 1]. This gives the general appearance of the caterpillar after it has become half or two thirds grown, and at a time when its depredations begin to be apparent. The recently hatched larva is a pale yellowish or whitish creature with long, irregular hairs. As it feeds, increases in size, and casts its skin [pl. 7, fig. 5] from time to time, one after another of the characteristics of the full grown larva are assumed.

When maturity is reached, the larvae spin their thin cocoons in the crevices of the bark [pl. 7, fig. 4], interweaving their long hairs, and within this shelter transform to yellowish white pupae more or less shaded with dark brown or black [pl. 7, fig. 7].

The difference between the sexes in the adult stage is strikingly shown by comparing on plate 7, figure 2, an illustration of the male, with figure 3, a representation of the female. The former is a beautiful moth with large, feathery antennae, tufted legs, and the wings and body delicately marked with several shades of gray and grayish white. On the other hand, the female is a nearly uniform gray, with simple antennae, and but rudimentary wings.

The eggs are deposited on the empty cocoon under a conspicuous white mass of frothy matter [pl. 7, fig. 3], which soon hardens and forms a very effective protection. The individual egg is nearly spherical, about 1/25 inch in diameter, white or yellowish white, and with a light brown spot surrounded by a ring of the same color.

Life history and habits. The winter is passed in the conspicuous, white, easily removed egg masses, the young emerging about the latter part of May in this latitude. They begin to feed on the more tender lower epidermis of the leaf and soon devour all but the principal veins. While young, the caterpillars frequently hang by a silken thread and with continued jarring many may drop to the ground. The growth of the caterpillars occupies a month or a little more, pupation occurring the latter part of June and early in July. In Albany most of the larvae had pupated by July 7 in 1898, and some recently deposited egg masses were to be seen at that time. A few individuals spin up earlier than the mass and some do not till numerous egg clusters indicate that most of the insects have already completed the round of life.

From 10 to 15 days are passed in the pupal state. At the end of this period, the wingless female emerges and crawls on her cocoon, pairing takes place, and immediately afterwards deposition of the eggs begins, as stated by Dr L. O. Howard. They are laid in masses as described above, the eggs of a cluster ranging in number from 100 to 500, as given by several writers. In what appeared to be a good sized mass collected in Albany, there were 330 eggs. After her full complement has been discharged, the female dies and drops to the ground. In Albany there is normally one annual generation, but in New York city and vicinity and in Boston Mass., there are two broods, while at Washington D. C., there are three broods each year, according to Dr Howard. Occasionally a few larvae belonging to this species may be met with in Albany during August and

September though as a general rule they are scarce. One small tree was observed in 1902 which had suffered severely from a second brood of this insect and a number of nearly full grown caterpillars were present the latter part of August.

The young larvae feed on the under surface of the foliage [pl. 7, fig. 6], and as they increase in size more and more holes are eaten, till when full grown all but the main ribs of the leaves, well represented in plate 7, are devoured. A peculiar habit, recorded by the late Dr Lintner but not observed by others outside of Albany, is the girdling of elm twigs by the larvae of this insect. This is caused by their eating a portion of the bark around the twig near the beginning of the season's growth [pl. 7, fig. 8]. The affected tips soon die, break off, and fall in numbers to the ground. The larvae drop from the trees readily, specially when young, suspending themselves by silken threads, and then may be blown or carried considerable distances. When nearly full grown, the caterpillars travel to a great extent; this is said to be specially true of the larger ones, females, and more likely to occur if they are very abundant. At such times there may be quite a migration to other trees. The cocoons are found very generally on the trunks and particularly on the underside of the larger branches.

The wingless females, at the time they emerge from their cocoons, attract large numbers of the opposite sex. Dr Lintner records an instance of one attracting one hundred males within an hour. Collections at electric lights in Poughkeepsie N. Y., by Dr Dyar, show that the males fly during July and into August.

Food plants. This insect, though commonly destructive to comparatively few trees, has been recorded as feeding on a number of others, as the following list will show: linden, horse-chestnut, buckeye, maples (specially the soft and Norway), box elder, honey locust, apricot, garden plum, wild plum, garden cherry, chokecherry, rose, pear, apple, quince, ash, elm (several species), sycamore or buttonwood, butternut, black walnut, hickory, oak, birch, alder, willow, poplar, spruce, fir, larch and cypress.

Distribution. This native species "ranges from Jacksonville Fla., to Nova Scotia on the eastern coast and extends west certainly as far as

Keokuk Ia., and probably farther," according to Dr L. O. Howard. It has been recorded as common in Nebraska, and reported as present in Oregon.

Natural enemies. This insect has so many efficient natural enemies, that account of them should always be taken in any effort to check the pest. It is probable that quite a number of birds prey on the caterpillars of this species. A recent article by Mr E. H. Forbush, ornithologist to the Massachusetts State Board of Agriculture, lists 47 species of native birds which have been observed feeding on hairy caterpillars, and he states that

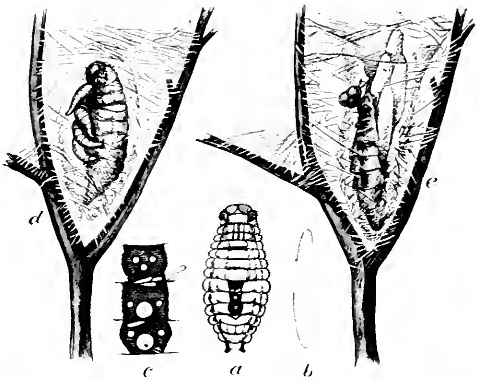

Fig. [illegible] Pimpla in[illegible] [illegible] tussock moth caterpillar bearing parasite eggs [illegible] eggs in situ, d larva [illegible] feeding on spun-up caterpillar, [illegible] of parasite [illegible] slightly enlarged [illegible] still more enlarged, [illegible] greatly enlarged (After Howard, from Yearbook, Dep't Agric. [illegible])

probably all of them will feed on this pest. It has been known for some years that the robin, Baltimore oriole, black-billed cuckoo, and yellow-billed cuckoo will feed on the caterpillars of this species, and to this Mr Forbush adds the following by observation: whip-poor-will, chimney swift, phoebe, blue jay, robin and English sparrow.

The insect parasites of this species are extremely valuable allies and should be encouraged in every practical manner. The extensive studies by Dr L. O. Howard[1] have made valuable and very material additions

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[1] U. S. Dep't Agric. Div. Ent. Tech. Ser. 5. 1897.

to our knowledge of these interesting forms. His paper gives a very good idea of the inter-relations existing between the various species. His studies show that there are 21 primary parasites of this pest and three others that probably hold the same relationship. He obtained 14 hyper-parasites and 11 species were reared from dead chrysalids or cocoon masses. He states that in Washington D. C., Pimpla inquisitor Say and Chalcis ovata Say [fig. 18, 19] are the two species most effective in controlling this pest, and that large numbers of the former insect hibernate as larvae within the cocoons of the host, while in no instance was the latter parasite reared from cocoons of Hemerocampa taken the previous winter. He has also shown that when hymenopterous parasites are comparatively scarce, certain tachinids may destroy large numbers of this pest, the more important being Tachina mella Walk., Frontina frenchii Will. and Euphorocera claripennis Macq. Besides those mentioned above, Dr Howard gives the following as primary parasites of this species: Pimpla conquisitor Say, Pimpla annulipes Say, Amorphota orgyiae How., Meteorus communis Cres., Meteorus hyphantriae Riley, Limneria sp., Limneria valida Cres., Theronia fulvescens Brullé, Apanteles delicatus How., Apanteles hyphantriae Riley, Apanteles parorgyiae Ashm., Pteromalus cuproideus How., Cratotechus orgyiae Fitch, Telenomus orgyiae Fitch, Frontina aletiae Riley, Exorista griseomicans V. d. W. and Winthemia 4-pustulata Fabr. At Washington these parasites became so abundant that in the autumn of 1895 about 90% of the larvae were destroyed. In addition to the above named parasites, Dr Howard records that Ichneumon subcyaneus Cres., Ichneumon coeruleus Cres. and Allocota thyridopterigis Riley were all observed investigating recently formed Hemerocampa cocoons and were apparently about to oviposit. The last, he states, is parasitic upon Pimpla.

In his study of these parasites Dr Howard found that the conditions were not uniform in all parts of the city of Washington, the parasitism being more general in the vicinity of the grounds of the Department of Agriculture, where most of the observations were made, than in other portions of the city. The difference due to locality is also shown by the parasites[1] in the state collection reared by the late Dr Lintner from this species, though his study of them was by no means so extensive as that at Washington. The one occurring most abundantly was Tachina mella Walk. Pimpla hirticauda Prov., a species not reared at Washington from this insect, was bred in greater numbers than any other of the larger hymenopterous parasites. Most of the individuals belonging to this species were reared in July, but two appearing in June and a few others in August.

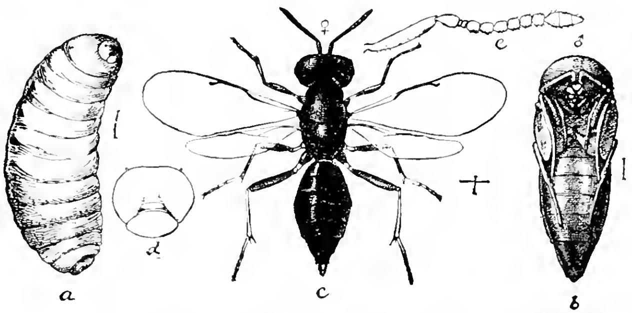

Fig. 21 Dibrachys boucheanus: a, larva; b, pupa; c, adult female — greatly enlarged; d, head of larva; e, antenna of adult still more enlarged. (After Howard, U. S. Dep't Agri. Div. Ent. Tech. Ser. 5. 1897)

Pimpla inquisitor Say, P. conquisitor Say and P. annulipes Brulle occurred in about equal numbers. Of the smaller primary parasites Pteromalus cuproideus How. and an unnamed species belonging to the same genus were about equally abundant.

Though the list of primary parasites is long and includes some very important species, many of these are in turn the victims of enemies. The parasites breeding in those which prey on injurious forms must be classed as enemies to man, since they indirectly protect a species injurious to his interests by destroying large numbers of its parasites. One of the most

[1] Determined through the courtesy of Dr L. O. Howard.

abundant of the hyperparasites reared by Dr Howard at Washington was Dibrachys boucheanus Ratz. [fig 21], it being present in such force as to almost kill off Pimpla inquisitor the latter part of 1896. This species was also reared in large numbers by Dr Lintner in 1883. It is in turn, as demonstrated by Dr Howard, preyed upon by Asecodes albitarsis Ashm. The following is a list of the hyperparasites of Hemerocampa leucostigma, as given by Dr Howard: Hemiteles townsendi Ashm., Bathythrix meteori How., Bathythrix pimplae How., Adistola americana How., Otacustes periliti Ashm., Habrocytus thyridopterigis Ashm., Pezomachus insolitus How., Spilochalcis debilis Say, Eupelmus limneriae How., Dibrachys boucheanus Ratz., Elachistus cacoeciae How., Elasmus atratus How., Syntomosphyrum esurus Riley and Asecodes albitarsis Ashm.

A number of scavengers were reared by Dr Howard from the pupae or masses of cocoons. The list is as follows: Helicobia helicis Towns. Sarcophaga species, Phora nigriceps Loew, Phora incisuralis Loew, Phora fasciata Fall., Phora agarici Lintn., Limosina species, Homalomyia scalaris Fabr., Gaurax anchora Loew, Neoglaphyroptera bivittata Say and Diplosis species.

In addition to these, a Eulophid was reared in some numbers from the cocoons of Hemerocampa by Dr Lintner in 1883 and 1884. A dermestid beetle, Perimegatoma variegatum Horn, has been recorded in *Insect Life* as a very effective destroyer of the eggs of Hemerocampa in California. The wheel bug, Prionidus cristatus Linn., is said to prey on the larvae in the Southern States, and in 1898 the writer observed a mite, a species of Rhyncholophus,[1] eating the contents of many eggs.

Remedies. The simplest and most satisfactory remedy is found in gathering and destroying the egg masses. Prizes were offered in Rochester N. Y., in 1894, to school children gathering the largest number of egg

[1] Determined through the courtesy of Dr L. O. Howard.

masses, and most excellent results were obtained. In places where this is practically the only shade tree pest, this system or the payment of a bounty on the egg masses would undoubtedly result in the pest being kept under control at a comparatively small outlay. As the eggs are in a compact mass which is readily torn from the supporting cocoon, either by hand or some form of a scraper, the task is easily and quickly performed. Dr Howard has recommended the use of creosote oil for the destruction of the eggs, since each mass has only to be moistened with the substance. In winter it is necessary to add some turpentine in order to keep the creosote liquid. On account of the female being wingless, a tree once thoroughly cleaned will not become reinfested very soon if larvae are not abundant near by, and even then a band of loose cotton bound tightly near its middle around the trunk and the portion above the string turned down, will prevent their ascending and a consequent reinfestation. It should be kept in mind that only the eggs must be collected or destroyed, on account of the beneficial parasites which may occur in cocoons not bearing egg masses. This is specially true in the autumn and applies to a certain extent in the spring, since it has been shown that some parasites hibernate as larvae within the cocoons of the host, and if these are collected and destroyed, it means the death of many beneficial forms. The egg masses are more readily seen after the leaves have fallen and in localities like Albany, where one annual generation is the rule, the gathering of the eggs may well be deferred till autumn, or, better still, till early spring, since there will then be less chance of destroying valuable parasites. As the young caterpillars begin to hatch the latter part of May, collection of the egg masses can not be delayed with safety after the middle of that month. In Boston, New York city and more southern localities, it may be necessary to make a midsummer collection of the eggs laid by the first brood of moths, and in case it is impracticable to do this, dependence must be placed on spraying with some arsenical poison. This is satisfactory if properly done early in the season under favorable conditions. It is very difficult to have the spraying properly done, and then there may be hindrances incident to several days or a week of rain or other causes at the time the poison should be applied.

Not a few wait till the trees show signs of serious injury and then ask for some means of stopping the ravages. Resort may be had under such conditions to spraying with a larger proportion of poison in order to kill the caterpillars quickly or they may be shaken from the limbs, provided the tree is not too large. The latter means will give a certain amount of relief where practicable and should be supplemented by the use of cotton bands or other measures for preventing the ascent of those shaken from the tree.

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Fall webworm

Hyphantria textor Harris[1]

Conspicuous web tents in July and August inclosing skeletonized, usually brown leaves on the tips of branches are the most conspicuous signs of the presence of this insect, a species which feeds on a large number of trees and occurs commonly on the white elm, willows and poplars in New York State.

The conspicuous webs of this caterpillar are very familiar objects the latter part of summer. They may be recognized at once by their inclosing all the leaves of a twig or branch and if these features are kept in mind there will be no danger of confounding this species with the common tent caterpillar, a pest which forms webs in early spring in the crotches of the limbs and does not inclose leaves within its webs. The hairy fall webworms feed under their tent on the softer upper portions of the foliage which soon dries. The beauty of the tree is seriously marred by the unsightly nests and the brown, skeletonized foliage within them. Occasionally this insect is present in such large numbers as to devour most of the

[1] Discussed under Hyphantria cunea Drury in 5th report of Fisheries, Forest and Game Commission.

foliage, and in southern cities entire rows of trees may have their leaves destroyed by this pest.

Distribution. This insect is an American species and occurs from Canada to Georgia and certainly as far west as Montana and Texas. It appears to be more injurious in some of the southern states like Kentucky, where the development of a vigorous second generation is the rule, than it is farther north.

Description. The yellowish, globular eggs [pl. 10, fig. 1] are deposited in clusters of 1 to 300, usually on the underside of the leaf. The yellow changes to a dull leaden hue, due to the developed caterpillar within, just before the eggs hatch.

The recently emerged caterpillar has been described as pale yellow, sparsely haired, with a black head and with two rows of black marks along the body, but as there is considerable variation in the color of the larva later in life, it would not be surprising to find the same more or less true of its earlier stages. The hairy, yellowish, brown and black marked caterpillars vary considerably in appearance. A half grown and two full grown larvae are represented on plate 10, figure 2, a dorsal and a lateral view being given of the latter two. The head is black and the whitish or brownish hairs spring in clusters from the black and orange tubercles.

The oval cocoon is thin and mixed with larval hairs or, where it is spun at or just below the surface of the ground, particles of soil may be entangled in its meshes. The brownish pupa may be recognized by the swelling near its middle [pl. 10, fig. 3, 4].

The moth is very variable in appearance and ranges from a pure white to a form much spotted with black. [*Compare* fig. 5 and 6, pl. 10.]

Identity of the insect. The extreme variability of the adult has led to the bestowal of a number of scientific names on the insect, which in its larval state makes the conspicuous web above described. The studies of Mr H. H. Lyman led him to conclude that two species have been confused under the name of Hyphantria cunea Drury. The web made by the larva of the more common species in this State belongs to Hyphantria textor Harris and it is therefore noticed under its proper name, though in a preceding paper the author refers it to Hyphantria cunea Drury. This latter insect may also occur in the State to some extent but appears to be rarer than the other species.

Life history. The moths fly from early in June till the middle of August, at least, occurring in large numbers in the middle of June, the early part of July and the first half of August, according to captures by Dr H. G. Dyar at Poughkeepsie N. Y. Records kindly placed at my disposal by Prof. G. H. Hudson of the normal school at Plattsburg, show that moths appear in small numbers at that place from the 9th to the last of May, that they are quite abundant throughout June, being most numerous from the 8th to the 10th and from the 14th to the 30th. They were also present in small numbers throughout July, occurring in larger numbers on the 3d and 4th, and one individual was taken August 2. The caterpillars begin to be noticed the latter part of June or early in July and are most abundant in August. They were observed at Annandale, Dutchess co., June 27, 1900 and at Buffalo, Erie co., July 3 in the same year. Thus in the southern portions of the State the normal occurrence of at least a partial second brood can hardly be questioned, but so far north as Plattsburg it would appear from the record given by Professor Hudson that but one generation a year is the usual rule.

The yellowish or greenish eggs are deposited in clusters of several hundred on the underside of a leaf and are frequently protected by adhering white scales from the mother's body. They hatch in warm weather in from 7 to 10 days, the young caterpillars beginning at once to spin a web under which they feed. This protecting web is extended to include more and more foliage till finally a considerable proportion of a branch may be inclosed. The caterpillars feed only on the upper portion of the leaf, devouring only the softer parenchyma. The skeletonized leaves within the nest soon dry, turn brown and they with the frass and cast skins of the caterpillars, render the nests very unsightly objects. Occasionally the caterpillars may be forced to leave their webs on account of a scanty food supply but ordinarily this does not occur till they are nearly full grown, which is usually about a month after hatching and then they wander in search of a place to undergo their final transformations. The caterpillars may spin their thin, semitransparent cocoons in crevices of the bark and in similar shelters at or below the surface of the ground. The insect usually hibernates in an underground cocoon but Professor Garman of Kentucky has recorded an instance where the adults emerged in the fall and successfully wintered. A recently issued moth was also taken in Washington D. C., in early January of 1890. The first generation of caterpillars are said to spin their cocoons above ground by preference.

Food habits. This caterpillar is a very general feeder as is attested by a list of 120 food plants, comprising fruit, shade and ornamental trees, that has been compiled by the Division of Entomology of the United States Department of Agriculture. The white elm, willows and poplars suffer perhaps as much as any trees in New York State, though more complaints are received of the depredations of this insect on fruit trees. This is doubtless due to the fact that the injury to the latter is more generally reported on account of the greater value of the trees.

Natural enemies. Fortunately this insect is preyed on by a number of natural enemies. A tiny egg parasite, Telenomus bifidus Riley, may sometimes destroy most of the eggs in a cluster. There is a record of Eremotylus glabratum Say having been reared from this insect. Apanteles hyphantriae Riley and Limneria pallipes Prov. are important parasites of this pest and they in turn are attacked by Elasmus atratus How. Meteorus hyphantriae Riley is another valuable parasite of this insect. Its suspended cocoon may be recognized by the

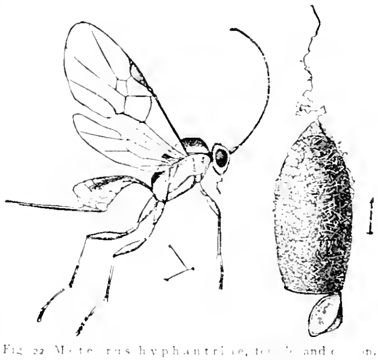

Fig. 22 Meteorus hyphantriae, female and cocoon. (After Riley. U. S. Dep't Agr. Div. Ent. Bul.)

accompanying figure. The spined soldier bug, Podisus spinosus Dall, and the allied Euschistus servus Say prey on the caterpillars. The larvae of a Carabid beetle Plochionus timidus Hald., have been observed in Missouri within the nests in considerable numbers feeding on the caterpillars. Calosoma scrutator Fabr., dragonflies and a species of robber fly prey on the moths. The praying mantis, Stagmomantis carolina Linn., and the wheel bug, Prionidus cristatus Linn., are two forms which attack caterpillars in the Southern States. A fungus, Empusa grylli, has been recorded as very destructive to this pest in Kentucky in certain years.

Remedies. The habit the caterpillars have of feeding under a large web renders it comparatively easy to cut off the infested portions of the limb and kill the pests by crushing or burning, and where the insect is present in small numbers, this is probably the most satisfactory method. The pests can also be fought by burning them with a torch while the web is still on the tree, but many of the caterpillars may escape destruction, and unless the work is very cautiously done, the fire may injure the tree seriously. Spraying with arsenical poisons about the time the caterpillars appear is most satisfactory where apparatus for such work is at hand.

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Elm leaf beetle

Galerucella luteola Müller.

Irregular [illegible] occurring in the leaves of elms, particularly of the European species, [illegible] of the under surface of the foliage by the grubs and subsequent [illegible] remaining tissues, are very characteristic features of this insect's [illegible]

This imported insect is in all probability responsible for more ruined elm trees in the Hudson river valley than all other destructive agencies combined. The above is a sweeping assertion, but a careful examination of conditions in various cities and villages compels one to accept this conclusion as very close to the truth. The extensive and vigorous means employed in controlling this pest in Albany and Troy N. Y., have mitigated the injury very materially and have demonstrated the possibility of keeping the insect under control. The results in Albany are evident to any observer, for instead of a large proportion of the elms having their leaves skeletonized and brown in midsummer, as was the rule in 1896 and 1897, the effects of the work of this pest are seen only here and there where trees have not been thoroughly sprayed or else entirely neglected. These more local injuries show that the pest is still here with unabated vigor and warrants the assumption that the improved condition of the elms is due largely to the extensive spraying operations.

Distribution. This beetle, as stated by Dr Howard, is common over a large part of Europe, but it is injurious only in the southern portions of Germany and France and in Italy and Austria. It probably established itself in this country about 1834, as it was very injurious to elms in Baltimore in 1838. Its southernmost range has been given by Dr Howard as Charlotte N. C. and Prof. F. M. Webster records finding it north of Salem Mass. It occurs as far west as Kentucky at least and is well established in Ohio. The progress of this insect up the Hudson river valley is interesting to follow, indicating as it does, the distribution of the beetles along the lines of travel. The pest was abundant and destructive at Newburgh in 1870, and two years later it was reported from Poughkeepsie, in 1890 from Hudson, in 1891 from New Baltimore, in 1892 it was known in Albany and Troy, in 1896 it was taken at Mechanicville, in 1900 it was located at Schuylerville and Salem, and in 1904 it was found in numbers at Glens Falls, it was abundant at Hoosick Falls in 1899 and it has also been taken at Oswego, Hastings and Rochester. It occurs at Ithaca and is present in numbers at Elmira, Chemung co. The above dates indicate approximately the rapidity with which the insect has made its way from one place to another, and show that it spreads much more readily along the Hudson river than east or west from its banks. The distribution of the species in this State may be given briefly as follows: the Hudson river valley north to Glens Falls and westward to Schenectady, at least in the Mohawk valley and with several colonies in the south and western central portions of the State. These latter are of great economic importance as they indicate that the species can exist in that section of the State, and gives rise to the fear that in time it may become as destructive there as it now is in the Hudson river valley.

This insect has spread over a large proportion of Connecticut and into Rhode Island. It had made its way up the Connecticut river valley to Springfield by 1891 and to Amherst by 1895. It has now attained a rather general distribution throughout Massachusetts.

The above record indicates most clearly that this pest has not made its way to all portions of New York State where it may be expected to thrive. The climate of the upper austral life zone seems to agree with the insect, judging from its abundance and the number of broods in Albany and vicinity. Briefly, this area embraces Long and Staten islands, the valley of the Hudson river north about to Saratoga and a large portion of the northwestern and central part of the State adjacent to Lake Ontario and including Oneida, Cayuga and Seneca lakes and neighboring bodies of water. The insect will probably make its way along the lines of travel to most of the cities and larger villages lying within the above limits. The fact of its having become established at localities not yet included within this zone indicates that it may have a somewhat wider range, though climatic conditions will probably prevent its becoming destructive outside this area.

Recent injuries about Albany. The elm leaf beetle was recognized in Albany by the late Dr Lintner about 1892, having probably made its way here a year or two earlier. Its ravages became more and more serious from that time till 1897, when most of the European elms along our streets were completely defoliated in early summer. The second growth of foliage was seriously injured the same year and some trees had their third set of leaves attacked. It was estimated in 1898 that fully 1000 elms had been killed within the city limits by this pernicious insect and many more would have suffered a similar fate had it not been for the systematic spraying undertaken then and since continued. See plates 35, 36, and 37 for representations of the injury caused by this pest.

The record of this insect in Troy has been even worse than in Albany. It probably made its way to that city about the same time that it came here, and up to 1898 practically no effort had been made to check its ravages. At that time probably 1500 elms had been killed within the corporate limits of Troy and since then many others have suffered a similar fate, though not so many have died the last few years on account of the large amount of spraying done in different parts of the city for private parties. Even now it is possible to go into sections of the city and see within two or three blocks 50 to 100 or more dead elms. These are not aged trees that would have died irrespective of attack by insects, but are in most cases elms which a few years ago were as thrifty and vigorous as anyone could desire.

The story of the city of Watervliet has been virtually that of Troy except that less effort has been made to check the pest; also, as a large proportion of the elms in Watervliet were of the American or white variety on which the beetle does not thrive so readily, the destruction was not quite so rapid. It hardly seems possible, however, that fewer than 1500 magnificent trees have been killed or practically ruined by this insect in Watervliet.

Practically the same story has been repeated here and there in small towns along the Hudson river valley where this pest has established itself in force; and, unless the insect is checked on its advent into a village, this is likely to be the record wherever it makes its way.

Inaction means death to the elm. The defoliation of a tree in midsummer is a serious injury since the leaves are breathing organs, and if this occurs for successive years, even once a season, the early death of the elm may be expected, and when it occurs two or even three times in a summer, it is very easy to see that the danger to the tree is increased manifold.

Such is the record of the elm leaf beetle in this section. The time to control this pest is not after it has become enormously abundant in a city or village and has seriously weakened or nearly destroyed the majority of the elms; the work should be begun at the outset and the insect prevented from establishing itself in large numbers in any uninfested city or village in New York. Village improvement societies and public spirited individuals interested in the welfare of a community where this beetle occurs would do well to undertake at least an educational campaign against it.

Description. The skeletonized, brown appearance of the foliage of an infested tree in midsummer is very striking and in the Hudson river valley cities and villages this condition is quite apt to be the work of this pest, but in the western part of the State one or more species of canker worms occasionally strip a few American elms nearly as completely and its work should not be confused with that of this imported elm insect.

The parent beetle may be recognized by the aid of the colored figures (pl. 8, fig. 5, 6). This insect is about 1/4 inch long with the head, thorax and margin of the wing covers a reddish yellow. The coal black eyes and median spot of the same color on the head are prominent. On the thorax there is a dorsal black spot of variable shape and a pair of lateral ovoid ones. The median black line of the wing covers is separated from the lateral stripes of the same color by greenish yellow. The wing covers or elytra are minutely and irregularly punctured, bear a fine pubescence and at the base of each wing cover there is an elongated black spot in the middle of the greenish yellow stripe. The markings are fairly constant in the beetle but the color is quite variable during life and changes more or less after death. Many beetles emerging from winter quarters have the conspicuous greenish yellow stripes of the wing covers nearly obliterated by black. The antennae or feelers are golden yellow with more or less brownish markings. The legs are yellowish with the tibiae and tarsi marked with brown. The under surface of the head and prothorax is yellowish, that of the metathorax and abdomen black.

The orange yellow eggs are usually deposited in irregular rows side by side, forming clusters of from 3 to 20 or more on the under surface of the leaf. Each egg is somewhat fusiform, attached vertically by its larger end, with the free extremity tapering to a paler, rounded point [pl. 8, fig. 1, 1*a*]. Under a powerful lens, the eggshell is seen to be finely reticulated.

The recently hatched grub is about 1/20 inch long, with the head, thoracic shield, numerous tubercles, hairs and legs jet black. The skin is dark yellow but the tubercles are so large and the hairs so prominent that the prevailing color of the larva at this stage is nearly black. As the grub increases in size and molts, the stiff black hairs become less conspicuous and the yellow color more prominent [pl. 8, fig. 2] till the last stage, which is represented at figures 3, 7, plate 8. The full grown larva is about 1/2 inch long, more flattened than in the earlier stages, with a broad yellowish stripe dorsally and a narrower stripe of the same color on each side, the yellow stripes being separated by broad dark bands thickly set with tubercles bearing short, dark colored hairs. The dorsal yellow stripe is broken on each side by a subdorsal row of dark tubercles, which increase in size posteriorly. The lateral yellow stripe includes a row of prominent tubercles with dark tips bearing short hairs of the same color. The under surface is yellowish.

The pupa is a bright orange yellow, about 1/4 inch long, and with a very convex dorsal surface which bears transverse rows of stout, inconspicuous hairs [pl. 8, fig. 4].

Life history. The transformations of this insect are so rapid that a man must know what to expect or in fighting the pest he will accomplish practically nothing, because a substance effective against the beetles or grubs may not kill the pupae, and, after the larvae have begun to descend the trees, may be of no value.

The winter is passed by the beetles in attics, sheds outhouses and in other sheltered places. With the advent of warm weather in the spring, they emerge from their retreats and may be found on the walks during the sunny portion of the day or upon the windows of houses trying to escape. The last of April or early in May, with the appearance of the elm leaves, the beetles fly into the trees and eat irregular holes in the foliage [pl. 37, fig. 2, pl 8, fig. 6] Some time is occupied in feeding before the deposition of eggs begin, a process which may continue over four and possibly for five or six weeks. These prolific beetles consume a large amount of foliage during this time, depositing clusters of three to 20 or more eggs every day or two. Over half the total number of eggs may be laid within about 12 days at the hight of the season, which in 1898 was from June 12 to June 23. One female has been known to deposit 923 eggs and it is possible that under more favorable conditions an even larger number might be produced.

The young grubs emerge from the eggs early in June, as a rule, or in about five or six days after the eggs have been deposited, later in the season. They soon begin to feed on the under surface of the leaves, producing the familiar skeletonizing [pl. 8, fig. 7 and 8, and pl. 37, fig. 1], which is caused by their eating the softer under part, leaving the upper epidermis and the veins. The results of their feeding is so marked that it is easy to detect the presence of the grubs by the semitransparent patches in the foliage, which latter soon dry and turn brown.

The grubs or larvae complete their growth in from 15 to 20 days in summer (in cooler weather the time is extended), become restless, forsake the leaves and descend the limbs and trunk to a great extent, seeking a slight shelter under which to pupate. Seven days are spent in this state in warm July weather, while in September it is extended to 12 days and in October to 24. The descent of the grubs of the first brood usually occurs in Albany the last of June or early in July. Some were observed descending June 19 in 1899 and beetles of the second brood were to be found on June 30. The oviposition of the second brood of beetles may begin by the middle of July and from then till late in autumn it is possible to find all stages of the insect in some part of Albany. The beetles of the second brood are naturally attracted to fresh growths of foliage and consequently more eggs are deposited on such trees, which are most frequently those defoliated earlier in the season. Thus a tree is very apt to lose two sets of leaves in a season and may possibly have its third set badly marred by this pest. The second brood of grubs may complete their growth about the middle of August, transforming to beetles the latter part of the month, and if there be an abundant supply of fresh leaves a third generation may be produced in considerable numbers. This last brood rarely develops on the second or third set of leaves, but is more frequently found on nearby trees which had not suffered much earlier in the season. It may be considered the rule in Albany that a considerable second brood will appear with a possible third generation in smaller numbers. This beetle attacks European elms by preference, though frequently it is very destructive to American elms.

Natural checks. Many have thought that in the course of a few years some natural agent might reduce this grievous pest to comparatively harmless numbers. This can hardly be expected for some time, at least, because the beetle is still very injurious at Washington D. C., where it has been for many years, and the same is true of other localities. Many of the beetles are killed while hiding in damp places by a fungus, Sporotrichum entomophilum Peck. The toad must devour large numbers of the beetles if the following record be its normal habit. Pupils under the direction of Miss Clara Russell of the State Normal College, Albany N. Y., observed one toad eat 50 elm leaf beetles within an hour. Though we have seen nothing of the kind in this vicinity, one gentleman affirms most positively that the English sparrow feeds on the elm leaf beetle larvae, having repeatedly observed it picking them off the trunks of the trees. If the sparrow has this habit, it offsets to a certain extent its many bad traits.

Several insects are known to prey on this pest, its pupa or its larva. Three beetles, Platynus punctiformis Say, Quedius molochinus Grav. and Chauliognathus marginatus Fabr., feed on this species as recorded by Riley. A fly, Cyrtoneura stabulans Fall., destroys many pupae in Washington. In this latitude the half grown nymph of Podisus spinosus Dallas has been observed with an elm leaf beetle grub on its extended beak, and it probably preys extensively on the larvae, since in Washington all stages are known to attack it. Unfortunately this beneficial species is not abundant, though it is to be hoped that the large food supply will lead to an increase in its number A small capsid, Camptobrochis grandis Uhler, sucks the eggs. Larvae of lacewing flies, also called aphis lions, are frequently found on leaves with the young of the elm leaf beetle, and are reported by Riley to feed on both eggs and larvae. Mites have been observed by the writer near egg clusters that had suffered injury. This insect finds an enemy in the southern portion of its range in the praying mantis, Stagmomantis carolina Linn. It is very probable that the European praying mantis, Mantis religiosa Linn., recently established in a number of localities in the state through the efforts of the writer, will also prey on this injurious beetle.

Remedial measures. The secret of controlling an insect frequently lies in a knowledge of some vulnerable place in its life history. It is practically impossible to get at the insect while it is hibernating but, if the leaves are thoroughly sprayed with an arsenical poison early in the spring when the beetles begin to feed, many of them will be poisoned. The disinclination of this insect to fly a great distance is encouraging to the man who protects his own trees, since it reduces the liability of their flying from neglected trees near at hand. The local spread of this beetle is slow and the most should be made of it by keeping the pest in check wherever it occurs, even though the infestation be a small one and the injury at the time of little importance. It is a mistake on the part of local authorities to wait till the creature becomes destructive. It should be fought at the very beginning, even before it has secured a fair foothold in a locality.

The grubs feed almost exclusively on the under surface of the leaf, rarely occurring on its upper side. The attack usually begins on the upper, more tender leaves, hence the tops of the trees need spraying most, and in order to kill the grubs the poison must be thrown on the underside of the leaves, and, as a rule, this treatment will be found most satisfactory. The full grown larvae crawl down the trunks in great numbers and the golden yellow pupae may be found in abundance in crevices in the bark and on the ground about the trees. Large numbers of these insects can be killed at this time by spraying them with a contact insecticide such as kerosene emulsion, whale oil soap solution or by pouring boiling water on them.

These palliative measures are advisable only when others can not be carried out, and in order to secure the best result the grubs and pupae should be destroyed every five days so long as the pests are seen in numbers. Bands of tar, sticky fly paper, cotton batting, etc., while they do no harm, can not be considered as of much value in keeping the elm leaf beetle under control. The relatively few grubs caught on a sticky band are but a drop in the bucket compared with the mass which complete their transformations. It is worse than useless to attempt to control this or any other insect by boring a hole in the trunk of a tree and inserting therein a compound of any nature. The tree is weakened and unless the chemical be powerful enough to kill the tree, the insects are not affected.

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Elm saw fly

Cimbex americana Leach

A cylindric, coiled, yellowish white worm with a black line down the middle of its back, may be met with in midsummer on willows, elms, poplars and other trees.

This species is a rather common one in New York State and is usually met with in more or less numbers each year. It occurs with us mostly on the willow and elm and is sometimes present in considerable numbers in limited localities. It is not injurious as a rule in New York State, though it might become so under unusually favorable conditions.

Early history. This species has been noticed in a more or less fragmentary way by a number of entomologists. Dr C. V. Riley in 1885, recorded a peculiar injury by this pest at Washington D. C. Admiral

Ammen called his attention to the work of the adult fly. The tops in a plantation of imported willows looked as if fire had run over it and on investigation it was found that the mischief was due to their being gnawed by the perfect fly, which made deep transverse incisions just below the dead portion of the willow. The cut often extended more than half way around the twig or else there were a number of smaller incisions one after the other.

Professor Bruner writing of this species in 1888, states that this species sometimes defoliates white willows growing as hedges in Nebraska, and that it also infests the different native willows growing along the small streams back from the timber belts bordering the larger water courses. He adds that from upwards of 400 pupae collected he failed to rear a single parasite. The cutting habit observed by Admiral Ammen was brought to the attention of Prof. F. M. Webster in June 1889 by a gentleman residing in Nebraska. He states that thousands of the adult sawflies were to be found flying among the tops of the largest trees, and adds that the insects cut a rough gash with their jaws almost completely around the limb, seeming to kill the outer bark as far as they go. Mr E. D. Ball observed this same injury in Nebraska, and states that in his experience the slits always heal over and that the principal injury is caused by the feeding of the larvae.

Life history. Dr Riley states that the eggs of this species are deposited between the epidermis and parenchyma of the leaf and that when the plant is examined from above, the place of oviposition is hardly perceptible, it appearing as a very slight blisterlike swelling and accompanied on one side by a faint ferruginous line. These blisters are very plainly seen on the under surface of the leaf since they are much paler than the rest of the surface, and in an advanced condition show a reddish tinge. He states that they are always on the face of the leaf, usually nearer to the outer margin than to the midrib, never on or near the midrib and rarely extending across one of the lateral veins. They may vary from one to nine or more on a single leaf He states that the young larva after hatching remains for some time within the blister and finally leaves it through an irregular slit at the middle of the epidermis and is at that time a bluish-gray color. The recently hatched larvae are uniformally curled up on the underside of the leaf. The sawflies become full grown in New York State during the latter part of July or in August, at which time they forsake the leaves and spin a tough, coarse silken cocoon among the debris at the base of the tree or just below the surface of the ground. The insects remain unchanged in this shelter till spring when they pupate and the perfect fly appears in May.

Description. The egg when about to hatch has been described by Dr Riley as oblong oval, somewhat flattened, and with a shell so thin and pliable that it not only loses its regular shape with the slightest pressure, but even by a slight movement of the embryo larva within. The shell is perfectly clear and with no visible sculpture, except some fine, irregular wrinkles and its surface is very sticky. At an earlier stage the egg is elongate, nearly cylindric. The larva when full grown is about 3/4 inch long, of a pale yellow color, with black eyes, a glaucous green body and a black stripe along the middle of the back. The head is large, rounded and is as wide as the body. The legs are pale whitish green and there are 8 pairs of prolegs. The abdomen is rolled up like a helix when the insect is at rest and the segments are finely wrinkled and the ridges bear small flattened warts [pl. 16, fig. 4].

The adult sawfly has a shining black head and thorax and her oval body is of a steel blue or deep violet color, with 3 or 4 elongate oval yellowish white spots on each side, which, in some specimens are much larger than in others, and uniting within form continuous bands across the upper side of the body. The antennae are short, knobbed, buff color, except the basal segments which are dusky. The wings are semitransparent and smoky brown in color. The legs are bluish black with yellowish tarsi [pl. 16, fig. 5]. The male may be recognized by his more slender, longer body.

Food plants. This species occurs more commonly on the willow and elm in New York State. It has also been recorded on poplar by Dr Lugger, and on alder by Dr Packard, who found it on that bush at Brunswick Me. Dr J. A. Lintner states that he has received this species on maple from Camden N. J., and Dr J. B. Smith adds linden to this list, though he states that the species usually occurs in New Jersey on willow.

Parasites. This large species has a number of natural enemies in the Western States at least, though they appear to be somewhat scarce in the East. Messrs Orcutt and Aldrich record rearing the following parasites from this insect: Opheltes glaucopterus Linn., which they state to be by far the most important parasite since it destroyed a large lot of the sawflies under observation. Eight or 10 examples of Cryptus nuncius Say were found in one cocoon by these gentlemen and about 20 specimens of Limneria ferrugineipes Ashm., were obtained from smaller cocoons inside those of Cimbex. Mesochorus melleus Cress. was reared in small numbers from a cocoon from Egan S. D., and two specimens of Sarcophaga cimbicis Towns. were bred from this sawfly. Three small flies, Phora cimbicis Ald., P. minuta Ald., and P. setacea Ald., were also obtained from cocoons, but these small flies in all probability are not parasites and live on decaying vegetable matter.

Remedial measures. This species can easily be controlled by arsenical poisons wherever they can be employed to advantage. Professor Bruner also advises hand picking, since the large size of the larvae and their habit of dropping at the least disturbance would prove of advantage. It is not at all impossible that in cases where they were excessively abundant, it might pay to destroy the cocoon collected at the base of the trees.

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Spiny elm caterpillar

Euvanessa antiopa Linn.

Large black red marked spiny caterpillars about 2 inches long may be frequently seen in June defoliating the terminal branches of elm, willow, poplar and several other trees.

The depredations of this insect attract considerable attention from time to time. It is common in the butterfly form, though its connection with the spined, black, red spotted caterpillars may not be known to many. This insect was present in great numbers in various sections of the State in 1896 when its depredations on elms led to considerable complaint. It not only feeds on elms but occasionally it is so abundant as to literally strip acres of poplars.

Description. The parent insect is a magnificent dark maroon butterfly with blue spotted, black and yellow bordered wings which have an expanse of about 3 inches [*see* pl. 10, fig. 11]. The under surface of the wings presents a striking contrast, being a dark bluish black and brown intermixed with some yellowish gray. The yellow border of the upper surface is represented by a brown specked gray with a little dull yellow. The color of the under surface of the wings is somewhat variable but it is remarkable for its protective value. The butterfly with its closed wings frequently appears much like a scale of loosened moss or a bit of brownish or black vegetable matter. The yellowish eight or nine ribbed eggs which soon turn [illegible] and finally black just before hatching are deposited in a band or a nearly complete one around a twig, as shown at figure 7 on plate 10, one egg much enlarged being represented at figure 8. This shows not only the larger ribs but the transverse markings between them. The dot beside the egg represents its natural size. The recently hatched caterpillars are brown, black and hairy and as they increase in size the other characteristics shown at figure 9 on plate 10 become more apparent. The full grown caterpillar is about 2 inches long, black and armed with numerous short branched spines. Along the back there is a row of somewhat diamond shaped red spots and closer examination shows the caterpillar to be marked with transverse rows of minute white spots. The abdominal prolegs are reddish. The chrysalis is a peculiar, angular looking structure which is variable in color and in nature it usually harmonizes pretty closely with surrounding objects. It is represented at figure 10 on plate 10.

Life history. Strange though it may seem, this apparently delicate butterfly successfully withstands the rigors of our northern winters with no better shelter than that afforded by a crevice among stones, a sheltering board, a cavity in a tree or a similar place. It is one of the first butterflies to come forth in the spring, frequently appearing before the snow has entirely disappeared and occasionally it may be seen during unusually warm weather in midwinter. The over-wintered individuals are said to pair about the middle of April but eggs are not laid till the first half of May. The deposition of the eggs has been observed a number of times. They are placed in somewhat alternating rows, the female requiring about 40 minutes to deposit 300 eggs, and as many as 450 have been recorded for one cluster. The eggs require 12 to 15 days for hatching in the spring and in midsummer but nine. The caterpillars are gregarious and when young range themselves side by side with great regularity. They are more frequently found near the top of a tree and as they increase in size, defoliated branches usually give the first indication of their presence. The caterpillars are often found on a near-by partly stripped limb which frequently bends under their weight. Their habit of feeding close together makes their injuries more apparent than would otherwise be the case. The caterpillars of the first brood attain their growth in New York State the latter part of June or early July and butterflies from them may be seen ovipositing during July. The deposition of eggs was observed at Albany July 17 and nearly grown larvae were taken the latter part of August. Caterpillars of this insect are much more abundant in June than later, and those observed in August and September must be considered representatives of a second brood. There is possibly a third generation some years. The relative scarcity of the caterpillars later in the season may probably be explained by the increasing abundance of their natural enemies and it is by no means impossible that some butterflies of the first brood may hibernate over winter as suggested by Professor Weed.

Common names. This butterfly has received a number of common names. One widely adopted and perhaps best known in this country is the mourning cloak, a translation of the German Trauermantel. It has also passed under the names of antiopa butterfly and willow butterfly to a considerable extent, and the English designations of Camberwell beauty and

Grand Surprise are worthy of mention. The injurious caterpillar could easily be designated as the larva of the mourning cloak or whatever common name is preferred, but it is simpler for a person interested only in the practical side of the subject to use a special name for the caterpillar and therefore, following Dr C. M. Weed, we have employed the designation of spiny elm caterpillar for this destructive larva.

Food plants. This insect is more frequently brought to notice on account of its depredations on the white or American elm, though it is also very injurious to willows and poplars but the small value of the latter two renders the damage of less importance. The caterpillars are also recorded as feeding on the hackberry, Celtis occidentalis, and the butterfly has been observed depositing its eggs on white and canoe birch.

Distribution. Mr Scudder in his work, *The Butterflies of New England*, writes that this insect "is apparently distributed over the entire breadth of the northern hemisphere below the Arctic circle as far as the thirtieth parallel of latitude." He further states that it is found in nearly equal abundance throughout New England and flies to but does not breed on the highest summits of the White mountains.

Natural enemies. There are several insects which prey on this species. A minute, four winged fly known as Telenomus graptae How. watches its opportunity to oviposit in the eggs of this butterfly. Pteromalus fuscipes Prov., was reared in Albany last summer from this insect. Three other Chalcids, Pteromalus vanessae How., Pteromalus puparum Linn. and Entedon antiopae Pack., all minute, four winged flies, attack the caterpillars, the former two sometimes in large numbers. Several ichneumon flies are parasitic on this species in Europe but no records of such rearings in America have been found. A dipterous parasite, Euphorocera claripennis Macq., has been reared in this country from the caterpillars. A fierce ground beetle, Calosoma scrutator Fabr., is another enemy. This beneficial species is comparatively rare however. Two predaceous bugs, Podisus placidus Uhler and P. serieventris Uhler, prey on the caterpillars as recorded by Mr Kirkland. The yellow and black billed cuckoos feed on the spiny caterpillars.

Remedies. The gregarious habit of the caterpillars may be taken advantage of by cutting off the branch on which they are clustered and then they may be killed by crushing. They may be dislodged by shaking, jarring with a padded mallet or by use of a torch and then crushed on the ground. This species can also be controlled by spraying with an arsenical poison and when the caterpillars are very abundant, this will probably be the most satisfactory way of checking the insect.

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Elm leaf miner

Kaliosyphinga ulmi Sund.

Circular, somewhat irregular mines occur in considerable numbers in the leaves of European and American elms.

This leaf miner was exceedingly abundant in Albany and vicinity on European and American elms from 1895 to 1900. The larvae make very irregular blotched mines, which are frequently fused together so that several occur in a mine, and occasionally so much of the parenchyma is eaten out, that from one half to two thirds or even three fourths of the leaf is destroyed. This is particularly true of Camperdown elms, which are more liable to attack than other species, and in several instances observed, over 90% of the leaves were very badly infested. The work of this leaf miner is more apparent the latter part of the summer because the drying of the tissues makes the old mines very conspicuous. The attack was first observed on European elms and later it spread to American elms. This species, as stated by Cameron, mines the leaves of the Scotch and English elms, several larvae living in the same leaf. It is said that there is but one brood in England, where it is very common. The species is also recorded by Cameron from Scotland, Sweden, Germany, France and Russia.

Description. Cameron describes the larva as white, with a pale brown head, darker at the sides; mouth reddish brown. Legs encircled with brown. Beneath on the second segment there is a black, oblong plate sometimes with a dot on either side. There is a small, black central dot on each of the following segments, though they are often absent on the posterior one. Length when full grown, 5 lines. The adult has been described by Cameron as follows:

Black, shining. Antennae short, stout, covered with a stiff pile; two first joints together equal in length to the third, which is twice longer than the fourth, the remaining joints to the eighth shorter, the ninth joint conical, longer than the preceding. Head a little narrower than the thorax, scarcely pubescent, shining, smooth, sutures moderately distinct; labrum and mandibles piceous; palpi dark testaceous. Thorax shining, smooth, glabrous; tegulae black. Abdomen short, conical, thick, smooth, semitruncated at the apex; blotch large, sheaths of saw exserted. Legs: femora, coxae and trochanters black; apical half of the two anterior femora, knees, tibiae and tarsi, dark testaceous. Wings faintly smoky; first radial cellule a little smaller than the second, second cubital cellule more than double the width of the base at the apex, angled where it receives the recurrent nervure. Male similar, but with thicker and longer antennae, the joints from the fourth being perceptibly thicker than the basal ones. Length $1\frac{1}{4}$ lines.


Fig. 23 Work of *Kaliosysphinga ulmi* (original)

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Brown tail moth

Euproctis chrysorrhoea Linn.

Small web tents on the tips of trees in midwinter very likely belong to this species, particularly if small caterpillars are found within.

This species does not at present occur in New York State, but it is only a question of time before it will become established within our borders, since it is spreading rapidly in the adjacent commonwealth of Massachusetts. It is a serious enemy of fruit trees such as pear, apple, plum and cherry and promises to be a dangerous forest and shade tree pest, since it thrives on oak, maple and elm in the order named, stripping many trees in infested sections. Not only is this species injurious because of its defoliating trees whenever abundant, but it is also very annoying to man, since the hairs of the caterpillar are exceedingly irritating. This is so marked that serious illness has resulted from persons being in the immediate vicinity of large numbers of cocoons; particularly is this likely to occur in the case of those in delicate health.

Description. The male moths have a wing spread of about 1¼ inches, are pure white with a satiny luster on the fore wings and have a conspicuous reddish brown tuft at the tip of the abdomen. Sometimes there are a few black spots on the fore wings. The antennae are white and fringed with pale yellowish hairs.

The females have a wing spread of about 1¾ inches, are the same color as the males, except that they have no black spots on the wings, and the anal tuft is larger and lighter in color, while the antennae are shorter and with shorter fringes.

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

The young caterpillars emerge from their winter retreats before the leaves begin to appear, often attack swelling buds and complete their growth in the early part of June, when they transform to pupae. The full grown caterpillars range from 1 inch to 1¼ inches in length. The pale brown head is mottled with dark brown and has reddish brown hairs scattered over its surface. The body is dark brown or black with numerous fine, dull orange or gray spots over the surface, which are most pronounced on the second, third and fourth segments. Long reddish brown, finely barbed hairs arise from all the tubercles, and white branching hairs from the upper side of the latter tubercles on segments 4 to 12 inclusive. These white hairs form elongated white spots along each side and are one of the most striking characteristics of this caterpillar. The subdorsal and lateral tubercles on segments 4 to 12 inclusive are covered with fine, short spines of uniform length. There is a bright red retractile tubercle on the top of the 10th, and also one on the 11th segment.

The pupae are ¾ inch in length, dark brown in color and with fine, yellowish brown hairs scattered over the surface.

Life history. The winter, as previously stated, is passed by the partly grown caterpillars in conspicuous webs on terminal twigs. They begin work in the spring, feeding downward from the tip of the branches, leaving the naked twigs and the gray tents at their extremities, conspicuous evidence of their presence. The entire leaf, except the midrib, is devoured, except that in those like the sycamore maple, all the larger ribs are untouched. The caterpillars when numerous may devour not only buds, leaves and blossoms, but even green fruit. They are gregarious till nearly full grown, when they disperse to some extent, and this spreading is more marked when the food supply on a tree becomes exhausted. Several caterpillars frequently pupate in a common cocoon within the leaves at the tip of the branches, and sometimes in masses under fences, clapboards or on the trunks and larger branches of trees. The webs of the brown tail moth may be easily distinguished from those of the tent caterpillar or the fall web worm. The tent caterpillar makes its webs in the forks of the branches, whereas those of the brown tail moth occur at the tips. The fall web worm rarely occurs on pear, which is a favorite food plant of the brown tail moth, and the former usually makes a much larger, more open web than that of the brown tail moth. Moreover, it is never firmly attached to the twigs by bands of silk as is the case with this species [pl. 44, fig. 3].

Natural enemies. A number of parasites have been bred from the pupae in this country. Professor Fernald records the rearing of Phaeogenes hebe Cress., Diglochis omnivora Walk., Euphorocera claripennis Macq. and a large number of unnamed dipterous parasites. He states that the work of Diglochis is specially valuable and worthy of commendation. He also records the destruction of the caterpillars by a soldier bug, Podisus serieventris Uhl. and states that the Baltimore oriole, black-billed cuckoo, crow, bluebird and English sparrow have also been observed feeding on these insects, and quotes Mr Kirkland to the effect that the birds eat not only the moths, but their young, adding that it was no uncommon sight at Somerville to see flocks of 20 or more sparrows collect the moths from a picket fence. In addition to the above mentioned birds, Mr E. H. Forbush has recorded the robin, bluejay, black and white warbler, the rose-breasted grosbeak, the chestnut-sided warbler, the scarlet tanager, redstart, chickadees, red-eyed vireo, the yellow-throated vireo and the male indigo bird as feeding on the caterpillars. The records given by Mr Forbush include the number of larvae eaten by each bird and the time occupied. None ate less than 9, and one as many as 57 caterpillars, the latter operation occupying 20 minutes. These observations show that our native birds will undoubtedly prove very efficient aids in checking this pest. Professor Fernald has also recorded bats as feeding on the moths at night, and he states that toads devour the caterpillars during the early summer and the moths later in the season.

Remedial measures. The conspicuous hibernating nests are easily detected, particularly in early spring, and can then be cut off and burned. The species is also very amenable to spraying with arsenical poisons.

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European elm case bearer

Coleophora limosipennella Dup.

Curious brown, somewhat flattened cases occurring in considerable numbers during June and July on mined leaves of English and Scotch elms, probably belong to this insect.

The writer's attention was called to the presence of this species in 1901, by Mr E. T. Schoonmaker of Cedar Hill, who submitted specimens of the insect from the vicinity of New York city. The statement was made that the pest was so abundant as to be quite injurious to English and Scotch elms, and samples of the work corroborated the statement. Its depredations were also brought to our notice again in July 1902. Accompanying the latter sending were very badly mined leaves, and apparently this European species is capable of causing a great deal of injury. Bred examples appeared July 26, 1901, and were submitted to Dr Howard for identification. A reply was received stating that it has been determined by Mr Busck, who adds that it is in all probability a recent importation. It appears to have become established in the vicinity of Brooklyn, it occurs at Oyster Bay, and may make its way to other places in the State and prove a pest of considerable economic importance.

Description. This species may perhaps be most easily recognized by its work as shown in plate 34, figure 1. It will be observed that the larvae feed like other known species of this genus, by eating a circular hole through the epidermis and then mining or eating away all the delicate tissues within reach. The mined portions are evidently limited by the larger veins of the leaf and consequently the brownish blotches are more or less rectangular in shape. The holes through which the larvae do their feeding, are well shown in an enlarged representation of their work, plate 34, figure 2. The case of this little insect is about 3/8 inch in length, with a slight crook at the head end and with the posterior extremity somewhat flattened and of a lighter brown color. The caterpillar has a light brown head, a dark brown, well developed thoracic shield and with a heavily chitinized area on the dorsum of the second thoracic segment. The dorsal surface of the last abdominal segment is protected by a dark brown, heavily chitinized, subtriangular plate.

The delicate buff colored and gray marked moth has a wing spread of nearly 1/2 inch. The fore wings have a nearly white costal border and are tipped with dark buff. Both pairs are beautifully margined with long, hairlike scales. The antennae are setaceous, white, ringed with brown. The normal resting position of this moth is with the wings slightly diverging and sloping a little from the median line, the antennae being appressed and extended forward in a straight line.

Remedial measures. This species, like the more common cigar case bearers on our fruit trees, should be easily controlled by early spraying with an arsenical poison, making the application at the time the leaves begin to start.

Maple trumpet skeletonizer

Thiodia signatana Clem.

Red maple leaves folded in August or September, containing a long, tapering, blackish trumpetlike tube, with the adjacent tissues of the underside skeletonized, are very characteristic of this insect.

This species is one which has attracted comparatively little attention in economic literature, though it seems to be a rather common form on the red, and to a much smaller extent, on the sugar maples of Nassau N. Y. It was also abundant on maples at Onteora N. Y. in 1904. This form is probably overlooked as a rule because it appears on the trees so late that the injury is very slight, even though the caterpillars be abundant. The work of this insect is very characteristic. The larger leaves are invariably folded to form an irregular, loose retreat with the under surface, on which the caterpillar feeds, inside. The folded, partly skeletonized leaves can be detected at a considerable distance, and on opening them there is a conspicuous tapering, frequently crooked larval tube sometimes nearly 2 inches in length. This structure is composed of web with excrement on the outside, and increases in size with the development of the caterpillar.

Description. The nearly full grown caterpillar is about 1/2 inch in length, head yellowish and body a variable light green. The mouth parts are distinctly brown, the mandibles being tridentate with their apices dark brown; eyes black. Body tubercles very much flattened, semitransparent, two subdorsal and a lateral one upon each abdominal segment, each bearing a slender, nearly colorless hair. Tips of true legs dark brown, well developed prolegs on the third to sixth and 10th abdominal segments. The tube of this larva was first described by Clemens under the name of Castastega aceriella. It was later referred by Dr Dyar to Clemens's species originally named Hedya signatana. Clemens's description of the adult follows:

Fig. 24 Trumpetlike tube of Hedia signatana in maple leaf (original)

Fore wings white, marked with dark brown. The basal patch is distinct, dark brown and consists of three or four angulated lines, the exterior being the broadest. The dorsal patch is white, extended to the costa, contracted in the middle of the wing and is traversed by a few broken, indistinct, brownish lines. The central fascia is dark brown, rather indistinct, and contains three black dashes opposite the ocelloid patch, which is white and rather indistinct. The costa is marked with dark brown streaks and near the tip are three or four geminated white spots, the dark brown streak which separates the two nearest the tip of the wing is extended along the hinder margin to the ocelloid patch. At the extreme tip is a black semicircle in the cilia, upon a dark brown ground. Hind wings dark fuscous.

Remedial measures. Arsenical poisons applied to the underside of the leaves should check this species readily.

Larch case bearer

Coleophora laricella Hübn.

Tips of larch needles sometimes turn yellow or brown, and on investigation it is found that the interior has been eaten away by a small, brown, black headed worm.

This insect is a European species, and its presence in this country was first recorded by Dr Hagen, in 1886.[1] Specimens were sent him by Mr Henry Watson of Northampton Mass., who stated that it caused considerable injury to a number of larches about 30 years old. This insect has been known in this country for a number of years; possibly earlier than the above date, according to Mr J. G. Jack who, writing in 1896,[2] stated that the insect had been known for a good many years at the Arnold arboretum. This species does not appear to multiply very rapidly in this country, and though present in these two places, and probably others, for several years, has not caused damage enough to arouse apprehension. It is not mentioned in our economic literature, and while we have observed the species for some years on larches at Albany, it has never inflicted much damage.

Life history. The delicate gray moths occur in June or July, and according to Stainton, the recently hatched larva which appears in the autumn doubtless contents itself with mining in a leaf, but as soon as the mine is big enough to form a case, it cuts off a portion and proceeds with this protection, to an adjoining leaf. The case is at first whitish but gradually becomes gray, and the caterpillar renders it less transparent by lining it with silk. The method of feeding is similar to that of our native species, and the larva when attacking a needle, first cuts a circular hole through which its head, and later its body may extend into the interior. Its case is attached to the edge of the orifice in the needle and the mine, as well as the evidence of various observers, shows that it rarely gets far from its domicile, evidently preferring the shelter of its silk-lined case to the protection afforded by a mined leaf. The larvae retire to the large stems on the approach of winter and hibernate, becoming active again in early spring

[1] Can. Ent. 18: 125–26

[2] Garden and Forest, 9: 269

and continue their feeding. Stainton observes that at this time the previously formed case is too small, and as the diameter of the larch leaf is limited, the larva is forced to slit down its old case and add thereto a piece of mined leaf, thus affording necessary space. He also states that there is but a single generation, and this accords with our observations.

Description. The adult insect can be recognized by reference to plate 18, figure 9. It will be seen that it is a modest, gray moth with no very distinctive markings.

The caterpillar is brown with the head, thoracic shield, small spots on the dorsum and the anal plate black [pl. 18, fig. 7]. The characteristic appearance of a mined leaf, illustrating also the hole through which the larva feeds, is shown at plate 18, figure 5.

The case resembles somewhat that of our cigar case bearer, Coleophora fletcherella Fern., being straight and nearly cylindric, though close observation will disclose the ridges caused by the edges of the leaves used in its construction. It is usually a light grayish color with the head end obliquely truncate.

Distribution. This species is widely distributed, according to Stainton, who lists it from a number of English and Scottish localities, and states that it occurs throughout Germany and has been observed in Finland, Switzerland and France. Professor Meyrick states that the larch is not indigenous to Great Britain, and that this insect must have been introduced with its food plant.

Remedial measures. The larch being frequently used as an ornamental tree, is sometimes quite valuable, and wherever this miner becomes abnormally abundant, it can probably be controlled by thorough spraying in early spring with an arsenical poison. This has been found very effective in the case of allied case bearers affecting fruit trees. We suggest that arsenate of lead be used, and that the application be made as soon as the young leaves begin to appear, so as to poison the over-wintering caterpillars before much feeding occurs. Otherwise, it will be almost impossible to destroy the insects, since they do so much of their feeding within the leaf.

DESTRUCTIVE SUCKING INSECTS

The work of sucking insects is easily distinguished from that of other classes because in no case is tissue removed. Their operations are usually followed by shrinking, discoloration, and decay.

Key to destructive sucking insects

[illegible]

Leaves, species found on foliage only

Yellowish green, brown marked aphids or plant lice occurring in clusters on the underside of Norway maple.................... Chaitophorus aceris, p. 174

A pretty winged, red eyed, black and white marked plant louse, together with pale yellowish, wingless young, may be found on the under surface of soft maple leaves, specially on those near the tips

Painted maple aphid, Drepanosiphum acerifolii, p. 175

A slight, inconspicuous plant louse on the underside of American elm leaves

Elm leaf aphid, Callipterus ulmifolii, p. 176

Curled and gnarled leaves of white elm in June, with whitish pellets of honeydew dropping from the tree

Woolly elm leaf aphid, Schizoneura americana, p. 177

Sugar maple leaves bearing numerous cottony masses protruding from under brownish scales .... Maple leaf scale, Pulvinaria acericola, p. 179

Cottony white insects on the under surface of sugar maple leaves and masses on the trunk................ Maple Phenacoccus, Phenacoccus acericola, p. 182

American elm leaves deformed by a peculiar cockscomblike gall in June.

Cockscomb elm gall, Colopha ulmicola, p. 186

Snow white, woolly plant lice on larch needles in May and June

Woolly larch aphid, Chermes strobilobius, p. 187

Somewhat cone-shaped, many-celled galls at the base of young spruce shoots

Spruce gall aphid, Chermes abietis, p. 189

Small, yellowish white, jumping insects about $\frac{1}{8}$ inch long occur in swarms during midsummer, on rose leaves .... Rose leaf hopper, Typhlocyba rosae, p. 191

Bark, aphids or plant lice and scale insects on limbs or trunk

Species with more or less flocculent matter

Clusters of white woolly substance on elms and trunks of white elm

Woolly elm bark aphid, Schizoneura rileyi, p. 192

Patches of flocculent, downy matter on the smooth bark of white pine

Pine bark aphid, Chermes pinicorticis, p. 192

Conspicuous cottonylike bunches hanging from the underside of alder stems
Alder blight aphid, *Pemphigus tessellatus*, p. 195

Underside of smaller soft maple twigs festooned with cottony masses protruding from under a brownish scale, occurs on maples, elms, grape etc
Cottony maple scale, *Pulvinaria innumerabilis*, p. 196

Species with no flocculent matter except when very young

Small, hemispheric, reddish, black marked scale insects on the underside of the smaller limbs of hard and soft maples
Black-banded scale, *Eulecanium nigrofasciatum*, p. 200

Under surface of elm leaves thickly clustered in summer, with reddish, woolly-bordered bark lice................. Elm bark louse, *Gossyparia spuria*, p. 203

American elms with whitish, irregularly oval scale insects on the bark
Elm scurfy scale, *Chionaspis americana*, p. 207

Large, nearly hemispheric, brownish scale insects in clustered masses on the under side of tulip limbs....... Tuliptree scale, *Eulecanium tulipiferae*, p. 208

Brownish, oyster shell-like scale insects exceedingly abundant on ash, balm of Gilead and also many other trees.......... Oyster scale, *Lepidosaphes ulmi*, p. 211

Dirty, blackish scale insects on Euonymus and Celastrus
Euonymus scale, *Chionaspis euonymi*, p. 213

Whitish, scurfy appearance on the trunk and limbs of Japanese quince and some other trees and shrubs....... Scurfy scale, *Chionaspis furfura*, p. 214

Circular, grayish or yellowish scale insects very abundant on Japanese quince and some other trees.......... San José scale, *Aspidiotus perniciosus*, p. 216

Circular or oval, dark gray or black scale insects about $^1/_{12}$ inch in diameter and with a dark red cast skin or exuviae to one side of the center, may be met with in small numbers on various native trees
. Putnam's scale, *Aspidiotus ancylus*, p. 226

Scurfy, whitish, irregular scale on alder and Cornus. *Chionaspis lintneri*, p. 227

Irregular, whitish scale insect on roses, blackberries and raspberries
Rose scale, *Aulacaspis rosae*, p. 228

Circular, snow-white scale on juniper..... Juniper scale, *Diaspis carueli*, p. 229

Elongated, whitish scale insect on needles of various pines
Pine leaf scale, *Chionaspis pinifoliae*, p. 229

Large, freely moving species usually on trunks or limbs

A stout, large, black insect with membranous orange veined wings and red eyes
Periodical cicada, *Tibicen septendecim*, p. 231

A stout, large, greenish insect with greenish veined wings

Dog day cicada or harvest fly, Tibicen tibicen, p. 237

A blackish, red marked bug occurring on box elder, western in range

Box elder plant bug, Leptocoris trivittatus, p. 239

Chaitophorus ? aceris Linn

A yellowish green, brown marked plant louse, with long hairy antennae and reddish eyes, is frequently abundant throughout the greater part of the season on the underside of Norway maple.

This species is present in Albany and vicinity and yearly causes considerable injury. It was exceedingly numerous in 1897, and several large colonies were not uncommon on the under surface of many of the leaves. The pest was abundant and such large amounts of honeydew were excreted that walks under infested trees were usually damp in midsummer. Large sticky masses on the surface of the foliage were not uncommon, and they frequently dried into hard clear beads of considerable size. A great many leaves dropped from the trees, probably due to injury by the plant lice.

Description and habits. This plant louse is found in clusters usually along the veins of the leaf, or near its base [pl. 11, fig. 5, 6]. The very young are a pale greenish yellow, with red eyes, and the antennae are about ½ the length of the body. As they increase in size, the antennae become longer and are marked with brown near the tips, and brown markings appear on the dorsum. There is a central brown area on the thorax and anterior abdominal segments, and irregular markings on either side of the median line near the posterior extremity of the body. The honey tubes are short, ornamented with black at the tips. The markings become darker as the insect increases in size, and in some wingless females may be almost black and cover a considerable portion of the dorsum. The winged females are relatively quite rare, and differ from the others only in the possession of organs of flight.

Natural enemies. This species is fortunately a prey of other insects, which undoubtedly do much in keeping it in check. One of the most active of these is the common two-spotted ladybeetle, Adalia bipunctata

Linn., and its young. This species was very abundant at the time of the outbreak in 1897, and its grubs were observed in considerable numbers crawling about in the vicinity of infested trees. The larger 15-spotted lady-beetle, Anatis ocellata Linn., was also associated with the preceding in feeding on this plant louse. It occurred in considerably smaller numbers, and was therefore not so valuable. The young of syrphus flies and of lace-winged flies were also observed on the infested trees, and undoubtedly did much towards checking the pest.

Remedial measures. Ordinarily, this species will be kept in check by its natural enemies, and active remedial measures will not be necessary. This pest is capable of causing very serious injury, and when not kept well in check by natural agents, it should be controlled by spraying with a kerosene emulsion or a soap solution. Thorough treatment with either of these substances, taking special pains to throw the insecticide on the under surface of the leaves, will reduce its numbers materially.

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Painted maple aphid

Drepanosiphum acerifolii Thos.

A pretty winged, red eyed, black and white marked plant louse, together with pale yellowish wingless young, may be found on the under surface of soft maple leaves, specially on those near the tips.

This little plant louse appears to be generally distributed throughout the State, and is usually present in small numbers on most of the soft maples. Occasionally it is abundant enough to cause considerable injury. This was true in and about Albany in 1897, at which time a number of species of plant lice were unusually abundant. This form was observed by the writer in early September, 1899, at Onondaga Valley, Syracuse, where many of the leaves of the soft maple had fallen and those in the upper portion of the trees were badly shriveled. Abundant honeydew was observed on the foliage and as the trees were badly infested with this plant louse, it was doubtless partly responsible for their poor condition. Many infested maples were seen at this time at Batavia, but the injury was not as great as at Syracuse. The work of this species was also observed at Amsterdam and in Albany, and it doubtless caused serious injury in the latter places. A few syrphid larvae were found on the infested trees.

Description. This is a small species, the winged adult measuring only about 1/10 inch in length. The antennae are about twice the length of the body and nearly colorless, except for the black tips of each segment. The eyes are a brilliant red, and the dorsum is a variable brown, as is also true of the thorax. The wing veins are heavily fringed with dark brown near the tips. The dorsum of the middle abdominal segment is also marked with dark brown, and that of the anterior and of the terminal segments is frequently a grayish white. The long slender legs are nearly colorless. The last thoracic segment and the second and third abdominal segments bear paired black spines, one on each side of the median line, the middle spines or tubercles being the highest. This species is somewhat peculiar in that old adults may have the greater part of the abdomen broken off without apparently suffering much inconvenience. The wingless individuals are a pale yellowish green color, the eyes are a bright red, and the tapering antennae are dark at the tips. The honey tubes are short and capitate in nearly full grown individuals. The middle tibia, tarsi, and the base of the posterior tibiae are frequently dark. [*See* pl. 11, fig. 1–4]

Elm leaf aphid

Callipterus ulmifolii Monell

A very slight, inconspicuous plant louse frequently occurs on the underside of the leaves of American elms during midsummer

This delicate species was present on American elms in Albany in great numbers in 1897. It caused considerable injury at that time and its work was plainly indicated by the constant dampening of sidewalks with large amounts of honeydew falling from the infested trees. The attack of that year continued throughout July and August, when it was finally arrested by heavy rains in conjunction with the efficient work of ladybugs and their young. This species is one which is widely distributed throughout the State and frequently causes considerable injury, though active measures for its control will as a rule be avoided, largely on account of the attendant expense.

Description and habits. The young and adults occur here and there over the leaves, there being no clusters, such as are so characteristic of the Chaitophorus occurring on the Norway maples. The winged adult is yellowish green, and harmonizes very closely with the color of the veins on the underside of the leaves. The very delicate antennae have each segment tipped with black. The dorsum of the thorax and of the anterior abdominal segments is marked with inconspicuous brownish spots. There are four small, black tipped tubercles on the dorsum of the anterior abdominal segments. The honey tubes are very short. The wings are nearly colorless, except for the light brown and greenish shades along the veins. The wingless individuals are nearly the same color as the adults, and are even less conspicuous. The thorax is spotted dorsally with very small light brown markings [*see* pl. 11, fig. 12-14]. It frequently happens that the best signs of this insect's presence are the numerous whitish exuviae cast by the growing young. These cling to the leaves for a considerable time, and give a very good idea of the previous abundance of the insect.

Remedial measures. Thorough spraying with a contact insecticide, taking special pains to make the application to the underside of the foliage, is a most efficient check on this species, though it is a costly method in the case of large trees.

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Woolly elm leaf aphid

Schizoneura americana Riley

Curled and gnarled leaves of white elm in June with whitish pellets of honeydew dropping from the trees, are characteristic of this plant louse.

This insect is sometimes very abundant on American elms and frequently the first indication of its presence is the whitening of foliage under the infested trees, a disfigurement caused by falling wax-covered pellets of honeydew. An examination of the elm usually shows that one side of the leaf has turned under the other, forming a cavity which is frequently brimful of struggling plant lice and particles of whitened honeydew. It is occasionally abundant enough to cause considerable damage, though as a rule, the disfigurement of the tree and the shrubs below constitute the principal nuisance.

Life history. The life history of this species has been carefully worked out by the late Professor Riley, who states that the over-wintering egg is a minute, dull yellowish, ovoid object about 1/50 inch long, which is deposited in cracks and crevices of the bark during the summer. This remains dormant till the leaf buds begin to swell, at which time the young plant lice issue, crawl to the terminal leaves and branches and settle on the first tender leaflet they find. This is the first generation or stem mothers, and they establish themselves on the under surface of the leaf and very soon cause it to swell and curl, usually from one edge. The curl varies however, depending somewhat on whether one or several stem mothers settle on the same bud. The stem mother, at first pale yellowish red, with dark appendages, increases rapidly in size, depending somewhat on the nourishment in the leaf. In about 25 days young begin to appear at the rate of about one to every six or seven hours, according to temperature. The colony increases in numbers and early in June in this latitude, the affected leaves may be literally overflowing with plant lice and the honeydew they produce. In favorable years the lice soon become so abundant that the leaves do not protect them, and are covered with multitudes of old and young, some wingless and others with organs of flight. At this time the second generation of wingless mothers are surrounded by smaller colonies, all of which in turn acquire wings. Other generations are produced, as many as six occurring in one season, the last depositing eggs in the crevices of the bark as mentioned above.

Dr Riley states that this species is very closely allied to the European S. ulmi Linn.

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Maple leaf scale

Pulvinaria acericola Walsh & Riley

Brownish scales, with cottony masses protruding from under them may be found on the leaves of the sugar maple. This form resembles the preceding very much.

This species, as pointed out by Dr Howard, was probably observed by Dr S. S. Rathvon at Lancaster Pa., at the time he studied and characterized Pulvinaria innumerabilis. It was figured by Walsh and Riley in the first volume of the *American Entomologist*, and by later writers it was referred to Dr Rathvon's species. It was left to Dr Howard to point out in 1898 that two species had been confounded and that the very characteristic illustration published by Messrs Walsh and Riley was sufficient to carry the name.

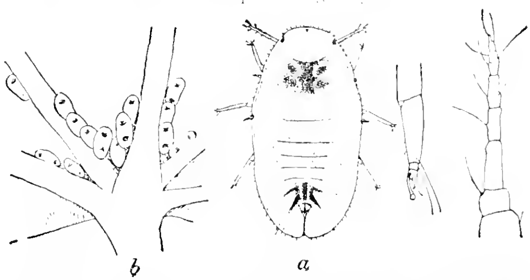

Fig. 23 Pulvinaria acericola: *a*, larva of third stage of early hibernating female with tarsus and antenna at right, greatly enlarged; *b*, larvae of third stage on lower side of leaf, before migrating to twigs, enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 22, n. s. [illegible])

Description. The adult female, found on the leaves as described by Dr Howard, is not so large as the corresponding stage of P. innumerabilis Rathv. and the secreted cottony mass is somewhat depressed, faintly bilobed and transversly undulated. This species has been taken only on the sugar maple and in this State it has been recorded from Ithaca. It is also known to occur in Iowa, Alabama, Washington D. C. and New Jersey. The paucity of records is probably due in part at least to its being confused with our more common species.

Life history and habits. The following account of the life history and habits of this species is based on Dr Howard's work. Eggs received from Knoxville Tenn. in 1898, began to hatch in June, while others from

D[illegible] began to [illegible] in the latter part of May, and [illegible] ending [illegible] approximately June 6. The secretion of [illegible] and the deposition of eggs in the mass of wax and fibers commenced [illegible] Washington late in May and continued gradually [illegible] June, young beginning to hatch on the 13th. The newly hatched [illegible] pale yellowish in color, with a slightly brownish [illegible] and dark purple eyes. July [illegible] the first molt occurred and the [illegible] a very pale yellowish white color and almost transparent. [illegible] specimens were marked with a pale purplish spot near the [illegible] of the body. The growth from this time till October, at which time the second skin was cast in 1906, was very slow. The third [illegible] observed as early as June 26, 1908. The young had deserted the leaves [illegible] by Oct. 15. They were at this time of a pale [illegible] color, somewhat darker along the median line, and were [illegible] marked with a large reddish, almost crimson, medio-dorsal spot on the prothoracic segment, and with a similar one just in front of the anal cleft. The eyes were minute, black, and nearly twice as large as before. Most of the larvae had settled for hibernation on the trunk by Oct. 21 and then the sexes could be distinguished. The females are recognized by their more broadly oval shape. At about the time the migration to the twigs began, late in October, the great majority of the young were located along the ribs on the underside of the leaves, though a large number were also found on adjoining twigs, generally in and about the forks, in excrescences or near buds or other projections. They run about quite actively at this time in search of suitable places for hibernation, and a delicate layer of waxy secretion appears which gives the insect a somewhat grayish appearance. Nov. 1, 1908, all the young had settled for hibernation, and were of a considerable darker color, harmonizing well with the bark. There was little or no change in their condition in December and the same was practically true at the end of the following March. Males and females were found April 8 on potted trees. The latter were of a dark purple color with a yellow median ridge. The first male transformed to a pupa April 22 and by the 28th the anal filaments had begun to protrude and May 1 the adult emerged. May 18 the females had increased greatly in size, indicating that impregnation had taken place, and on the 22d they began to move from the young branches out on the twigs and on the 23d one had reached the underside of the leaf and had commenced to form its ovisac. Within 24 hours the extruded white wax formed a nearly complete circle about the insect, and 48 hours later it had reached a length of 1/5 inch, and was distinctly divided from the first secretion by a deeply impressed line. The first wax extruded contained no eggs, but the real ovisac, comprising the last 1/6 inch was full of eggs which hatched June 13, and thus completed the life cycle.

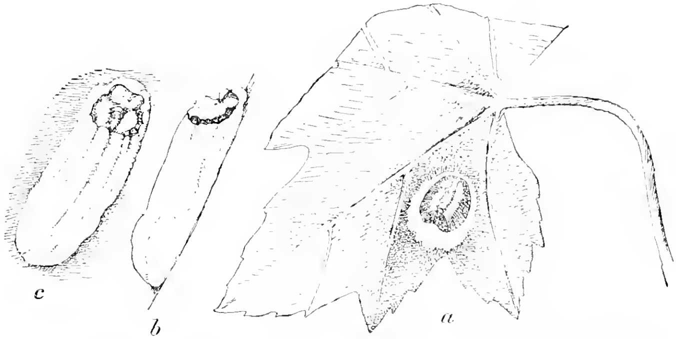

Fig. [illegible] Pul[illegible] [illegible] [illegible] wintering [illegible] from [illegible]
[illegible] egg sac [illegible] same, with egg sac completed, from side [illegible] After
Howard U. S. Dep't Agric. Div. Ent. Bul. 22, n. s. [illegible]

Natural enemies. The only enemy observed by Dr Howard at Washington was a small ladybug, Hyperaspis signata Oliv., which was received in the larval condition from Knoxville Tenn. The larva of this little beetle is very interesting on account of its resembling the larva of a mealy bug [fig. 27]. It, or an allied species, was met with by the writer in 1901. Prof. R. H. Pettit, who collected the insect at Ithaca in 1893, reared six parasites which were determined by Dr Howard as follows: Aphycus hederaceus Westw., Aphycus flavus How., Coccophagus fraternus How., Pachyneuron altiscuta How., and Chiloneurus albicornis How., and a small fly, Leucopis nigricornis Egger. Professor Pettit also obtained the small ladybug named above.

[illegible]

Remedial measures. This species is so closely allied to the more common cottony maple scale, Pulvinaria innumerabilis Rathv. that measures of value against one should prove of nearly equal service in the case of the other.

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Maple phenacoccus

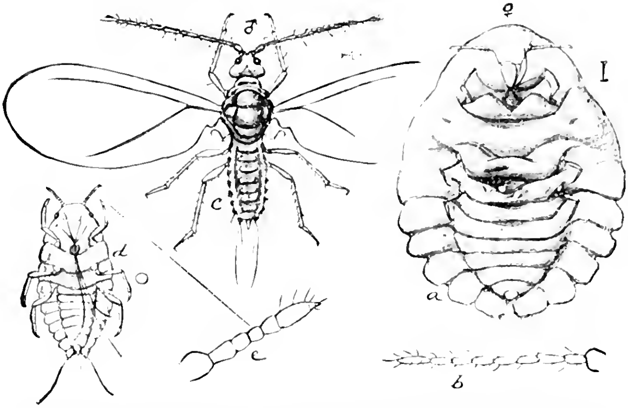
Phenacoccus acericola King

Cottony, white scale insects occurring on the underside of sugar maple leaves, or cottony, white, masses or patches on the trunk may be those of this insect.

This species is a relatively rare form which has attracted very little notice till recent years. It was apparently brought to the attention of the late Dr Lintner but once during his long term of service as state entomologist, and previous to 1901 had been sent to the writer only once. It was, however, extremely abundant in 1901 on hard maples in Albany, and it was observed on a great many of these trees at both Worcester and Springfield Mass. One tree in Albany was so badly infested that thousands of the cocoons were to be seen on the trunk, forming masses which could be detected at a distance of several hundred feet. The leaves of the lower branches were badly injured by the females, and examination in 1902 showed that many of the lower branches had been killed. The insect was breeding rapidly Aug. 6, 1901, at which time many young were observed on the leaves. Partly grown individuals were assembled in long rows on both sides of the principal veins on the under surface of the leaves, and a marked subacid, not unpleasant odor was observed in connection with this species.

[illegible] leaf; [illegible] Howard. [illegible]

Early history. This species was first noticed in America by Miss Emily A. Smith of Peoria Ill. in 1880. Miss Smith made a thorough study of the insect and observed it only on the sugar or hard maple, and referred it to Goeffroy's P s e u d o c o c c u s a c e r i s. That reference was allowed to stand till 1902, when it was described by Mr G. B. King. This scale insect must have been quite abundant in Illinois in 1880. It was not noticed again till 1894, when Dr L. O. Howard gave a summarized account of its life history and commented on its rarity. He states that since the publication of Miss Smith's article in 1880 and the preparation of his account 14 years later, the species had not been sent to the division of entomology, United States Department of Agriculture, a fact which establishes its rarity. It was received by Dr Howard in 1894 from Mr John G. Jack, who stated that the species was very abundant in some localities in the vicinity of Jamaica. It was also sent him from other localities in Massachusetts, and from Prof. W. G. Johnson, then at the State Laboratory of Natural History, Champaign Ill., to whom it had been sent on sugar maple leaves from Mt Karner. Prof. L. F. Kinney of the Rhode Island Experiment Station, also sent specimens of the insect to Dr Howard during that year. Since this latter date the species was not abundant till 1901, as stated above, when it occurred in large numbers, not only



in New York State, but in localities in Massachusetts, and probably in other sections of the country.

Life history. The life history of the insect, as given by Miss Smith and Dr Howard, may be stated briefly as follows. The adult females occur on the leaves in summer, and are about 1/4 inch in length and a little less in transverse diameter. The adults are concealed by an oval mass of powdery, slightly stringy wax within which is the female and her eggs, the insect occupying the anterior end and her body constituting about 1/4 its bulk.

She is light yellow in color and about 1/5 inch long. The light yellow eggs are very abundant in the waxy secretion, and measure about 1/75 inch in length. The young female is pale yellow, elongated oval, and tapers gently toward each end. The young male is reddish yellow, and the adult red. The young remain on the leaf after emerging from the eggs, unless it is too crowded, when they crawl down the petiole and seek food on a healthy leaf. The males on attaining full growth, become restless and wander over the trunks and limbs for from 7 to 10 days and finally secrete themselves beneath the rougher outer bark of the tree and transform to pupae. The white, oval male cocoons were present in thousands on the bark of the hard maples under observation at Albany in 1901. The perfect insects appear in about 15 days, and by this time the females have attained maturity, left the leaves and are wandering about on the limbs or trunk. The growth of the females is rapid after pairing and they soon settle on the underside of the leaf, seldom crowding each other. Miss Smith states that not more than three or four remain on a leaf, while Dr Howard records as many as 13 on the underside of a single leaf, and specimens collected at Albany have borne nearly as many. The waxy secretion soon becomes very dense, and the eggs are pushed out into it, both the secretion and the number of eggs increasing proportionally. One individual may deposit over 500. Miss Smith's observations at Peoria showed that there were three generations each year, and that the winter is passed by young in crevices of the larger limbs and in that latitude they may be quite active during warm days. The second brood hatches in June, and the third in August, the young of the latter generation over-wintering. Dr Howard calls attention to the fact that the young of all generations have the habit of migrating to the trunk of the tree, in the earlier generations, however, they remain on the bark for only a short period, while the young of the last, as previously stated, winter on the trunk.

Natural enemies. Miss Smith succeeded in breeding a minute Chalcid fly, Rhopus coccois Smith, which frequently deposits its eggs on the female about the time of oviposition. Miss Smith also observed a syrphus larva feeding on the young bark lice, while from the puparium of this larva she reared another Chalcid, which she identified as a species of Eulophus. Three lady beetles, Hyperaspis signata Oliv., Chilocorus bivulnerus Muls., and Anatis ocellata Oliv., were observed by her feeding on the bark lice, and a species of Chrysopa was engaged in the same work. A syrphid fly, Baccha fascipennis Wied. was reared by Dr Hopkins from Massachusetts specimens and from the puparium of this fly he obtained a species of Pachyneuron, which he thinks may possibly be the insect referred to Eulophus by Miss Smith. The larvae of Hyperaspis signata were also observed feeding on specimens from Massachusetts.

Remedial measures. This insect could be easily controlled by an application of such contact insecticides as a whale oil solution or a kerosene emulsion. The treatment will be more effective if performed at the time when most of the young are crawling. Miss Smith found by experiment that a wash composed of 3 gallons of water, ½ pound of hellebore and 1 teaspoonful of carbolic acid, put on with a whitewash brush during the early spring, was effectual.

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Cockscomb elm gall

Colopha ulmicola Fitch

The leaves of the American elms are not infrequently more or less deformed by a [illegible] or cockscomblike gall which appears in June, and is the work of a small aphid or plant louse.

This interesting gall is a very common one in the vicinity of Albany, and occasionally is quite abundant. It is sometimes so numerous as to produce very serious deformations of the leaves, and a corresponding injury. The young galls appear about the first of May as slightly elevated ridges on the upper side of the leaf. Soon after, on the opposite side, elongated openings appear, and on spreading these apart, a glossy olive brown plant louse may be seen within the cavity. This insect is the mother of the colony inhabiting the gall. Four to five weeks after the inception of its growth and during the month of June, an examination of the interior of the gall shows the adult plant louse surrounded by numerous young in different stages of growth. Within the gall, among the many occupants are small glistening globules of a sweet liquid or honeydew, excreted by the plant lice. Later the opening into the gall spreads apart and permits the insects to escape, and when the tree is badly infested, as stated by Dr Lintner, there are almost showers of honeydew falling from the leaves on the ground beneath. The stones of the walks under the infested trees in cities may be kept moist and black by this copious excretion. The members of the second generation, as stated by Dr Lintner, are wingless females, parents of the gall-producing generation, from which, later in the season, sexual individuals develop and deposit eggs in sheltered places beneath the bark. The winter is passed in this stage and the stem mother appears the following spring.

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Woolly larch aphid

Chermes strobilobius Kalt.

Snow-white, wooly aphids or plant lice on larch needles in May and June and masses of purplish eggs at the base of leaf fascicles may be this insect.

This species is somewhat common on the larches in Albany, and has been under the writer's observation for the past five years. It is occasionally exceedingly abundant, and the woolly masses excreted by this plant louse are sometimes so conspicuous as to give a tree the appearance of having been dusted with flour or starch. This was specially true the latter part of June 1897 [*See* pl. 18, fig. 1, 3, 4]

Life history. The life history of this insect as observed by the writer in Albany is substantially as follows: May 3, 1897, the larches were alive with females and eggs. Large masses of eggs were to be found at the base of nearly every fascicle of leaves on some limbs. Over 200 were counted in an egg mass of moderate size, while around the base of other fascicles two to three times this number were to be found. The young were beginning to hatch on this date, and some had already settled on the larch needles, at which time they presented a close resemblance to a grain of black gunpowder. The young increase in size in the course of a few weeks, and excrete an abundance of white wooly matter. The period when the insect is most conspicuous is during the latter part of June. Later in the summer it is not nearly so abundant, though it can usually be found upon the trees in smaller numbers up till September and possibly later. The life history of this species as worked out by Dr Cholodkovsky of Europe is most interesting, comprising, as it does, a life cycle of 2 years duration and involving five generations. It is as follows: (gen. 1) wingless female lice pass the winter at the base of young pine buds, produce galls in the spring and in them winged (gen. 2) females develop, part of which migrate in August to the larches and lay eggs on the needles. From these eggs emerge (gen. 3) young which hibernate in the crevices of the bark and the following spring attack the base of the buds and produce the eggs which attract attention on the larches, and from which the black (gen. 4) young emerge, a portion eventually developing into winged females, and returning to the pines the latter part of May (probably later in this latitude, as this generation is abundant on larches till the last of June), where they lay eggs producing (gen. 5) males and females, which in turn are parents to the hibernating form first mentioned and thus the life cycle is completed.

The writer, so far as known, was the first to record the occurrence of this species in America though doubtless it had been established in this country for some years. The following synonyms are those given by Dr Cholodkovsky: *Chermes coccineus* Ratz.? in part; *C. laricis* Ratz., Koch in part; *C. geniculatus* Ratz., in part; *C. hamadryas* Koch; *C. atratus* Buckton?; *C. lariceti* Altum?

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Spruce gall aphid

Chermes abietis Linn.

Somewhat cone-shaped, many-celled galls are formed at the bases of young spruce shoots; later these dry, turn brown and open, thus allowing the inclosed plant lice to escape.

This species has been observed by us on spruce in Albany, and it also occurs in other parts of the State. It is, according to Professor Cooley, widely distributed in America, since it has been met with in New England, recorded by him from Canada, occurs as far west as Washington, and has been received from a number of intervening localities.

Description. The gall is a somewhat conelike, many-celled structure about $3/4$ inch in length. It is at first entirely green or more or less rosy in color, taking on a yellowish tinge in August, at which time the cavities open slowly and the gall begins to dry up and turn brown.

The eggs are deposited in small clusters, each attached to a leaf by a slender stem. They are ellipsoidal in form, about $1/60$ inch in length, light yellow when deposited, gradually turning darker. The newly hatched young measure about $1/60$ inch in length, are oval, tapering slightly toward the posterior end. The full grown young are about $1/12$ inch long, with the head, thorax and all the appendages yellow, the abdomen rather reddish and the wing pads tinged with green in many individuals, though in some they are light brown. The winged female is from about $1/8$ to $1/10$ inch in length, with a wing expanse of about $1/5$ inch. Recently emerged individuals are a nearly uniform yellowish color, but with age darker markings become apparent and the head and thorax are then a nearly uniform deep brown, while the abdomen retains its yellowish color, the fore wings with the stigma and costal cell are distinctly green. The posterior end of the thorax is covered with a white, flocculent secretion, which extends along the sides of the abdomen toward the thorax. The young of the winter generation measure about $1/60$ inch in length. The dorsum of the head and thorax and the spots on the dorsum of the abdomen are brown; the remainder of the body is yellowish brown.

Life history and habits. This account of the life history and habits is based on that published by Prof. R. A. Cooley. The eggs are deposited from the second week of May to about the time the spruces are putting forth new shoots, and may be found at the base of buds enveloped in a white, wooly mass. A cluster contains about 300 light yellow eggs, each attached by a slender stem. The eggs hatch in about a week, and in a few hours the young venture out from the protecting wooly mass, crawl to the tender, young shoots and nestle closely in the cracks at the base of the leaves of young galls which have already begun to form. The starting of the galls must therefore be attributed to the female rather than to the young, though the latter undoubtedly have some influence on their further development. There is nothing on the young gall to indicate that there will ever be cavities to inclose the nymphs. It gradually grows over the insects, the cavities slowly closing, leaving only a semicircular incision surrounded by a grayish or pinkish pubescence. Late arriving nymphs sometimes experience difficulty in finding a cavity open enough to allow admission. Generally all the nymphs in one gall come from an egg cluster laid by a female. After the cavities close, the space within enlarges, and in a few days the young may be seen closely adhering to the sides, heads directed toward the opening. The nymphs become full grown in early August, at which time the galls begin to loose their dark green color, slowly turning yellowish. The cavities gradually open and the nymphs emerge one by one, molt, leaving the cast skins attached to the leaves, the wings developing as they crawl along. The first winged specimens were observed at Amherst Mass., Aug. 10, and most of the adults emerged before the 20th, but stragglers continued to appear for some time. About two days after attaining maturity, the female begins laying eggs after having first permanently attached herself to a leaf, generally near its tip, where she remains, her dead body serving as a protection for the egg cluster. The eggs do not all hatch at the same time, a period of about two weeks being required. The young nymphs remain under the dead body of the mother for a short time and then the young wingless females spread over the nearby limbs, some attaching themselves to leaves, others locating in crevices at the axil of leaves and at the base of buds, only a portion of those at the base of buds surviving the winter. Minute young of this generation are almost invisible, but as the winter approaches they secrete from the dorsal pores a coating of coarse, white threads, which make them more conspicuous. The old winter coat is molted in the spring, about the third week in April, after which a more copious wooly coating is produced. The first eggs were observed at Amherst Mass., May 6.

Natural enemies. This species is subject to attacks by several natural enemies. The larva of the common lace-winged fly, Chrysopa arcuata Say., feeds voraciously on the nymphs of this insect as they issue from the galls. Protection of smaller insectivorous birds such as tits, the nuthatch and golden-crested wren, has been recommended because they probably prey on this plant louse to some extent.

Remedial measures. Thorough spraying of infested trees in April, with a whale oil soap solution, 1 lb to 2 gal. of water, has proved very effectual in checking this insect. The galls may also be cut off and burned in June, thus destroying the insects.

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Rose leaf hopper

Typhlocyba rosae Harris

Small, yellowish white, jumping insects about 1/8 inch long occur in swarms during midsummer, on rose leaves.

This is one of the common pests of rose growers and occasionally these small leaf hoppers cause a great deal of injury. They winter under fallen leaves and rubbish on the surface of the ground and appear on rose bushes some time in May, occurring on the underside of the foliage, in all stages, during the greater part of the summer. They draw the sap from the foliage and thus produce whitish, discolored spots which, if the injury be severe, results in the affected leaves turning yellow and dropping.

This pest is most easily controlled by thorough spraying with a contact insecticide such as a whale oil soap solution or a kerosene emulsion, taking special pains to hit the insects before they can jump out of harm's way. The adults are somewhat difficult to destroy and where thorough work is necessary it may be advisable to knock them to the ground with a weaker spray and then complete the work by drenching them with a stronger solution. Thorough spraying with a powerful jet of water from a hose has been found very effective in keeping this pest in check, and where such is available, recourse to the disagreeable insecticides will probably be unnecessary.

Woolly elm bark aphid

Schizoneura rileyi Thos.

Clusters of a white, woolly substance on limbs and trunks of white elms, accompanied by knotted, contorted growth of wood, are very likely the work of this species.

This insect is widely distributed in the State, and here and there badly deformed trees are met with as a result of the operations of this plant louse. It does not, as a rule, cause much injury. The lice are met with on the trees in May, June and possibly later, and as they are easily seen it is not difficult to control them, since they can be killed, according to Dr Riley, with a weak solution of cresylic acid soap. It is very probable that thorough spraying, particularly if a forcible spray be employed, with either whale oil soap emulsion or a carbolic acid and soap emulsion would destroy them as readily.

Pine bark aphid

Chermes pinicorticis Fitch

Patches of flocculent downy matter may be observed on the smooth bark of white pine and these will be found to conceal minute plant lice.

This insect appears to be a somewhat common one on pine growing in parks and under somewhat artificial conditions in New York State. The writer has observed the work of this species for a number of years in Washington park, Albany, where it has frequently been so abundant as to literally cover the smooth bark of a considerable proportion of the trunks of certain young white pine. The presence of large numbers of this insect reduces the vitality of a tree and apparently leads to a sickly condition, which, in a few cases, appears to have eventually resulted in death. It is impossible to say that this plant louse is the sole cause of the injury but our observations indicate this to be probable in some instances.

Early history. This insect was noticed by Dr Fitch in 1850. He states that it was more troublesome to ornamental trees and described its general appearance and also the insect. It was noticed in 1883 by Mr Saunders, who records it as a species which is sometimes very destructive to the white pine, and one which is preyed on by a number of natural enemies. In 1885 Dr Lintner gave a somewhat extended notice of this plant louse, presumably on account of its abundance on pine in the vicinity of Albany. Dr E. B. Southwick, entomologist of the Department of Public Parks of New York city, stated in 1894 that this insect gave him a great deal of trouble and that he found a stiff spray was one of the best methods of subduing it. Prof. Lawrence Bruner, in the same year, stated that he had received reports of injuries by this species from several localities in Nebraska. A detailed notice of this plant louse by E. L. Storment[1] appeared in 1898, in which he states that this insect has been quite injurious in Illinois. This last writer lists the insect as occurring in a number of Illinois, New York, Iowa and Maryland localities, and adds that it is probably much more generally distributed than the few localities which he has been able to find recorded, would seem to indicate.

Life history. The life history of this insect has not been worked out in detail. The eggs commence to hatch early in May in favorable seasons, at which time the young emerge in large numbers from their protective balls of woolly matter and travel actively over the bark for a time. They are so small as to be nearly invisible to the naked eye and in the early part of May they are more abundant than at any other time. Traveling soon ceases and they attach themselves to the tender bark of young twigs. They increase rapidly in size, assume a dark reddish brown color approaching black, and the secretion from the body commences and soon hides them

[1] 1898. E. L. Storment. Ins. of Ill. 20th Rep't, ap. p. 3-24

from view. Maturity is probably reached toward the last of May and the wingless females deposit eggs for another brood. Winged females are produced about the first of June. There are several broods during the summer and the winter appears to be passed in some years, at least, by wingless females which commence feeding toward the latter part of March and begin to deposit eggs in early April. These hatch about the 15th and young begin to attach themselves the 20th. The wingless females disappear about May 1, and hatching ceases by the 7th; winged adults appear about the 9th, by the 17th all the young are attached, and by the 23d the winged adults disappear. These latter records are based on observations made by Mr Storment. He further states that this species may have an alternative food plant which at present is unknown.

Description. The eggs occur in downy balls near the bases of the needles and vary in number from 5 to 60 or more in each, usually there are only a few. They are oval, dusky or reddish yellow, slightly ovate, about .34 mm long and with a transverse diameter of .17 mm.

The young of the winged form, as described by Professor Osborn, are oval in shape, flattened, yellowish or light brown. The antennae are three jointed, the first short and thick, the second slightly longer and not so thick and the third is three times as long as the first and half as thick, and set with a few stiff hairs at the apex. As these young develop they become darker in color, assuming a deep red or brown and finally become almost black. The woolly substance is thick on the abdominal segments and also on the meso- and meta-thorax, hiding the insect and changing its appearance to that of a ball of white down.

The winged form, as described by Professor Osborn, is light reddish in color, and the wings are very white, expand rapidly and become transparent, while the body darkens till almost black. The antennae are five jointed and short. The tarsi are one jointed, with a rudimentary first joint and two claws. The forewings are folded rooflike over the body, the anterior pair having a strong subcostal vein which is branched at the basal third, the lower branch running parallel for a distance and then turning obliquely toward the posterior margin. From this branch there are two oblique discoidal veins running to the posterior margin. The stigma is indistinct. The wingless female is enclosed in a woolly mass which adheres to the bark. The legs and antennae are persistent, small, the latter being three jointed and the tarsi one jointed and terminated by a pair of claws.

The body is elongated, pyriform during egg laying and contracts to a globular or flattened shape afterwards or in the winter.

Natural enemies. This species is subject to attack by a number of natural enemies; among the more important may be mentioned several species of ladybeetles, particularly the 15-spotted one, Anatis ocellata Oliv., and the two-spotted form, Adalia bipunctata Linn; both species have been observed by the writer in considerable numbers around infested pines in Washington park. The twice stabbed ladybeetle, Chilocorus bivulnerus Muls., and the spotted ladybeetle, Megilla maculata De G., have also been recorded as preying on this aphid. Syrphid larvae and ant lions, Chrysopa and Hemerobius, are recorded by Mr Storment as being very destructive to this insect.

Remedial measures. This insect is easily reached by sprays, and as previously noted Dr E. B. Southwick has found that very stiff sprays are efficient in combating this pest. Mr Storment states that thorough spraying with kerosene emulsion in May proved very efficient. The standard emulsion was probably diluted with 9 parts of water. In case it was undesirable to use kerosene emulsion, it is probable that the insect would be equally susceptible to a whale oil soap solution, 1 pound to 4 gallons of water, or even a forcible spray of cold water would wash off large numbers of the insects. This latter could be used very well where a nearby hydrant afforded sufficient head.

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Alder blight aphid

Pemphigus tessellatus Fitch

Conspicuous cottonylike bunches hanging from the underside of alder stems, are very characteristic of this insect.

This species is exceedingly abundant in sections of the Adirondacks during July and August. It occasionally occurs on cultivated alders in parks, in which latter place it sometimes occasions considerable injury. This species is preyed on by the caterpillar of the little orange butterfly, Feniseca tarquinius Fabr., which deposits its eggs among or near groups of the plant lice as observed by Miss Morton. This caterpillar also feeds on the related P. fraxinifolii and P. imbricator.

The aphid can be controlled on cultivated trees by thorough spraying with a contact insecticide, and where a good head of water is available, a strong jet from a hose would probably be equally effective.

Cottony maple scale

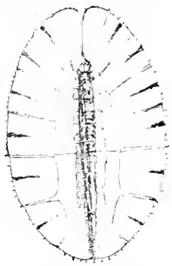
Pulvinaria innumerabilis Rathv.

The small twigs of many soft maples are sometimes festooned on the underside with cottony masses protruding from under a brownish scale. It occurs more sparingly on other maples, elms and grapevines, as a rule.

This species is generally distributed throughout the greater part of the State, and occasionally becomes excessively abundant, specially on the soft or silver maple, one of its favorite food plants. This scale insect flourishes, particularly in certain seasons, on Long Island and in its vicinity. Sometimes the trees are fairly festooned with masses of conspicuous females. In 1880 it was so abundant in Brooklyn N. Y., as to lead Mr A. S. Fuller to report that thousands of trees were dying from its attacks. It was present in large numbers at Buffalo N. Y., the same year and in 1898 many complaints of serious injury were received from widely separated localities.

Description. This pest, inconspicuous earlier in the season, most often comes to notice after the females have attained their full growth late in June or early in July and have excreted an abundant cottonlike substance, which protrudes from under the scale covering the insect, as represented at figure 11, on plate 2. The entire under surface of limbs is frequently covered with these insects with their cottony fibers full of minute eggs and young. A recently hatched scale insect is represented very much enlarged at figure 10, on plate 2. The young soon forsake the protecting filaments of the mother, wander to the leaves, settle along the veins as a rule, secrete a scaly covering and in the fall present the appearance shown at figure 12, on plate 2.

Life history and habits. This species is very prolific. One female rarely deposits less than 500 eggs and most frequently produces over 2000, as estimated by the late J. D. Putnam, who published an exhaustive paper on this species in the proceedings of the Davenport Academy of Natural Science, of Iowa. Certain facts regarding the life history of this insect are taken from his treatise on this scale insect. The young leave the mother in immense numbers about the latter part of July, in the latitude of Albany N. Y., and establish themselves along the veins and usually on the underside of the leaves. Some may be found on the upper surface, and occasionally attacking the more tender twigs. The breeding season in Washington D. C., as stated by Dr Howard, extends from the latter part of May or early June, into early July, and may last till August. He states that the young on the underside of the leaves appear to grow more rapidly than those on the upper surface. The first molt occurs in the vicinity of Washington D. C., in about a month. This is followed by the secretion of a homogeneous layer of wax. The insects are yellowish for a period, the females showing deep red markings about the time the delicate two winged males appear. They later change to a brownish color, and migrate to the side of the twigs shortly before the leaves fall. Mr Putnam found that the males appear in Iowa, Aug. 1 to Sep. 15, pair and then die. Dr Howard records the appearance of the males at Washington D. C., on Aug. 18, and states that the full grown male scales may be easily recognized by their narrower and more convex form. The females pass the winter on the underside of the twigs, and in the spring increase rapidly in size and secrete large amounts of honeydew, which gums the leaves and smears everything beneath the infested trees. The last of April or early in May, in the vicinity of Washington D. C., the insects begin to excrete the familiar cottony



matter in which the eggs are deposited. The females are very noticeable about Albany in July when present in numbers.

Food plants. This pest, as is well known, is most destructive in New York State to the soft or silver maple, though it attacks many other plants, such as sugar and Norway maples, elms and grapevines. The above named are the more important trees and vines injured by this scale insect.

Method of distribution. The young of this species are carried from tree to tree in about the same manner as allied forms. Birds, other insects and even spiders frequenting infested trees are often compelled to assist in the distribution of this pest by the active young crawling on them as they rest on the twigs. Once a young scale is on a bird's foot or on an insect, there is a good chance that it will be carried to another tree before it leaves its host. Winds probably aid somewhat in the dissemination of the pest, and it is undoubtedly carried on infested trees shipped to distant parts of the country.

Natural enemies. One would hardly suppose that a mouthful of wax would be very palatable, yet Dr Howard states that he has often observed English sparrows apparently feeding on this insect. This prolific species is preyed on by a number of beneficial insects. The twice stabbed ladybeetle, Chilocorus bivulnerus Muls., is one of the more common insects living on the pest in New York State, and in some localities, at least, it appears to be a very efficient check. The 15-spotted ladybeetle, Anatis ocellata Linn., Hyperaspis signata Oliv., and H. bigeminata Rand are allies of the above named in checking this pest. The interesting Lepidopterous enemy, Laetilia coccidivora Comst., was reared by Prof. J. H. Comstock from this scale insect. The caterpillars of this very interesting form flourish on the scale infested twigs, webbing its hosts together and working its way through the masses from one scale to another. Thus one caterpillar destroys many scale insects. Dr Howard is of the opinion that this insect alone caused the disappearance of this scale insect from the Washington shade trees at the close of 1879. The caterpillar is stated to not only destroy the old female scale insects, but also the eggs and young larvae. A more important species than the preceding, according to the experience of Dr Howard, is a minute chalcid fly known as Coccophagus lecanii Fitch. Dr Howard states that the activity of this parasite in 1898 made it almost impossible to carry the cottony maple scale through the season at Washington, and that less than 1% attained maturity. His observations show that this parasite develops very rapidly, the life cycle occupying not more than 2 or 3 weeks. This permits a very rapid increase in its numbers and adds materially to the value of the parasite. This little insect even gained access to the breeding cages in the insectary at Washington and threatened the destruction of all the insects.

Coccophagus flavoscutellum Ashm. is a more southern species than the preceding, and according to Dr Howard, is almost equally effective in the southern portions of this insect's habitat. Atropates collinsi How., is another important parasite of this insect which was reared by Dr Howard from Brooklyn material. A single specimen of Eunotus lividus Ashm. was also reared from material sent from Brooklyn. Two other parasites, Aphycus pulvinariae How., and Comys fusca How., are known to live on this species. Aphis lions or larvae of lace-winged flies were observed by Dr Howard preying on the young of this insect, and a species of harvest mite attacks the pest as stated by Miss Murtfeldt.

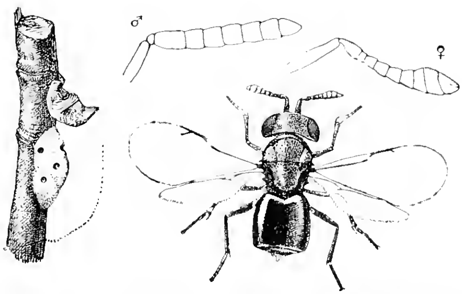


Fig. [illegible] Eunotus lividus, greatly enlarged, [illegible] antennae above still more enlarged and cocoons [illegible] at left, also enlarged (After Howard. U. S. Dep't Agric. Div. Ent. Bul. 22, n. s. 1900)

Remedies. Brushing with a stiff broom will dislodge many insects.

This should be done before the young scatter and would be more effective if the brush was dipped frequently in kerosene emulsion or other insecticide. Prof. C. M. Weed states that this pest can be fought with a considerable degree of success by washing it from the tree with a stream from a hose. Where there is a good head of water this might prove the best method of controlling the pest. Otherwise, infested trees must be headed in and sprayed with a 10 to 12 per cent kerosene emulsion at the time the young appear.

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Black-banded scale

Eulecanium nigrofasciatum Perg.

A small, hemispheric, reddish, black marked scale insect may be met with in large numbers on the underside of branches of maple and of some other trees.

This small species is somewhat common and quite injurious to the soft and sugar maples in certain cities and villages of New York State. It was brought to the notice of the late Dr Lintner several years ago, because of its remarkable abundance on sugar maples at Poughkeepsie, and the writer has since had his attention called to its presence in several localities. It is now a very common and destructive pest of both soft and sugar maples in the city of Albany. Mr Pergande, its describer, states that he has known the insect since 1872, when it was discovered on peachtrees at Hillsboro Mo., and that since then it has increased steadily and has been gradually spreading over the peach orchards of the Middle, Southern and Eastern States. He seems inclined to consider its original home as being in the region south of New York and north of the Potomac river, and he believes that it has been distributed from this region by means of cuttings and young trees and to a lesser degree through the agency of birds and insects.

Food plants. This scale insect was originally considered an enemy to the peach, and Mr Pergande wrote of it under the common name of peach Lecanium. In his account of this species, he has recorded it as occurring on various kinds of plumtrees and also on the sugar maple, Norway maple, a variety of the red maple, on apple, Crataegus, sycamore, Bumelia, linden, benzoin, olive and on Vaccinium. The writer has met with it almost exclusively on hard and soft maples.

Life history. The life history of this scale insect has been studied in detail by Miss Mary E. Murtfeldt of Kirkwood Mo., and the following is taken from her account of the insect in that latitude. She observed the species May 2 on a young Lombard plumtree, and at that time the twigs and smaller branches were incrusted with the pest. The scales were filled on the 20th with fully developed eggs, but the young did not appear till June 10, and by July 15, hatching was completed. By this time the earlier appearing individuals had nearly all become established on the leaves and transformed to male pupae. July 22, winged males appeared in the rearing jar, showing the pupal period to be about a week, and Aug. 22, hundreds of them were to be met with as well as fresh pupae and active young, on the leaves. The male appears to live about a week. Sep. 5, Miss Murtfeldt found that the males had disappeared and that the females had attached themselves to the bark of such twigs as were still somewhat vigorous.

The above account agrees very closely with our observations about Albany. The young began to appear in 1901 about June 14, and by July 15 they were about $\frac{1}{50}$ inch in length. July 10, 1902, the young were very abundant on the greener shoots near the base of the leaves and on the base of the leaf petioles. They are frequently arranged along the larger veins of the leaves on both the upper and lower surface, and they also cluster on the younger twigs. The species appears to breed over an extended period, since a few very young were found early in September, 1902, at which time honeydew was excreted in large amounts. Males were also emerging then in considerable numbers, and the numerous empty scales indicated that they had begun to appear some time before. The male scales were clustered largely on leaf stalks and along leaf veins. Sep. 15 the leaves were deserted by the insects and the males had probably all emerged. Badly infested twigs have a sour, semiputrid odor due in all probability to the decomposition of the large amount of honeydew excreted, since stones beneath badly infested trees were kept moist with this substance even on hot, midsummer days.

Description. The adult female, plate 12, figure 3, 11, is from 1/8 to about 1/6 inch in length by less than one half that in diameter. She is slightly broadest posteriorly, hemispheric, highly polished, and when not rubbed, is covered with a very delicate, transparent, glossy or waxy secretion. There are apparently 12 or more distinct radiating ridges on each side, which are most noticeable around the margin of the body but start at some distance from the disk of the scale, those of the thoracic segments being more highly developed. The disk or medial dorsal stripe is smooth or faintly rugose. The general color is a light or dark red with a broader or narrower, blackish, subdorsal band surrounding the disk and composed of confluent spots. There is also a marginal row of elongated, rectangular spots of the same dark color between the ridges. These markings frequently extend to the subdorsal band and give the scale insect a very pretty appearance. The scales are frequently entirely black, with the exception of the median stripe, which is red, or they may be entirely red with but faint traces of darker markings. The adult males are brick-red, rather stout insects with nearly transparent wings and an elongated, rather thick style at the tip of the abdomen, plate 12, figure 10. They are about 1/25 inch in length. The recently hatched young, plate 12, figure 4, are yellowish, about 1/50 inch in length and with two peculiar, knobby protuberances near the anterior third. The dorsum is flat in many individuals and in others it is decidedly grooved. The posterior extremity bears two slender, curved setae.

Parasites. This species is undoubtedly kept in check to a considerable extent by natural enemies. Probably the most efficient are certain minute parasitic Hymenoptera. We succeeded in rearing four species, kindly determined through the courtesy of Dr Howard, by Dr W. H. Ashmead, as follows: Aphycus annulipes Ashm., Pachyneuron altiscuta How., Coccophagus lecanii Fitch and Blastothrix sericea Dalm. The first named, represented at figure 33 is a very strongly marked though minute insect with remarkable antennae shown in side view at figure 34. It will be noticed that the second segment is enormously dilated and that it and the terminal one are jet black. All of these species were reared in some numbers and are presumably of nearly equal value as natural checks upon this pest.

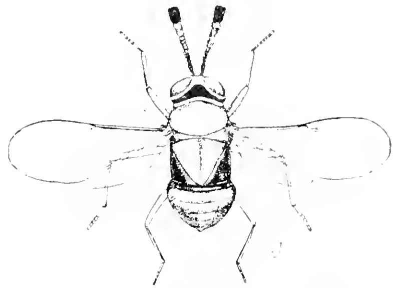

Fig 33 Aphycus annulipes, enlarged (original)

Fig 34 Lateral view of the antenna of Aphycus annulipes, much enlarged (original)

Remedial measures. This species can probably be controlled most easily by thorough spraying in midsummer with either a whale oil soap solution or kerosene emulsion, care being taken to apply the insecticide in such a way as to drench all of the delicate young.

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Elm bark louse

Gossyparia spuria Modeer

Underside of elm limbs may be thickly crowded in summer, with reddish, woolly bordered bark lice, about 1/10 inch long, and the stones beneath infested trees are frequently moistened with the excreted honeydew.

The elms of New York State are unfortunate in suffering from the attacks of two imported insects. The elm bark louse has proved itself a worthy second of its predecessor, the elm leaf beetle, and though it may not of itself be quite so injurious as this pernicious leaf feeder, still its constant sapping of elms already weakened by repeated losses of their foliage is a serious matter. The extent of this drain is hardly appreciated till one observes the damp sidewalks, which even the heat of summer can not dry, and the blackening fungus covering broad leaf expanses, indicating the loss of an equal amount of moisture, all drawn by these little creatures from the struggling elms. On bright sunny days in June it is very easy to see the exudations of these bark lice falling in showers from infested trees.

Introduction and distribution. This insect, like many of our worst insect pests, is an introduced species. It was first brought to notice in this country in 1884 by Mr Charles Fremd, of Rye, Westchester co., N. Y., who complained that thousands of elms in his nursery were infested. This species was probably accidentally imported several years previous to its discovery. It has now become established at a number of points in the Union, having been recorded from Vermont, Massachusetts, District of Columbia, Michigan, Nevada and California, besides localities in New York State. It is known to occur on Long Island and in a number of places along the Hudson river north to Greenwich, and it has been received from Ogdensburg, St Lawrence co. Thus, if this pest has not already attained a general distribution throughout the State, it is only a question of time before that will occur.

Description. The adult females are by far the most conspicuous form of this insect. They may be seen clustered along the underside of the smaller limbs, usually beside a crack or crevice in the bark, and presenting a general resemblance to a growth of lichens. The full grown, viviparous females are about 1/10 inch long just before giving birth to their young, oval in outline and with slightly pointed extremities [pl. 3, fig. 16, 16*a*]. Each is surrounded with a white, wooly secretion, which also extends partly over the insect and thus renders its segmentation more apparent.

The young are yellowish specks and may easily be recognized as they move over the younger limbs and leaves [pl. 3, fig. 15]. They have an elongated, oval form, rounded anteriorly and tapering posteriorly to a pair of pointed processes, each bearing a long and a short seta. The body segments are marked by lateral spines and there is a row of six around the anterior border of the head and an irregular row down the middle of the back. The young soon become darker and finally assume a yellowish red color. The dorsum becomes covered with spiny, wax secreting processes, and the general form of the young larva is retained [pl. 3, fig. 10, 13]. The antenna of the female before impregnation is composed like that of the young, of 6 subequal segments, the second and third being the longest and the fourth and fifth shortest. The antenna of the immature male has 6 nearly equal segments and a longer seventh.

The oval cottony cocoon of the male is well shown at figures 11, 12, plate 3. The presence of the perfect insect within may be known by the two long, protruding anal filaments. The male is not seen without special search. It is a delicate, two winged, reddish insect with rather large antennae, and a pair of white anal filaments nearly twice the length of its body [pl. 3, fig. 18]. It moves slowly over the limbs in a clumsy way, is not easily disturbed and rarely takes wing. A most interesting feature is the occurrence of two forms. The normal one has already been described, but 10 days earlier than its occurrence there may be found large numbers of males which are characterized by the possession of wing pads but no wings. These are known as pseudimagos and one is represented at figure 17, plate 3. The reason for the existence of two forms of males is unknown.

Life history. This insect is most conspicuous during the months of April, May and June, at which time the females are preparing to give birth to their young, which make their appearance in the latitude of Albany early in July. The new born insects move readily over the bark for a time and then settle along the veins of the leaves, principally the midvein, and in large numbers on the greener tips of the twigs. Occasionally a twig will be almost yellow from the large number of young nearly covering it. Others establish themselves in crevices among the old females. They remain in these positions till into September or later and then those on the leaves migrate to the twigs. Some do not take this precaution soon enough and are carried away on the falling leaves and scattered by the winds. The winter is passed as partly grown insects which are quite well protected by a waxy secretion from the dorsal and lateral processes. The first warm weather in spring brings signs of activity. Early in April the females molt and the males form their cocoons. At this time many travel considerable distances before establishing themselves; this is specially true of the males, which are quite apt to spin cocoons on dead twigs. Honeydew is excreted by the females in very large quantities from this time till the young appear in July. This is evidently the period when the insect is most injurious. The wingless males or pseudimagos were present in large numbers May 10, 1900, while the perfect males were not abundant till May 21 and there was a time between these dates when no males could be found. Soon after pairing there is a marked difference in the appearance of the female. Her form changes from eliptic [pl. 3, fig. 14] to oval [pl. 3, fig. 10] and the secretion of the wax is much more copious and is mainly from the lateral spines instead of from both lateral and dorsal, as occurred in the fall.

This bark louse, like the elm leaf beetle, appears to thrive best on the European species of Ulmus, specially the Scotch elm.

Means of distribution. This insect can be carried long distances on young trees and it is undoubtedly in this way that it has succeeded in establishing itself at the widely separated points named above. Its rapid dissemination throughout a city is probably due to the agency of birds, particularly the English sparrow. There appears to be no other adequate explanation of the general occurrence of this pest throughout Albany and Troy. It is also possible that the young falling with the leaves are blown to new localties and succeed in establishing themselves on uninfested trees. This latter means is so uncertain, compared with birds which habitually fly from tree to tree, that it can not be considered as a source of much danger.

Natural enemies. It is very probable that a number of ladybeetles in both adult and larval condition feed to some extent on the young of this insect. The two spotted ladybeetle, Adalia bipunctata Linn., has been seen in considerable numbers about infested trees in Albany but it was not observed feeding on the pest. Many flies and other insects are attracted to infested limbs by the abundant honeydew.

Remedies. Spraying with a contact insecticide, kerosene emulsion or a whale oil soap solution, is probably the best remedy for this insect. This treatment will be most effective if given early in the spring just after the hibernated forms have molted or soon after the young make their appearance. A solution four times the normal strength is necessary to kill the insects late in the fall. Small trees have been effectually cleaned by going over them with a stiff brush and this would be more effective were it done in early spring and the brush kept well wetted with kerosene emulsion or whale oil soap solution. A good stream of cold water would be much better than nothing and when directed against the masses of females could hardly fail to wash off large numbers. This latter method is advisable only where a good head of water and hose is convenient.

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Elm scurfy scale

Chionaspis americana Johns.

A whitish, irregularly oval insect, about [illegible] inch in length, and with a yellowish speck at the slightly elongated anterior point, may frequently be observed on American elms.

This species appeared to be a very common one in New York State, for all that it was not characterized till 1895. The reason for this is that in all probability it has been confused with the exceedingly common, widely distributed scurfy scale, Chionaspis furfurfa Fitch.

This species sometimes becomes very abundant and is destructive to a certain extent, but in New York State at least we have met with very few trees which showed serious injury as a result of its presence.

Life history. The insect passes the winter in the egg stage, the young appearing at Amherst Mass., according to Professor Cooley, about the middle of May and all emerging within a very short time. Professor Johnson's observations show that the insect is two brooded and that the females confine themselves to the bark of the tree, and may be found from the trunk to the very tips of the twigs. The males occur both on the bark and on the underside of the leaves. The female is stated to lay about 70 eggs as a rule, but the number varies from a very few to about 85.

Distribution. This is a native American species and appears to have a wide range, it having been recorded from a number of eastern and western states.

Description. The eggs are about 1/12 inch in length, ellipsoidal and purplish in color. The young are about 1/2 inch in length, oval in outline, broadest posteriorly, reddish, and with distinct anal filaments, about as long as the width of the middle of the body. The female scale is usually broadest near the middle, about 1/8 inch in length, convex, moderately thick and white, though often coated by black particles from the bark. The exuviae are long, brown, frequently almost completely hidden by the adherent coatings.

Natural enemies. Professor Johnson has reared two parasites from this insect, Perissopterus pulchellus How. and Physcus varicornis How. He has also observed the young and adults of the twice stabbed ladybug, Chilocorus bivulnerus Muls., feeding on it.

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Tuliptree scale

Eulecanium tulipiferae Cook

Large, nearly hemispheric brownish scales occurring in clustered masses on the underside of the limbs of tuliptrees.

The tuliptree is commonly unaffected by insects, but in this large species of Eulecanium it finds an enemy that occasionally causes considerable injury. Several twigs from a tuliptree, showing a very bad condition of affairs [pl. 12, fig. 6], were received Oct. 11, 1898, from Mr Alfred Pell, of Highland Falls N. Y., with an inquiry as to the nature of the attack. The insects were so crowded on portions of the bark, that the old scales were huddled together and badly deformed. Under a lens it was seen that thousands of young had established themselves in the immediate vicinity of their parents, almost covering the bark in many places, while a few occurred along the veins of the leaves. The young were still issuing from the parents, as a number of paler individuals were to be seen crawling over the twigs. Branches of Magnolia soulangeana badly infested by this species have also been received recently from Fishkill.

Earlier injuries by this species. In 1878 this scale insect was mentioned by Professor Cook as one that frequently destroys tuliptrees in Michigan. He states it was so abundant in 1870 on the college grounds at Lansing Mich., that some of the trees were killed outright and others much injured. In the *Rural New Yorker* of May 10, 1890, a more serious outbreak of this species is recorded at River Edge, Bergen co., N. J. Three years before, the tuliptrees in that vicinity were attacked by this scale insect, and at the time the notice was written, not only had trees in front yards been rendered worthless, but the lower branches of those growing wild had been killed. Severe injuries to tuliptrees in 1890 at Hartford Ct., have been reported by Dr Sturgis of the Connecticut Agricultural Experiment Station, and Dr J. B. Smith of New Jersey, observed a serious attack by this insect the same year in his State.

Description. The adult females are among the largest of those belonging to the genus [pl. 12, fig. 6]. Some received measured 3/10 inch in diameter. The scale is light brown, mottled with dark brown, and very convex. The under surface is concave, and in the examples before the writer, there are two pairs of ventral, transverse, white lines composed of short cottony filaments, one on each side near the middle and the oblique pair nearer one extremity, probably the anterior. Both are interrupted in the middle. The young [pl. 12, fig. 8, 9] at this time [October] range in color from a light brown to almost black. The abdominal segments are sharply defined, the caudal extremity is notched, and from the tips of the last segment there extends a pair of delicate filaments. The young have a general resemblance to tiny trilobites.

Life history. No signs of eggs were to be seen, though Professor Cook describes them as small, yellow and oval. On examining the adults, a number of young were found underneath. Apparently the species is viviparous in this latitude, as recorded of it farther south by Dr Riley. In Florida all stages have been observed during the winter, and it hibernates as larvae at Washington D. C., according to Dr Riley. The numerous young on the branches and those still issuing would indicate that the larvae must hibernate in New York. The only observed difference in October between those which had issued some time before and those emerging, was in the color. The older ones still retained the larval form, but they had turned black, were closely applied to the bark and attached by a slender thread. In this condition they were apparently ready for hibernation, since on being disturbed there was no effort to move off, as in the case of younger individuals.

There is probably but one annual generation in this latitude, as there is little chance that young would be produced earlier here than in Michigan, where they appear late in August as stated by Professor Cook.

This insect produces a large amount of honeydew, which has a nauseating odor. A parasite, Coccophagus flavoscutellum Ashm., has been reared from this scale insect, as recorded by Dr Howard.

Remedies. In case of a bad infestation, it would be well to scrape all the old insects from the branches in the autumn, and then treat the infested limbs with either whale oil soap or kerosene emulsion. This, if undertaken before many young have emerged, should nearly free the affected trees.

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Oyster scale

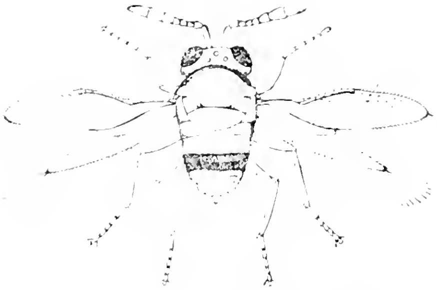
Lepidosaphes ulmi Linn.

A brownish oyster shell-like scale, about 1/8 inch long, may be found on a considerable number of food plants though usually more abundant on ash and balm of Gilead.

This is one of our more common scale insects, well known to many fruit growers because of its occurring on apple, pear and other trees producing valuable fruits. It is also occasionally quite abundant on some of our forest trees and the writer has observed a number of cases where ash saplings of considerable size have become literally incrusted with this insect and died. It is sometimes nearly as abundant on balm of Gilead and some poplars, though these trees do not as a rule succumb so readily to attacks by this insect. This species has been noticed so many times that only a brief summary of its life history and habits is advisable in this connection.

Description. The adult female scale is about 1/8 inch long, usually slightly curved and widening from a slender tip to a broad rounded posterior end. The scale has at its anterior end a yellowish very small pellicle, the first cast skin of the young, and the small scale three times its size attached to it. There is usually a larger or second cast skin, to which is attached the largest or chief part of the scale which is of a variable brown color marked with curved, transverse lines or wrinkles. The female is found beneath the scale, and when alive is a yellowish, legless, wingless, eyeless form about 1/12 inch in length. The female scale turned over in winter will be found to contain a large number of minute whitish eggs, and near its anterior end the shriveled yellow or brown body of the female may be detected. The recently hatched young are very minute, yellowish, and to the naked eye appear like specks [*see* pl. 13, fig. 9–14].

Life history. This insect produces but one generation annually in the northern states though in the south there may be two. The winter is passed in the egg under the protecting scale of the female, and the young appear from the middle of May to early June, and in the case of badly infested trees, parts of the twigs may be literally yellow because of their abundance. Professor Lowe has observed them at Geneva N. Y., as early as May 7. They soon settle in a place and begin sucking nourishment from the underlying bark tissues, and in about 2 days, white waxy filaments extend from the back of the young, and when numerous, the infested branches are adorned with patches of white woolly matter. This excretion mats down and soon forms a protective covering which is supplemented later by the cast skins of the insect. Fully developed females may be found about the first of August and egg laying begins soon after and is completed by the latter part of the month or early in September. One female deposits from 50 to 100 eggs.



[illegible] (After H [illegible]

Food plants. This species is of economic importance chiefly on account of its depredations on some of our more valuable fruit trees as previously pointed out. It also occurs on ash and poplars in considerable numbers and has been recorded on willow, linden, horse-chestnut, elm, sugar and swamp maple.

Natural enemies. A small hymenopterous maggot was observed by Dr Fitch to live on the eggs of this pest. What was in all probability the same parasite was described by Dr Le Baron some years later as Aphelinus mytilaspidis, which he found had destroyed from about 50% to 60% of the scales. Aphelinus fuscipennis How. is recorded as a most efficient parasite of this scale in California. Aspidiotiphagus citrinus Craw. has been reared from this pest in that state. The accompanying figure will give a good idea of the appearance of these tiny Chalcids. The best evidence of their work is the small circular holes in the dead scales, orifices by which these little friends have escaped. Aphelinus abnormis How. is another parasite of this bark louse. Anaphes gracilis How. and Chiloneurus diaspidinarum How. have also been reared from this insect.

Coccinellid or ladybeetle larvae prey on this species, and certain mites, like Tyroglyphus malus Shimer, are also credited with this habit. A French investigator has apparently shown that this Tyroglyphus does not feed on the eggs, but a species is described under the name of Hemisarcoptes coccisugus Lign., which does valiant service in destroying them.

Three European birds, the blue tit, the long tailed tit and the tree creeper are known to feed on this insect.

Remedies. The hatching of the young the latter part of May renders it practicable to control this insect by applying a contact insecticide about June 1 in order to kill the young scale insects before they are protected by a thick scale.

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Euonymus scale

Chionaspis euonymi Comst.

Dirty blackish scale insects, about ⅛ inch in length and with one or more yellowish specks at the smaller end, may be found on Euonymus and Celastrus associated with large numbers of small snow-white tricarinate scales, on one end of which is a yellowish oval cast skin.

This insect is evidently a southern species, which ranges as far north as New York city, and extends up the Hudson river valley for a short distance. It has been brought to the writer's attention on several occasions because of its great abundance on Euonymus. This species appeared to be specially numerous in 1899, when it was received by the writer from Fishkill, where it occurred on Euonymus; from Great Neck N. Y., where it abounded on lilac, and from Irvington, where it thrived on Prunus pissardi and was stated to be present on other shrubs. It was also received in 1900 from Blauvelt N. Y., where it infested Celastrus scandens. [*See* pl. 14, fig. 10–13 for colored figures of this pest and its work]

This species has received very little attention at the hands of economic entomologists, though our experience in this State would appear to show that at times it may become very abundant and correspondingly injurious to the plant. Professor Comstock records this insect as having been found in great numbers by Dr Howard on orange trees in Louisiana and he states that he has received it from Havana, from which place he thinks it may possibly have been imported into this country. Prof. T. D. A. Cockerell has recorded the reception of this species on plants imported from Japan, indicating that the insect has an extended distribution.

A single parasite, Aphelinus fuscipennis How., has been reared at the United States Department of Agriculture from this insect.

Remedial measures. Experiments conducted by Dr C. L. Marlatt against this insect have demonstrated that the young could be killed with a standard kerosene emulsion diluted with 9 parts of water, and that in order to destroy the adults it was necessary to employ an emulsion of four times that strength, or the standard emulsion diluted with but $2\frac{1}{2}$ parts of water. He states that owing to the hatching period of this insect extending over a number of weeks and the intermingling of broods later in the season, it is difficult to control.

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Scurfy scale

Chionaspis furfura Fitch

A whitish, scurfy appearance on the trunks and limbs of certain trees may be due to the presence of large numbers of this scale insect. The female scale is irregular, oval, with a yellowish point and about 1/8 inch in length. The male scale is three ridged, snow white, with a yellowish point at one extremity.

This exceedingly common species is of interest in this connection largely on account of its occurring so abundantly on the Japanese quince. It is sometimes present in such large numbers that the bark is nearly covered with dirty white, scurflike patches and it is from this that the popular name of the insect has been derived.

Description. The fresh female scale is irregularly oval in outline, about 1/10 inch in diameter, and with a slight prolongation tipped with a yellow speck, which latter is the early cast skin. The male scales are elongate, narrow, and consist of a small yellowish pellicle on one end of a much larger, tricarinate white scale. The turning over of an adult female scale in late winter will usually uncover a mass of purplish eggs. The young are active, reddish, and to the naked eye appear as small, snowy specks.

Life history. The winter is passed by this species as eggs underneath the protective scale of the female, and the young appear from about the middle to the last of May. They soon establish themselves at favorable points on the bark of the trunk and branches, and begin drawing nourishment from the underlying tissues. Occasionally they settle in numbers on the fruit, in which case they may be surrounded by an irregular reddish area. The young grow rapidly, pass through several molts, and in the latter part of August or early in September, 30 to 75 purplish eggs may be found under the scale. There is but one generation in the Northern States, though it is stated that two and possibly three may occur in one season in the Southern States.

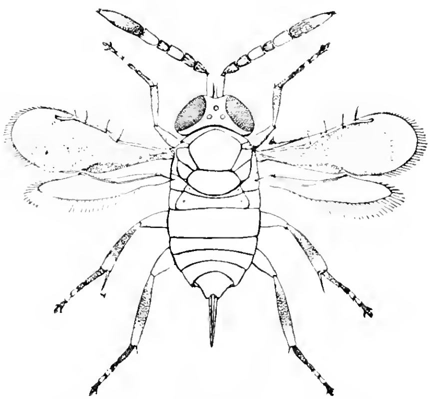

Fig. [illegible] Ablerus clisiocampae, female, greatly enlarged. (After Howard. Insect Life. 1894. 7:7)

Food plants. This species, has a special fondness for Japanese quince. It has been recorded by Dr Howard as so abundant on mountain ash in the Catskill mountains, that hardly a twig or branch was uninfested. Aside from cultivated fruit trees, it is known to occur on the following food plants: chokecherry, wild red cherry, shad bush, cherry currant, wild flowering currant, black walnut and black alder (C l e t h r a a l n i f o l i a). It is possible that more than one species may have been confused, though Mr King has recently compiled a list of 23 food plants on which this form is said to occur.

Distribution. This species is common over a large proportion of New York State, and has been recorded from most of the Eastern and some of the Western States, and also from Ontario, Nova Scotia, New Brunswick and Prince Edward Island.

Natural enemies. One hymenopterous parasite, Ablerus clisiocampae Ashm., has been bred from this scale insect by Dr Howard. Two Coccinellids, Hyperaspidius species and Chilocorus bivulnerus Muls., the twice stabbed ladybeetle, prey on this pest. The latter is stated to be a specially valuable enemy.

Remedies. The recommendations for controlling this insect are the same as those advised for the oyster scale, to which the reader is referred.

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San Jose scale

Aspidiotus perniciosus Comst.

A circular, grayish or yellowish scale insect, about [illegible] inch in diameter, and frequently surrounded by large numbers of much smaller, nearly black scales having a central nipple and one or two grayish rings.

This introduced species has become so well known to fruit growers that we commonly think of it as depredating almost entirely on fruit trees. Such is not the case as this species occurs on a large number of other trees and may be very abundant on the flowering quince in particular. It also thrives on a number of other plants grown in parks for ornamental purposes and a brief account of this species is therefore included in this work.

Description. This species is more readily recognized by its effect on the tree or shrub than by the characteristics of the individual. Trees which have been badly infested for some time have a rough bark covered with dark gray scurfy patches, and if this be rubbed with the oblique edge of a knife or even with the fingernail, an oily yellowish substance will be crushed from the living insects under the scales. This species breeds so rapidly that it is not uncommon to find a large number on trees previously comparatively free. Their presence under such circumstances is indicated by a peculiar granular look and those familiar with the normal appearance of the bark know that something is wrong. The plant tissues immediately under the living scales are almost sure to have a reddish discoloration, and the fruit leaves and green twigs are usually marked by red blotches encircling the scales [pl. 13, fig. 5].

The adult female is usually about $1/16$ inch in diameter, nearly circular, and with a central dark nipple, and one or more well defined yellow rings. The young scales are nearly black, have a central nipple, and one or two grayish rings. The largest scales are just about the size of the head of an ordinary pin, while the small ones are mere dots and resemble black specks on the twig [pl. 13, fig. 6, 7 and 8]. The full grown female under one of the larger scales is yellow, usually somewhat kidney-shaped, and without legs, eyes or wings. She is, however, provided with a very long, slender proboscis which is used to draw nourishment from the underlying plant tissues.

Life history. The winter is passed by this insect in a partly grown dormant condition. Vital activities are resumed with the approach of warm weather, and the first outward indications of life are seen in the appearance of winged males and later of the crawling young, the latter appearing in this latitude toward the last of June. The females produce young for a period of about six weeks according to Dr Howard, averaging about 400, or from 9 to 10 every 24 hours. The eggs develop within the mother and the young are born alive. They may be seen as tiny yellow specks escaping from under the maternal scale from which they wander in search of a favorable place to establish themselves. This pilgrimage is limited to a few hours, a little over $27\frac{3}{4}$ hours as determined by Professor Lowe. The young soon establishes itself, inserts its slender proboscis in the bark and begins to feed. The development of the scale begins even before the young has selected its feeding place, as very minute waxy filaments, which spring from all parts of the body rapidly, become thicker and slowly mat down to form the circular white scale with a depressed ring and central elevation. This gradually darkens and in a few days is black or dark gray with one or more lighter rings. Several molts take place and the males attain maturity in from about 24 to 26 days from birth, according to Dr Howard, while the females require from 33 to 40 days in the latitude of Washington. This species breeds in the vicinity of Albany from the latter part of June through October and appears to develop three generations normally with the possibility of a fourth under exceptional circumstances.

Food plants. This species is able to exist on a large number of food plants, as is evidenced by the recent list[1] prepared by Prof. W. E. Britton, state entomologist of Connecticut. Professor Britton has gone to considerable trouble in preparing this, consulting entomologists throughout the country, and the bare list of plants is reproduced below.

List of hardy trees, shrubs and vines commonly or badly infested

Acacia sp.
Akebia sp. New York.
Akebia quinata Decaisne.
Amelanchier canadensis Medic. and other species. Shadbush, Juneberry.
Citrus trifoliata Linn.
Cornus alba Linn. var. sibirica Lodd.
Cornus baileyi Coult & Evans.
Cornus sanguinea Linn.
Cotoneaster sp.?
Cotoneaster vulgaris Lindl.
Crataegus sp. Hawthorn
Crataegus cordata Soland
Crataegus oxyacantha Linn., English hawthorn
Crataegus coccinea Linn
Crataegus crus-galli Linn
Cydonia vulgaris Pers. Quince.
Cydonia japonica Pers. Japanese or flowering quince.
Fagus sylvatica Linn. var. purpurea Ait. European purple leaved beech.
Juglans sieboldiana Maxim. Japanese walnut
Ligustrum vulgare Linn. Privet.
Populus sp. Poplar
Populus deltoides Marsh. Carolina poplar.
Populus nigra Linn. var. italica DuRoi. Lombardy poplar.
Prunus amygdalus Stokes. Almond.
Prunus armeniaca Linn. Apricot.
Prunus avium Linn. Sweet cherry.
Prunus pumila Linn.
Prunus pumila var. besseyi Waugh. Sand cherry.
Prunus cerasifera Ehrh. var. atropurpurea Dipp. (P. pissardi) Purple-leaved plum.
Prunus domestica Linn. European plum.
Prunus hortulana Bailey. Wild goose plum.
Prunus japonica Thunb. Flowering almond.
Prunus maritima Waugh. Beach plum.
Prunus persica Sieb. & Zucc. Peach.
Prunus triflora Roxbg. Japanese plum.
Prunus serotina Ehrh. Cherry.
Prunus virginiana Linn. Chokecherry.

[1] 1903. Britton, W. E. Ct. State Ent. 2d Rep't. 1902. p. 132-37

Ptelea trifoliata Linn. Hoptree.
Pyrus communis Linn. Pear.
Pyrus sinensis Lindl. Sand pear, including Kieffer.
Pyrus baccata Linn.
Pyrus malus Linn. Apple.
Pyrus sp. Crab apple.
Ribes oxyacanthoides Linn. Gooseberry.
Ribes aureum Pursh. Missouri or flowering currant.
Ribes rubrum Linn. Currant.
Ribes nigrum Linn. Black currant.
Rosa sp. Rose.
Rosa carolina Linn.
Rosa lucida Ehrh.
Rosa virginiana Mill.
Rosa rugosa Thunb.
Salix sp. Willow.
Salix lucida Muhl.
Salix pentandra Linn. Laurel leaved willow.
Salix vitellina Linn.
Salix babylonica Linn. Weeping willow.
Salix humilis Marsh.
Salix incana Schrank.
Sorbus sp. Mountain ash.
Sorbus americana Marsh. American mountain ash.
Sorbus aucuparia Linn. European mountain ash.
Sorbus melanocarpa C. Koch. (Aronia nigra Koehne.) Black chokeberry.
Symphoricarpus racemosus Michx. Snowberry.
Syringa vulgaris Linn. Lilac.
Syringa persica Linn. Persian lilac.
Tilia sp. Basswood, Linden.
Tilia americana Linn. American linden or basswood.
Toxylon pomiferum Raf. Osage orange.
Ulmus sp. Elm.
Ulmus americana Linn. American elm.
Ulmus campestris Smith. English or European elm.

Occasionally or rarely infested

Acer sp. Maple.
Acer saccharinum Linn. Silver maple.
Acer saccharinum. Weir's cut leaved maple
Acer platanoides Linn. Norway maple.
Actinidia arguta Mig. (A. polygama).
Aesculus hippocastaneum Linn. Horse-chestnut.
Alnus sp. Alder.
Ampelopsis quinquefolia Michx. Virginia creeper.
Betula sp. Birch.
Betula alba Linn. Cut leaved white birch.
Buxus sp. Box.
Castanea americana Raf. Chestnut.
Catalpa sp.
Catalpa bignonoides Walt. Common catalpa.
Ceanothus americana Linn.
Celtis occidentalis Linn.
Cercidiphyllum japonicum Sieb. & Zucc.
Citrus aurantium Linn.
Cornus alternifolia Linn.
Cornus stolonifera Michx.
Cornus circinata L'Herit.
Cornus amomum Mill.
Cornus candidissima Marsh.
Cornus florida Linn.
Cornus florida. Red flowering cornus.
Deutzia sp.
Diospyros virginiana Linn. Persimmon.
Elaegnus sp.
Elaegnus longipes Gray. Silver thorn.
Eucalyptus sp.
Euonymus sp.
Ficus carica Linn. Fig.
Forsythia sp.
Fraxinus sp. Ash.
Fraxinus americana Linn. White ash.
Gleditschia tricanthos Linn. Honey locust.
Hibiscus syriacus Linn. Shrubby althea.
Hicoria pecan Britt. Pecan nut.
Juglans nigra Linn. Black walnut.
Juglans regia Linn. Persian or English walnut.
Kalmia latifolia Linn. Mountain laurel.

Kerria japonica DC. Globe flower, Kerria.
Ligustrum ovalifolium Hassk. California privet.
Lonicera sp. Honeysuckle.
Morus sp. Mulberry.
Morus sp. Tea's weeping mulberry.
Physocarpus opulifolius Maxim.
Picea alba Link. White spruce.
Prunus cerasus Linn. Sour cherry.
Photinia villosa DC.
Rhodotypos kerrioides Sieb. & Zucc.
Rhus sp. Sumac.
Rhus cotinus Linn. Smokebush.
Robinia sp. Locust.
Rubus strigosus Michx. Red raspberry.
Rubus nigrobaccus Bailey (R. villosus) Common blackberry.
Rubus villosus Ait. (R. canadensis) Dewberry.
Sambucus sp. Elder.
Sassafras officinale Nees. Sassafras.
Sorbaria sorbifolia A. Braun. (Spiraea sorbifolia L.)
Spiraea sp.
Thuya occidentalis Linn. Arbor vitae.
Viburnum sp.
Viburnum cassinoides Linn.
Viburnum opulus Linn.
Vitis sp. Grapes.

Not infested

Ailanthus glandulosa Desf. Tree of Heaven.
Amorpha fruticosa Linn.
Andromeda sp.
Aralia spinosa Linn. Hercules' club.
Aristolochia macrophylla Lam. Dutchman's pipe.
Asimina triloba Dun. Papaw.
Baccharis halimifolia Linn. Groundsel tree.
Benzoin odoriferum Nees. (Lindera Benzoin Blume.) Spicebush.
Berberis (all species). Barberry, including Mahonia.
Bignonia sp. Trumpet vine.
Calycanthus floridus Linn. Carolina allspice, sweet scented shrub.
Carpinus sp. Hornbeam.
Cedrus sp. Cedar.
Celastrus scandens Linn. Bittersweet.
Cephalanthus occidentalis Linn. Buttonbush.
Cercis canadensis Linn. Judas tree, Redbud.
Chamaedaphne calyculata Moench. (Cassandra) Leather leaf.
Chionanthus virginica Linn. Fringe tree.
Cladrastis tinctoria Raf. Yellowwood.
Clethra alnifolia Linn. Sweet pepperbush.
Corylus sp. Filbert. Hazelnut.
Daphne mezereum. Linn.
Diervilla sp. Weigela.
Dirca palustris Linn. Leatherwood, moosewood.
Exochorda grandiflora Lindl. Pearl bush.
Gaylussacia sp. Huckleberry.
Genista tinctoria Linn. Dyer's greenweed.
Ginkgo biloba Linn. Maidenhair tree.
Gymnocladus canadensis Lam. Kentucky Coffee tree.
Halesia tetraptera Linn. Silver bell, Snowdrop tree.
Hamamelis virginiana Linn. Witch-hazel.
Hedera helix Linn. English ivy.
Hicoria sp. (Excepting H. pecan Britt.) Hickory.
Hydrangea (all species).
Hypericum moserianum Andre. Gold flower.
Ilex sp.
Itea virginica Linn. Virginian willow.
Jasminum nudiflorum Lindl. Yellow jasmine.
Juglans cinerea Linn. Butternut.
Juniperus sp. Juniper.
Koelreuteria paniculata Laxm. Varnish tree.
Laburnum vulgare Griseb. Golden chain.
Larix sp. Larch.
Liquidambar styraciflua Linn. Sweet gum.

Liriodendron tulipifera Linn. Tuliptree.
Lycium halimifolium Mill. Matrimony vine.
Magnolia (all species).
Myrica cerifera Linn. Wax myrtle.
Nyssa sylvatica Marsh. Tupelo, Pepperidge, Black gum, Sour gum.
Ostrya virginica Willd. Hornbeam, Ironwood.
Paulownia imperialis Sieb. & Zucc.
Phellodendron sp.
Philadelphus coronarius Linn. Mock orange, syringa.
Pinus sp. Pine.
Platanus occidentalis Linn. American plane. Buttonwood.
Potentilla fruticosa Linn.
Quercus (all species). Oak.
Retinispora (all species). Japan cypress.
Rhamnus sp. Buckthorn.
Rhododendron sp.
Sciadopitys verticillata Sieb. & Zucc. Umbrella pine.
Shepherdia sp.
Smilax sp.
Sophora japonica Linn. Japanese pagoda tree.
Staphylea sp. Bladdernut.
Stephanandra flexuosa Sieb. & Zucc.
Styrax japonica Sieb. & Zucc.
Tamarix sp.
Taxodium distichum Rich. Bald cypress.
Taxus sp. Yew.
Tecoma radicans Juss. Trumpet creeper.
Tsuga canadensis Carr. Common hemlock.
Vaccinium sp.
Wistaria sp.
Xanthoceras sorbifolia Bunge.
Xanthoxylum americanum Mill. Prickly ash.

The above list shows a very wide range of food plants, and it will undoubtedly prove of considerable value to parties setting out trees in sections where this pest occurs, since it may be possible in many instances, to select species not liable to serious injury, a procedure which might result in material saving in the course of a few years. It is also well to call attention in this connection to the limited means of dispersal possessed by this species, and on large estates in particular, it would probably be advantageous to have the surrounding trees, so far as possible without interfering with more important plans, largely of species unfavorable to the development of the scale. This would materially lessen the danger of its being brought on the place, and the likelihood that control work would be marred by the indifference of adjacent landowners would be much diminished.

Means of dissemination. The method of spread is of considerable importance, particularly in places where this scale has not become established. It is conveyed long distances almost entirely by nursery stock and there is very great danger in budding from infested stock, since this scale insect has a marked tendency to gather about buds and other rough portions of the bark. Aside from this, the pest can be spread only by the crawling young being carried either by birds, other insects or animals. The first three can hardly be controlled. Great care should be taken during the breeding season not to allow men and teams which have been working among infested trees to go directly to uninfested ones, since the scale is easily conveyed in this manner.

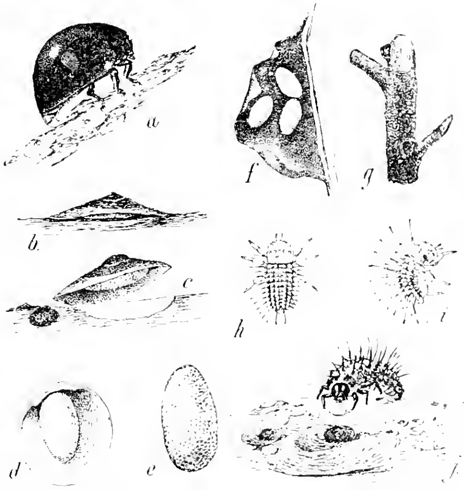
Distribution. This species has now attained a wide distribution in this country; though it is still unknown in certain states, and in many is confined to more or less restricted localities. It appears to be particularly abundant about some of our larger eastern cities, such as New York. Recent investigations of Dr C. L. Marlatt seem to have established the fact that the original home of this species is in northern China.

Natural enemies. A number of true parasites have been reared from this scale insect. Anaphes gracilis How. was obtained from infested twigs taken in Charles county (Md.) and Aspidiotiphagus citrinus Craw. was bred from the San José scale in California. Aphelinus mytilaspidis Le Baron and A. fuscipennis How. have been reared from scales taken in a number of localities in Maryland by Prof. W. G. Johnson. The latter species was bred in large numbers by Prof. Johnson and promises to become an important aid in controlling this pest.

Fig. [illegible]

A very small black lady beetle, Pentilia misella Lec., an American species feeding on the San José scale, was found by us in considerable numbers in an infested orchard near Albany. The beetle, in its various stages, is represented in the accompanying figure. It is quite convex in shape and only $^1/_{16}$ inch long. The twice stabbed lady beetle, Chilocorus bivulnerus Muls., is another native form known to feed on this pest. The beetle may be recognized by its jet black color relieved by two red spots on its wing covers. Several lady beetles introduced into California were colonized on trees infested with San José scale, and of these, three have since been discovered feeding on the pest. They are Orcus chalybeus, O. australasiae and Scymnus lophanthae.

There is another interesting natural enemy known as the Chinese lady beetle, Chilocorus similis Rossi, which has been recently introduced by agents of the United States Department of Agriculture, and may prove a valuable ally in controlling this pernicious scale insect, particularly in the Southern States. It closely resembles our native twice stabbed lady beetle, Chilocorus bivulnerus Muls., presenting appreciable differences only in the larval stage. Its general appearance and habits are well shown in figures 38 and 39. Several attempts have been made to introduce this species in New York State, and while it bred freely several seasons, it does not appear to have withstood our severe winters and it is very doubtful whether material benefit will result from its presence. It



[illegible] Chinese lady beetle [illegible] [illegible] sculpturing [illegible] dorsal and lateral views [illegible] Marlatt, U. S. Dep't Agr. [illegible] seems to possess a greater fondness for scale insects than our native species and may, in the course of years, prove of some service in checking these pests.

A fungus disease, Sphaerostilba coccophila Tul., attacks this pest, and in some localities it has killed a considerable number of the scales. Prof. P. H. Rolfs credits this organism with practically exterminating the pernicious scale in one Florida orchard and with reducing by considerable the numbers of the pest in others. It is undoubtedly a native of Florida, as it is very common on Chrysomphalus obscurus Comst. This fungus was cultivated, and new colonies of scales infested, but unfortunately, like other fungi it is very dependent on favorable climatic conditions, and this limits its usefulness seriously. Fungus-infested scales were sent to other states, and the disease was at least temporarily established in several places. After the disease has consumed the insect, an orange colored protuberance forms at the base of the scale or breaks through it, but, as this is only from $\frac{1}{40}$ to $\frac{1}{8}$ inch in hight, it is not very apparent.

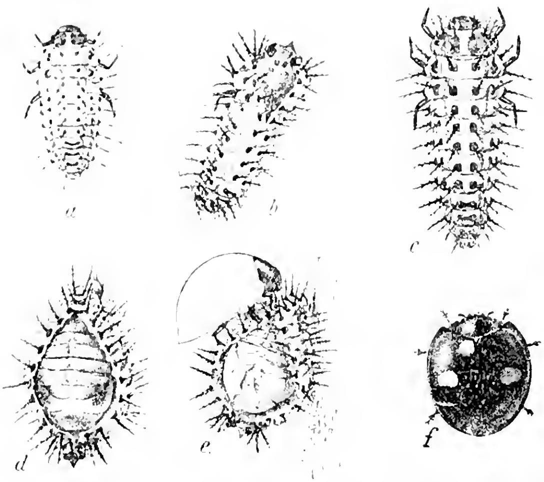


Fig. [illegible] Lady beetle. Later stages [illegible] larva, e pupa within [illegible] enlarged [illegible] (After Marlatt, U. S. Dep't Agr. [illegible] Year B[illegible])

Remedial measures. This insect is very difficult to control because of its exceeding prolificacy, its resistance to insecticides, and particularly because of its extended breeding season. It is a sucking insect and since it draws its nourishment from underlying tissues, it can be controlled only by the use of some substance powerful enough to penetrate the covering scale and destroy the underlying insect. A large number of materials have been employed for this purpose. The nearly naked crawling young are unprotected and on that account easily killed. The great difficulty of attempting to check the insect in this stage, is that young are produced during an extended period and therefore the best results have been obtained by the use of materials powerful enough to penetrate the sheltering scale of the adult, and such materials are so strong that they can be applied to deciduous trees only when in a dormant condition. The best results, as a rule, have been obtained by early spring applications, preferably deferring the treatment till shortly before the buds begin to open.

A wide variety of materials have been employed, prominent among which may be mentioned whale oil soap solution, kerosene emulsion, crude petroleum and its emulsions and the lime-sulfur washes. The whale oil soap solution at the rate of 2 pounds to 1 gallon of water, is fairly effective though costly, and in commercial orchards, has quite generally given way to other materials. Both kerosene and crude petroleum in pure and mechanical emulsions, have been employed to a considerable extent, but in most cases they likewise have been displaced by the cheaper, safer lime-sulfur washes which, as a rule, have been most successful. There are many formulas for these latter, some of which have been used for years and others developed within 12 months. The formulas for several excellent washes and methods of preparing the same, have been given on page 30, to which the reader is referred for further details. It is well to bear in mind when fighting this insect, that thoroughness is absolutely essential, and that it lies within the power of the man at the nozzle to make or mar the entire work. It is advisable, before spraying, to cut the trees back as much as possible, and in sections where this scale is prevalent, low heading will doubtless become popular because of the greater ease in fighting this pest. Another important point is to spray with the wind wherever conditions permit, making the application on the other side of the trees when the wind is blowing in an opposite direction, since it is almost impossible to thoroughly spray a tree, particularly a large one, without the aid of a favorable breeze. Spraying outfits are rather expensive, and a man with a few trees will undoubtedly find it much cheaper to hire his spraying done, and in some cases at least, cooperative neighborhood work will prove the most economical and satisfactory method of controlling this dangerous pest. The species has such a range of food plants that only in exceptional cases is it advisable to attempt the extermination of the species in a locality.

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Putnam's scale

Aspidiotus ancylus Putn.

Circular or oval, dark gray or black scale insects about 1/12 inch in diameter, and with a brick red cast skin or exuviae to one side of the center, may be met with in small numbers on various native trees.

This is one of our most common native species of Aspidiotus and occasionally it occurs in such large numbers as to be somewhat destructive, but ordinarily natural agents of one kind or another keep it in check.

Description. This species may be more easily recognized by its dark gray or black color and by its brick red cast skin or exuviae which is a little to one side of the center. The full grown scale insect is about 1/12 inch in diameter. The young scales remain white or pink for a considerable period, and usually have a well developed nipple and an inconspicuous ring. A twig badly infested by this species has a dark gray or almost black color, relieved here and there by the reddish exuviae. [*See* pl. 14, fig. 5-9]

Life history. This insect passes the winter in a partly grown condition. There is but a single generation. The studies of Mr Putnam, in Iowa, show that the males appear there the latter part of April, and that the female deposits from 30 to 40 eggs in the late spring or early summer. The crawling young of this species may be seen during most of July, in the latitude of Albany, indicating that the hatching of the eggs extends over a considerable period. Professor Johnson states that this species may cause a purplish tinge in green tissue, but it is not so marked as with the San José scale. This discoloration has not been observed in New York State.

Food plants. This species has been recorded on a number of plants aside from fruit trees. Professor Comstock has found it on ash, beech, bladdernut, hackberry, linden, maple, oak, Osage orange, peach and water locust. It has also been recorded on elm and willow. Professor Johnson attributes the killing of an English oak in Illinois to this scale insect. It has been received from this State by Dr Howard on pin oak and hemlock, and it also occurs on mountain ash, pear, Ilex verticillata, Ilex laevigata, white birch, Prunus and American elm.

Distribution. This species is probably widely distributed in the United States and is an exceedingly common species in New York, where it has been recorded from a number of localities.

Natural enemies. A single parasite, Physcus varicornis How., has been reared from this species.

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Chionaspis lintneri Comstock

This species has been recorded as occurring within the bounds of the State and is known to live on alder, Viburnum lantanoides, Betula papyrifera, Cornus alternifolia, C. stolanifera, and a species of willow. It has also been found on Lindera odorifera and Corylus americana.

Distribution. This species has a somewhat extended range as it has been recorded from Prince Edward Island, Canadian localities, and several places in Buffalo.

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Rose scale

Aulacaspis rosae Bouché

Patches of irregular white objects, sometimes scurfylike in character, on roses, blackberries and raspberries, are very likely this species.

Fig. 40 Rose scale on blackberry

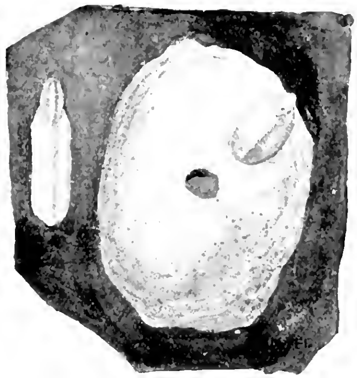

Fig. 41 Male, female and young rose scale, very much enlarged

This scale insect occurs in sparing numbers in the southern portions of New York State and occasionally becomes somewhat abundant on rose, raspberry and blackberry bushes. It begins to breed in Pennsylvania about the middle of May, and in New York the young may be expected the latter part of the month and for several weeks thereafter. Thorough spraying with a kerosene emulsion or whale oil soap solution should be effective in checking this scale insect whenever it is at all abundant. [*See* pl. 14, fig. 1-4 for colored illustrations of this species]

Juniper scale

Diaspis carueli Targ.

A circular, snowy white scale, about 1/25 inch in diameter, with nearly central yellowish exuviae, may be found on juniper.

This species was brought to the writer's attention in September 1898, when it occurred on Irish juniper at Ossining N. Y. The specimens accompanying the inquiry showed that the insect was quite abundant. This species has been recorded by Professor Comstock as very common at Washington D. C., where he found it infesting several species of juniper and arbor vitae.

Description. The female scale is circular, whitish, about 1/25 inch in length, and with a central or nearly central yellowish exuviae. The male scale is white, slender, and about 1/25 inch in length. It has a prominent median ridge and at the smaller or anterior end there is the oval yellowish exuviae.

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Pine leaf scale

Chionaspis pinifoliae Fitch

An elongated, whitish scale on the needles of various pines.

This pest is somewhat abundant on the needles of hard and Austrian pines in New York State, and has come to the writer's notice repeatedly in recent years.

Early history. This insect was brought to the attention of Dr Fitch in 1855, and his second report contains an extended account of the species. He states that this scale is more apt to occur on transplanted pines and this agrees with our experience. Its abundance on Austrian pines in Washington park, Albany, was brought to the attention of the late Dr Lintner in 1889. He states that millions of the peculiar white scales of this destructive species had attached themselves to the leaves, almost as thickly as they could rest, nearly whitening the trees, and almost obscuring its natural green. Hundreds of scales could be counted on a single leaf, and the attack was so severe that a number of the trees were very nearly killed.

Description. The scale of this insect is oval, elongated, snow white in color, and with the small, yellow cast skins at the smaller ends. This species can be easily recognized by reference to plate 10, figure 9.

Life history. This insect is recorded as passing through two generations annually in the northern United States. Hibernation occurs in the egg stage, 20 to 27 eggs being found under each scale, according to Mr Cooley, who states that he has seen the egg hatch at Amherst Mass., May 25, while we have observed the young in Albany May 12. Dr Le Baron has recorded them hatching May 10 to 25, and Dr Riley, as early as April 25. Dr Le Baron states that the first eggs which hatch produce only male insects, while the later individuals are females. The young crawl about over the leaves for two or three days, then come to rest and begin feeding. The latter author states that the young males settle entirely on the old leaves, while the females usually migrate to the tender needles at the ends of the twigs. Mr Cooley states that this does not seem to be a fixed habit since, after watching this insect, he did not observe this marked difference in the place of settling of the two sexes. The male requires about 10 days for the development of its scale, and the female, three weeks. The male develops much more rapidly than the female and he matures at the time the latter is passing through her second molt, immediately after which pairing takes place. Mr Cooley states that it is impossible to separate the two broods of this insect, as the time of hatching extends over so long a period that scales in all stages of development can be found any time during the summer. He adds that he is not at all sure there are not three broods in the latitude of Amherst Mass. Dr Le Baron states that females complete their development and commence laying eggs in July which begin hatching the first of August, and continue till the middle of September. These produced the second brood of young and the adult females resulting therefrom lay eggs which remain in that stage through the winter and give rise to the first brood the following season. The protracted laying period makes the development of the second brood very irregular and no precise dates can be given. Mr Cooley states that he has seen living females at Amherst which were just completing egg laying December 6.

Natural enemies. Two small hymenopterous parasites, Perissopterus pulchellus How. and Aphelinus mytilaspidis Le B. have been reared from this scale insect. The beneficial twice stabbed ladybeetle, Chilocorus bivulnerus Muls., has been repeatedly recorded as feeding on this scale insect. Other species observed feeding on this pest are Cybocephalus nigritulus Lec., Scymnus species, Harmonia picta Rand and Chrysopa species.

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Periodical cicada

Tibicen septendecim Linn.

A stout, large black insect with four membranous orange veined wings and red eyes, frequently oviposits in the twigs of many trees, causing them to wither and fall.

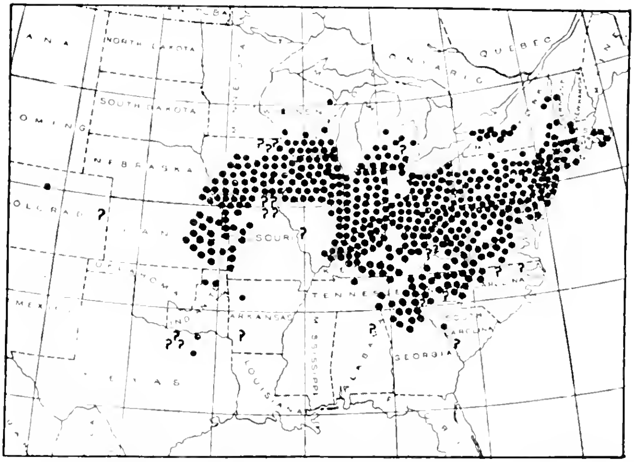
This insect is one of the most interesting species occurring in the State. Its presence in enormous numbers from time to time, and its extremely long life cycle, excites great popular interest. This species can hardly be considered of much economic importance, though frequently exceedingly abundant in some localities, since most of its operations are confined to forest trees, where the loss of a great many twigs is not a serious matter. Occasionally, this insect appears in enormous numbers in young orchards or on grounds set with choice trees, and by ovipositing in them inflicts great loss. These latter instances, however, are relatively rare.

Life history. This insect presents an extraordinary life cycle, requiring 17 years in the Northern States to complete its final transformations, though the adult existence is relatively extremely short. What is believed to be the same species has a life cycle of only 13 years in the Southern

States. The first cicadas appear in this latitude about the latter part of May or in early June, and continue till July. An enormous brood which appeared in the Hudson river valley in 1894 had entirely disappeared by July 20. The pupa emerges from a circular hole or burrow about ½ inch in diameter and climbs the nearest supports. Here it fixes itself firmly and prepares for the final transformation. The skin soon splits along the back and the creamy white adult, with its red eyes and the black spots on its thorax, works itself slowly out of the old case. It is soft just after emerging, and as it dries the parts harden and assume the size and color of the perfect insect. The cicadas may be found resting on branches or twigs throughout the day or engaged in ovipositing. There has been some question as to the adult feeding, but this has recently been settled beyond all question by Prof. A. L. Quaintance, who has demonstrated that the insects insert their beaks into plant tissues, draw nourishment therefrom, and that the digestive tract is continuous and functional. The cicadas, however, require so little nourishment during their brief existence that very little or no harm is done in this manner. The principal injury is caused by the insects gouging the tender twigs for the purpose of inserting their eggs. This operation has been described by Mr Ira H. Lawton as follows:

After finishing one fissure the female moved slowly forward about two steps, depressed her ovipositor about 45°, and setting her saws in motion, first alternately and then simultaneously, rapidly penetrated the bark, but the ovipositor was soon elevated to 25°. After penetrating to the full length of her ovipositor and filling that chamber with eggs, she swung a little to one side and through the same hole in the bark excavated the opposite chamber and filled it with eggs. The making of each chamber occupied a little over 20 minutes or a total of 45 minutes for the whole. During the cutting of a fissure, the saws made about 80 strokes to the minute, and after making four, the female would rest for a time. The head of the cicadas were directed, in the main, from the tree but not invariably so, as some worked with their heads toward the trunk of the tree.

As many as 50 of these fissures may be made by the female in a twig, provided it is suitable, and after depositing her complement of eggs, which is said to be from 400 to 500, she drops from the branch and dies. The period required for hatching has been given by various authors at from 52 to 42 days down to 14. The recently hatched cicadas are slender grublike creatures, about 1/16 inch long. They are as lively as ants, and after running about on the tree for a short time, drop to the ground and bury themselves. Their strong forelegs are well adapted for digging, and are undoubtedly of great service in searching for the tender succulent rootlets on which they feed. The young grow so slowly and require so little food, that but slight injury to trees or shrubs results from their presence. They remain at a moderate depth, specially during the earlier and latter portions of their existence, though at times they have been found a number of feet below the surface. There is little change during the lapse of 16 years, except in size, between the newly hatched nymph and its full grown form. Towards the latter part of this period, there may be noticed four scalelike appendages, the rudimentary wings. The nymph makes its way to the surface in the spring of the 17th year, by boring a smooth, firmly compacted gallery with a channel just large enough to allow the insect to pass. This gallery may even be made through a firmly compacted pathway or around stones and other objects which can not be pierced. The pupa remains in the upper portion of this gallery till the time comes for it to forsake the earth and undergo its final transformation. Under certain conditions, the nymphs construct curious chambers over the mouths of their burrows, and prior to 1894, these structures were regarded as exceedingly rare, but investigations by Dr Lintner in that year revealed their presence in numbers in many localities in the Hudson river valley. Mr Benjamin Lander of Nyack, found one tract of land of about 60 acres in extent which had from 5 to 22 of these structures to the square foot. These interesting chambers were also found at Upper Nyack, South Nyack, Grand View on Hudson, Piermont, and on the top of the Palisades near Alpine. A number were found at West Point, and Miss Emily G. Morton observed them in the grass at New Windsor. They were seen at Marlboro, occurred in the sandy soil along the river at Poughkeepsie and were found under the leaves in the woods at Bangall, were met with at Athens, and were also observed at the Rural cemetery near Albany and at Bath-on-Hudson. These peculiar structures are made by the nymphs bringing up pellets of earth and depositing them about the mouths of their galleries. Mr Lander observed one repairing its injured chamber. There have been a number of theories advanced to account for these peculiar structures, but as they were built under such very diverse conditions, no explanation appears to be entirely satisfactory.



Map [illegible] the distri[illegible] of the [illegible] 17 year race. (After Ma[illegible]) Dep't Agric. Div. Ent. Bul. 14, n. s. [illegible] p. 26)

Description. The perfect insect may be easily recognized by its black body and the bright red eyes, and the red veined wings, in connection with plate 11, figure 17. A smaller variety, described by Dr Fisher as Tibicen cassinii, occurs in connection with the large form.

Distribution. The general distribution of the 17 year broods is graphically represented in the accompanying map prepared by Dr C. L. Marlatt. It will be seen, in connection with the one showing the distribution of the broods of the 13 year race, that these latter overlap those having a longer developmental period only to a limited extent.

Broods in New York State. The life cycle of this insect is completed in 17 years and yet it appears in some portions of New York State at much more frequent intervals. The reason is found in the fact that several broods occur in the State. The adults of each emerge in different years. These appearances have been very closely followed by entomologists during the latter half of the last century at least, and some records include much earlier dates, so that the periodicity of this insect is established beyond all question. Dr Fitch in 1856, records 6 broods as

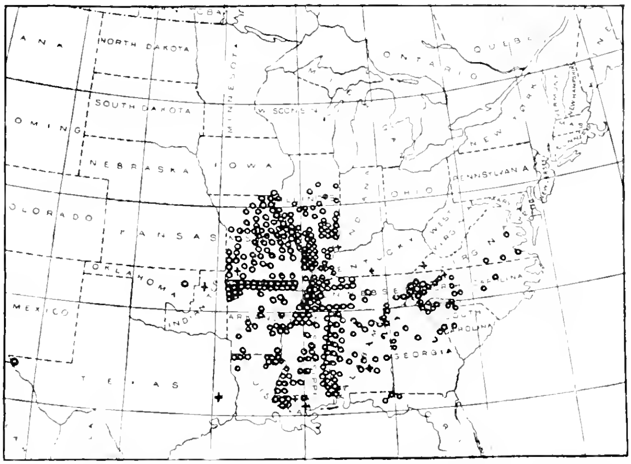


Fig. 4 Map [illegible] the distribution [illegible] the broods of the 13 year [illegible] (After Marlatt U. S. Dep't Agr. Div. Ent. Bul. 14, n. s. [illegible] p. [illegible])

occurring in the different parts of the United States, and mentions 3 as appearing within the borders of New York. Dr Lintner stated in 1885 that 5 broods were known to occur within the bounds of this State. Dr C. L. Marlatt in 1898 records 6 broods, one of these being based on a doubtful record. The several broods which have been recorded from New York State are briefly as follows:

Brood 8.[1] This is no. 6 of Messrs Walsh and Riley and was the one Dr Fitch confused with the 13 year brood which occurred in 1855. It has been recorded only from Long Island. It is due to appear in 1906.

Brood 12. This is one of the best recorded broods since it occurs very largely in the thickly populated regions of the Eastern States. This facilitates its observations very much. It is the brood which occurred in New York State and was very closely studied by Dr Lintner in 1894. It is Dr Fitch's no. 1, and Walsh and Riley's no. 8. It has been recorded from Albany, Columbia, Dutchess, Greene, Orange, Putnam, Richmond, Rensselaer, Rockland, Saratoga, Ulster, Washington and Westchester counties and from Long Island. It appears next in 1911.

Brood 17. This is no. 7 of Dr Fitch's, and no. 12 of Messrs Walsh and Riley. It was recorded from Richmond and Westchester counties in 1898, and it will therefore not be seen again till 1915.

Brood 19. This brood was founded by Dr Riley on the records of Dr Smith's register which runs back to 1797. It is recorded as appearing in Cayuga, Kings, Livingston, Madison, Monroe, Onondaga, Ontario, Richmond, Schenectady, Wyoming and Yates counties, and is due to appear in 1910.

Brood 20. This is Dr Fitch's second brood and no. 14 of Walsh and Riley. It is due to appear next in 1917. It has been recorded in New York State, so far as known to us, from only one locality in the extreme southwestern portion of Chautauqua county.

Brood 22. This is one of the largest broods which occurs in the United States. It appeared in New York in 1902. It has been recorded from Kings, Monroe, Niagara and Richmond counties. A recent report from Chester Young states that this brood appeared in 1902 in localities in Nassau and Suffolk counties. It probably occurs also in Queens county. It is not due again till 1919.

Natural enemies. This insect occurs in such large numbers that it fre-

[1] The comprehensive numbering of Dr Marlatt has been adopted as being more likely to be permanent.

quently attracts the attention of vertebrates, such as cats, dogs, skunks, ground hogs, and even gray squirrels feed on them. Domestic fowls of all kinds relish them, and in some places they remain in the woods all day during "locust time." The adults are eaten by most birds, and the English sparrow has been recorded as possessing a special fondness for this insect. Robins are said to prefer them to strawberries, and the crow eats them readily. Other birds recorded as feeding on them are as follows: cuckoo, kingbird, oriole, sparrow, catbird, thrushes, ground birds, and even the common land turtle has been known to feed on the nymphs. Ants attack cicadas, but they probably do not molest living, healthy individuals. A fungus, Massospora cicadina, has proven fatal to many insects in widely separated localities.

Remedial measures. It is practically impossible to prevent these insects from emerging, and the best known method of protecting trees, consists in inclosing them with fine netting, this course being practical only in the case of highly valued ones. Agriculturists may prevent damage to a considerable extent by not setting trees for two or three years before a large brood is expected in the locality.

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Dog day cicada or harvest fly

Tibicen tibicen Linn.

This species is rather common in July and August in many sections of the State and may be readily recognized by its large size and peculiar form [pl. 45, fig. 1], as well as by its shrill call so frequently heard. The body of the insect is nearly triangular when viewed from above and measures almost $1\frac{1}{4}$ inches in length, while the wings spread nearly 2 inches. This species may be readily distinguished from the 17 year cicada, Tibicen septendecim Linn., by its stouter form, its yellowish and greenish markings on the head and thorax and the green veins of the wings. A single specimen was taken by the writer on hard pine at Karner, July 10, 1901. It is much more frequently met with on other trees, particularly maple, oak and horse-chestnut. It is said that two years are required to complete its life cycle.

The ugly clay-colored nymph of this insect may be met with in midsummer as it forsakes the earth and crawls on a tree to cast its skin and appear in the adult form. This operation is an extremely interesting one and requires only a few hours for its completion. The pupal skin cracks over the thorax and the insect gradually works its way out by a series of irregular jerks and during the process presents to the observer's eye very delicate and beautiful shades of pink and green. The bright pink simple eyes, or ocelli, and the alternating dark and brass-colored markings on the head and prothorax make an admirable combination, which is further enhanced by the delicate yellow on the costal margin of the wings and the bright green of most of the veins. The tarsi or feet are reddish at this stage. The irregular jerking continues and the limp legs and wings are slowly dragged from their cases by the weight of the backward bending body and are moved only after a lapse of five to 10 minutes and then but feebly. The fully extended wings are a delicate green with traces of yellow at the outer third of the costal margin. This latter color disappears soon and the fully emerged insect is then a beautiful object with its delicate pea-green organs of flight. The entire time occupied by this transformation is about an hour, though the insect does not fly readily for several hours.

This species is rarely present in sufficient numbers to cause serious injury, though its large size makes it an object of special interest.

Box elder plant bug

Leptocorus trivittatus Say

This western blackish red marked bug is specially fond of the box-elder.

This insect is not known to occur within New York State, but it has been making such rapid progress eastward that its advent within our borders may not be far in the future.

Its northward and eastward spread. Dr Lintner states that in 1888, this species had not been recorded north of Missouri. It was reported in 1891 from the southeast corner of the state of Washington, where it had appeared the preceding year, and was then destroying large quantities of plums, peaches, apples and some grapes. The same year Professor Osborn listed it among the Hemiptera of Iowa as common in the western part of the state. Soon thereafter it had increased to such an extent as to appear in myriads in some localities and command popular attention. It was found in 1894 in such immense numbers in North Dakota as to excite considerable interest. It reached the Mississippi river at McGregor Ia. in October 1895, and since that date has become established in Illinois. In view of the rapid progress this species has been making northward and eastward, it would not be surprising if, in the course of time, it becomes established within our bounds.

Distribution. This insect, as stated by Dr Lintner, presumably occurs in each state and territory west of the Mississippi river. It extends south into New Mexico and Mexico. Northward it is known in Iowa, Nebraska, North Dakota, South Dakota, Idaho and Washington, and, as previously stated, it has since become established in Illinois.

Habits of the insect. This species has been closely studied by Professor Popenoe of the State Agricultural College of Kansas, and the following account is by him.

The species has been known in this locality for over 10 years as a tree pest, appearing at times in great numbers on the box-elder, and occasionally attacking the ash. During the winter the adults are hidden in sheltered nooks and corners everywhere, but are especially abundant in crevices of stone walls and the angles of stone buildings, on the south sides of which they appear, singly and in clusters, every warm day during the season. As soon as the increasing warmth of spring allows, they leave these shelters and seek the trees attacked by them. From the time of their scattering in the spring until the appearance of the first adults after midsummer they are much less conspicuous, and are not likely to be noticed except upon search directly for them. It is at this time, however, that their eggs are laid, and the numerous young are hatching and beginning their work on the trees. After midsummer their gregarious tendency is again manifested in the flocking of the bugs of all sizes and in great numbers in lines up and down the trunks and branches of the trees. Not infrequently they may be seen crowded in a broad line extending from the ground to the secondary branches, the company including nymphs of all sizes, and fully matured individuals. This habit persists more or less completely until October and November, or until the trees are bare. During the warm days of Indian summer the bugs fly everywhere, flocking to the warm sides of the buildings and entering houses where, though otherwise harmless, they become troublesome through their abundance and through their propensity to fall clumsily into pails of water, crocks of milk and other articles of food left uncovered.

They are principally found, as stated, upon box-elder trees, but observations show them to be much more general in their selection of food plants. They feed also on the ash, and I have observed them in abundance sucking the sap from the Ampelopsis clinging to the south side of a stone building. Into the greenhouse many make their way during the autumnal flight, and such are specially fortunate, for they find there not only the desired shelter, but abundance of food as well. They are not slow to test the qualities of the juices of the plants growing in the house, and we have seen them with beaks inserted in the stems of geraniums, cactuses, lilies, Coleus, Ageratum and other plants.

Remedial measures. This pest like many suctorial species can be controlled only by the employment of contact insecticides such as kerosene emulsion or a soap solution. When abundant at the base of trunks of trees the bugs can be killed with kerosene emulsion or hot water.

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THE BATTLE OF THE WEAK

OR

INTERESTING FACTS ABOUT APHIDS

The Aphididae or plant lice comprise an exceedingly interesting group and illustrate in a most admirable manner the means by which some of the weaker forms of life are able to exist. The general characteristics of aphids, or plant lice, are familiar to almost every person, since they are exceedingly common on almost every plant, not excepting those grown in houses. We all know that they are frail creatures, some with and some without wings, and so tender that it is extremely difficult to take one up without inflicting serious injury. These nearly helpless, practically defenseless forms are nevertheless represented in North America by about 325 species, as given by Professor Hunter in a recent list. It is patent to all that some of these species are occasionally enormously abundant, so that in spite of their almost absolute helplessness, there seems little danger of the forms becoming extinct.

Summarized life cycle. The life history of these interesting insects may be briefly summarized as follows. Many of the species pass the winter in what we know as the winter egg, which is usually deposited in crevices of the bark or at the base of buds or branches, where it remains during the winter. The young hatch therefrom in some cases at least at about the time the foliage begins to develop and in other instances not till well toward midsummer, establish themselves at some favorable situation and begin to draw nourishment from the unfolding tissues. These young are all females and in the language of science are known as "stem mothers." They usually begin to produce young in a few days after hatching from the egg and these are also females and in turn produce others. This method of reproduction is what is known as agamic or asexual and differs from the ordinary in that males have no part in the process. A number of generations may be produced in this way, the adults being wingless and after a time, usually at the end of a certain number of generations, winged females develop. These latter forsake the original, usually by this time crowded, food plant and either fly to similar ones in the neighborhood or, as in the case of some species, betake themselves to entirely different plants, where another series of wingless agamic or asexual generations are brought forth. This may continue for sometime and after a certain number of generations the plants again become crowded, winged females are produced and there may be a return migration to the original food plant, where one or more generations may be produced and ultimately perfect males and females, which latter pair and deposit eggs in crevices of the bark or other shelters, as stated above and remain unhatched over winter.

Economic importance. Aphids or plant lice are of considerable economic importance and the literature of the subject abounds with notices of considerable injury inflicted on important crops by these comparatively insignificant, defenseless creatures. Our grains are occasionally seriously injured by species of aphids or plant lice, while the damage inflicted by those occurring on apple and cherrytrees is well known to almost every one at all familiar with plants. The species affecting appletrees are sometimes so abundant and injurious in western New York State as to necessitate the carrying over by nurserymen of thousands of young appletrees stunted in growth by these little pests, which are at rarer intervals numerous enough to seriously injure larger trees. Recent years have witnessed grave losses on our pea crop, particularly in Maryland and adjacent Atlantic states, caused by a species which has been so injurious as to lead to the almost entire abandonment of late varieties and has compelled growers to raise the earlier peas or go out of business. The species occurring on the hop is another familiar form. It occasions considerable loss from year to year and is sometimes exceedingly destructive, thereby having a material effect on the value of this important crop of central New York.

Natural checks. Aphids or plant lice are defenseless creatures, subject to a number of adverse agencies of one kind or another, which reduce their numbers very materially and prevent what would otherwise be exceedingly serious outbreaks. Among the most effective natural agencies are cold rains occurring in early spring just as the insects are beginning to develop and before the foliage is abundant enough to afford adequate shelter. Such inclement weather undoubtedly destroys large numbers of these delicate insects, and severe continued rains later in the season may also be quite injurious, not only by washing the insects from the leaves or removing protective coverings from them, but also because the damp weather favors the development of bacterial or fungus diseases.

There are also a number of insect enemies which are very effective in controlling these forms. Among the most important and certainly the most conspicuous are our well known lady beetles or ladybugs, which may be observed in practically every portion of the country, and are usually found in numbers wherever plant lice are abundant. These little insects comprise an entire family of beetles, most of them feeding very largely on plant lice of various species. Their general form and appearance is so familiar that no description is necessary in this connection. The flower or syrphid flies are also very efficient checks on the increase of plant lice, and a number of species may be found about plants where aphids are numerous. The eggs of these insects are whitish, oval, very delicate affairs with the surface of the shell marvellously chased. The maggots or young of these flies may be easily recognized by their somewhat conical appearance and usually bright colors. The slender, pointed head of the creature is extended to its victim and the fluids rapidly drawn from one plant louse after another.

The aphis lions, or young of the delicate green, golden eyed lace-winged flies, are also well known enemies of plant lice and are frequently met with on bushes where these pests are numerous. The exceedingly voracious young have a somewhat oval, depressed body with a flattened head. They may be at once distinguished by the enormous forward projecting mandibles with incurved points meeting at the tip. The little creature approaches a plant louse, grasps it between its enormous mandibles and draws the nourishment from its struggling victim. Certain small four winged parasitic flies, known as Chalcids, are also exceedingly beneficial species and are important factors in keeping these insects in check. The abundance and almost universal presence of plant lice is strikingly illustrated by the fact that an entire subfamily, the Aphidiinae, of these small, parasitic flies are dependent, so far as known to scientific men, entirely on these little insects for sustenance. There is another exceedingly interesting enemy of certain plant lice which deserves notice because of the remarkable divergence in food habits from its allies. It is the caterpillar of a small butterfly, Feniseca tarquinius Fabr., which may be found feeding on masses of the cottony plant lice, Pemphigus tessellata Fitch, sometimes so abundant on alders, and better known as the alder blight.

Honeydew and its value to plant lice. The above outlines briefly some of the factors with which aphids or plant lice must contend in the battle for life. They are, as previously stated, comparatively helpless and fall ready victims to all of these agents, and one unfamiliar with nature might wonder why the entire group had not been exterminated long ago. The fact is that aphids, or plant lice, are able to exist on account of no defensive powers of their own, but must rely on other means. We will discuss briefly a few of the factors which enable this interesting and extensive group to hold its place in the world of nature. Most, if not all, species of plant lice excrete a substance known as honeydew which undoubtedly serves indirectly as a method of protection, since it is eagerly sought after by various species of ants which are ever ready to afford more or less protection to the producers. Some ants are very energetic in defending these little plant lice and whenever a leaf bearing them is approached by an enemy, they will endeavor to protect the little honeydew producers so far as possible. This is apparent when a leaf bearing a few of the aphids is picked and their protectors at once turn and undertake to give battle to the venturesome fingers. There are a species of ants which carry this protection even further and tenderly care for the eggs or the plant lice themselves during the long winter and establish them on the roots of proper food plants in the spring, in order that later they may reap the desired harvest of honeydew. This excretion not only attracts certain species which render a direct service by intentionally driving away various enemies of one kind or another, but it also draws wasps and bees, insects which, while they may not intentionally render a service, in all probability aid to some extent in scaring away parasites which might otherwise be attracted to the leaves in search of prey.

The honeydew is a disadvantage in certain respects, since it occasionally collects on the trees in immense quantities and may become the medium for the growth of a black sooty fungus which clogs the leaf pores and interferes with the growth and development of the tree, something which can hardly be considered favorable to the aphids. Occasionally this honeydew is excreted so copiously that it collects in large drops on the leaves, evaporates and forms semisolid gelatinous masses. This has been repeatedly observed by the writer on Norway maples in particular, infested by a species of Chaitophorus.

Protective devices. Plant lice or aphids resort to a number of protective devices of one kind or another. Not a few species are covered with a whitish, powdery matter which is evidently an excellent shelter from the wet, since it is almost impossible for moisture to penetrate this excretion. This is of the greatest value perhaps to the inhabitants of galls, where the insects are overcrowded and there is considerable dampness resulting not only from the excretions from the plant lice themselves but also from the interior walls of the gall. These particles of moisture become coated with this powdery matter and roll about among the crowded, struggling plant lice and yet do not wet the individuals because of the enveloping excretion. This is undoubtedly of very great importance to gall inhabitants since it is a fact well known to collectors that almost any insect placed in an empty corked vial will soon become stuck to its sides by the accumulated moisture and perish much sooner than if placed in one with a piece of grass or other footing on which it can sustain itself and prevent contact with dampness. In other words, the constant presence of moisture on the bodies of the insects is certainly very unfavorable to life and may result in speedy death, either from suffocation or possibly by development of bacterial or other diseases. In other species of plant lice this protective device is carried to an even greater extent, and the whitish powdery matter is secreted copiously from more highly developed glands as long woolly filaments. Such protection is very common and one has only to refer to such species as the woolly apple aphid, Schizoneura lanigera Hausm., the woolly alder aphid, Pemphigus tesellata Fitch, frequently known as alder blight, and also in the case of such leaf-feeding species as the beech leaf aphid, Phyllaphis fagi Linn. This woolly matter undoubtedly affords considerable protection from inclement weather and also from parasites and predaceous enemies. The unprotected parts of the plant louse are those near the legs or head where it would be comparatively easy for the insect to frighten away the small parasite and the presence of the woolly filaments probably renders its bearer distasteful to such predaceous forms as the lady beetles or their young. The economic or practical entomologist is well aware of the protective value these filaments possess, since it is very difficult to kill such plant lice by the application of ordinary contact insecticides. There are many other species which illustrate different protective devices and among these we may include the leaf curlers. It is a well known fact that most of our species of plant lice feed to a considerable extent upon the underside of the leaves where they are largely protected from inclement weather and this shelter is immensely increased whenever the insects are abundant enough so that their attack results in more or less irregular curling of the leaves. This curling is the mechanical result of the abstraction of fluids from the underside of the leaf and is very marked in attacks by the common cherry aphid, Myzus cerasi Fabr., where the leaves are frequently so deformed that it is almost impossible to hit the insects within with any kind of a spray. Aphids are almost invariably more abundant near the center of the curled leaf where protection is most perfect. This curling affords shelter from inclement weather and probably wards off, to a considerable extent, attacks of parasitic and predaceous insects. Leaf curling is carried further in some instances and we may have, as in the case of a species, Hamamelistes spinosus Shimer, occurring on birch, the formation of what are known as pseudo-galls, which are nothing more than depressions in the underside of the leaf and corresponding elevations on its upper surface. These gradually become more and more marked till the lateral veins nearly coalesce and form admirable shelters.

This may be continued further as in the case of the cockscomb elm gall, Colopha ulmicola Fitch. Here we have eventually a beautiful cockscomblike structure on the upper surface of the leaf, while beneath there is only a longitudinal slit marking the edges of the orifice. These galls are sometimes so abundant as to deform the leaves very seriously and they mark a more advanced stage of leaf curling. There are a number of plant lice which make more or less defined galls, many of them being simply abnormal growths from the leaf stalk or developing bud. The species, Pemphigus populi-transversus Riley, making a gall on the leaf stem of our common poplars is rather abundant in the vicinity of Albany. The abnormal growth is very characteristic, being about the size of a walnut, and on examination there will be found a conspicuous transverse scar on one surface. The growth of this gall is in all probability substantially as follows. The parent insect establishes herself about the middle of the developing leaf stalk, begins to draw sustenance therefrom and her operations excite an enormous development of tissue which gradually rises over and finally incloses the insect and her young. A still more advanced stage is exhibited in the gall of the hickory gall aphid, Phylloxera caryaecaulis Fitch, the orifice of the gall being closed.

Another very interesting gall is that produced by Pemphigus rhois Fitch, on sumach, another, Pemphigus ulmifusus Walsh, equally unique, occurs on slippery elm. The galls of plant lice may be distinguished from those of hymenopterous gall flies by the external orifice, though it may be much obscured by the abnormal growth. This opening is a necessity because aphids never lay eggs within plant tissues.

Prolificacy. The protective devices of one kind or another enumerated above would never be sufficient for the maintenance of so many of these defenseless insects, were it not for the fact that they were exceedingly prolific. This subject early attracted the attention of naturalists, and we have the record of Reaumer's experiments which show that a single plant louse might in one year of uninterrupted breeding under favorable conditions become the progenitor of the enormous number of 5,904,900,000 individuals. This immense number is beyond the ready grasp of most persons and we may perhaps appreciate it a little more by the following calculation. The average length of most plant lice would be approximately 1/8 inch, but if we call it 1/10, which is certainly a very moderate estimate, and group this host of individuals in a column of four, which is the ordinary military formation, and bring each file closely behind the other, we will have an army long enough to encircle the globe at the equator and enough would remain to stretch across this continent, or in other words we would have an army 27,052 miles in length, all possible descendants from a single plant louse in one season. This almost passes credibility, yet the same thing has been figured out by another competent naturalist, namely Huxley, who estimated that from the uninterrupted breeding of 10 generations from one individual, there would result a mass of organic matter equal to the bulk of 500,000,000 human beings, or about the population of the Chinese Empire. The enormous number of these insects occurring on a tree is shown by the calculation of Dr Fitch, who estimated that on one small cherrytree there were over 12,000,000 aphids. Such facts as these illustrate the possibilities and show in no uncertain manner the immense value of the natural checks enumerated above.

Short life cycle essential to prolificacy in plant lice. This startling prolificacy is not brought about by the production of immense numbers by any individual, but, as is the case with many other animals, is accomplished by the extraordinary rapidity with which the life cycle is completed. This is admirably illustrated by the hop aphis, *Phorodon humuli* Schrank. The cold season is passed in what is known as the winter egg and the young insect hatching therefrom, known as the stem mother, begins to produce young when two or three days old, bringing forth from two to seven daily, and each of these in turn begins to produce young in about eight days. It will thus be seen that multiplication instead of being arithmetic is really geometric, and this accounts for the immense number of descendants which may result from one individual in a single season, provided there is an adequate food supply. This very rarely or never occurs in nature and it is extremely fortunate that such is the case. The hop aphis, to refer to this species again, normally produces three generations on the plum, about eight on the hop and then migrates back to its original food plant, so that the production of 10 generations in a single season is normal for certain species. The immense rapidity with which the life cycle is completed is rendered possible by the development of generation after generation of agamic or asexual individuals. This means that there is a nearly continuous production of females, each of which begins producing young very early in life, so that reproduction is exceedingly rapid. It is interesting to note in this connection that there appears to be some relation existing between the defensive powers of an insect and its prolificacy. There is apparently, if one may use the term, a certain amount of vital energy in each species which may be used in several ways. Prolificacy may be sacrificed for the development of efficient, aggressive weapons, for a substantial defensive armor, or these may be sacrificed in turn for prolificacy and immense numbers of comparatively defenseless individuals produced. This latter is true of plant lice and is accomplished mainly through successive generations of asexual or agamic individuals. The limit of asexual reproduction has never been reached. Kyber in 1815 had the rose aphis under observation for a period of four years and during that time failed to detect the presence of a single male. Practically the same thing has been done by Professor Slingerland[1] in later years with an aphis, probably Myzus achyrantes Monell, on Achyranthes (Iresine), and in this latter instance there was no possibility for doubt, since the experimenter carefully isolated several young on the day they were born and as soon as they produced young their descendants were isolated and this continued uninterruptedly for two years and ten months, during which the insect was carried through 62 generations.

[1] 1893. Science. Jan 27 21: 48-49

Value of alternate food plants. The ability of plant lice to hold their own is much increased by the habit possessed by certain species of living on alternate food plants. This means that a usually somewhat definite number of generations is produced on one food plant and then migration occurs to another and a second series of generations is passed followed by a return migration to the original food plant. This latter may occur the same year or the following season, and after the development of one or more generations completes the life cycle. This migration is undoubtedly of value to the species since it affords, in the case of those completing the life cycle in a single year, an opportunity to feed on practically fresh foliage three times during the year. This occurs when the stem mothers hatch from the winter eggs and attack the presumably vigorous foliage in early spring. The second opportunity is when the insects forsake the original food plant and establish themselves on the other, which presumably has not suffered materially from insect enemies earlier in the season, and the third comes after the return migration, the original food plant having had an opportunity to rejuvenate itself while its enemies were feeding on the secondary host. This change is undoubtedly of value and another factor is that at each migration the aphids escape for a time from such natural enemies as ladybugs, syrphid flies and aphis lions and in the case of forms breeding so rapidly as do our plant lice, this is of considerable importance and affords the species an opportunity to reestablish itself in numbers before its enemies discover it in the new location. This latter method of escaping from natural enemies would in all probability be accomplished equally well if the insects migrated simply to uninfested plants of the same species, but the chances of finding such at hand are not nearly so great as are those of securing an entirely different food plant practically free from aphids.

Alternation of generations. Breeding on alternate food plants is sometimes accompanied by a true alternation of generations, as is exhibited in two species, the life histories of which have been worked out by Mr Theodore Pergande of the United States Department of Agriculture, Bureau of Entomology. The life histories of these two species is given in detail elsewhere but for the sake of convenience may be summarized in this connection. One species, Hormaphis hamamelidis Fitch, produces a pecular conical gall on witch hazel, which begins to develop at Washington D. C. about April 15. The winter egg is deposited near the base of the buds or leaf scars and resembles those of the ordinary apple aphis. The stem mothers are black, fringed and adorned with waxy rods and appear about April 15, become full grown by the middle of May and produce young for three or four weeks. The second or migratory generation completes its development in 16 to 20 days, is winged and flies from the last of May to the last of June and later to the birch, where a third generation is developed on the underside of the foliage, which in the fourth and last stage resembles an Aleuroydes, being oval, flattened and fringed or adorned with waxy rods. The fourth and fifth generations are like the third and also occur on the birch. The sixth, however, is more like the normal plant louse. It is clothed in its second to fourth stages with a dense, evenly shorn waxy secretion and matures into normal appearing aphids, which migrate back to the witch hazel from the last of August to early October, where the seventh or sexual and wingless generation develops on witch hazel, each female producing from five to 10 eggs. It will be noted in this species that there is a marked difference in form in the third to fifth generations, the insect for some reason or other mimicking Aleuroydes.

The other form, Hamamelistes spinosus Shimer, has in some respects a more remarkable life history than the preceding. The earlier generations subsist on witch hazel buds, which gradually develop into conspicuous spiny galls, and two years are required for the completion of its life cycle. The winter egg is deposited between the middle and the last of June and hatches about the last of May or early the following June, nearly 11 months being spent in this form. These eggs are commonly placed between or near the crotches formed by the twigs and petioles of the flower buds or scars of flower buds or seed capsules. The stem mother settles on the side of the young bud against the twig, the opposite side grows rapidly and soon arches over and finally incloses the plant louse, leaving a transverse scar and a small opening. The gall is at first rosy, then green and is adorned with large curved spines. The second generation develops within the gall and early in July, about six weeks from the birth of the stem mother, the winged adults migrate to the birch and continue there till late in the fall. The third generation is developed on the leaves and later wanders to the twigs and branches. The young are Coccidiform and resemble a young Lecanium and in the early stages are fringed with short waxy rods. They hibernate on the twigs and on the stems, where they attain full maturity. The fourth generation returns to the leaves, forms pseudo-galls by sucking the fluids from the under portion and causing an arching up of the areas between the lateral ribs. The young in the second stage bear conspicuous tufts of a white waxy secretion on the sides of the posterior segments of the abdomen. The adults of these produce the fifth or migratory generation which returns to the witch hazel from early in July till about the middle of the month. It is much like the preceding in character and is remarkable in the production of accessory wingless females, parents of a secondary migratory generation, which in turn flies to the witch hazel. The young of these migratory generations, wingless males and females, pair and produce the winter eggs which, as previously stated, are deposited between the middle of June and early July. This latter life history is fully as remarkable as that of the preceding and, as noted above, it will be seen that not only is there an alternation of food plants and alternation of generations but there is also a prolonged life cycle and an extended period of nearly 11 months passed in the winter egg.

These two species illustrate some of the remarkable features about aphids or plant lice and it is very probable that further investigations would reveal other hitherto unsuspected relationships. It is not at all impossible that some of the 325 species supposed to be distinct, may in reality be only different forms. Our knowledge of the Aphididae is altogether too limited to permit the drawing of many general conclusions and the study of this family both from the systematic and the biologic aspect affords a very enticing field for the earnest conscientious worker.

MORE IMPORTANT FOREST TREE PESTS

This division is more or less arbitrary and is adopted solely because of its convenience. It is exceedingly difficult to distinguish between the more and less important species, and the following separation is undoubtedly influenced somewhat by personal opinion. It must not be forgotten that most of the species listed as important enemies of shade trees, also feed, as previously pointed out, on forest trees, and that sometimes these earlier noticed forms may be exceedingly destructive in forest land. Our fall webworm, Hyphantria textor Harr., for example, is occasionally very abundant on forest trees and causes a considerable amount of injury. The spiny elm caterpillar, Euvanessa antiopa Linn., lives by preference on willows and poplars, occasionally defoliating extensive areas, and the depredations of the forest tent caterpillar, Malacosoma disstria Hübn., are too well known to require more than mention in this connection.

Conditions are such in this country that we must rely very largely on natural agents of one kind or another to prevent serious injury to forest trees. This will ordinarily be accomplished through the activities of various predaceous and parasitic forms, which rarely attract attention because of their abundance. Fungous diseases and unfavorable climatic conditions also play an important part in checking insect ravages. Some of our native species, in spite of these checks, are occasionally very injurious over large areas. One of the most striking cases is that of the forest tent caterpillar, a species which feeds very largely on hard maples, and at irregular and rather widely separated intervals becomes so enormously abundant as to defoliate extensive areas year after year, spreading therefrom to our shade trees.

The dangerous nature of introduced species has been generally recognized and it is well known that a considerable percentage of the more serious enemies of general agricultural crops have come to us from abroad. It is fortunate that comparatively few destructive forest pests have been brought into the country. The two most important at the present time are the gipsy moth, Porthetria dispar Linn. and the brown tail moth, Euproctis chrysorrhoea Linn. Inability to fly on the part of the first named makes it a local species, dangerous only because of its voracious appetite and the large number of food plants subject to attack. The latter species flies readily and within recent years has shown a marked tendency in America to spread into woodlands, particularly white oaks, large areas of which have been defoliated. It is nearly as destructive to hard maples and as a consequence both species are serious menaces to our woodlands. It is obviously impractical to advise extensive spraying of forests with poison, the general collection or destruction of egg masses in woodlands or similar measures, because of the enormous expense involved. It is most sincerely to be hoped that either native parasites or introduced forms, some of which have already been imported, will prove adequate checks on both of these dangerous species and obviate the necessity of employing more expensive methods for checking these pests. Experience with the larch sawfly, Lygaeonematus erichsonii Hartg., is not encouraging, since this species has for a number of years defoliated larches over wide areas in the Adirondacks and is still a serious pest.

It will probably be some years before our forests are managed with the same care as those in Europe, and for a time, at least, methods for the control of insects in woodlands must be of a more or less makeshift character. It is obvious that dead trees, whether infested by dangerous insects or not, should be removed as soon as possible if anything of value is to be gotten therefrom. The problem of adequately controlling insects in forest areas is very difficult at best and in most cases one can hardly expect at present to secure the adoption of anything more than the least costly of preventive measures. Our present system of lumbering is wasteful not only on account of the large amount of valuable material left upon the ground but because this refuse affords an almost ideal breeding ground for certain species which, under such conditions, may become excessively abundant and correspondingly injurious to adjacent trees. A more careful working up of forest products would reduce this danger very considerably and at the same time lessen the chances of destructive fires following lumbering operations. This work may be continued farther and under certain conditions it may be practical, in case serious damage is threatened by some borers, to girdle trap trees and destroy them before the insects attracted thereto and breeding within can escape and cause extensive injury over large areas. This method has a limited application and in the case of voracious leaf feeders the prospects are even less hopeful, except in parked woodlands where wholesale treatment with arsenical poisons or some other cheap method may prove advisable. It must be confessed that remedial or control measures in forest entomology are still in their infancy, but it is most sincerely hoped, in view of the great value of our lumber interests and their increasing importance, that adequate means will be devised in the near future, so that the more serious insect outbreaks can be prevented or controlled.

The importance of adequately protecting our forest areas, comprising about 26% of the entire acreage of the State, can not be overestimated. This is particularly true when it is remembered that forest products are rapidly becoming more valuable with the increased difficulty of securing an adequate supply. This alone justifies a most careful husbanding of these immense natural resources. Statistics show that the maximum output, 544,234,207 feet, compiled by the Forest Preserve Board, was attained in 1898. It is doubtful if this record will again be equaled. A farther idea of the importance of this interest to New York may be gained by reference to work already done by the State. Through its Forest, Fish and Game Commission, a general supervision is exercised over the forests, and a comprehensive plan for the creation of extensive forest preserves is being carried out. These latter, situated in the Catskills and Adirondacks, now amount to nearly a million and a half acres and will prove of inestimable value to future generations. This immense area is carefully protected from the depredations of lumbermen, and recent years have witnessed an earnest endeavor to reforest some of the barren sections through the establishment of forest nurseries in the Catskills and Adirondacks and the setting out of the product therefrom. The recent establishment of a state college of forestry with an experimental tract of 30,000 acres, is another evidence of the importance of our forest resources. The general interest in forest exploitation, using the term in a strictly economic sense, is attested farther by the fact that the demand for competent foresters by both federal and state governments and private individuals, is far in excess of the supply. The trend of the times points to a more scientific, careful administration of forest areas, and it logically follows that the insect enemies of our trees should be the subject of more extended investigations for the special purpose of ascertaining some practical methods of controlling the more dangerous species on wild land. This work, in bringing together many scattered records, should prove of great value in all subsequent studies along these lines.

ENEMIES OF DECIDUOUS TREES

Wood and bark borers

Broad, irregular, shallow galleries in the inner bark and outer sapwood of oak, hickory and several other trees, may be the work of this species
Rustic borer, Xylotrechus colonus, p. 259

A slender grub $\frac{3}{4}$ inch long and not quite $\frac{1}{16}$ inch thick, bores in the solid wood of white oak, changing to a weevil with a rather prolonged, thick snout
Northern Brenthian, Eupsalis minuta, p. 261

A blackish, golden marked beetle about $\frac{3}{4}$ inch in length, is frequently bred from hickory logs . ... Painted hickory borer, Cyllene pictus, p. 264

A brownish beetle about $\frac{1}{2}$ inch in length, may be found on cut hickory the latter part of May, the large, fleshy grubs making irregular, longitudinal burrows in the wood
Banded hickory borer, Chion cinctus, p. 267

Large, creamy yellow grubs excavating large holes lengthwise in the inner bark and sapwood of living hickory, oak, and possibly some other trees
Tiger hickory borer, Goes tigrina, p. 268

A large, white, legless grub making good sized galleries in bark and sapwood
Hickory Saperda Saperda discoidea, p. 269

Girdled and occasionally severed twigs and branches of hickory and various trees, may be the work of a thick bodied beetle measuring from a little over $\frac{1}{2}$ to nearly $\frac{3}{4}$ inch in length, the wing covers of the male being irregularly dotted with faint, tawny spots............ .... Twig girdle, Oncideres cingulatus, p. 271

A black, long snouted beetle about $\frac{3}{16}$ inch in length, breeds commonly in dying and dead hickory limbs.............. Hickory snout beetle, Magdalis olyra, p. 274

Small, brown or black beetles about 1/5 inch in length, making longitudinal burrows from which small, legless grubs excavate galleries at nearly right angles. The beetles also work in the leaf petioles and on the young twigs, causing the wilting of the foliage in midsummer

Hickory bark borer, *Scolytus quadrispinosus*, p. 275

Logs of black ash and dying trees are frequently seriously injured by borers making numerous holes in the wood, also attacks elm and hickory

Banded ash borer, *Neoclytus capraea*, p. 279

A white, flat headed grub makes very tortuous, interlacing burrows under chestnut and oak bark.............. Two-lined chestnut borer, *Agrilus bilineatus*, p. 280

Oval swellings with 4 to 5 longitudinal scars occurring on the small limbs and stems of wild thorn........... .... Thorn limb borer, *Saperda fayi*, p. 283

A flattened, whitish, rather delicate grub about 3/4 inch in length, with a large, flattened head, may be found boring the inner bark of white and other birches

Bronze birch borer, *Agrilus anxius*, p. 284

Small, pinholelike perforations in elm, particularly the diseased bark, may be the work of a minute cylindric, dark brown beetle about 1/12 inch long

Dark elm borer, *Hylesinus opaculus*, p. 288

A small, brownish, rather stout, cylindric beetle bores commonly in freshly cut ash

Ash timber beetle, *Hylesinus aculeatus*, p. 288

A minute, reddish brown, cylindric beetle about 1/32 inch in length, sinks small, cylindric galleries in dead beech, spruce and other trees

Apple wood stainer, *Monarthrum mali*, p. 289

A light brown, nearly black, cylindric beetle about 1/5 inch long, frequently enters the exposed wood of beech, oak and other trees........ *Xyloterus politus*, p. 292

Similar species of about the same general appearance, boring in white, paper and yellow birch and poplar........................... *Xyloterus* (several species), p. 293

A minute, slender, dark brown beetle about 1/25 inch long, sometimes riddles the dead inner bark of red oak

Minute oak bark beetle, *Pityophthorus minutissimus*, p. 295

Similar species working in dead black birch .... *Pityophthorus* sp., p. 296

Species usually working in seasoned wood

Fine, white, dustlike borings and numerous minute holes in well dried hard woods

Powder post beetle, *Lyctus unipunctatus*, p. 296

Dried birch and maple wood is sometimes infested by a small, dark brown beetle about 3/16 inch long, with bright, rufous antennae

Small red horned borer, *Ptilinus ruficornis*, p. 298

Forming galls on or killing willow shoots

European willows are attacked by a small, black midge which produces irregular, somewhat fusiform galls inhabited by yellowish jumping larvae

European willow gall midge, Rhabdophaga salicis, p. 299

Sudden wilting of terminal shoots may be caused by a sawfly girdling the twigs after depositing her eggs.............. ... Willow shoot sawfly, Janus integer, p. 302

Leaf feeders

Reddish, white striped or black, white haired caterpillars from [illegible] to 1½ inches in length, feed in large clusters in midsummer on black walnut and other trees

Black walnut caterpillar Datana integerrima, p. 303

A large, bluish green caterpillar with four conspicuous hornlike projections on the thoracic segments and a number of smaller ones, occurs in September on hickory and other trees................... ... Hickory horned devil, Citheronia regalis, p. 305

Black spiny caterpillars with 4 orange yellow stripes on the back and 2 along each side, frequently strip the foliage from scrub and other oaks in August

Yellow striped oak caterpillar, Anisota senatoria, p. 306

Small, black, spiny caterpillars occur in early summer, feeding in company on the leaves of various oaks, particularly in swampy places

Buck or maia moth, Hemileuca maia, p. 310

Snow white, black dotted, black tufted caterpillars occur in clusters during July, August and September, on the tender leaves of hickory and other trees

Hickory tussock moth, Halisidota caryae, p. 314

Leaves of white birch are sometimes skeletonized by a small, pale green caterpillar. The foliage turns brown the latter part of the summer, and the small, brownish yellow, ribbed cocoons serve to identify the depredator

Birch leaf skeletonizer, Bucculatrix canadensisella, p. 315

Yellowish beetles or blackish grubs about [illegible] inch in length, frequently defoliate willows and poplars, specially in the Western States

Cottonwood leaf beetle, Melasoma scripta, p. 317

Greenish black sawfly larvae about [illegible] inch long and with heart-shaped, yellowish spots on each side, defoliate willow and poplar

Yellow-spotted willow slug, Pteronus ventralis, p. 322

Blisterlike spots or eroded, skeletonized areas on honey locust leaves

Locust leaf miner, Odontota dorsalis, p. 325

Sucking insects

A circular, convex, bright yellow or golden scale insect about 1/16 inch in diameter, sometimes occurs on oak twigs in very large numbers

Golden oak scale, Asterolecanium variolosum, p. 329

Gall insects

Bulletlike, hollow, green galls of a leathery texture, may occur on hickory shoots in June, turning black the latter part of the month or early in July, and somewhat resemble the black knot of plum. . Hickory gall aphid, Phylloxera caryaecaulis, p. 331

Rustic borer

Xylotrechus colonus Fabr.

Broad, irregular, shallow galleries in the inner bark and outer sapwood of oak, hickory and several other trees, may be the work of this species

Our attention was called in 1903, to a magnificent hickory tree some 15 inches in diameter, which was badly infested by this insect, so much so that over 600 beetles were bred from two sections of the trunk, most of them appearing in May. The tree stood by itself, and as it had evidently been recently infested by large numbers of the insects, we are inclined to the belief that they attacked it while living and possibly while in perfect health; certainly their galleries were so numerous that the trunk was entirely girdled, and as the tree was living the preceding year, no other conclusion appears possible.

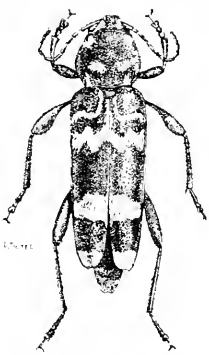

Fig. 44 Rustic borer, much enlarged (original)

Description. The larval galleries of this insect are very irregular, shallow [pl. 38, fig. 1], about $1/4$ to $1/8$ inch in diameter, and in our specimen, are so numerous that it is impossible to follow the course of any one larva. The pupae appear to lie from $1/2$ to 1 inch below the surface of the wood, the galleries penetrating no deeper. The exit holes are slightly oval and a little less than $1/4$ inch in diameter.

The adult beetles are blackish, variegated with yellowish or slate white markings, and range in length from a little less to a little over $1/2$ inch. The species may be recognized, according to Mr Wickham, by the unspotted prothorax, sometimes fasciated with pubescence, and by the absence of an apical and basal pubescent band, the elytral bands being about as broad as other intervals. Mr Leng states that the markings are very variable, but the yellow waved line running from the suture and forming the included mark, seems to be constant and peculiar to the species.

The full grown larva is about $\frac{3}{4}$ inch in length, rather stout, legless, and with dark brown mouth parts. The pupa is about $\frac{3}{4}$ inch in length, possesses the shape and general characters of the adult, and with the dorsum of the penultimate segment ornamented along its posterior margin with a nearly transverse row of four stout spines, a pair just in front of these, one on each side, and smaller ones on the anterior margin of the same segment. The terminal segment bears a single row of four rather small, curved spines on its dorsum.

The various stages of the insect have been minutely described by Dr Packard.

Distribution. This species is probably widely distributed in northeastern United States, since Dr Packard reports it as a common form, and it has been listed from Mt Washington, by Mrs Slosson, and from Ohio and southwestern Pennsylvania, by Messrs Hamilton and Dury, while Mr Ulke reports it as very common in the District of Columbia.

History. This insect is a common species and has been brought to the attention of economic entomologists, at various times, and occasionally it must be abundant, though it rarely causes apprehension on account of its killing trees.

Life history. Nothing very definite has been recorded concerning the life history of this insect, though it is probable that the transformations are completed in one year. The larvae and pupae were taken by us in April and May, and beetles appeared in large numbers throughout the latter month. The eggs are probably deposited in crevices of the bark.

Food plants. Dr Packard has named this insect the oak Clytus because it appears to infest this tree most frequently, though as stated above, we have bred it in enormous numbers from hickory. It has been met with by Mr Hunt, under the bark of sugar maple in the Adirondacks, and Dr Hopkins reports it as infesting logs and dead trees of black oak, white oak, hickory, chestnut, ash and elm. Dr Smith, in addition to those named above, lists it from chestnut and "other trees." Mr Young took a beetle at

Big Moose, July 6, 1903, on hemlock where it was probably about to oviposit.

Associated species. Several other beetles were bred from the hickory trunk infested by this species. Neoclytus erythrocephalus Fabr., was obtained in small numbers, the beetles appearing at the same time as Xylotrechus. A few specimens of Tomoxia bidentata Say, were reared from the more decayed portions of the tree and appeared in early June. The common flat headed borer of the apple, Chrysobothris femorata Fabr., was also bred in small numbers, the beetles emerging from the wood in early June. A cucujid, Catogenus rufus Fabr., was obtained in small numbers the latter part of May and early in June. This species undoubtedly occurred under the dead bark and in no way assisted in the destruction of the tree. A horn tail, probably the pigeon tremex, Tremex columba Linn., was at work in some of the more decayed portions of the trunk, accompanied by its parasite, the lunate long sting, Thalessa lunator Fabr.

Parasites. This species was rather extensively parasitized by the common enemy of many wood borers, Melanobracon simplex Cress., most of which emerged in the month of May. A few specimens of a large Ichneumon, Arotes decorus Say, were bred out in early June.

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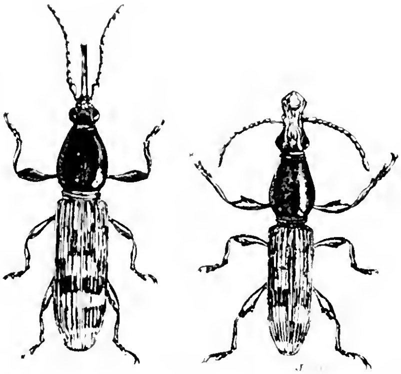
Northern brenthian

Eupsalis minuta Drury

A slender grub ¾ inch long and not quite ⅛ inch thick, bores in the solid wood of white oak, changing to a weevil with a rather prolonged, thick snout.

This is one of the most peculiar beetles found in New York State. The female is remarkable not only on account of her slender proportions, but because the beak is prolonged into a long snout which, unlike that of most snout beetles, extends almost directly forward. The male is larger and instead of a slender beak, has enormously developed mandibles, which are probably of considerable service in excavating the bark preparatory to egg laying and also in the fierce battles individuals of this sex are said to wage. This species is generally distributed in New York State, though rarely met with in numbers, probably because of its retiring habits. This insect may be easily recognized by reference to the accompanying illustration.



[illegible] brenthian [illegible] enlarged [illegible]

Description. The larva and pupa have been described by Dr Riley as follows:

Larva. Length, .55–.75 inch; diameter in middle of body, .05 inch. Body almost straight, cylindrical, 12 jointed, with a few faint hairs only on prothorax and around anus; thoracic joints short, bent a little forward, swollen and broadly and deeply wrinkled, with two especially prominent swellings on top of joints 2 and 3, converging towards head, and having each a granulated rufous spot; the other joints with about three dorsal transverse wrinkles; joints 5–9 subequal, as long as 1–3 together, twice as long as 4; 10–12 diminishing in length, slightly swollen, the anus retracted; six very small, 3-jointed thoracic legs, the terminal joint being a mere bristle; stigmata quite distinct and brown, the first pair much the largest, between the fold of joints 2 and 3; the others on anterior fifth of joints 4–11, the last pair more dorsal than the rest. Head pale yellow, darker around mouth; rounded, more or less bent over the breast, with sparse, stiff, pale hairs springing from elevated points; ocelli, none; antennae not visible, unless a dusky prominence lying close between mandibles and maxillae be called such; labium small, with two depressions and other inequalities, the margins slightly angular, allowing the jaws to closely fit around it; jaws stout, triangular, the inner margin produced at middle into a larger and smaller tooth, and with a slight excavation near tip; maxillae long, with but a short, horny cardinal piece; the palpi apparently 2 jointed and with difficulty resolved, on account of three or four other prominences around them; garnished on the inside with a close row of stiff hairs and on the outside with two stouter hairs; labium large, oboval, the palpi placed in front and 2 jointed.

Pupa. Average length .40 inch, with the antennae curled back over the thorax, the seven or eight terminal joints each with a more or less distinct, forwardly directed, brown thorn; the snout lying on the breast and varying according to sex; abdominal joints with a more or less distinct row of small thorns on the posterior dorsal edge, the last joint with a more prominent thorn directed backwards in a line with the body.

Life history. The eggs, according to Dr Riley, are laid during the months of May and June. The female bores a cylindric hole in the bark with her slender snout and pushes an egg to the bottom. The operation has been described by Dr Howard, as follows:

It requires about a day to make a puncture and deposit the egg. During the time the puncture is being made, the male stands guard, occasionally assisting the female in extracting her beak; this he does by stationing himself at a right angle with her body, and by pressing his heavy prosternum against the tip of her abdomen; her stout forelegs serving as a fulcrum and her long body as a lever. When the beak is extracted, the female uses her antennae for freeing the pincers or jaws of bits of wood or dust, the antennae being furnished with stiff hairs and forming an excellent brush. Should a strange male approach, a heavy contest at once ensues, and continues until one or the other is thrown from the tree. The successful party then takes his station as guard.

Dr Riley is of the opinion that the larva lives but a single year, though larvae of different sizes occur in midwinter with the beetles.

Food plants. This insect evidently attacks recently dead and dying trees, preferably oak, though it has been recorded by Dr Hopkins from chestnut, beech, elm, cypress and most other species of deciduous forest trees. He states that the larvae excavate extensive galleries in the solid wood.

Distribution. This species probabiy has an extended distribution in the northeastern United States, having been recorded by various writers, from New York, New Jersey, District of Columbia and Minnesota.

Painted hickory borer

Cyllene pictus Drury

A black and golden marked beetle, about [illegible] inch in length, is frequently bred from hickory wood.

This species is somewhat common in New York State, and occurs rather frequently in hickory, it being brought to notice occasionally on account of the beetles emerging in midwinter or early spring from firewood and appearing in houses. This species in the adult condition resembles very closely the insect so common on black locust, and the two beetles may be easily separated by the fact that the hickory borer is rarely abroad, except in the spring, while the locust borers commonly occur in large numbers in the fall. The two forms were confused in earlier days and for a time it was believed that they both belonged to the same species. The demonstration that these two beetles were really distinct species was largely the work of Dr Walsh and to him we owe a carefully tabulated list of differences between the two forms.

Early history. This borer is recorded by Dr Walsh as being rather rare in Illinois in 1866, and he adds that during 17 years' steady collecting he had met with but three specimens. He states that it appeared to be quite common near Philadelphia, where it was said to inhabit the walnut as well as the hickory.

This borer has been recorded by Dr Packard as occurring not only in hickory but also in black walnut, and Dr Lintner in 1893, added butternut to the list of food plants. Prof. Lawrence Bruner writing in 1893, stated that the hickories of Nebraska are very subject to attacks by this species, and Dr A. D. Hopkins records this species in dead branches and small mulberry and hickory trees in West Virginia. He obtained adults Ap. 9 and 14, pupa and larva Ap. 6, and in 1894 he found a fully matured pupa Sep. 24, evidence that this beetle may emerge in the fall. Messrs Webster and Mally have recorded the presence of this borer in Osage orange posts, 1½ feet in length and 4 inches in diameter. A large number of individuals were bred during the months of February, March and April 1897. Dr Lintner, in the same year, called attention to the abundance of these beetles in a house where they bred from firewood, a fact which has been previously recorded. He states that this species is usually rarer than the locust borer. Dr J. B. Smith records this insect as common throughout New Jersey where it breeds in hickory and is often rather injurious.

Life history. The life history of this species has been practically given, so far as known, in the preceding records. The beetles commonly appear in the spring in New York State, oviposit shortly thereafter, and the young bore in the trunk during one season and possibly longer. The winter may be passed in the pupa state as recorded by Dr Hopkins and possibly in the larval form. The characteristic work of this species is shown on plate 15, figures 7–12.

Description. The larva of this species has been described by Dr A. S. Packard as follows:

Larva. Body thick; mouth parts black; head reddish behind the antennae. Prothoracic segment (first behind the head) large and broad, being one half as long as broad; flat and broad above, the upper surface being lower than that of the succeeding segment; the anterior edge thickened, being slightly corneous; a mesial deeply impressed line, especially on the hinder two thirds, where it becomes a broad, deep, angular furrow, dividing the tergum into two quadrant-shaped halves; the outer edge of the segment rises above the flattened tergal portion, which is sparsely covered with hairs, the latter thicker along the sides of the body. The body contracts in width behind the fourth abdominal segment; the upper side of each of the first six abdominal segments (corresponding to those segments in the beetle) is raised into blisterlike swellings, especially on the fifth and sixth segments, which are much narrower than the four preceding segments. These dorsal swellings are smooth and free from fine hairs. Abdominal segments seven to nine convex above, not swollen, and the abdomen is narrowest between the fifth and sixth segments. A pair of large spiracles on the mesothoracic segment, and a pair on each of the first eight abdominal segments.

Antennae three jointed; the two basal joints being of the same length; the basal one being one third stouter than the second; the third joint filiform, and one half as long as the second joint, and ending in two or three hairs. The thin membranous labrum is divided into two parts, the basal solid, the terminal portion forming a movable flap, overlapping and reaching nearly to the end of the mandibles when closed; the basal portion is shorter than broad, being broadly trapezoidal and smooth; the outer division is broader than long, the edges being rounded so that it is almost broadly ovate (transversely) and smooth, covered with long hairs. It is pale membranous with a testaceous hue. Mandibles black, very thick and stout, with obtuse, rounded edges; they are almost as long as the base is broad. Maxillae membranous, flattened, maxillary palpi two jointed. Labium membranous, with a transverse chitinous band near the insertion of the two jointed palpi; both joints short; second one half as thick as the first; edge hairy, the hairs reaching to the ends of the palpi. Length of the body .50 inch; breadth of prothoracic segment, 4.2 mm; breadth of head, 3.2 mm.

The adult beetle is about 3/4 inch long, jet-black in color and rather prettily marked with golden yellow lines as in figure. The antennae are a dark brown and the legs a light brown. Dr Walsh states that this species may be distinguished from the closely allied locust borer by its relaxed antennae extending beyond the tip of the wing covers by the entire length of the terminal segment, by the greater robustness of these organs and by the terminal or eleventh segments being fully one half longer than the penultimate and composed of two portions connected by a suture. The wing covers of this species are widened at the base and taper toward their tips, and the second or W-shaped band is whitish instead of yellowish as in the locust borer [pl. 15, fig. 10].

Natural enemies. Dr A. D. Hopkins records Hemirhipus fascicularis Fabr. as attacking the larva of this borer in mulberry and Mr F. H. Chittenden states that Bracon erythrogaster Brulle was reared from hickory wood infested almost exclusively by this beetle.

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Banded hickory borer

Chion cinctus Drury

A brownish beetle about 1 inch in length, may be found on cut hickory the latter part of May, the large, fleshy larvae or grubs making irregular, longitudinal burrows in the wood.

This species is more or less common wherever hickory grows, though it seems to have received comparatively little attention from entomologists. It works more particularly on cut timber, and wood that has lain for a year or two after felling, is frequently so full of galleries that its value, even for firewood, is greatly diminished, while it is entirely worthless for other purposes.

Description. The adult, according to Professor Osborn, is a grayish brown beetle about 1 inch long, commonly with a yellowish, oblique band on each wing cover, a mark sometimes absent. The thorax is cylindric, with a sharp spine at each side and there are two at the extremity of each wing. The antennae of the female are about as long as the body, while in the male they are twice the insect's length.

The full grown grub is fleshy, yellowish, with the thoracic segment somewhat swollen. There are three pairs of very minute thoracic legs. The boring is elliptic in cross section, and in some cases has a longer diameter of 1/2 inch, and may extend for 3 or 4 inches with the grain of the wood.

Life history and habits. The adult beetles issue about the latter part of May, according to Professor Osborn, single females containing as many as 93 eggs. The insects display marked preference for cut timber. The young grubs commence boring the wood at once and the life cycle is probably completed within two or three years, though instances are on record where beetles have issued from furniture, carriages etc., some years after manufacture. This prolonged larval existence is probably abnormal. The transformation from grub to pupa takes place the latter part of the winter or in the spring, occasionally as early as the first of January. The gallery before and behind the insect is loosely filled with chips prior to the change.

This form is usually recorded as a hickory borer, though Mr Chittenden cites an instance where he reared this species from plum branches badly infested by the fruit tree bark beetle, Scolytus rugulosus Ratz. He also reports it as injurious to all kinds of oaks. Dr Lugger records it from apple, and Dr Hopkins has listed it from chestnut.

Distribution. This species appears to be widely distributed though not abundant in the northeastern United States, having been recorded from Massachusetts, New York, New Jersey, District of Columbia, Ohio and Minnesota.

Preventive measures. This borer displays a marked preference for felled timber, and Professor Osborn states that if the wood be cut in the fall or early winter, so that it becomes thoroughly dry before the beetles appear the following summer, there is much less danger of injury. Peeling the bark is also believed to afford considerable immunity, though this has not been established by experimental evidence. The above statements are based largely on Professor Osborn's account of this insect in *Garden and Forest* for May 1888, p. 148.

Tiger hickory borer

Goes tigrina DeG.

The large creamy yellow grubs of this species may make large holes lengthwise in the inner bark and sapwood of living hickory, oak, and possibly some other trees.

This species has been characterized by Dr Packard, as perhaps the most common borer in hickory and walnut in the Southern States. The young larvae, according to Dr Fitch, live at first on the soft outer layers of the sapwood, mining a shallow cavity about the orifice. The overlying bark dies and turns black. With increase in size and correspondingly stronger jaws, the larva gnaws into solid wood from the upper part of the burrow, boring obliquely inward and upward, all the lower portion being commonly packed with sawdustlike chips. Finally, when the grub has attained full growth, the upper end of the burrow is extended outward to the bark, in order that the adult may readily escape from its burrow.

Description. The adult has been characterized by Dr Fitch, as a long-horned beetle about 1 inch long, brown, covered with an incumbent, short, tawny, gray pubescence, more dense on the wing covers, which latter have a broad, dark brown band beyond their middle and another on their base. The thorax has an erect blunt spine on each side, and the antennae are pale yellowish except for the dark brown first joint.

Food plants. This species has been recorded by Dr Hopkins, as mining the inner bark and sapwood of living hickory and oak, while Mr Beutenmuller states that it works in the solid wood of hickory, oak and walnut, seeming to prefer white oak. This species is probably more destructive south of New York.

Hickory saperda

Saperda discoidea Fabr.

A large, white, legless grub, making good sized galleries in bark and sapwood, is very likely to be this insect.

This species is a rather common borer in hickory, though ordinarily it does not cause a great deal of damage. It frequently follows the work of the destructive hickory bark borer, Scolytus quadrispinosus Say, and is occasionally so abundant that a piece of bark 6 inches square may contain a dozen or more larvae. It is remarkable in having the sexes so unlike that one unacquainted with it, would certainly consider them distinct species. There are individuals to be found having the same color and markings as the females, and some very poorly developed specimens of the latter entirely lack the characteristic markings of the sex.

Life history. The beetles occur abroad the latter part of June and in July. The larvae feed partly on the bark and partly on the wood, and on approaching maturity enter either the bark or the wood and transform to beetles. Nothing is known concerning the duration of the life cycle or method of oviposition.

Food plants. This species has been recorded from the walnut as well as hickory. It does not appear to infest other trees.

Description. The female is about 3/4 and the male about 1/2 inch in length. The former may be recognized by the yellowish thorax and the yellowish markings on the brownish wing covers, while the latter has a black head and thorax and uniform gray wing covers.

Distribution. This species has been recorded from Canada south to Louisiana and as far west as Nebraska. It is probably generally distributed in the northern United States, at least.

Remedial measures. As in the case of other borers, it is manifestly impossible to do much except for the more valuable trees. The attack may be prevented to a large extent by keeping the trees in thrifty condition, as this insect exhibits a marked preference for unhealthy or diseased tissues. Digging out the borers may possibly be of some value.

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Red-edged saperda

Saperda lateralis Fabr.

This species is about the same size as the common elm borer, S. tridentata Oliv., and like it occurs in the elm. Its principal food plant is hickory, it being partial to injuries near the roots and infests the base of sprouts on recently cleared lands.

The beetles occur in June in northern localities, and like most Saperdas feed on the bark and stems of leaves at the ends of shoots. We have bred this species from hickory stems in which the larvae lived at the juncture of dead and living bark. They have also been recorded as inhabiting the base of dead shoots. Dr Packard states that he has reared this species from alder, but this habit seems to be exceptional. It rarely causes serious injury.

Description. The adult is a black beetle with the wing covers, thorax and head margined by a broad red line and a central one along the suture.

Distribution. This species ranges from Canada southward to Pennsylvania and westward to Nebraska. It appears to be widely distributed in the northeastern United States.

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Twig girdler

Oncideres cingulatus Say

Girdled and occasionally severed twigs and branches of various trees, may be the work of a thick bodied, long horned beetle measuring from a little over ½ to nearly ¾ inch in length, with the wing covers of the male irregularly dotted with faint, tawny spots.

This beautiful species was described by Say in 1826, who stated that it was not common and occurred on hickory. It was noticed by Dr Fitch in 1859, as a hickory insect. The work of this interesting girdler in hickory, was brought to the attention of Messrs Walsh and Riley in 1868, who were at first unable to identify it, and afterwards recognized the depredator as this species, and on looking over the literature, they ascertained that its curious method of operation had been previously discovered by Haldeman. This insect has been repeatedly noticed in various parts of the country specially because of its curious method of operation, and particularly in the Southern States, where it appears to be more abundant and destructive than farther north.

Description. The egg has been characterized by Professor Parrott, as white, elongate, oval in shape, with the ends obtusely rounded, indented with slight longitudinal depressions, and about 1/11 inch long by one fourth as wide.

The newly hatched larva has been described by him as a soft, fleshy, legless grub slightly covered with light colored hairs. It is about 1/16 inch long, somewhat shiny, white, with its mouth parts slightly tinged with brown. When full grown it is about ¾ inch in length, nearly cylindric in form, tapering a little posteriorly and swollen at the anterior extremity, within which the small head may be retracted. The mandibles are then light brown, shading to almost piceous at the tip. The other mouth parts are yellowish, except for some brownish colored notches. "On the upper and subdorsal portion of the epicranium, near anterior margin, is a row of short, parallel, chitinous ridges, interrupted at the middle by the dorsal suture. Upon the dorsal surface of each segment of the mature larva, commencing with the third and ending with the tenth, and on the ventral side of each segment, commencing with the second and ending with the tenth, appears a slight swelling containing a double, transverse row of toothlike projections, from twelve to eighteen in number, sometimes with a few odd ones in front of each row." [*See* pl. 9, fig. 12]

He has described the pupa as yellowish white and about 3/4 inch in length: "The antennal sheaths arise from the notch on the inner, upper half of the eyes, and crossing them, pass down along each side of the back, over the wing sheaths and just above the sheaths of first and second pairs of legs, and then turning inward, pass back toward the mouth parts, where they turn outward, forming a circle over the sheaths of first pair of legs. The first and second pairs of legs are above, and the third pair with exception of tarsi are below the wing sheaths. On the inner and upper margin of the base of the antennal sheaths is a short, slightly curved, hornlike protuberance, pointing backward and outward. Small, brownish, sharp points occur on the following parts of abdomen: the swellings which appear on the side of each abdominal segment with exception of the first, the upper surface, and posterior margin of anal segment, which is thickly fringed with sharp, excurved points."

The adult insect, as previously stated, ranges in length from a little over 1/2 to nearly 3/4 inch. It may be easily recognized by reference to plate 9, figure 6.

Life history. The first contribution to the life history of this insect, was by Professor Haldeman, as mentioned above, but it is to Messrs Walsh and Riley that we owe our first illustration of the insect and its work, and a somewhat detailed discussion of its life history. The adult beetles occur in Pennsylvania, according to Haldeman, during the last two weeks in August and the first week in September, feeding on the bark of the tender branches of young hickories. This insect has been the subject of close studies in Kansas, by Messrs Scheffer and Parrott, who worked independently. Professor Parrott has observed the girdling of the twig, and states that the female selects a twig seldom more than 1/2 inch in diameter, and does not make a complete circle at once but cuts section by section, as if cutting as deep as the edges of the groove will permit her. One section after another is thus cut till the twig is girdled, the entire operation taking 12 hours in some cases. These gentlemen state that the eggs are deposited beneath the bark of the girdled branches and just at the base of side shoots or aborted buds. Usually there is but one in a shoot, but in case the latter is large there may be two or three. Professor Parrott states that often two, sometimes four or five eggs are deposited, and in a number of instances they are placed at the side of and above the offshoot. A dozen or more may be found on a single branch. Mr Scheffer states that the egg protected with a gummy cap, is deposited in a puncture which has an oval aperture. It lies just under the bark, or in some cases between the layers of the bark. He also states that no punctures were found on side shoots, while Professor Parrott has observed a number. There appears to be no fixed rule regarding places where eggs may be deposited. They hatch in from three to four weeks after the branches drop, the young appearing as very small, cream-colored, footless grubs, which do not increase much in size before winter. Professor Parrott states that a few of the insects pass the winter in the egg, and that the larvae make little growth during this time. With the approach of warm weather they commence to eat and grow rapidly. The grubs become full grown about the middle of July, according to Professor Parrott, at which time they make a pupal cell at one end of the channel. This stage lasts about two weeks and the adults appear in Kansas between July 18 and Aug. 3. The characteristic work of this species is shown in plate 9, figures 6–12.

Injuries. Occasionally this species becomes quite destructive, as was the case in Kansas in 1894 to 1898, at which time elms in certain sections of the State suffered very severely. Professor Atkinson, in 1889, stated that this species attacks hickories and elms particularly in North Carolina, and that in some seasons it causes much injury. Serious damage to hickory, pecan and persimmon have also been reported from Mississippi.

Food plants. This borer has been known as the hickory and also as the elm twig girdler, these common designations indicating the trees most likely to suffer from its injuries. It has a considerable range of food plants, and in the South is injurious to the persimmon, oak, pecan, and is known as a depredator on apple, pear, quince, peach and orange trees. It has also been observed girdling rosebushes.

Distribution. This insect has been recorded from most of the eastern and central United States, though it appears to be rare in Minnesota and some of the northern states, while in the South its work is more abundant. Dr J. B. Smith has listed it from several New Jersey localities, where it is recorded as girdling twigs of oak, hickory, persimmon and a number of fruit trees.

Remedial measures. It is comparatively easy to control this insect, because the winter is passed in the twigs lying on the ground, and in the case of valuable trees on lawns and in similar localities, it would not be difficult to collect and burn them at any time during the winter or early spring.

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Hickory snout borer

Magdalis olyra Herbst.

A black, long snouted beetle about 3/16 inch in length, breeds commonly in dying or dead hickory limbs.

Examples of this species were bred from hickory limbs taken at Ilion N. Y., in August 1902. The tree was badly infested with a gnarly growth and presumably in poor condition. We have also met with it in large numbers in recently cut hickory limbs.

Description. The beetle is about 3/16 inch in length, jet-black, with the thorax angulated anteriorly, coarsely punctured; wing covers deeply grooved by nearly confluent series of punctures. The grub is a short, white, fleshy larva closely resembling that of the pine weevil and of other species of Magdalis.

Life history. This species appears to confine its attacks very largely to diseased and dying trees and is sometimes present under the bark in enormous numbers, at which time the inner bark and sapwood may be almost riddled by the many irregular, anastomosing galleries.

Food plants. This species is credited by Dr Packard with boring in oak as well as in hickory. It appears to prefer limbs from 4 to 6 inches in diameter, though it has also been bred from small twigs.

Distribution. Dr Horn states that this insect has the same distribution as M. barbita Say, which latter he records from Canada, Pennsylvania, Georgia and Dakota, and adds that this form is rare in the Southern States. This weevil is common in the northeastern states, since it has been recorded in a number of local lists, most of them also stating that it breeds in hickory.

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Hickory bark borer

Scolytus quadrispinosus Say

Small brown or black beetles, about 1/5 inch in length, make longitudinal burrows from which small legless grubs excavate galleries at nearly right angles. The beetles work also in the leaf petioles, and on the young twigs, causing the wilting of the foliage in midsummer.

The hickories of the Genesee valley were very seriously injured and many succumbed in 1901 to the deadly work of this bark borer. The damage was brought to public notice by Hon. W. Austin Wadsworth, formerly president of the New York State Fisheries, Forest and Game Commission, whose handsome estate of over 5000 acres is adorned with a large number of hickories, many of which have already been killed by this insect. The trouble was first observed on Mr Wadsworth's estate in 1898 and 1899 at which time many trees died; others perished in 1900 and large numbers in 1901. A personal investigation late in the fall of 1901 convinced us that 90 to 95% of the hickories in one woodland of about 200 acres in question had been killed by this borer. In fact so many of these trees had been destroyed that it was difficult to find one uninjured. This attack extended at least two miles north and south of the village and it is not improbable that a much larger area may have been seriously affected by this pest.

An examination by Mr M. F. Adams of Buffalo, Aug. 16 and 17, 1901, showed that nearly every hickory was more or less infested or had been killed, that the beetles were mostly dead at that time and that the secondary galleries made by the grubs were from 1½ to 2 inches long. He also observed that the females entered green living tissues by preference and that a large proportion of the hickory foliage had been destroyed at that time by the beetles burrowing the leaf petioles and twigs. Black walnut twigs had also suffered to some extent.

Earlier injuries. The outlook for hickories in that section of New York State is not very encouraging if we may judge from the previous records of this insect. The attention of the late Dr Riley was called in 1867 to the very destructive work of this insect about Princeton Ill., where it had destroyed hickory trees for the previous 10 years and in 1872 the injuries caused by this beetle in Washington county, Mo., were brought to his notice. This pest is recorded as having caused considerable damage about Newark N. J. from 1891 to 1894, at which latter date general alarm was felt on account of so many trees dying. It was reported as quite injurious about Crafton, Alleghany co., Pa. in 1894. The next year or two it must have caused considerable mischief as the trouble was noticed in the report of the Pennsylvania Department of Agriculture for 1896 and there this insect was characterized as the most destructive bark beetle in Alleghany county where it had caused the death of a large number of hickories.

Mr C. W. Johnson observes in this report that the borer was most destructive in woods where the underbrush had been trimmed out and it may be well in this connection to notice that practically the same conditions obtain among the infested hickories at Geneseo.

Professor Osborn records considerable injury to hickory and walnut trees in Iowa about this time, the leaves of all being cut off more or less and some 8 inch shell bark trees killed.

Life history and habits. The life history of this borer may be summarized as follows. The beetles appear from the last of June to the last of July and may be found in New York State up to the middle of August. They bore young twigs, terminal buds and green nuts, evidently for food, and in this manner they frequently cause the wilting of leaves and the death of twigs. They attack the bark of the trunk and the larger branches in July, each female making a vertical gallery an inch or more in length and along the sides of which she deposits in small notches 20 to 40 or 50 eggs. The parental galleries are frequently very regularly placed on the tree one above another. The eggs soon hatch and the grubs work in the tissues at first at nearly right angles to the primary galleries but those at the extremities soon diverge from the others till they run nearly parallel with the wood fibers. The larval galleries rarely cross each other. Winter is passed by the grubs in a nearly full grown condition. They transform to pupa the last of May and the beetles appear about a month later. [*See* pl. 30, fig. 4 for method of work in trunks]

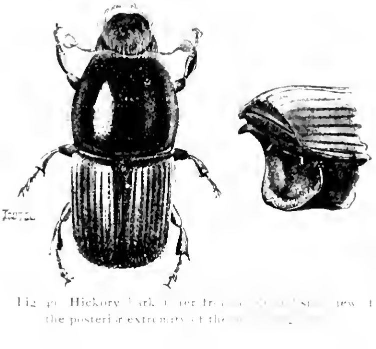

Fig. 46 Hickory bark borer [illegible] view of the posterior extremity of the [illegible]

Prof. J. B. Smith of New Brunswick has expressed the opinion that two broods of this insect may occur in Pennsylvania but no other writer has observed anything which indicated more than one annual generation and the latter seems to be true in New York State at least.

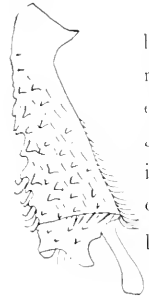

Fig. 47 Middle tibia of hickory bark borer (original)

Description. The adult insect is a small brown or black beetle about 1/5 inch in length. This species is more easily recognized by its characteristic work in hickories as the differences between the adults of the various forms are not very apparent to other than experts. The grubs are about 1/4 inch in length, white with brownish heads and powerful dark colored jaws. The structure of the antennae is shown at plate 67, figure 15.

Signs of injury. The preliminary signs of injury are exceedingly important because they frequently tell of the trouble before it has passed the remedial stage. Wilting leaves and dead twigs in midsummer are the principal indications of the beetle's work though this is not usually observed till the trees begin to die at the top from no apparent cause. Examination of the infested bark may reveal parental galleries 1 to 1½ inches long with diverging, dilating larval galleries and if the brood has completed its transformations, portions of the bark will be dotted with holes, such as might be made with no. 8 buckshot, through which the beetles have escaped.

Natural enemies. This insect has a number of natural enemies but unfortunately in the case of the Geneseo outbreak they appear to be relatively scarce. There are three very small four winged flies which breed on the grubs in their galleries. They bear the scientific names of Spathina trifasciata Riley, S. unifasciatus Ashm., and Lysitermus scolyticida Ashm. We obtained examples of the Spathius from infested wood from Geneseo. Another four winged fly known as Bracon scolytivorus Cress. also breeds in this insect and appears to be one of the forms we reared. A predaceous bark beetle, Clerus ichneumoneus Fabr., preys on this species and is probably the form we found in association with this borer.

Remedial measures. Previous records indicate that such attacks may extend over a series of years and result in the death of a very large proportion of the trees in a locality, and nothing but the prompt execution of drastic measures over the entire infested area would avail much when the pest is abundant over large areas. It has been shown that the insects spend most of their lives boring the inner bark and outer sapwood and are therefore mostly within the tree and hence inaccessible to attack unless the trees are cut and the infested bark removed. It is not enough to simply cut the trees. The removing of the bark will cause the death of most of the borers but more thorough work will be accomplished by burning the infested limbs and trunks before the beetles emerge in June. Thoroughly infested trees and affected portions of others are doomed and therefore it can hardly be considered a loss to cut them at once while a great risk is taken if they be allowed to remain, thus rearing hosts of beetles which may be expected to attack other trees the following summer. The more valuable trees should have all their infested branches cut away and burned. It might pay in the case of highly prized individuals on lawns to spray them about the middle of May with arsenate of lead, using one of the prepared paste forms at the rate of 6 to 8 pounds to 50 gallons of water and taking special pains to cover the twigs and base of the leaf stalks with the insecticide. The object of this is to kill the beetles as they begin to gnaw their way into the twigs and leaf stalks. Similar treatment of the limbs and trunk might aid to a considerable extent in preventing the entrance of the beetles though it would require very thorough work, as the insects usually enter the tree from under some projecting scale of bark, a place where it would be very difficult to put the poison. Our principal dependence must be in the destruction of the infested trees.

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Banded ash borer

Neoclytus capraea Say

Logs of black ash and dying trees are frequently seriously injured by borers belonging to this species

This insect has been known for years, and Dr Riley has placed on record an instance of serious injury presumably by this species. Mr Shelby Reed of Scottsville N. Y., in 1880 referred briefly in the *American Entomologist*, to a widespread destruction of black ash forests in his vicinity by an insect which was probably this species. The beetle may be recognized by the following description:

Dark brownish purple, head and thorax darkest; eyes nearly circular, behind them a narrow yellow border; thorax barrel-shaped, deep purple, surrounded by three very narrow yellow lines, one at each end and one in the middle; scutel yellow; wing cases crossed by three yellow bands; first, a semicircular band from the scutel running backwards and round up to each shoulder; then another of similar shape about the middle, with the circle reversed; then a straight band, and a strong spine at the tip of each; length, $\frac{1}{2}$ inch; width, $\frac{1}{6}$ inch.

It is separated, according to Professor Wickham, from allied forms, by the femora not being spinose, its falciform antennae and the many strongly elevated, though more or less confused transverse ridges on the thorax, in connection with its apically rounded elytra and the yellowish, transverse bands forming an oval figure at the base of each, behind which are two slightly oblique fasciae. This species is reported as rare in New Jersey. It has been listed from the District of Columbia, where the adults were found on flowers and trees, and Dr Hopkins has taken it in West Virginia. The latter reports it as very injurious to dying trees and sawlogs of black ash, the larvae making numerous holes in the wood. Mr Beutenmuller, in addition to the food plants given above, records it also from the limbs and trunk of elm and hickory.

Two-lined chestnut borer

Agrilus bilineatus Weber

This white, flat headed grub makes very tortuous interlacing burrows under chestnut and oak bark

This species was brought to the writer's attention in November 1901 because of severe injury to oaks at Geneseo. Several large trees had been killed by the work of this borer and examination of the infested bark showed that the inner layers were very badly riddled by the interlacing galleries of this insect.

Early history. This species is comparatively unknown to economic entomologists. It was recorded by Dr Packard as occurring under the bark of an oaktree at Providence R. I. He found pupae May 30, and beetles were common on the leaves. Mr Adams Tollman of Concord Mass., reports taking over 100 specimens of this beetle on white oak June 15, 1885, and Dr A. D. Hopkins, writing of this insect in 1894, states that different species of oak in and around Madison Wis., were seriously affected by this borer which caused the death of isolated trees and groups of trees. He also noted what appeared to be the same trouble at different points through Ohio, Wisconsin and Indiana, and later in West Virginia observed a number of trees dying in the same manner. He found the larvae mining the inner bark and outer sapwood and from his observations was led to believe that the insect was capable of attacking and killing healthy oak and chestnut trees. Two years later he states that this species was responsible directly or indirectly for the death of a great quantity of oak and chestnut timber not alone in West Virginia, but in different sections of the country between there and the Mississippi river. Prof. C. W. Johnson in 1896, found that the red oak near Natrona, Allegheny co., Pa., were dying at the top, and examination showed that the bark of the living portion of the tree near the top was a complete network of Agrilid burrows, probably this species, scores of larvae being found in the inner bark. Mr W. H. Harrington in the same year, records taking this insect on beech, and expresses the belief that it infests this tree. This beetle was the subject of an extended notice by Mr F. H. Chittenden in 1897, and from his account many of the following facts are taken. He records injury to chestnut trees by this species in Botetourt co., Va. in 1891, and the following year to chestnut in the District of Columbia. His attention was called in 1893, to serious injuries in Virginia in the vicinity of Washington D. C., and investigation showed that this insect had inflicted considerable loss. He states that the chestnut was almost universally infested and that the majority of the trees had been recently killed. The damage was estimated at about 50%, and Mr Chittenden further states that a similar condition existed in neighboring forests of the surrounding region.

Life history and habits. This species operates just under the bark of the tree, making galleries which run mostly across the grain, and when completed are from 6 to 10 inches in length. The result is that a tree seriously infested is very quickly girdled. The larval galleries were observed by Mr Chittenden from the base of the tree well upward toward the top.

The life history of this insect has been summarized by him as follows: The adult beetles appear in the District of Columbia during May and the early part of June, their emergence varying according to season and locality. Eggs are deposited on the tree and the larvae work under the bark in the manner described above. The following spring they construct a chamber which in living trees, so far as observed, is always in the bark, and in the case of small dead trees in the wood. The final transformations take place in cells thus formed. The pupal stage lasts about two weeks and then the beetles appear. Mr Chittenden records this species as infesting the white, scarlet and yellow oaks.

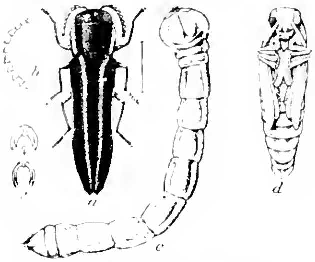

Fig. [illegible] A g r i [illegible]: a, adult beetle, enlarged; [illegible] antenna of same, enlarged; [illegible] claws of posterior tarsi of female, somewhat enlarged; [illegible] same of male, somewhat enlarged; [illegible] larva, enlarged; d, pupa, enlarged (After Chittenden, U. S. Dep't Agric. Div. Ent. Circ. [illegible] ser. [illegible])

Description. The beetle is nearly 3/8 inch in length, elongate and subcylindric in shape. It is black with a more or less greenish tinge, and the thorax is clothed with a light golden yellow pubescence, and the wing covers are each marked with a stripe of the same color. The larva or borer is long, slender, considerably flattened, and a milk white or yellowish color, except the mouth parts and the peculiar anal forks which are dark brown. The pupa is white like the larva.

Distribution. This species is a native insect and has been recorded as occurring from Maine and Massachusetts, southward to Texas and westward to the Rocky mountains.

Natural enemies. A single parasite, S p a t h i u s s i m i l l i m u s Ashm., has been bred from this insect in considerable numbers. Mr Chittenden states that it was exceedingly abundant in the District of Columbia during the two years this borer was destructive. Another parasite was reared but has not been identified.

Preventive or remedial measures An infested tree can not be saved and for the sake of others it should be cut before the appearance of the beetles, and the bark at least destroyed by burning. Clean culture, which in this instance would mean the removal of dying or dead limbs or injured trees, would do much towards preventing injury, as it will naturally tend to reduce the numbers of this pest.

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Thorn limb borer

Saperda fayi Bland

Oval swellings with four to five longitudinal scars occurring on the small limbs and stems of wild thorn, are the work of this species.

This little borer is local and badly infested thorntrees may be only a short distance from others entirely free from attack. It appears to be widely distributed in New York State, and should this species, like its allies, acquire a taste for cultivated fruit trees it would probably not be a dangerous enemy, as its galls indicate the presence of the borer and they could easily be cut off in time to destroy the contained insects.

Life history. The beetles appear during the last week in May or the first of June at Allegheny Pa., the males preceding the females by three or four days. They do not appear to eat and are short-lived, the whole brood, excepting stragglers, emerging and disappearing within about 10 or 12 days. The insects fly but little and usually oviposit on the same tree they inhabited as borers and drop to the ground and conceal themselves whenever disturbed. Oviposition probably occurs at night, and limbs from 1/3 to 1 1/4 inches in diameter are selected. Three to six longitudinal incisions about 3/4 inch long, equally distant and parallel one to another, are made through the bark and an egg placed in each. The larva bores underneath the outer layer of the wood for a distance of perhaps 1/8 inch and uses this as a retreat from which it feeds on diseased wood caused by the incision. The gnawing of the larvae results in an increased flow of sap and the development of the gall. The borers are about 1/4 inch in length at the beginning of the winter, at which time they retire a little further into the wood and close the opening of the burrows. When in thick limbs two or three bore obliquely till they reach the center or near it, and then proceed up it two or three inches, the galleries of different burrows being parallel but not communicating. Dr Hamilton calls attention to the fact that larvae near the center are larger, and he believes that only they attain maturity, though in our experience the different sizes indicate the sexes and unless parasitized all emerge. The larvae feed the second summer and hibernate in pupal chambers near the center and emerge the following spring. This insect and its work is shown on plate 6, figures 20–25.

Description. The beetle is a cinnamon brown, white marked insect with one elongated spot near the middle of the wing covers and a nearly circular one toward the apex.

Distribution. This species has been recorded from Canada, New York, New Jersey, Pennsylvania and Ohio, and appears to be limited in its range to the northeastern United States.

Natural enemies. Infested limbs are frequently investigated by woodpeckers and undoubtedly many larvae perish owing to the activity of these beneficial birds.

Remedial measures. It should be comparatively easy to keep this insect in check by cutting away the galls and burning them before the insects have an opportunity to escape. The only objection is that this procedure would be likely to mar the symmetry of the tree.

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Bronze birch borer

Agrilus anxius Gory.

A flattened whitish rather delicate grub, about ¾ inch in length, with a large flattened head, may be found boring the inner bark of white and other birches.

The work of this destructive borer was brought to the writer's attention in 1898, because of its serious injuries to white birches at Buffalo. Numerous specimens of the insect and its work, together with observations regarding its habits, were received from Mr M. F. Adams of that city in 1899 and 1900, and injury to cut leaved birches was reported from Rochester. A serious difficulty at this time with white birches in St Lawrence county, was considered as probably the work of this species.

Early history. This insect was till recently comparatively unknown to economic entomologists. The first record concerning its habits is that given by Dr Lintner, in his report as state entomologist for 1883, published in the 37th annual report of the State Museum. Dr Lintner states that he met with this insect on some cut poplars piled by the wayside. The beetles were observed alighting from flight in the bright sunshine and running actively about. 62 specimens were taken at the time, and Dr Lintner adds that the larvae is probably a borer in poplars. Dr Fred Blanchard in 1880, records the taking of a few specimens of this insect on the summit of Mt Washington N. H., where they had flown from below, and states that the form described occurred in Massachusetts on poplar sprouts and trunks. Prof. G. C. Davis records this species as making galls in branches of the willow, *Salix discolor*. Prof. Davis describes those made by this birch borer as an oval swelling on the stem, very similar to the one made by *Saperda concolor*, found at work on the same trees. He states that the latter insect remains mostly within the swelling and makes its exit from it, while this species excavates an oval gallery downward from the gall, sometimes in the pith, but oftener indiscriminately through the wood and emerged therefrom, frequently 1/2 inch below. Mr E. A. Schwartz mentions this species as injuring birch in connection with *Xyloterus politus* in 1890, and Mr J. G. Jack in 1896 records injury to birch trees in the Arnold Arboretum, by what is probably this insect.

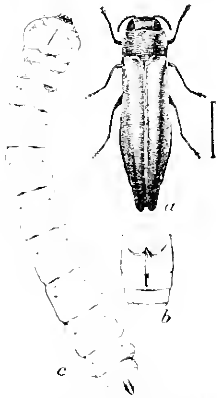

Fig. 4. Br[illegible] male beetle [illegible] first [illegible] segments [illegible] female [illegible] larva [illegible] times (After Chittenden U. S. Dep't Agric. Div. Ent. [illegible])

Description. The adult beetle is moderately robust, olive brown, and is from 3/16 to nearly 1/2 inch long. The general form of the insect is well represented in the accompanying illustration. The white pupa is about 1/2 inch in length, rather slender, and tapering to tip of the abdomen. The grub or larva is nearly 3/4 inch in length, creamy white in color and with dark mouth parts. It will be observed that the flattened head is only slightly wider than the abdominal segments. The tip of the larva is armed with a pair of linear, serrate chitinous bars.

Distribution. The distribution of this insect as given by Mr Chittenden is as follows: Mt Washington, Boston, and Jamaica Plain Mass.; Adirondacks, Elke Lake and elsewhere in New York; Alleghany Pa.; Lake Superior, Marquette, Detroit, Agricultural College and Port Huron Michigan; Stony Creek Va., and Province of Quebec near Ottawa.

Life history and habits. The larvae or borers winter under the bark. They begin to transform to pupae in the early part of May. Mr Adams states that larvae had straightened out though none had assumed the pupal form May 5, 1900, and that on the 27th some had changed color. Most of the pupae were a pure white on this later date, though a very few had commenced to color. June 3, no beetles had emerged, and more of the pupae had assumed a dark color. May 29, 1899, he removed some adult beetles from birch, and found many pupae, and few larvae. June 2, beetles began to issue from dry sticks, and on July 14, he found some young larvae about 1/4 inch in length at work in the cambium layer, at which time they had traveled some distance. The presence of this insect may be detected by the reddish discoloration of about 1/4 inch in width, caused by the exudation of sap and the ejection of excrement. The dying of the tops of infested trees is another characteristic [pl. 40, fig. 1]. The borer first attacks the tops, killing the upper limbs, while the lower branches remain green. Its presence is also indicated by uneven, wavy appearances on the bark, showing more or less regular spiral ridges on the smaller branches. The burrows of this insect are very irregular and interlace in a most perplexing manner. Plate 40, figure 2, is a photograph taken by

Mr M. F. Adams, and represents the intricate manner in which this insect operates. The larva enters the wood in the fall and constructs a cavity which probably serves the purpose of a pupal cell, where it undergoes its final transformation in late spring or early summer. This insect, so far as observed by Mr Adams, deposits no eggs in branches smaller than $\frac{1}{2}$ or $\frac{3}{4}$ inch in diameter.

Food plants. This species has been recorded by Mr Adams as infesting the black birch, yellow birch, and the cut-leaved birch, and as previously noted, Dr Lintner has observed it on poplars and Professor Davis has recorded it from willow.

Natural enemies. One of the common woodpeckers, probably the hairy woodpecker, Dryobates villosus, feeds quite extensively on the larvae of this pest. This bird is said to select a place on the trunk of the tree in which the larvae are concealed, and makes an incision in the bark such as that made by a penknife driven straight into the tree. This it does till it locates the borer, when it proceeds to pick open the bark and remove the grub.

Preventive measures. It seems very probable that a portion of the injury is due to carelessness in failing to remove the lower part of the trunks of infested trees. Mr Adams states that in some instances the upper portion of the tree was cut, and about 6 feet of the trunk was allowed to remain as a support for flower vases or for some other purpose. The leaving of such a trunk would be very favorable for the pest, and undoubtedly results in the breeding of large numbers. Nothing better can be suggested than cutting and burning the infested trees, or portions of the same, before the beetles appear in the summer. The application of an insect lime such as dendrolene would hardly be advisable in the case of a light colored tree like the birch. It may pay to band more highly prized trees with paper during the latter part of May, allowing the wrapping to remain for a period of two or three months.

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Dark elm bark borer

Hylesinus opaculus Lec.

Making small, pinholelike perforations in elm, particularly diseased bark in August and September, a minute, cylindric, dark brown bark beetle about $\frac{1}{8}$ inch long, its wing covers marked with deeply impressed, punctured furrows and bearing short hairs.

This species mines under the green bark of elms, particularly those in a sickly or dying condition. It is not, as a rule, injurious.

Description. This beetle has been described by Dr LeConte as follows: "Cylindrical, brownish black, opaque, thinly clothed with short stiff yellow hairs; antennae and feet ferruginous; head convex, thickly punctured; prothorax nearly as long as wide, narrowed in front, side subsinuate near the tip; densely but not finely punctured, with a very narrow faint dorsal carina; elytra with striae composed of deep subquadrate punctures, intervals narrow, rough with transverse rugosities." The antennal structure is shown on plate 67, figure 6.

This species has been recorded from the Middle States and Pennsylvania by Dr LeConte, and Dr Smith lists it from New Jersey, where it is said to mine the green bark of elms.

Ash timber beetle

Hylesinus aculeatus Say

A small, brownish, rather stout, cylindric beetle bores commonly in freshly cut ash.

This species is our most common ash borer, and specimens may be found wherever ash posts have been split in the spring of the year. The main adult burrow is usually excavated in the inner bark and sapwood by two females working in opposite directions from the entrance point, which latter is usually indicated by a slight notch. The compound main gallery is from about 1 inch to nearly 4 inches in length, and eggs are deposited at short intervals on each side, young larvae making their gradually dilated burrows at approximately right angles to the parental groove. The lateral burrows are from about $\frac{1}{2}$ to nearly 2 inches in length.

Description This beetle has been described by Zimmerman as follows: "Of the same form as the European H. fraxini but smaller; blackish brown, thickly clothed with very short ashy squamiform hairs; antennae and feet ferruginous; a large spot on the middle of the prothorax and the side margins are blackish brown; upon the elytra the fifth interval from the base to the middle is blackish brown, the color is then divided into two branches, and prolonged obliquely to the suture; the humeri are ferruginous; the rows of small acute elevations on the intervals of the elytra have suggested the name of this species." Dr LeConte states that in well preserved specimens, beside the two oblique bands behind the middle, there is a third one very near the tip and with the sides of the elytra also dark colored.

[illegible] Middle tibia of Hylesinus aculeatus much enlarged (original)

Distribution. Zimmerman records this species from the Northern States and LeConte from Massachusetts to Texas, Kansas and Oregon. Dr Smith states that it is common in New Jersey on cut ash and that it mines under green bark.

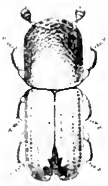
Apple wood stainer

Monarthrum mali Fitch

A minute reddish brown, cylindric beetle, about [illegible] inch in length, sinks small cylindric galleries in dead beech, spruce and other trees.

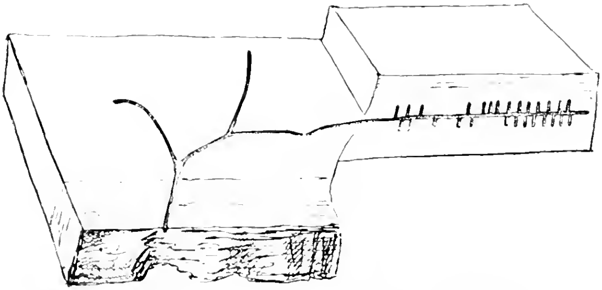
This little borer was taken by the writer Aug. 21, 1900, at Floodwood, in a fallen beech which had begun to decay. It was also found by him on the 22d at Axton, working in the stump of spruce 6 or 8 weeks after cutting. This species was met with by Dr Fitch in 1855, working in young thrifty appletrees. He states that the attack is characterized by the trees putting forth their leaves in the spring and then suddenly withering, as though scorched by fire, the bark becoming loosened from the wood, and soon after numerous pinlike perforations appearing in the bark of wood, from each of which emerges an example of this beetle. He adds that he knew of the insect only by specimens recently received from Middlefield Mass., from Lawrence Smith, who states that he took them July 6 from the trunk of an apple tree 10 inches in diameter, which was badly riddled by the burrows of this insect. It is probable that the effects described above were the result of some other agency since this species operates almost entirely in the wood. Mr E. A. Schwartz has observed this species at work in red oak at Washington D. C., and Dr LeConte states that it ranges from Lake Superior to Florida.

Description. The parent beetle is a minute reddish-brown, cylindric insect, about /32 inch long. The shape of the antennal club, the puncturing of the prothorax and the linear dotting of the elytra are well shown in figure 51. Structural details of the first are shown on plate 67, figure 1. The elytral declivity is slightly excavated and marked by two rather inconspicuous teeth on each side.

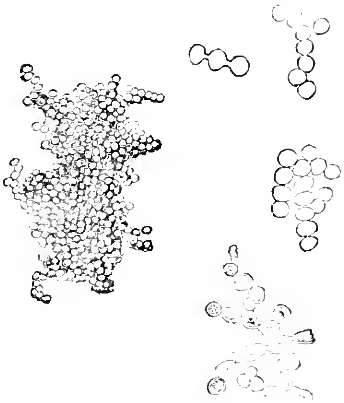


This insect enters the dying or dead tree vertically for a distance of about $\frac{1}{4}$ inch and from that point inward branches may diverge at oblique angles. The brood chambers are nearly $\frac{3}{8}$ inch long and extend vertically above and below the main branches [*see* fig. 53].

Food plants. Mr H. G. Hubbard states that this species attacks oaks, hickory, beech, maple, aspen, apple and orange, and that the list might be extended to include hard wood timber. Dr A. D. Hopkins has recorded this insect as occurring in West Virginia in pine, white oak, black oak, red oak, jack oak, elm, beech, maple, chestnut, bass wood, honey locust, yellow poplar or tulip, buckeye, morello cherry, red cedar and hemlock.



Life history. Mr H. G. Hubbard has made some interesting observations on the life history of members of this genus. He states that the males assist the females in forming new colonies, and that the young are raised in separate pits or cradles which they do not leave until maturity is attained. The galleries constructed by the female beetle, extend deeply into the wood with their branches mostly in a horizontal plane, figure 53. The mother beetle deposits her eggs in circular pits which she excavates in the galleries in two opposite series parallel with the grain of the wood. An egg is deposited in each and the cavity packed with chips taken from the fungus bed on which ambrosia had begun to grow. The young grubs eat the fungus and eject the refuse from their cradles. At first they lie curled up in the pit made by the mother, but as they grow larger they deepen the cradles with their own jaws till when full grown they slightly exceed the length of the fully extended grub. The young swallow the wood which they excavate. It passes through the body unchanged in texture and is excreted in pellets stained a yellowish color. A portion of the excrement is evidently utilized to form the fungus or food bed. The mother beetle is constantly in attendance on the young during their developmental period and guards them with jealous care. The mouth of each cradle is closed with a plug of the food fungus and as fast as this is consumed fresh material is supplied. The grubs perforate the plug from time to time and clean out their retreats by pushing the pellets through the opening. They are removed by the mother, and the opening again sealed with ambrosia. The transformation to the adult occurs in these lateral galleries or cradles.



Mr Hubbard states that the habits of Monarthrum fasciatum Say and those of this insect are identical and that they feed on the same fungus and are commonly associated in a tree, not seldom occupying galleries having a common entrance. He adds that both species are known to attack wine casks and that they probably breed only in dying trees.

Dr A. D. Hopkins has recorded this, among other species, as being attracted to a freshly painted geenhouse evidently by the odor of turpentine.

Natural enemies. Only one natural enemy so far as known to the writer, has been recorded. Dr A. D. Hopkins states that he found the predaceous beetle, Colydium lineola Say, with this species in jack oak.

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Xyloterus politus Say

A small light brown to nearly black, cylindric beetle, about 1/8 inch long, frequently enters the exposed wood of various trees.

This is apparently the more common species of this genus in New York State. It was taken by the writer at Floodwood, Aug. 21, 1900, in a fallen beechtree which had begun to decay, and also on Aug. 23 in the stump of a recently fallen soft maple at Axton. Newly transformed pupae were present in the brood chambers in the latter instance. This insect has been recorded by Dr Hopkins as occurring in the following trees: beech, black oak, white oak, red oak, hemlock, sugar maple, red maple, chestnut, magnolia, elm, hickory, ash, birch and black spruce. Mr E. A. Schwartz has also recorded this insect as infesting ash-leaved maple and box elder, Negundo aceroides. It will be seen by the above that this species is not closely limited in its selection of trees, and it appears very probable that the condition of the trunk has much to do with its being attacked.

This borer is stated by Mr Hubbard to infest the sapwood of deciduous as well as coniferous trees. He adds that it has a wide distribution in the diversified forest region of the eastern United States, and adds that it is a dangerous enemy to smooth barked trees whenever they become weakened, injured or shaken by storms.

Description. This beetle is more slender and a little smaller than Xyloterus bivittatus Kirby. It varies in color from light brown to almost black, is cylindric in shape, about 1/8 inch long. The form of the antennal club, and the sculpturing of the dorsal surface is shown in figure 55. This species and the following have divided eyes, the two divisions being some distance apart and connected only by a narrow, dark strip, best seen in recently transformed, light colored individuals. The galleries of this insect may extend to some depth in the wood, lateral burrows being given off at intervals and the brood chambers occurring very close together, almost like the cells of a honeybee. The walls of the galleries and brood chambers are a deep black as in the case of allied species. The antennal structure is shown on plate 70, figure 4.

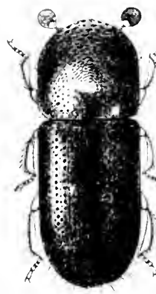

Fig. 55 Xyloterus politus (After Hubbard, U. S. Dep't Agric. Div. Ent. Bul. 7, n. s. [illegible])

Natural enemies. A predaceous beetle, Colydium lineola Say, has been recorded by Dr Hopkins as occurring in the burrows of this species. Another small beetle, Ips sanguinolentus Oliv., has been found by Dr Hopkins in association with this species feeding on the sap of sugar maple.

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Xyloterus sp.

A beetle belonging to this genus was met with by the writer at Saranac Inn, Aug. 20, 1900, in white birch, where it was working in partly dead wood.

Fully developed beetles were found in many of the side galleries, while numbers were empty.

The burrows of these beetles are about medium size, and the brood chambers are placed less than their diameter apart, in the specimens examined.

Xyloterus sp.

This rather stout species was taken Aug. 20, 1900, from the trunk of a partly decaying paper birch at Saranac Inn. There were many fully developed beetles in the brood chambers. The same insect, in all probability, was found Aug. 23 working in the dead, nearly dry limb of a yellow birch at Axton.

Description. The head, prothorax and ventral surface of this beetle are black. The wing covers are a dark, sooty yellow bordered with black. It is a rather stout species a little over 1/8 inch in length. The legs vary from an amber to a black, the tarsi usually being amber.

The burrows of this species penetrate, like others, some little distance before branching. The brood chambers are alternating and about 1/8 inch apart.

Xyloterus sp.

The work of a member of this genus was met with by the writer at Axton, Aug. 23, 1900, in a dead limb of a yellow birch. The tree was nearly dry when it was discovered. The burrows of this species are of a medium size and the brood chambers in the specimen examined were placed at a distance greater than their diameter from each other.

Xyloterus sp.

A cylindric, stout brownish black beetle, makes somewhat large galleries in stumps of poplar, Populus grandidente.

This species was met with by the writer in August 1900, at Axton, where it was running galleries in a stump of a tree cut about a year ago. This species is a large, rather stout one, and its galleries of a corresponding size, being nearly 3/32 inch in diameter.

Minute oak bark beetle

Pityophthorus minutissmus Zimm.

A minute slender, dark brown beetle, about 1/16 inch long, sometimes riddles the dead inner bark of red oaks.

This species was found by the writer in great numbers at Manor, Oct. 3, 1900, mining the bark of piled red oak cord wood which was probably cut the preceding winter. Dr A. D. Hopkins has recorded this species as infesting black oak, white oak, jack oak, chestnut oak and dogwood, and he has observed a chalcid fly attack the adults. This species has also been recorded by Dr Riley as mining the dry oak bark.

Description. The adult is a small, rather slender dark brown beetle, about 1/16 inch long. The head is ornamented with two bunches of yellowish, curved hairs. The prothorax is rather coarsely tuberculate and the wing covers or elytra are very finely striated. Certain structual details of this beetle are shown on plate 67, figure 11, and its method of work on plate 39, figure 1.

The beetle runs its galleries transversely to the bark fibers, depositing eggs on either side, the young hatching therefrom work at nearly right angles to the parental grooves and therefore nearly parallel to the grain of the wood. This insect, when present in numbers, soon riddles the bark and as the numerous exit holes allow ready access to moisture, decay soon follows. This can hardly be considered a species of much importance, except as it aids in hastening the decay of the wood, since it apparently confines its operations to dead bark.

A small beetle, Silvanus surinamensis Linn., was reared from a piece of infested bark, and it was evidently living on either decaying vegetable or animal matter, rather than preying on this bark borer.

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Pityophthorus sp.

A dead piece of black birch was found by the writer Aug. 5, 1900, which showed the work of this interesting species. The central chamber, as in the case of some allied species, opens into primary or egg galleries which run in the sapwood across the grain and are directly opposite each other. The specimen in hand, a twig about $1\frac{1}{4}$ inches in diameter, was half girdled by one pair of these galleries which are less than $\frac{1}{32}$ inch in diameter. The larval galleries are near together, dilate gradually, are somewhat tortuous, follow the grain of the wood, and may attain a length of $1\frac{1}{4}$ inches. They lie largely in the inner bark toward their extremity and the wood is scored somewhat.

Powder post beetle

Lyctus unipunctatus Herbst.

Fine, white dustlike borings and numerous minute holes in well dried hard woods are good indications of the presence of this little brown insect ¼ inch long.

This species is well known as destructive to seasoned woods and occasionally it makes its appearance in very unexpected localities. The writer's attention was called to this beetle in June, 1890, on account of its operations in some boards forming part of a carriage. Prof. G. C. Davis, formerly connected with the Agricultural College of Michigan, records this insect as infesting floorings in the college hall which had been laid two years before. He states that the beetles issued from the sapwood only and were probably in it at the time the lumber was sawed, and Dr J. B. Smith has noted an instance of this species emerging from a seasoned mantel which had been varnished. This insect is much better known as a pest of such well seasoned articles as wheel spokes and tool handles. The beetle has been bred from the branches of several species of oaks and from hickory, and Dr Hagen records it as injuring supple jack, a vine imported from Jamaica. Dr J. B. Smith states that it occurs in dry wood often after the latter has been manufactured into furniture or trim-

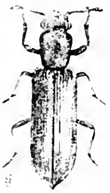

Fig. [illegible] Powder [illegible]

ming and Mr D. W. Coquillett has found this insect in dead grapevines and obtained it from an orangetree which had been cut down two years previously. He has also bred it from dry sycamore wood. Dr A. D. Hopkins states that this species infests, in addition to those given above, seasoned locust and wild cherry, and he likewise records it as injurious to stored handles, spokes and hoops. Prof. F. M. Webster states that in 1891 his attention was called to a peculiar condition of affairs in western Ohio. A complaint was made that the borer was eating not only shop floors of a manufacturer of agricultural implements but also the posts that supported the floors of the different stories. Professor Webster was able to trace the origin of the trouble to a lot of oak timber that had been piled in the yards for the purpose of seasoning and ascertained that the insect had been brought into the building as the wood was carried inside for the purpose of working it up. He states that the borer appeared to attack only the sapwood of the open floor, and would riddle this no matter where it was located, whether it was in the floor of a storeroom where it was quiet, or in portions that were constantly shaken by the rumble of machinery. A thin paper covering was left untouched on the post, while all of the sappy part within was soon reduced to powder. Professor Webster states that the larvae appear to burrow usually parallel with the grain of the wood and that they pupated in a chamber without forming a cocoon. He bred from this insect a little honey yellowish parasite, Hecabolus lycti Cress., in large numbers.

Remedial measures. Various remedial measures were recommended and tried with varying success. Professor Webster summarizes the results as follows:

Kerosene applied to the posts had little effect, and in the paint shop the frequent rubbing of paint brushes over the surface of posts did not appear to inconvenience the borers. The only place where they did not appear to depredate was in the basements, which were of necessity more or less damp. On the floors kerosene oil was effective for a time, but later investigations have shown that in time this would all evaporate and the beetles would then attack the wood a second time. The only application that was thoroughly effective and also a protection from subsequent injury, was a very thin mixture of turpentine and asphalt, or coal tar. This was applied to the posts and pillars by boring small holes obliquely inward and downward and then filling them with the mixture, which would quickly penetrate the powdery mass in the burrows, not only killing all life with which it came in contact, but also carrying with it the asphalt, thereby rendering the uneaten portion permanently distasteful to the insects.

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Small red horned borer

Ptilinus ruficornis Say

A small dark brown beetle, about [illegible] inch long, with bright rufous antennae, may be found boring in wood of various kinds.

This species was brought to the writer's attention July 11, 1900, by the receipt of a number of examples from Saranac Inn N. Y., accompanied by the statement that birch and maple floors were severely injured in some of the cottages.

This beetle also infests trees where the wood has been exposed, and it has even been found in kindling wood. Mr W. H. Harrington states that he has seen great numbers of these insects issuing from maple trees which had been riddled with small holes. He states that these beetles are very common and attack various trees, both living and dead. He adds that when a tree, such as an oak, hickory or maple has been injured by blazing or peeling off the bark, this little beetle may frequently be seen boring into the exposed wood, or if the injury be an old one, possibly numbers may be found emerging.

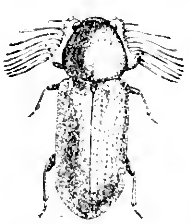

Fig. 57 Small red-horned borer, much enlarged (original)

Mr W. L. Deveraux is said by Dr Packard to have found larvae of this insect in great abundance in timber, logs and cord wood. He states that it deposits its eggs in the summer in which the tree is cut and that many generations follow each other for a number of years in the same log. Dr A. D. Hopkins records this species as infesting dead or dry wood where the bark has been removed on living trees, logs and stumps of beech, wild cherry, cultivated cherry, maple and ironwood, and states that he has met with the adults in February, April, June and July.

The adult insect is a dark brown beetle, about [illegible] inch long and with bright rufous antennae, which are remarkable in the male because of the extremely long lamellae or pectinations, those of the female being strongly serrate. The immature stages have not been met wich by the writer.

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European willow gall midge

Rhabdophaga salicis Schrk.

European willows are attacked by a small black midge which produces irregular, somewhat fusiform galls inhabited by yellowish jumping larvae.

This is another imported species which has apparently become well established in this country, it having been found in considerable numbers in the vicinity of Rochester N. Y. during the last four years. It was brought to the writer's attention by Mr H. C. Peck, a nursery inspector, sending infested willows with an inquiry as to the cause of the trouble. Repeated efforts to ascertain the identity of the species met with failure, till early spring of 1902, when living material was sent to Prof. J. J. Kieffer, a well recognized authority in this group, who kindly determined the insect.

Injuries. This pest produces many celled galls in the stems of small willows which are grown by nurserymen for the purpose of tying stock into bundles. These abnormal growths make the willows brittle and consequently unfit them for binding purposes. This species may eventually prove a very serious pest to growers of willow for basket purposes, as infested shoots could not be used in this industry any more than for tying trees.

Introduction. This insect was doubtless introduced with imported nursery stock. Some infested willows were probably used to bind imported trees into bundles, and this is borne out by the fact that the locality where the flies were found is in close proximity to a place where an importer had been in the habit of unpacking stock.

Life history. Adults were bred from infested galls collected early in the season, from May 22 and onward. Other specimens received directly from the field, June 3 were disclosing flies, showing that in nature the adult issues at this time. The pupa, like those of many Cecidomyiids, wriggles partly out of the gall before disclosing the adult, and so many may emerge from a gall that it presents a somewhat peculiar appearance after the flies have escaped because of the numerous white, projecting pupal cases.

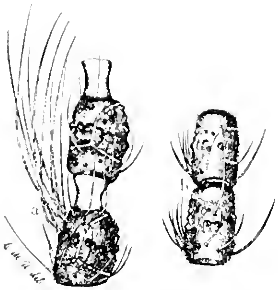

Fig. [illegible] Two antenn[illegible] [illegible]

The reddish orange eggs were deposited by captive flies on the leaves in irregular clusters or groups of three to six or more. The duration of the egg stage and of the larval existence was not determined. It seems probable that there is but one annual generation.

Description. The small black or dark brown flies are about $\frac{1}{8}$ inch in length. The eyes are black, finely granulated, emarginate anteriorly, confluent in the male and nearly so in the female. The male antennae are 17 jointed and are about the length of the insect and the female antennae are about half her length. The interesting structures occurring on the segments of the male and female antennae are shown in figure 58. The thorax is ornamented with two converging rows of silvery hairs, and a short row of smaller ones occurs on each humeral angle. The metathorax is tipped with a transverse row of the same vestiture. The venation of the wings, which are sparsely covered and well fringed with dark hairs, is represented in figure 59. The balancers or halteres are slender and tipped with yellow. The legs are very slender and long, claws bifid, toothed, and with well developed empodium. The distended abdomen of the gravid female is dark red with its load of eggs. The abdomen of the male is nearly black and the claspers are tipped with very short, minute teeth. The puparium is subconic, about 1/8 inch long, with the anterior two thirds dark straw color, and the posterior third dark rufous. The antennae and prominent dorsal processes of the pupa are represented in figure 60. The pupal mandibles are four toothed, tipped with light brown, chitinous, and the ventral tooth is nearly twice the size of the one next to it, which in turn is larger than the others, all curve some and taper to acute points.

Fig. [illegible] Wing of European [illegible], much enlarged

The larvae is stout, orange red, with 11 easily distinguished segments. It is 1/8 inch long, and the "breast bone" or sternal spatula is nearly black, enlarged slightly at both extremities, and two toothed anteriorly.

The reddish orange eggs are lanceo-elliptic in outline, and are about 1/75 inch in length.

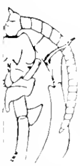

Fig. 60 Pupal skin of European willow gall midge, much enlarged

The gall occurs on the smaller shoots of the willow, and is a more or less irregular enlargement about 1/2 inch in length [pl. 50, fig. 4]. The bark from the infested portions turns brown or black before the insects appear, and the pupal case remains protruding from the empty gall.

Parasites. Several parasites were reared by the writer from this species and they have been kindly identified by Dr Ashmead, through the courtesy of Dr L. O. Howard, as follows: Tridymus salicis Nees, a species not previously known to occur in America; Tridymus metallicus Ashm. was bred in small numbers from galls received in the spring of 1902, and Polygonotus salicicola Ashm., was reared in considerable numbers. The presence of several parasites, and the abundance of at least one, leads to the hope that natural agents will soon control this pest.

Remedial measures. There is apparently no better method of checking this insect than by cutting and burning the infested shoots in early spring. If this is thoroughly done for a few years it should result in reducing the number of this pest materially.

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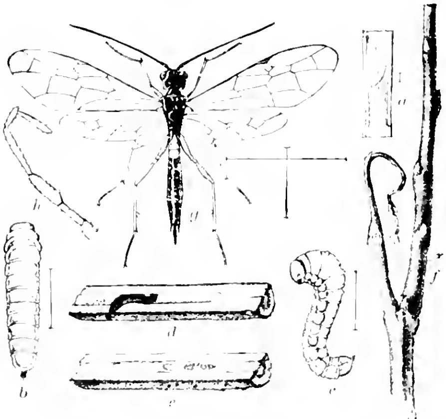
Willow shoot sawfly

Janus integer Nort.

Sudden wilting of terminal shoots may be caused by this insect girdling the twigs after depositing her eggs

This species has been known for some years in New York State as an enemy of currants, on account of its girdling habit, causing the tender terminal shoots to wilt. This sawfly has been recorded as inflicting considerable damage to both willow and poplar in Washington D. C., and in Maryland. The attack begins near the tips of the young shoots, causing them to hang down, turn brown and dry during the day. In one instance an entire field was so severely injured that it looked as though it had suffered from severe frost or as if a fire had run over it, and the insect was so abundant that by fall large numbers of the shoots had been killed down close to the ground. Similar injury has been observed by Mr W. H. Hubbard to basket willows in portions of the states of Kentucky, Indiana and Ohio, and it would not be surprising were the species to become more or less destructive in this way in New York State, though up to the present no report of such damage has been received.



Description. The adult insect is a rather slender, four winged wasplike creature with a wing spread of nearly 1 inch and a body length of a little more than $\frac{1}{2}$ inch. It is black, excepting the broad orange band at the base of the abdomen. The larva or borer is about $\frac{3}{8}$ inch long when full grown, legless, white, and with the thoracic segments slightly thickened.

Life history. The adult is abroad in early spring, and after depositing her eggs in a shoot, the female proceeds to girdle the stem below the point of oviposition, in order to prevent its further growth and thus protect the eggs from being crushed. The larvae gradually work their way downward through the pith a distance of two feet or more, and by the beginning of November have completed their growth and filled the lower ends of their burrows with frass or castings. They then gnaw a passage to the bark through one side of the shoot a little above where the pupal cell is to be formed. Within the latter they construct a delicate, transparent, cylindric cocoon in which they winter. The transformation to the adult occurs the following spring.

Remedial measures. The wilting shoots are an early sign of injury, and where the expense is not too great, the insect can be easily controlled by cutting them off below the injured point and allow them to drop to the ground. This procedure prevents the further development of the insect and affords parasites, if present, an opportunity to escape.

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Black walnut caterpillar

Datana integerrima Grote & Robinson

Reddish, white striped or black, [illegible] caterpillars, from [illegible] to [illegible] in length, feed in large clusters in midsummer on black walnut [illegible] trees

This species is the more common one of the genus found in New York State on black walnuts and hickories. It has been brought to the writer's attention a number of times during recent years, and in 1902 he observ that the caterpillars were quite abundant on the black walnuts and butternuts in and about Westfield. It was so numerous as to threaten the entire defoliation of many trees, and from statements made by residents it would appear that this is a not unusual condition. The work of the same species was observed in 1901 in and about Barker's N. Y.

Description. The eggs are deposited on the underside of the leaves in closely packed masses of 300 and over. They are rather small, elongate, hemispheric approaching cylindric and with the apex somewhat flattened. The color is a dull white and the surface somewhat roughened and with regular markings. Diameter less than 1/35 inch.

The recent hatched larva has been described by Dr Packard[1] as about 1/5 inch in length, with a brick-red body, having a faint subdorsal and a lateral yellowish stripe along the body and a diffuse spiracular yellowish line. The head, the distinct prothoracic shield and the true legs are black. The third stage has been described as nearly 3/8 inch in length, of a deeper reddish color, and with the yellowish lines more distinct, while the spiracular line enclosing the distinct black spiracles is a pale lilac.

The stage preceding the final one has been described by Mr Beutenmüller as follows:

Head and cervical shield jet-black. Body deep reddish brown, with three very fine narrow, sordid white stripes along each side, and a broader one below the spiracles, which are black, and another stripe along the middle venter. Thoracic feet, extremities of abdominal legs and anal legs jet-black, shining. The body is covered also with sordid white hairs. Length 32mm.

The same writer's description of the last stage is given herewith.

Body wholly jet-black, and covered with very long flosslike, sordid white hairs, becoming yellowish as the larva undergoes its changes to the pupa. Thoracic feet black, shining. Abdominal legs black outside and reddish brown on the inner side. Length 55mm.

These two descriptions agree entirely with the larvae observed by us in such numbers on black walnut and butternuts.

The adult insect is a brownish gray moth, having a wing spread of from about 1¾ to 2 inches, and with the forewings marked by a series of curving transverse lines. The prothorax bears a conspicuous mass of long scales bordered laterally and posteriorly with light gray [pl. 15, fig. 4].

Life history. The life history of this species is about as follows. The eggs are deposited in early August and the larvae may be observed during that month and September. They enter the ground after attaining full growth and transform to pupae within oval cells in the earth. The moths are stated by Dr Packard to appear in May and August, and this apparently indicates two broods, which may be true in the more southern portions of this insect's range but we have failed to note any signs of more than one generation in New York State.

Food plants. This insect prefers the black walnut. It also feeds on butternut, hickory and walnut, and has been recorded on beech, oak, willow, honey locust, thorn and apple.

Distribution. This species has apparently a wide range in the eastern United States at least, and has been recorded from Maine south to West Virginia, and westward to Kansas and Arkansas.

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Hickory horned devil

Citheronia regalis Fabr.

A large, bluish green caterpillar, with four conspicuous hornlike projections on the thoracic segments, and a number of smaller near by, occurs in September on hickory and other trees.

This, one of our largest native caterpillars, is a rare species in New York State. It feeds on hickory, also black walnut, and butternut, and has been recorded as occurring on persimmon and sumac.

Description. The full grown caterpillar is a magnificent creature, and may measure 5 inches when extended in its crawling attitude. Its general color is green with a yellowish cast. On the thoracic segments there are eight serrate horns, four small and black and the other four quite long, orange brown or red with black extremities. The adult moth is one of our most magnificent insects and may have a wing spread of about 6 inches. It is reddish brown with bright brick red markings and may be recognized by reference to plate 43, figure 3.

The larva is generally feared and in Virginia it is known as the hickory horned devil, an appellation which does not appear to be limited to that section of the country. The appearance of the caterpillar renders people very timid in handling it, though as a matter of fact, it is harmless. The pupa is black, short and thick, and may be found under ground. The moths appear during the last half of June. This species is very rarely abundant enough to cause material injury.

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Yellow striped oak caterpillar

Anisota senatoria Abb. & Sm.

A black spiny caterpillar with four orange yellow stripes on the back, and two along each side, frequently strips the foliage from scrub and other oaks in August.

This insect is extremely common on the scrub oaks at Karner, where it annually causes considerable injury. It is not unusual to see from one half to two thirds of these oaks stripped of foliage the latter part of August, or in early September, and more or less dead sprouts occur in that section as a result of this insect's work. The two scrub oaks, Quercus ilicifolia and Q. prinoides have very little commercial value, and the abundance of the insect in this locality can not be regarded as a serious evil. This pest however, attacks valuable oaks, as observed by the writer in 1900 on Long Island, and its depredations on such may cause considerable loss.

Early history. The attention of Dr Fitch was attracted to this insect in the latter part of August 1858, when he observed large numbers of the caterpillars in a cemetery at Saratoga where they had stripped most of the leaves from the oaks, and were at that time descending the trees probably in search of food elsewhere as few of them appeared to have attained full size. They were observed by him crawling on the surface of the light, sandy soil, and on the sides of monuments. Dr Lintner in 1889 records this species as being very abundant annually at Karner up to within recent years. The cause for their being fewer then was attributed to the destruction of their food plants by extensive fires. An earlier abundance of this insect was brought to Dr Lintner's attention by Dr James Eights, who stated that on one occasion the caterpillars were so exceedingly numerous on and about the railroad tracks between Albany and Schenectady, that the rails had to be sanded before the trains could run. This species was very abundant at Livingston, Columbia co., in 1882, as recorded by Mr Clarkson, who states that the caterpillars appeared the latter part of June, and before the middle of August had consumed all the leaves of young oaks, and had injured many of the older trees in lawns and on the borders of forests. The report of the United States Commissioner of Agriculture for 1869 contains the statement that "for 3 years the oaks near Kalamazoo, Michigan, have been entirely deprived of their leaves, and nearly all the trees attacked have died." Professor Claypole records great injury by this insect at New Bloomfield Pa., in 1882. He states that he had seen hillsides which looked as if fires had passed over them. Caterpillars were found crawling over almost every square inch of ground, and lying dead in dozens in every pool of water.

Life history. The moths appear in the latitude of New York State about the second week in June. The eggs are placed in large irregular clusters on the underside of the leaf. As many as 500 or more may occur in a single cluster as stated by Dr Lintner, though in our own collections, clusters between 200 to 300 were more commonly met with. The color of the eggs may vary from a clear white to a dull coral red. They hatch in from about a week to 10 days, and the yellowish caterpillars with their prominent black spines just behind the head, feed side by side in closely massed clusters. July 19, 1901, the writer observed many of these caterpillars feeding on oaks at Karner. Their presence at this time could easily be detected by the partly stripped branches, and also by the fine brownish excrement on the foliage below. They were so abundant that leaves covered with the little pests were easily found. The portion of the foliage on which the eggs were laid was usually untouched though everything else, and the adjacent leaves had been eaten. The small caterpillars at this time were about 1/4 inch long, and larger, darker ones, about 1/2 inch in length, were also observed. A lot of these latter were placed under observation and July 23, another molt occurred. The caterpillars were then coal-black, with bright red longitudinal stripes, and the thoracic horns considerably longer than in the preceding stage. July 27, caterpillars in at least three different stages were easily found at Karner, entire shoots had been defoliated and the younger caterpillars were frequently clustered on the under surface of the leaves. The larger larva at this time measured about 1 inch in length. Sep. 6, practically all the larvae had transformed to pupae. Dr Lintner has given the following as a summary of the life history. He states that they molt four times, the average period between each being about 9 days. Oviposition extends over a period of 3 or 4 weeks, consequently larvae may be found in several stages. Notes made by him in 1869 show that on Aug. 20, the larvae were small, some passing through their fourth molt and others in their last stage. Aug. 27 some were full grown, Sep. 8 mature larvae were found wandering prior to pupation, on the 14th, full grown larvae were still abundant, and on the 30th a few were seen. He states that the larger number probably enter the ground for pupation during the second and third weeks of September. They bury themselves to a depth of 3 or 4 inches and make a simple cell in which the final transformations take place.

Description. The moth is a bright reddish yellow color, with its front wings specked with black dots, and a large white spot near the middle. The female has an expanse of about 2 1/2 inches, and the male about 1 1/2. The latter is darker in color, and has the antennae broadly pectinated for more than half their length.

The following description of the larval stages is taken from Dr Lintner's account.

The very young larvae are black, pale yellow in color with a few short hairs, and on the second segment there are two straight subcylindrical black horns arising from a green base, and with a slight enlargement at the apex, which bears two black diverging setae about two thirds the length of the horns.

The larva in its second stage is an obscure green with seven dark lines of which the dorsal and the stigmatal are narrower, and the subdorsal ones each include a row of short spines. The thoracic shield, the anal segment and the true legs are black and the prolegs with a black spot laterally.

The third stage larva is about $\frac{1}{3}$ inch in length, head and thoracic shield glossy black, horns slightly spinose, enlarged at the tip and usually with apical spines. The abdominal stripes are black, with yellow brown between. The terminal segment is spinose and glossy black.

The fourth stage larva is about $\frac{6}{10}$ inch in length, glossy black and with eight yellow stripes. The horns are slightly tapering, clubbed at the tips, and $\frac{1}{5}$ inch in length.

The fifth stage larva has the head, thoracic shield, horns, anal shield, and legs shining black, and the body is covered with minute elevated points.

The full grown larva is about 2 inches long, about the thickness of a lead pencil, cylindrical, and of a coal-black color, with orange yellow stripes. It may be recognized by the aid of plate 17, figure 4.

Natural enemies. This species is the prey of a number of natural enemies. Its spines probably protect it somewhat from insectivorous birds, though Prof. A. J. Cook has recorded the robin and blue jay as feeding on it. One Hymenopterous parasite, Limneria fugitiva Say has been bred from this insect. Dr Lintner records the rearing of another parasite from this species, but unfortunately did not identify it. A young soldier bug, Podisus placidus Uhl., was observed feeding on the eggs of this pest.

Distribution This species is recorded as far less abundant in the Southern States than in the North. Its eastern range is apparently from Canada to Georgia and westward. It has been reported from Wisconsin, Missouri, Kansas, and California. It is a rather local insect and Dr Fitch states that he never met with it at Salem, where he resided, when it was very abundant only 25 miles distant. Dr Lintner adds that during many years collecting he had never seen it numerous in any other locality than at

Karner. The writer met with this insect in considerable numbers at Manor, Long Island, in 1900, but aside from that has not seen it in any other place than the above mentioned locality.

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Buck or Maia moth

Hemileuca maia Drury

Small black spiny caterpillars occur in early summer feeding in company on the leaves of various oaks, particularly in swampy places

This interesting species is one of the rarer forms met with in New York State. It was observed by Dr Lintner in early May 1869, at Karner, where he found a belt of eggs encircling a small twig of the bear or black scrub oak, and a colony of the insects were discovered by the writer in the same locality in 1902. The habit the larvae possess of feeding in company for a time and their large size as they approach maturity, makes the species a conspicuous one. The handsome moths are counted desirable additions to a collection.

Early history. This species was noticed in the early half of the last century by Dr Harris, who records it as a very rare moth in Massachusetts. It is stated to be more abundant in Illinois and Missouri, where it is called the buck or deer moth because of its flying late in autumn when deer run. The range of this species is given by Dr Packard as from Maine to Georgia, and westward to Kansas. It has also been rarely found west of the Rocky mountains at Dayton Nev., flying about willows in August. Dr Packard states that it occurs in California. Specimens from this latter place apparently agree, as stated by Dr Riley, with those reared by Dr Lintner in New York.

Life history. The life history of the insect may be summarized as follows. The moths begin to issue from the ground late in September and early in October in the Central or Eastern States. The males almost always appear first, as stated by Dr Riley, and in some instances emergence has been retarded a whole year. The eggs are deposited in small masses encircling twigs, the smallest number in one being 70 and ranging from that to 200. The deposition of the egg has been described by Dr Riley as follows:

Holding firmly by all her feet, the female stations herself upon a twig, with her head usually toward the end. She then stretches her abdomen to its fullest extent and fastens the first egg; another is then attached by its side, and so on, the body reaching round the twig without letting go the feet. In this manner, governed by the thickness of the twig, an irregular, somewhat spiral ring is formed and others added, until toward the last the abdomen is raised and the ovipositor brought up between the legs. The lower or first deposited ones incline so as to almost lie on their sides.

Dr Lintner states that the eggs are firmly united to one another and to the twig by a glutinous matter in which they are enveloped. This substance forms rings of black around the points of attachment of the eggs to the twig, and at the places of union between the eggs it assumes a reddish color. The young larvae hatch the latter part of May. Dr Lintner records the appearance of some on the 27th in 1869, and adds that their escape from the shell was, without a single exception, from the apex through a regular elliptic opening eaten by the larvae. The translucent or brownish yellow egg shells remain on the stems. The caterpillars feed ravenously. Those reared by Dr Lintner attained maturity July 17, entered the ground soon after and by the 22d, one had transformed to the pupa and the last by Aug. 1.

Food plants. This species has been recorded by Dr Riley as feeding on the leaves of our different oaks, and he adds that the larvae "are sometimes quite abundant on the young post, black and red oaks along the Iron mountain region." He also found them abundant on the scrub willow, Salix humilis in Northern Illinois and on a rosebush, and he states that it occurred on the common hazel, while Glover has recorded it as living on the wild black cherry. Dr Lintner states that this species probably feeds on most, if not all, of our oaks and that the larvae were readily changed from one species of oak to another.

Description. The moth is a beautiful blackish insect [pl. 17, fig. 9] with wings so thinly scaled in places that they appear semitransparent. They are ornamented with creamy white bands which are broadest on the hind wings. The male may be recognized by its broader black antennae and the smaller abdomen tipped with a large tuft of red hairs. The egg belts [pl. 17, fig. 10], range in length from 1/4 to a little over 1/2 inch, as stated by Dr Lintner, and contain from 70 to 200 eggs. The egg is about 1/20 inch long, obovate, compressed on the sides, and at the apex reddish brown above and yellowish white below, as described by Dr Riley. The following description of the various stages is abbreviated from Dr Lintner's account.

The recently hatched larva is at first reddish and then changes to nearly black and is about 1/8 inch long. It is adorned with five to eight rows of glossy black spines, each bearing four diverging spinules and a curved, ciliated bristle nearly double the length of the spine.

The young larva after its first molt is about 3/10 inch in length, has a shiny black head and a few black hairs. The body is black, and when highly magnified is minutely granulated. The spines are glossy black, with three or more branches, in the truncated tip of which is inserted a bristle about 1/3 the length of the spine. The spines of the two anterior segments are longer than the others. On segments 3 to 7 inclusive in the two superior rows, the main spine (which is trifid on segment 3, bifid on segment 4, and simple on segments 5 to 7) is acutely terminated, while its branches have the termination and armature of those elsewhere.

The larva in the second molt has a rufous head, and a fuscous body with obscure red stigmatal spots sprinkled with rufous granulations, of which there is a larger one laterally on each segment below the subdorsal row of spines. The spines and their branches are fulvous, those of the two superior rows tipped with a bristle, often black and numerously branched; the lateral spines less branching are tipped with longer fulvous bristles.

The legs and prolegs are rufous, and three hours after the molt the larva had changed to a uniform reddish brown color.

The caterpillars after the third molt are about 1 inch in length, of a fuscous color, and with the spines on the two superior rows on segments 3 to 10, and the median one on segment 11, red, with their terminal third black, simple, fasciculate, thickly radiating from a black, slightly elevated tubercle, the other spines are glossy black, branched and whitish near their tips. Spiracles linear and tawny.

The caterpillars after their fourth molt are about $1\frac{1}{10}$ inches long, and on emerging from the old skin, the head and all the spines are pale red. After a few hours the head becomes a reddish brown and the spines their normal color. The body is black, with numerous small whitish, oval papillae, each bearing a short black hair.

The larva after the fifth molt is about $1\frac{1}{2}$ inches in length and the superior spines on segment 2 have fascicular tawny, black tipped spinules, like those of the two dorsal rows, encircling their base. On segments 3 to 11 the lateral row of spines have similar fascicular spines bordering the upper half of their base, as have also the two ante-superior spines of segment 12 at their anterior basal half.

The full grown larva [pl. 17, fig. 8] measures from $1\frac{3}{4}$ to $2\frac{1}{2}$ inches in length. The head is red, round and bears a few short brown hairs. The cervical shield is glossy and bordered anteriorally with four of the eight spines with which the first segment is armed. The body tapers moderately to the extremities, is fuscous and sometimes black, and is sprinkled with numerous whitish ovoid spots, each bearing a short fuscous hair. The two superior rows of spines on segments 3 to 10 inclusive are fascicular, spreading over the anterior half of the segment, 30 to 40 in each fascicle, cylindric, tawny colored, tapering near their apex to an acute black spine. The spines of the lateral row, the substigmatal and the ventral are twice the length of the superior spines, of a glossy black color and tapering trunk, with about 12 lateral cylindric branches of nearly equal length. The spiracles are red, the anal plate a deep red, and with pitted surface and short hairs, the legs are glossy black with black hairs. The prolegs are red, with black hairs. There is a median line of brown red spots on the middle of each of segments 5 to 11.

Distribution. This species, as stated by Dr Lintner, is known to occur from Maine to Georgia and it has been reported from Indiana, Illinois, Missouri, and Iowa.

Natural enemies. The caterpillar is well protected with spines but these do not suffice to secure immunity from natural enemies. Dr Lintner states that eight out of 30 individuals he reared were parasitized by a small Ichneumon fly which proved to be Limneria fugitiva Say. He observed that this species spins a cocoon which was found under the elevated central portion of its victim's body, which was clasping a stem by its two extremities. 25 specimens of an undetermined species of Microgaster were also reared from the larvae of this insect. Dr Lintner states that their small white elongate, oval cocoons were spun on the outside of the larva and that after a few days the imagoes appeared. The same species was probably bred by the writer in 1902.

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Hickory tussock moth

Halisidota caryae Harris

Snow white, black dotted, black tufted caterpillars occur in July, August and September, on the tender leaves of hickory and other trees.

This caterpillar is rather common in New York State, and is a somewhat general feeder, though it shows a decided preference for walnut, butternut, and sumac, and is said to be common on elm, ash and linden. Dr Fitch states that he has seen clusters of this caterpillar on the larch and tamarack. It is occasionally present in such large numbers as to cause considerable injury to forest trees in limited localities.

Description. The full grown larva has been described by Dr Harris as follows:

White, covered with white hairs in short spreading tufts, a row of eight black tufts along the back; two long, black, pencil-like tufts on the fourth and tenth segments; four white on the second and third, two on the 11th and 12th. Head, prothoracic legs and surface of the body are covered with minute black tubercles and a transverse black line between each segment.

The cocoon is oval, ash gray.

The pupa is short, thick and rather blunt, not rounded at the hinder end and not downy, and the moth emerges during the month of June.

The adult insect has a wing spread from a little over 1½ inches to about 2 inches. It has light brown forewings which are irregularly spotted with silvery white and with the veins indicated by darker lines of color. The thorax is a light brown with dark brown at the base of the patagia, and the abdomen is a darker brown. The male may be recognized by its smaller size and the more pectinate antennae.

Life history. The life history of this species has been given by Dr Harris substantially as follows.

The caterpillars when young, feed in company on the leaves and when not engaged in eating bend down the head and bring over it the long hairs on the forepart of the body. They are 1½ inches long and when full grown, in the latter part of September, forsake the tree, and secrete themselves under stones or in crevices of walls, spinning oval, thin hairy cocoons.

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Birch leaf skeletonizer

Bucculatrix canadensisella Chamb.

Leaves of white birches are sometimes skeletonized by a small pale green caterpillar. The foliage turns brown the latter part of the summer, and the small brownish yellow ribbed cocoons serve to identify the depredator.

This species was exceedingly abundant in New York State in 1901, and skeletonized the foliage of white birch over large areas. It was so prevalent in the vicinity of Albany, that parties desirous of collecting the leaves for medicinal purposes experienced great difficulty in finding uninjured ones. A similar condition obtained over a considerable portion of Massachusetts. This attack is by no means unprecedented, though it is of more than usual interest on account of the large territory involved. This species was reported to Dr Lintner as very prevalent about Scottsville, Monroe co. in 1880, and in 1891 it seriously injured birches about Ausable Forks N. Y. Dr James Fletcher, entomologist of the Central Experimental Farms, Ottawa Can., stated in 1892, that for the previous three years birches of all kinds in the vicinity of Ottawa had been severely damaged by this insect. Dr Packard calls attention to the general occurrence of this species in Providence R. I., and in adjoining portions of Massachusetts, during the same year.

Description. The delicate little moth has been described by Dr Fletcher as follows.

Moth small, wings expanding 3/8 of an inch. General color, bright brown, the wings crossed with silvery white bars, three of these run from the outer edge about half way across the wings obliquely towards the apex, and there two shorter subtriangular blotches on the inner margin of each forewing. These latter, when the wings are closed, form two white dorsal saddles, the anterior of which is slightly the larger, and is followed closely by a tuft of raised black scales. At the extremities of the forewings are also several raised black scales, a few of which are separated into an apical spot by an irregular narrow white band. The cilia of the fringes are pale brown. Head white; frontal tuft dark brown in the center; antennae brown, slender, about 1/8 of an inch long. Thorax brown with margins including the bases of the forewings, white. Leg and body pale fuscous, silvery.

The full grown caterpillars measure less than 1/4 inch long, are very slender in form and taper considerably at each extremity. Deep incisions divide the body into well marked, rounded segments. The head is long, slightly bilobed, and of a pale brown color, body light green or yellowish green and bears short hairs on small tubercles. The caterpillar walks slowly, and when disturbed, drops from the leaf and suspends itself by a thread. The molting cocoon has been described by Dr Packard as being about 1/12 inch in diameter, and of white silk. The caterpillar is curled up within.

The yellowish brown cocoon is about 1/8 inch long, with a number of well marked ridges and is attached to any convenient object, such as bark and leaves.

Life history and habits. Little is known concerning the life history and habits of this insect. The eggs of the moth and the mining operations of the larvae have not been observed. The larvae occur the latter part of August or in early September, feeding on the soft parenchyma of the leaf and skeletonizing it thoroughly. At this time, small oval whitish, circular cocoons may be observed here and there on the leaves. These are spun as shelters during a molt. The true cocoons are interesting, brownish yellow, ribbed structures about 1/5 inch in length. These latter may be so abundant as to give color to portions of infested leaves. They are spun during the latter part of September, and the insect passes the winter within.

Distribution. This insect has been recorded from Canada, New England States, New York, and as stated by Dr Lintner, it will undoubtedly be found to have a wide distribution.

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Cottonwood leaf beetle

Melasoma scripta Fabr.

Yellowish beetles, about [illegible] inch in length, variably marked with elongated black spots or blackish grubs about [illegible] inch in length, frequently defoliate willows and poplars, specially in the Western States.

This insect is a well known pest of willow, cottonwood and poplar in the Western States, where it occasions very serious injury at times, specially to young trees. This beetle also occurs in the eastern United States, though it is rarely credited with causing much damage.

Injuring European willows. This species has proved a very serious enemy of the European osier or basket willow, grown in Onondaga, Cayuga, Seneca and adjoining counties, where many are raised for basket purposes. The small village of Liverpool, Onondaga co., depends almost entirely on the basket industry for its existence. Willows are grown there in large quantities, most of the inhabitants are basket makers, and nearly all the members of each family have a part in transforming the willow shoots into finished baskets. The extent of this industry is further evidenced by the fact that over 3000 tons of willows were grown about this village in one year.

Early injuries in New York State. This pest was known as early as 1875, and according to Dr Lintner, 57 acres of willows were destroyed in a swamp in Clay, Onondaga co. This discouraged the growers and for a time, fewer willows were raised. Dr Lintner's attention was next called to the insect by a gentleman who collected some of the beetles in 1887, and from that time up to 1894, it had increased in numbers steadily, and in the latter year caused so much injury as to attract general attention. The ravages of this insect in 1894 were serious enough to reduce the yield by 1000 tons. One grower raised 65 tons in 1894, and was able to secure only 25 the following year. Many fields were abandoned at this time and ploughed up and others were cut only in hopes that a better yield would be secured another season. The insect has been more or less abundant from 1895 to the present, 1902, and has been prevented from inflicting serious loss only by active measures.

Life history and habits. The beetles appear in the early spring with the development of the leaves and begin feeding at once. The most serious damage is done at this time, since they show a decided preference for the tender shoots, and by eating them make the willows branch very early, thus rendering them nearly useless for market purposes. After feeding for a time, oviposition occurs, and the yellowish or reddish eggs are placed on end side by side in clusters on the under surface of the leaf. The nearly black grubs hatch from the eggs and feed for a short time in company on the underside of the leaves, then separate more or less. The young grubs skeletonize the under surface of the foliage, and after increasing in size, eat out ragged holes. The grubs when alarmed, exude small drops of a milky white fluid which can be withdrawn at the pleasure of the insect. This process of expulsion and retraction may easily be observed by alternately alarming the grubs and allowing them to remain quiet. They also have a peculiar habit of elevating the abdomen and distending the anal proleg when alarmed. The exudation above described and the threatening movements are probably defensive means against native enemies. Pupation occurs in the partly cast larval skin which is firmly attached to the leaves by the prolegs. The pupae are known to growers as "hangers," and the adult beetles are called "hard shells." Professor Snow states that 15 days are required in August for this insect to pass through its immature stages, thus indicating that in the West, five broods may occur, though most writers credit the species with only three or four. There are said to be three annual generations of this insect in New York State, and it is very probable that with the advance of the season, there is more or less overlapping of the broods. July 23, 1902, it was possible to find all the stages of the insect. There were few eggs, more recently hatched grubs, many nearly full grown larvae, some pupae, and a few beetles. Adults, pupae and older grubs belonged to the second generation and the eggs and newly hatched larvae to the third. Most of the insects are said to disappear from the willows about Aug. 1.

Food plants. This species, according to Dr Riley, has long been known to feed on the leaves of different species of willows, and he states that it is never abundant or injurious on these trees. He adds that it also occurs on several species of Populus, and that its great liking for cottonwood appears to be a recent development. The species of willow suffering most severely from this insect in New York State, is the osier or basket willow of Europe, Salix viminalis. A German willow is also grown to a limited extent. This is a more vigorous plant, produces a larger yield, and is not so subject to insect attacks. It has a smaller market value as it is adapted only for the heavier bottoms of baskets.

Description. The adult beetle is quite variable in its markings. The black thorax is bordered with yellow, and the yellowish or yellow green wing covers are marked with three more or less interrupted lines of black spots. These markings are quite variable in their size and extent. The full grown larva or grub is about 3/8 inch in length, yellowish white, with black thoracic legs, and lighter colored prolegs. There are two rows of tubercles laterally, and four dorsally. The outer ones are glandular, and exude a pungent liquid referred to above. The eggs are about 1/40 inch in length, are deposited side by side in clusters of 10 to over 100. They vary in color from a light to a dark orange, and some have been observed of a yellowish white color. See plate 10, figures 14–20 for illustrations of the insect in its various stages and its work.

Distribution. This species is common in many of the Western States and ranges as far south as Louisiana. It has been recorded from Pennsylvania, is present, though not common, on native willows in New York State, according to Dr Lintner, and is common throughout New Jersey on willows and poplars, as recorded by Dr J. B. Smith. It probably occurs on willows and poplars throughout most of the northern United States.

Natural enemies. This species is subject to attacks by several natural enemies. Dr Riley observed adults of Megilla maculata DeG. feeding on the larvae and pupae of this pest. Prof. Conway McMillan states that besides Ichneumon and Chalcid flies, he has observed some predatory insects attacking this species, chief of these being the lady-bugs. He adds that tiger beetles and ground beetles both feed on this insect, and that he observed a reddish yellow mite clinging to the under surface of the abdomen of the beetles.

Remedial measures. Spraying with arsenical poisons has proved somewhat effective in controlling this species, and some experimental work conducted by Professor Lowe has shown that fairly satisfactory results could be obtained by the use of these compounds. The smooth surface of the willows mars the efficiency of this application because the poisoned liquid has a tendency to roll from the foliage and collect in drops. The habits of the beetles and grubs of feeding on the under surface to a great extent, makes it difficult to put the poison where they must eat it or go hungry. In all probability, a heavy application of arsenate of lead very early in the season, would give the best results. Despite the fact that spraying is cheaper than collecting the beetles, the willow growers have come to depend largely on the latter method of preventing injury. Several ingenious devices for the collection of these insects by hand or horse power, have been constructed. They are known as "bug catchers" to the willow growers, and consist essentially of a wooden trough about 20 inches broad and 4 feet long, on runners and with the sides and ends 8 inches high. Plough or other handles are fastened to the posterior end of the machine, and two diverging arms extend forward and outward at acute angles. These arms are designed to catch the tops of the willows, and bend them over the trough, the bottom of which is water-tight and contains kerosene and water. The arms for bending the willows over can be adjusted to various hights so as to accommodate willows at all stages of growth. The splashing of oil and water is prevented by several transverse and longitudinal partitions in the bottom of the bug catcher. The hand machine is pushed over the field and the tips of the willows are caught by the diverging arms, bent and the agitation shakes the insect off. The hand device is more efficient than that drawn by a horse, simply because the animal precedes the machine and frightens the insects so that many fall before the bug catcher can be brought under the willows. The former is difficult to operate and is employed only on smaller patches. It would seem possible to construct one considerably lighter than either of the forms described, and in that event the larger and improved apparatus might be operated by hand with comparative ease.

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Yellow spotted willow slug

Pteronus ventralis Say

Greenish black sawfly larvae about [illegible] inch long and with heart-shaped, yellowish spots on each side, defoliate willow and poplar.

This species is considered one of the worst enemies of basket willows, particularly in the South because of its producing several generations annually, and even in the North Dr Harris has recorded two broods as occurring in Massachusetts. All kinds of willow with the exception perhaps of the weeping willow and species developing into tall trees are injured by these slugs according to Dr Howard. The species and varieties of white willow appear to be preferred, and young poplars growing in proximity to these trees are also damaged, though their older and tougher leaves escape attack. The greatest injury is inflicted on young growth and as a consequence the species may be controlled with arsenical poisons. One of the serious features of injury by this insect is that the willow, after defoliation, produces leaves on side shoots, thus destroying the commercial value of the product for basket purposes, since the shoots should be of nearly uniform size throughout their length.

Description. The early stages of this insect have been described by Dr Dyar as follows:

Eggs [see *Insect Life*, 1:30]. In large clusters of flat, semicircular saw-cuts under the lower epidermis, 1 x 2 mm in size.

1st stage. Head round, shining black; width .55 mm. Thoracic feet long, spreading, black except at the joints; segments indistinctly 4-annulate, abdominal feet small, on joints 6–11, 13. Body slightly shining, blackish green, subtranslucent; anal prongs concolorous.

2d stage. As before. Head .75 mm wide. Body smooth, greenish black, anal prongs black.

3d stage. Head shining greenish black; width 1 mm; eyes and jaws black. Body scarcely annulate, smooth, shining, obscure blackish olive, anal fork black tipped. Thoracic feet blackish, marked with black. Body unicolorous, immaculate, or the orange spots of the next stage partly present (another brood).

4th stage. Head shining black, the front with four grooves and two dents above the clypeus; sutures around the mouth brown; width 1.4 mm. Thoracic feet large, pale olive, marked with black; abdominal ones small, on joints 6–11, 13, pale green. Body smooth, irregularly 5-annulate, the creases like slight folds; shining blackish, olivaceous, with a series of lateral pale orange spots, distinct only centrally. The spots are above the subventral fold on annulates 2 and 3.

Larvae vary in shade, some are blacker than others, and the orange spots vary in distinctness. The larvae scratch the leaf with their anal prongs and make a rasping sound.

5th stage. Width of head 1.4–1.6 mm. As before, slaty black, except the feet; lateral orange patches on joints 3–12; the two median annulates have somewhat corneous, dorsal, transverse areas, shining, but concolorous with body. Feet all pale watery. Two days after molting the larvae began to turn shining and livid and with a pale dorsal streak anteriorly and entered the ground to spin their cocoons.

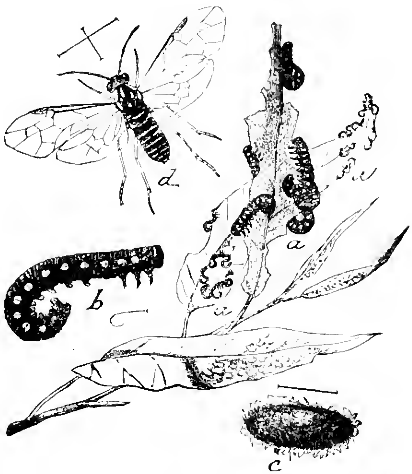

Fig. [illegible] Pteronus ventralis Say. a, larva in feeding [illegible] tion; [illegible] larva much enlarged; c, cocoon, enlarged; d, [illegible], enlarged (After Howard, Insect Life, [illegible])

The adult insect is brownish, black, marked with yellowish white and measures about 1/3 inch in length.

Life history. The first indications of the presence of these slugs on willow, according to Dr Howard, is seen in peculiar blisterlike swellings on the upper surface of the foliage, which sometimes give it a wavy or crumpled appearance. Investigation shows that these swellings are occasioned by the presence of oval, whitish eggs partially inserted in the under surface of the leaf substance. Black spots and streaks appear about the time hatching begins, four to eight days after oviposition, the effect of numerous wounds made in the leaves. The young slugs commence to gnaw small holes as soon as they hatch, those on one leaf usually feeding in close proximity to each other, though they are hardly gregarious. The entire leaf is devoured and the plant soon denuded, leaving only the thicker midribs untouched. No effort is made toward concealment and they can be easily distinguished by their black color and filthy moist excrement. Their peculiar curved position is very characteristic of the group, the posterior segments usually being turned so that they extend forward and not infrequently under a portion of the leaf on which the slug rests. The larva is full grown in from 10 days to three weeks, at which time it descends to the ground and forms a shining dark brown cocoon, apparently composed of a gluelike material. It changes within this retreat to a yellow pupa, and in the course of a week the winged sawfly appears. Eggs are deposited in the District of Columbia from May till the middle of October. This species has been recorded by Dr Packard, as feeding on wild cherry foliage.

Natural enemies. The eggs, according to Dr Howard, are frequently destroyed by a small calcid, Trichogramma, which becomes very numerous when the second brood of females is ovipositing. An ichneumon fly, Ichneumon subcyaneus Cress., has also been reared from this species, and the wheel bug, Prionidus cristatus Linn., is a very efficient enemy of this species in the Southern States.

Remedial measures. This species should be easily controlled by the application of an arsenical poison, preferably arsenate of lead, wherever it is abundant enough to warrant the expense.

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Locust leaf miner

Odontota dorsalis Thunb.

Blisterlike spots or eroded skeletonized areas on honey locust leaves, may be due to the work of the larvae and adults of this insect.

Dr Fitch describes the work of this leaf miner in his 5th report, briefly characterizes the larva, and states that he has never met with it in the eastern section of New York. This insect was also brought to the attention of Dr Lintner at various times, though he never found it in his extensive collections in Albany and Schoharie counties. It is very abundant, however, on Long Island and has been met with by the writer in Chautauqua county, where its work was very common in and about Westfield Aug. 15, 1902.

Injuries. This insect is occasionally so abundant that a large proportion of the foliage on the honey locust is ruined. The larvae form large blisterlike spots under the lower epidermis. The adult beetles feed on the under surface of the leaves, eating away the more delicate portion between the larger veins [pl. 45, fig. 2]. Dr H. G. Dyar, writing to Dr Lintner Aug. 31, 1890, stated that this insect was so abundant at Yaphank L. I., as to injure the trees very seriously, and cause a considerable proportion of the foliage to drop. Mr Chittenden records an instance where this species was exceedingly destructive in Fairfax county, W. Va., where all the locust trees over an area of several square miles were apparently dead, looking as though a fire had swept over the country. On one tract of 300 acres, on which were many locusts, not a tree could be found, either young or old, that was not in bad condition.

Description. The adult beetle is about 1/4 inch long, with the head, appendages and under surface and a median triangular area, widening posteriorly on the wing covers, coal-black, the remainder of the wings and the dorsum of the thorax are an orange red. The thorax is irregularly and deeply punctured and the wing covers strongly ridged and ornamented with deep, nearly confluent, thickly set rows of punctures.

The full grown larva is a trifle over $^1/_4$ inch long, with the head, thoracic shield, true legs and anal shield, coal black, and the remainder of the body a yellowish white. The segmentation is very distinctly marked and the abdominal segments bear conspicuous lateral tubercles, those on the second to the seventh are tipped with black and bear a black chitinous point. The brown spiracles are circular.

The egg of this species has been described by Mr Chittenden as short, oval in outline and flattened on two sides. He states that its color when freshly laid is milky white and that the shell is extremly thin, pliable, and with a very fine netlike sculpture, visible only with a strong magnifying glass.

Life history. The life history of this beetle in West Virginia, has been given by Dr Hopkins, as follows:

The adults probably appear in May or June and deposit eggs on the under surface of the leaves. The small grubs hatching therefrom burrow in and feed upon the delicate parenchyma, forming blisters near the edges which usually extend to the midrib. They transform within the blister to the pupa and the beetles soon emerge and feed upon the remaining unaffected leaves.

Mr Chittenden states that the beetle makes its first appearance in the vicinity of Washington soon after the leaves of the locust tree have fully developed, usually about the beginning of May, and from then it may be found continuously throughout the summer till the first half of September, it being quite abundant from the first week of July till nearly the middle of August. He states that the beetles of the first spring generation began to develop July 7 in 1902 and had transformed for the most part by the 12th. He adds that the beetles are usually seen apparently motionless on the surface of the leaves but close inspection will show that they are feeding. Early in the season the adults eat small oblong holes in the leaves, but later the lower half is left intact and the upper portion finely skeletonized. The injury done by the beetles, even when they are very numerous, is trifling when compared with the work of the larvae. Mr Chittenden states that during rainy weather, at night time and while ovipositing the beetles may be met with on the underside of the leaves. He finds that the eggs are deposited by the female at intervals of about two minutes, the act of oviposition itself requiring only a fraction of a second. On the completion of oviposition the beetle makes a sudden movement forward, sweeping the upper side of the egg mass with the tip of her abdomen and covers it with a large quantity of fluid, dirty yellow fecal matter which soon hardens and darkens. He adds that there are never more than five eggs in a mass. Mr Chittenden states that the young larvae invariably break through the eggshell on the underside and begin gnawing through the epidermis of the leaf without leaving the protection of the egg mass. They then proceed to devour the softer parenchyma, thus forming what is known as a tentiform mine. There is but a single entrance to the mine, the later hatching grubs availing themselves of the hole eaten by the earliest individual, therefore from 3 to 5 young grubs usually occur within a mine, which is rapidly enlarged by their united efforts. The mine in one leaf rarely occupies more than $^1/_2$ or $^2/_3$ of its area, and this means that in from two to four days after hatching the grubs forsake the original retreat, wander along leaf stems to other leaves and begin operations anew. This time each grub works by itself. The injury inflicted by the adults and the larvae, particularly the latter, causes the leaves to turn brown, wither and fall. The writer found mostly deserted mines and very few larvae at Westfield Aug. 15, 1902, indicating that the main portion of the brood had completed its transformations. Apparently there is but one generation in this latitude, specially since Mr Chittenden states that while the insect appears at Washington in May, a month earlier than in Massachusetts, and may be found in all stages throughout the summer till early in August, he has seen no evidence of a second generation being produced.

Food plants. This species prefers the locust. It also has been recorded as attacking the young leaves of red oak, and Dr Hopkins has found it on white oak, beech, birch and hawthorn in West Virginia. Mr Chittenden records the beetle as feeding on red clover, hog peanut and soja beans.

Parasites. Several small Chalcis flies have been reared from this insect. They are as follows: Spilochalcis (Smicra) odontotae Howard, was reared from the pupa. Sympiezus uroplatae Howard feeds externally on the larva within its mine. Trichogramma odontotae Howard, is an egg parasite issuing in July. Derostenus primus Howard was reared from the leaf mine of Odontota. Dr Howard thinks it may be a secondary parasite, preying on either of the first two species.

Natural enemies. In addition to the parasites named above, Mr Chittenden states that at Washington the wheel bug, Prionidus cristatus Linn., is particularly attracted by the presence of this leaf miner and the young of the wheel bug may be frequently observed walking slowly over the leaves till they have found an inhabited mine, when it deliberately thrusts its beak through the epidermis of the leaf into the Odontota larva. The beetles are attacked by this insect when met with and at once lifted in the air on the tip of the bug's proboscis.

Distribution. Dr Horn has given the distribution of this insect as "Middle and Southern States." Dr Packard records it from New England, Middle and Western States and Professor Webster has mentioned serious injuries by it in southern Ohio and the adjacent parts of Kentucky. In addition, Mr Chittenden states that it is known to occur in Massachusetts, Connecticut and Canada, though it does not appear to have ever been taken in Michigan, a State rather thoroughly collected over by Messrs Schwarz and Hubbard. He adds that the insect appears to be rare in Missouri and concludes that its southern range is practically limited by the States of Virginia and Kentucky, while Missouri defines its southwestern distribution.

Remedial measures. This beetle, like some other species, drops to the ground when alarmed and Dr Lintner has expressed the opinion that this habit might be taken advantage of in the case of valued shade trees. The insects could be jarred on a sheet, collected and destroyed. Mr Chittenden states that the beetles are susceptible to arsenical sprays and suggests the use of paris green. In all probability arsenate of lead would be more effective.

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Golden oak scale

Asterolecanium variolosum Ratz.

This circular, convex, bright yellow or golden scale insect, about 1/16 inch in diameter sometimes occurs on oak twigs in very large numbers.

This introduced species has become established in several localities within the State, and on account of its injuries and abundance has been brought to the writer's attention on several occasions. It was received on white oak twigs from Yonkers N. Y., Sep. 16, 1900, at which time many of the branches were literally covered in places with this insect.

Early history. This species was first recognized in this country in 1880 by Professor Comstock, who records it from imported oaks on the Department of Agriculture grounds at Washington D. C. He adds that the species is not a common one in Europe, though it is occasionally quite destructive to individual trees. Dr L. O. Howard, writing of this insect in 1889, states that it occurred at that time on the grounds of the Department of Agriculture at Washington, almost entirely on American oaks. This species was recorded on an old white swamp oak at Elizabeth N. J. in 1891, by Dr J. B. Smith, who states that a small branch was densely covered by the scales of this insect, and that the entire tree was badly infested. This attack was first observed in 1890. This species is characterized by the editor of *Gardening* in 1895, as the greatest enemy of the golden oak and the statement is made that most of these oaks appear infested by this pest. Mr A. S. Fuller in *Gardening* for the same year, states that he observed the species about 1889, and adds that many smaller twigs and branches of infested trees died as the result of attack. The following spring, however, he was unable to find any specimens. Mr Fuller records this scale insect as occurring rather widely on the English oak. This species was first reported from New York State by Professor Lowe who found the insect in 1894 very abundant on oaks at Geneva. He states that the species was present in great numbers and that two trees at the northern end of the row were nearly leafless and apparently dying. They were badly infested with the scales from the highest branches to nearly the base of the trunk, and the next two trees were apparently succumbing to the pest, since most of the lower limbs had not produced leaves and some of the smaller branches were dead. Prof. W. C. Sturgis records the presence of this insect on English oak at New Haven in 1895, and this species was brought to Prof. C. H. Fernald's attention in 1897, when it was found on golden oak at Worcester Mass.

Description. This scale may be easily recognized by its bright yellowish golden color, its circular convex form, and by the deep oval depressions it makes in the twig. It is, as previously stated, about 1/16 inch in diameter. See plate 12, figure 5.

Fig. 63 H[illegible] Howard, U.S. [illegible]

Life history. The young of this insect begin to appear in the latitude of Washington D. C., about the first of May, and at Geneva N. Y., they were first observed May 20, 1895 by Professor Lowe. Professor Sturgis records their appearance in April under laboratory conditions, and states that this is probably at least two weeks earlier than normal. The insect evidently passes the winter in the adult or nearly full grown condition.

Natural enemies. Nothing had been recorded concerning the natural enemies of this species in America prior to 1898, when Dr Howard called attention to the very beautiful European Habrolepis dalmanni Westw., an accidental introduction into this country, and states that he received a large series of this parasite from Mr A. H. Kirkland who had reared it from this insect which latter has become common on the oaks throughout the Middlesex Fells. Dr Howard is of the opinion that the parasite was probably brought over with the original importation and that this scale insect has become thoroughly established in that section. This beautiful parasite is illustrated at figure 63.

Mr R. H. Newstead of England states that he has seen the blue tit and the long tailed tit feeding on this and certain other scale insects. It would seem very probable that some of our native birds would feed on this insect to some extent, and it is likely that some of our common predaceous insects may learn to subsist on this pest.

Remedial measures. The experiments of Dr C. L. Marlatt show that the recently hatched young can be killed with a kerosene emulsion prepared according to the standard formula and diluted with 13 parts of water. This application should be made at the time the young are most abundant, which can be easily determined by a little observation about the middle of May or later.

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Hickory gall aphid

Phylloxera caryaecaulis Fitch

Bulletlike, hollow green galls of a leathery texture, occur on hickory shoots in June, turning black the latter part of the month or early in July, and somewhat resemble the black knot of plum.

These peculiar growths on the terminal limbs of hickory are brought to the writer's attention almost annually by the receipt of more or less deformed twigs with inquiries as to the cause of the trouble.

This species was noticed and described by Dr Fitch in his first report. He states that the insect is of frequent occurrence in New York and our observations accord with his. Dr Fitch described the excrescences on the limbs at the time of nut-gathering, as black, ragged, leathery, cup-shaped and as having a marked resemblance to some species of fungi.

Life history. Dr Fitch stated that this species probably winters in the egg and that early in the season females station themselves either on the midvein of one of the leaflets, on the leaf stalk or still further down on the green succulent twigs and cause a profuse flow of sap. It is probable that the insects so irritate adjacent tissue as to cause this abnormal growth and as the gall increases in size, young are brought forth and they in turn draw nourishment from its juicy walls. The galls are globular in shape and range in size from that of a pea to an ounce ball. They are attached to the side of the stem the whole length of their base and often cause a bend or distortion, specially when two or three are contiguous and confluent. The walls of the galls are about 1/16 inch thick with a fleshy texture, white on the inside and green on the outside. The inside of the gall at this time is literally covered with minute shiny lice of different ages and sizes and as Dr Fitch aptly states, it resembles the geode of the mineral, the surface of which is lined with a multitude of minute crystals whose sparkling points are everywhere glistening in the light. The dusky cast skins of the lice are also visible in the gall as well as numerous round black grains and smaller globules of honeydew. The black grains are the excrement of a larva, probably that of a weevil which lives within the galls. One would think that insects within such a retreat would be free from insect enemies, but Dr Fitch records meeting with four larvae, probably the young of a Syrphus fly, in one of these galls.

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EXPLANATION OF PLATES[1]

PLATE 1

[1] Plates 1–20 executed from nature, under the author's direction, by L. H. Joutel. Plates 2, 3, 4, 7, 8, 17, 19 and 20 reprinted from the 4th, 5th and 7th reports of the N. Y. Forest, Fish and Game Commission, plate 10 lithographed from the original published in the 5th report of the commission.

Insect galls

1 *Phylloxera caryaecaulis* Fitch gall on hickory leaf stem

2 Side view of same

3 Undetermined black galls along midrib of hickory leaf

4 *Cecidomyia holotricha* O. S. galls on underside of leaf

5 Undetermined Phylloxera gall on hickory

6 Appearance of same on upper surface of leaf

7 **Witch-hazel cone gall,** *Hormaphis hamamelidis* Fitch on witch-hazel leaf

8 *Diplosis caryae* O. S. gall on underside of hickory leaf

9 *Cecidomyia persicoides* O. S. gall on underside of hickory leaf

10 **Hickory tube gall,** *Cecidomyia tubicola* O. S. gall on underside of hickory leaf

11 **Bladder maple gall,** *Phytoptus quadripes* Shimer galls on underside of soft maple

12 Spotted maple leaf galls, *Sciara ocellaris* O. S.

13 Galls of *Cecidomyia verrucicola* O. S. on linden

13*a* Opening of linden mite gall on underside of leaf more enlarged

14 **Linden mite gall,** *Phytoptus abnormis* Garm.

15 Undetermined Phylloxera gall, probably same as shown at 5

16 **Oak pill gall,** *Cecidomyia pilulae* Walsh galls on underside of oak leaf

17 Galls of the same species on upper side of oak leaf

18 Saclike galls of *Cecidomyia erubescens* O. S.

19 **Hickory button gall,** *Phylloxera foveola* Perg., on underside of hickory leaf

20 Undetermined Phylloxera galls on underside of hickory leaf

21 **Hickory seed gall,** *Cecidomyia caryaecola* O. S. galls on underside of hickory leaf


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PLATE 2

a 335

Sugar maple borer, Plagionotus speciosus Say

1 Place where egg was laid.

1a Another more than normally discolored and showing excrement or borings thrown out by borer

2 Borer or grub in September from egg laid the same season

3 Nearly full grown borer

4 Adult or beetle

5 Hole through which the beetle escaped from the trunk

6 Sawdust or borings packed in burrow

Maple and oak twig pruner, Elaphidion villosum Fabr.

7 Grub or borer in its burrow, a portion of the twig being cut away to show its work.

7a Small twig with only a thin shell of bark, the wood being nearly all eaten

8 Pupa in burrow. The base of both twigs represented has been nearly eaten off by the larva

9 Adult or beetle

Cottony maple scale, Pulvinaria innumerabilis Rathv.

10 Active or recently hatched young

11 Adult females, many eggs can be found in the woolly masses

12 Leaf with many young scales on its underside

Plate 2

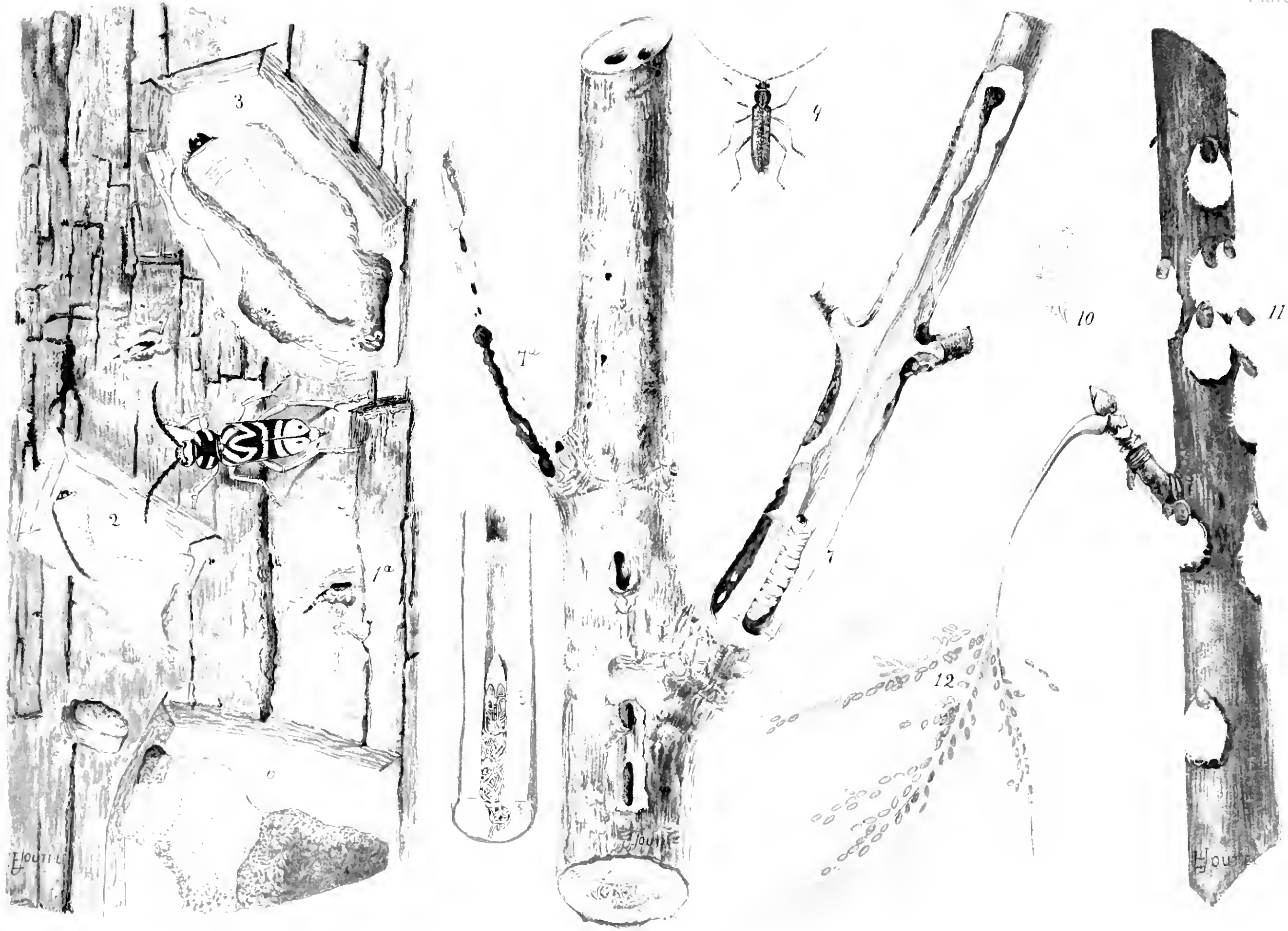

PLATE 3

a 337

Elm borer, *Saperda tridentata* Oliv.

1 Larva or grub within its burrow just under the bark, natural size

1*a* Larva or grub extended, natural size

2 Pupa within its cell just under the bark, natural size

3 Burrows of the grub as exposed after removal of the bark, natural size

4 Adult beetle, line beside it shows its natural size

Elm snout beetles, *Magdalis* sp.

5 Adult of *Magdalis armicollis* Say, line beside it represents its natural size

6 Adult of *Magdalis barbita* Say, line beside it represents its natural size

6*a* Side view of same

7 Larva of same, side view, natural size

8 Pupa of same within its oval cell just beneath the bark, natural size

8*a* Empty pupal cell of same, natural size

9 Burrows of *Magdalis barbita* Say as exposed after removal of the bark, natural size

9*a* Holes in the bark through which the beetles escape, natural size

9*b* Showing how bark is loosened by the burrows of this insect, natural size

Elm bark louse, *Gossyparia spuria* Mod.

10 Group of partly grown bark lice as they appear in early spring, natural size

11 Group of male cocoons, natural size

12 Group of male cocoons, much enlarged

13 Group of virgin females, much enlarged

14 A female, much more enlarged

15 Recently hatched young, very much enlarged

16 Mature female, much enlarged

16*a* Matured females on a twig, enlarged

17 Pseudimago or wingless male, much enlarged

18 Winged male, much enlarged, note also the long, white, anal filaments

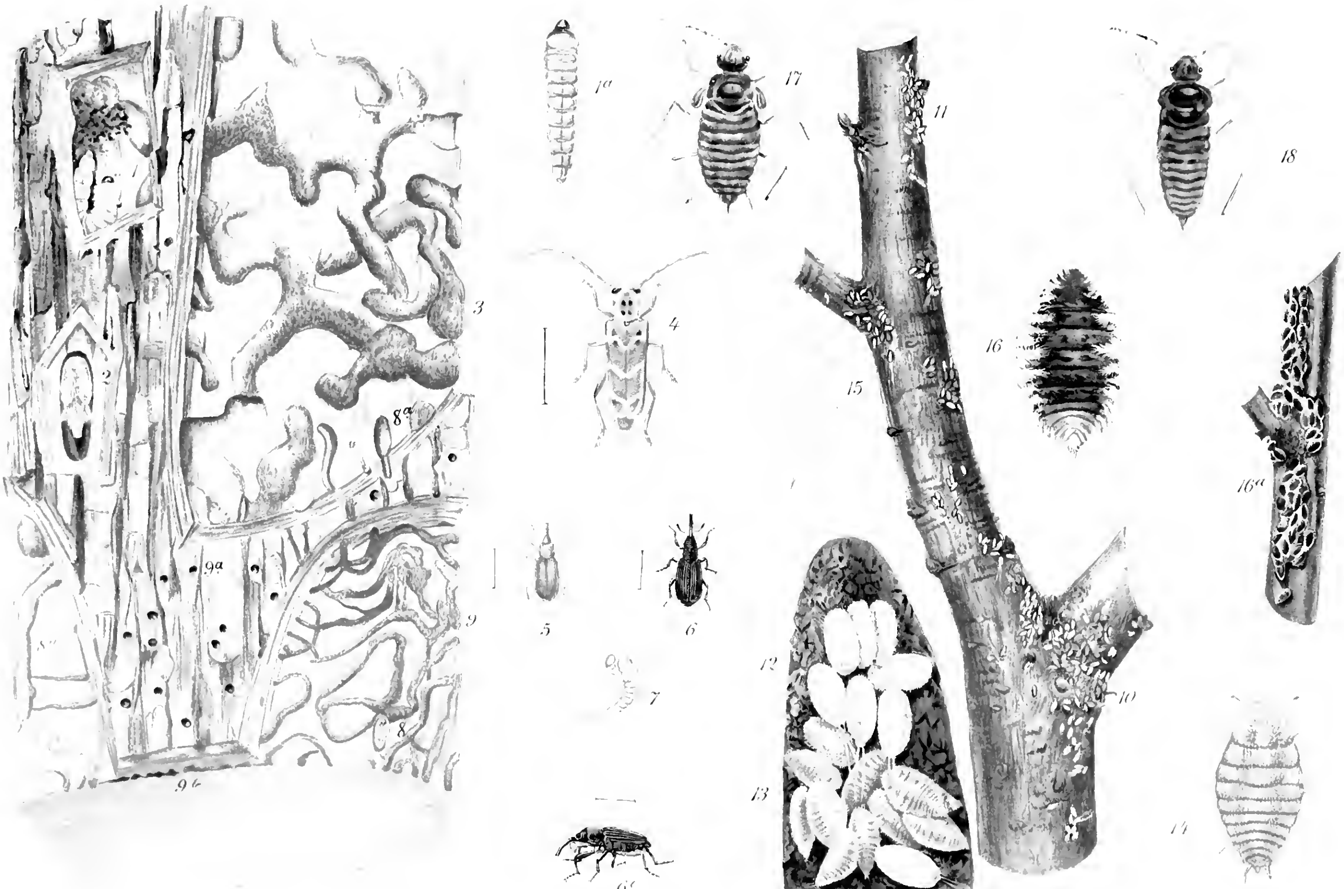
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PLATE 4

a 339

Leopard moth, *Zeuzera pyrina* Fabr.

1 Empty pupal case from which female moth has emerged

2 Female moth at rest on the bark

3 Male moth with wings expanded

4 Nearly full grown caterpillar, probably a female

5 Male pupa in its burrow

6, *6a* Exit holes covered by a loose piece of bark which the pupa will push off as it partly emerges

7 Hole made for the pushing out of excrement and then closed by a silk web

8 Same as above, but in use with particles of excrement dangling by silken threads

9 Work of caterpillar a preceding season

10 Work of caterpillar the present season

11 Young twig eaten by larva, point of entrance at *a*

Maple borer, *Sesia acerni* Clem.

12 Hole from which pupal case has fallen

13 Bark nearly eaten through ready for the pupa to push out

14 Empty pupal skin

15 Two cocoons as spun

16 Moths expanded and at rest

17 Excrement of caterpillars

18 Caterpillar in its burrow

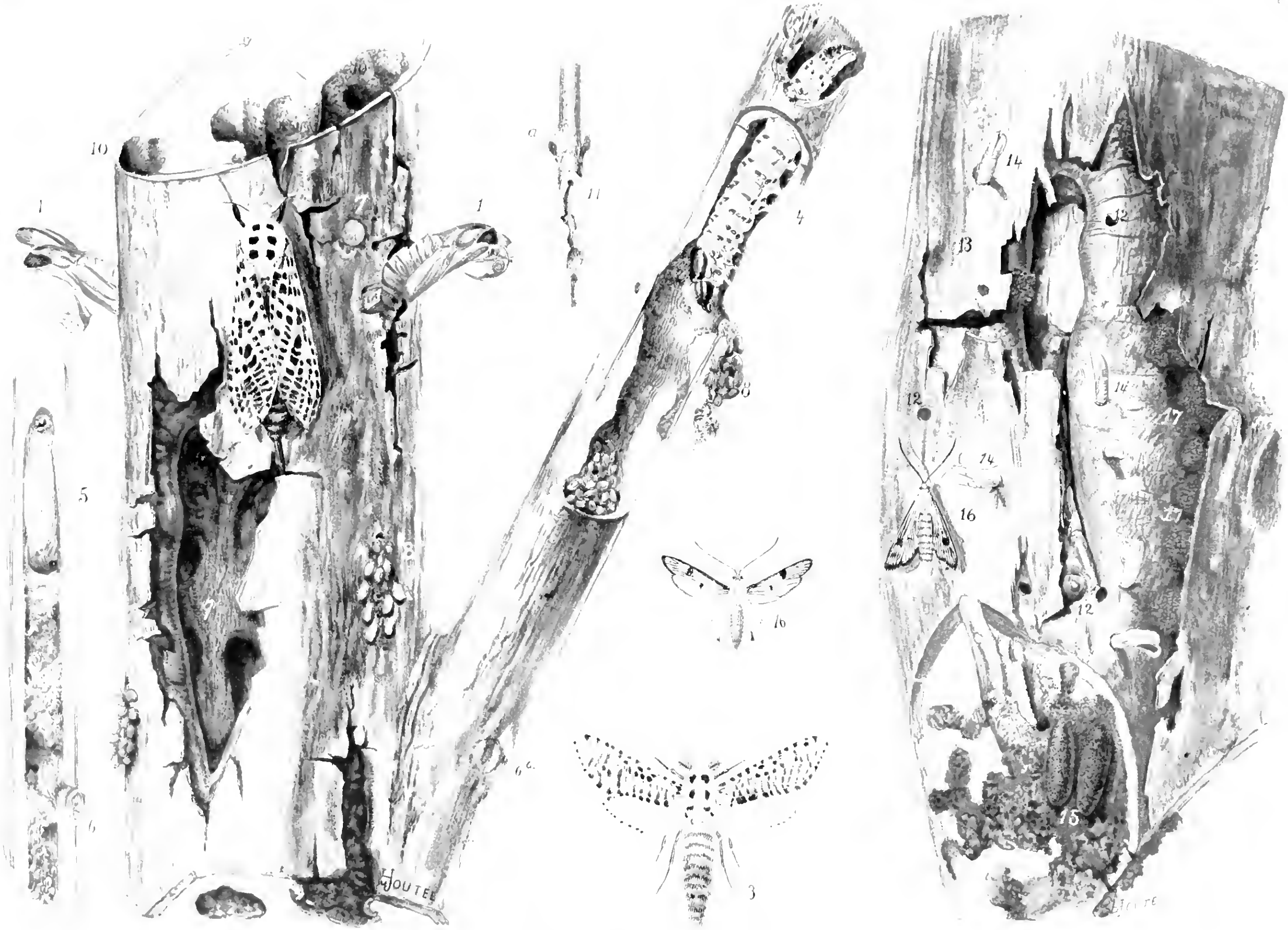
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PLATE 5

[341]

Locust borer, *Cyllene robiniae* Forst.

1 Pupa in its cell

2 Plug of wood fibers closing the free end of the pupal cell

3 Beetle at rest

10 Eggs deposited in crevices of the bark

Carpenter worm, *Prionoxystus robiniae* Peck

1 Female at rest on the bark

4a Dark colored eggs deposited loosely in the crevices

5 Pupal case partially projecting from the burrow

6 Pupa within its cell

7 Full grown larva with its head protruding from a burrow

8 Young larva at work in a small twig

9 Irregular borings of the full grown caterpillars


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PLATE 6

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Poplar borer, *Saperda calcarata* Say

A Piece of poplar showing work of this insect
1 Work of young larva
2 Adult
3 Orifice in bark through which borings are expelled
4 Gallery leading to orifice shown at 3
5 Peculiar excelsiorlike borings made by larva
6 Pupa in its chamber with one end stopped by excelsiorlike borings
20 Full grown larva

Linden borer, *Saperda vestita* Say

B Portion of base of linden showing the work of this species
7 Expanded gallery under bark made by larva
8 Gallery in wood extending under bark to 7
9 Sawdust packed in the larval gallery
10 Gallery leading into heart of the tree
C A piece of linden root with portion cut away to show operations of the grub
11 Larval galleries in cross-section
12 Circular exit hole of the beetle
13 Wound made by borer
14 Frass ejected by larva
15 Adult beetle on the bark
16 A portion of the bark cut away showing the borer in its gallery

Woodbine borer, *Saperda puncticollis* Say

D Piece of woodbine showing work of this species
17 Larval gallery in section
18 Pupa in its chamber showing orifice
19 Larva and its work under the bark
24 Adult beetle

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Thorn limb borer, *Saperda fayi* Bland

E Thorn limb showing workings

20 Section of gall illustrating operations of larva

21 Undeveloped gall due to premature death of inmate

22 Fully developed gall

23 Circular exit of adults

25 Adult beetle

PLATE 7

a 347

White marked tussock moth, *Hemerocampa leucostigma* Abb. & Sm.

1 Side view of full grown caterpillar
2 Male moth at rest
3 Female moth laying eggs on her recently vacated cocoon
4 Several cocoons
5 Cast skins of caterpillars
6 Work of young caterpillars on under surface of leaf
7 Male pupa
8 Branch girdled by caterpillar
9 End of branch broken off at the point where it was girdled

Forest tent caterpillar: maple worm, *Malacosoma disstria* Hubn.

10 Female moth with wings expanded
11 Male moth with wings expanded
12 Egg belt encircling twig
13 Side view of full grown caterpillar
14 Cocoon in a leaf
15 Pupa
16 Cast skins of caterpillar

PLATE 8

349

Elm leaf beetle, *Galerucella luteola* Müll.

1 Cluster of eggs much enlarged

1a Side view of single egg, still more enlarged

2 Dorsal view of recently hatched larva or grub, much enlarged

3 Dorsal view of full grown larva or grub, much enlarged

4 Pupa, much enlarged

5 Overwintered beetle, much enlarged

6 Fresh, brightly colored beetle, much enlarged

7 Under surface of leaf showing eating of larvae or grubs and a few holes eaten by beetles, eggs in clusters, cast larval skins and full grown larvae, natural size

8 Leaf nearly skeletonized by grubs or larvae and on it three cast larval skins, natural size

9 Leaf showing holes eaten by beetles, natural size

Bag or basket worm, *Thyridopteryx ephemeraeformis* Haw.

10 Bag or larval case as seen in winter, natural size

11 Same as preceding but cut open to show the pupal case and the eggs

12 Several eggs, very greatly enlarged

13 Side view of recently hatched larva, greatly enlarged

14 Cases of young larvae on twig, natural size. Notice that the dark ones are on the dark bark and the light ones on the green bark.

14a Leaf eaten by young larvae, natural size

15 Older larvae in their bags which are ornamented with pieces of leaves, one is on the leaf, another hanging from the edge and a third dangling by a thread, natural size

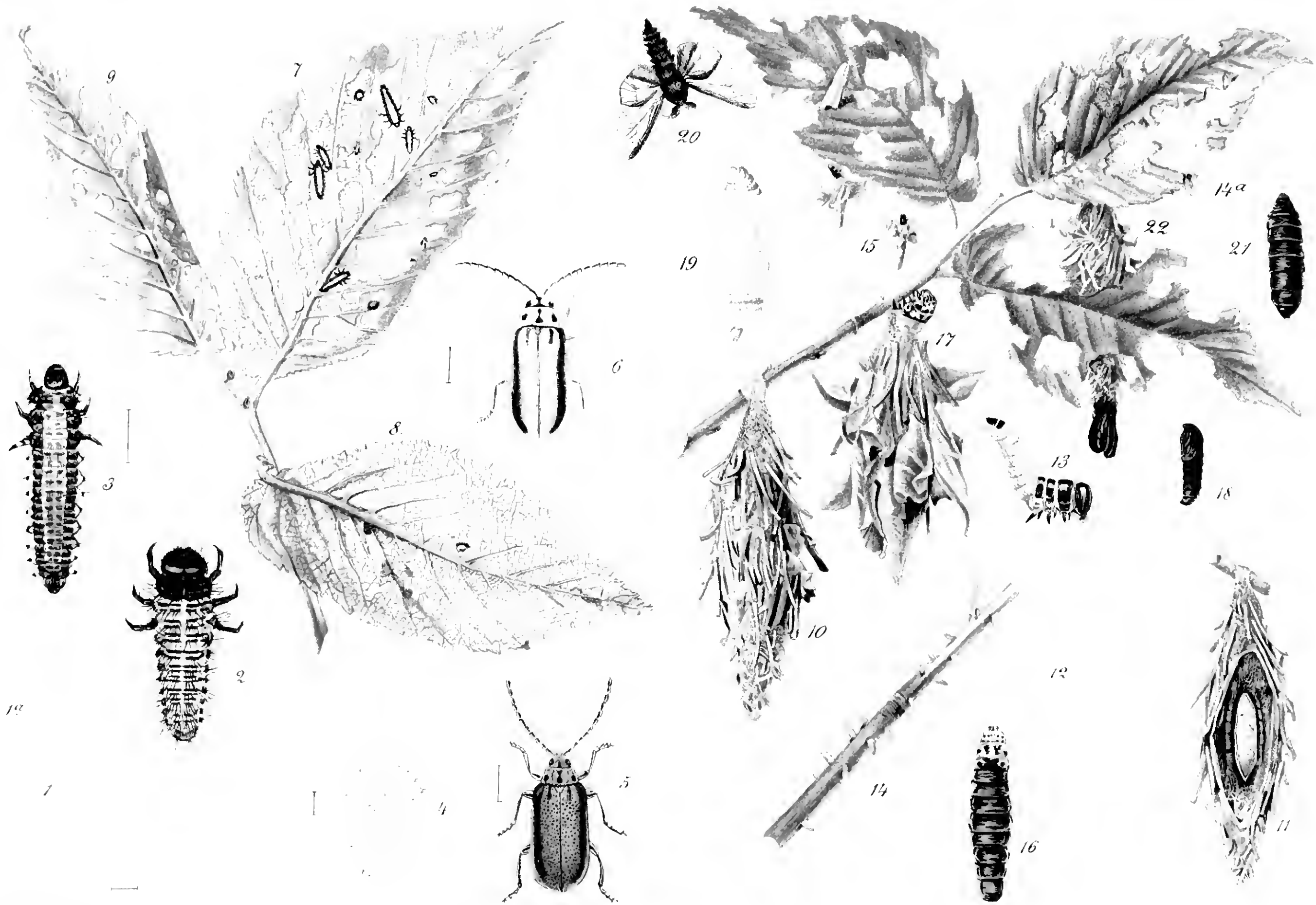
16 Full grown larva removed from its case, natural size

17 Full grown larva walking with its case, natural size

18 Male pupa, natural size

19 Wingless female moth, natural size

20 Male moth with wings spread, natural size



WORM

21. Female pupa, natural size.

22. Bag of male hanging from a leaf and with the empty pupal case protruding from its lower extremity, natural size. The leaf in front of the bag shows the work of half grown larvae.

PLATE 9

a 353

Beautiful hickory borer, *Goes pulchra* Hald.

1 Adult

2 Exit hole of same in trunk

3 Partially healed wound caused by young larvae

4 Work of same the year after the eggs are laid

5 Characteristic feeding of adult and also of the hickory twig girdler, *Oncideres cingulata* Say

Twig girdler, *Oncideres cingulata* Say

6 Adult girdling a branch

7 Girdling operations partly finished

8 Girdling operations of the preceding year

8a Characteristic scratchings on the bark in the vicinity of the girdled area

9 A completely girdled twig

10 Punctures at base of branch where eggs are laid

11 An early girdled twig; a portion of the branch beyond containing the larva has broken off and fallen to the ground

12 Larva in its burrow

Gipsy moth, *Porthetria dispar* Linn.

13 Male with wings spread

14 Female moth at rest on the bark

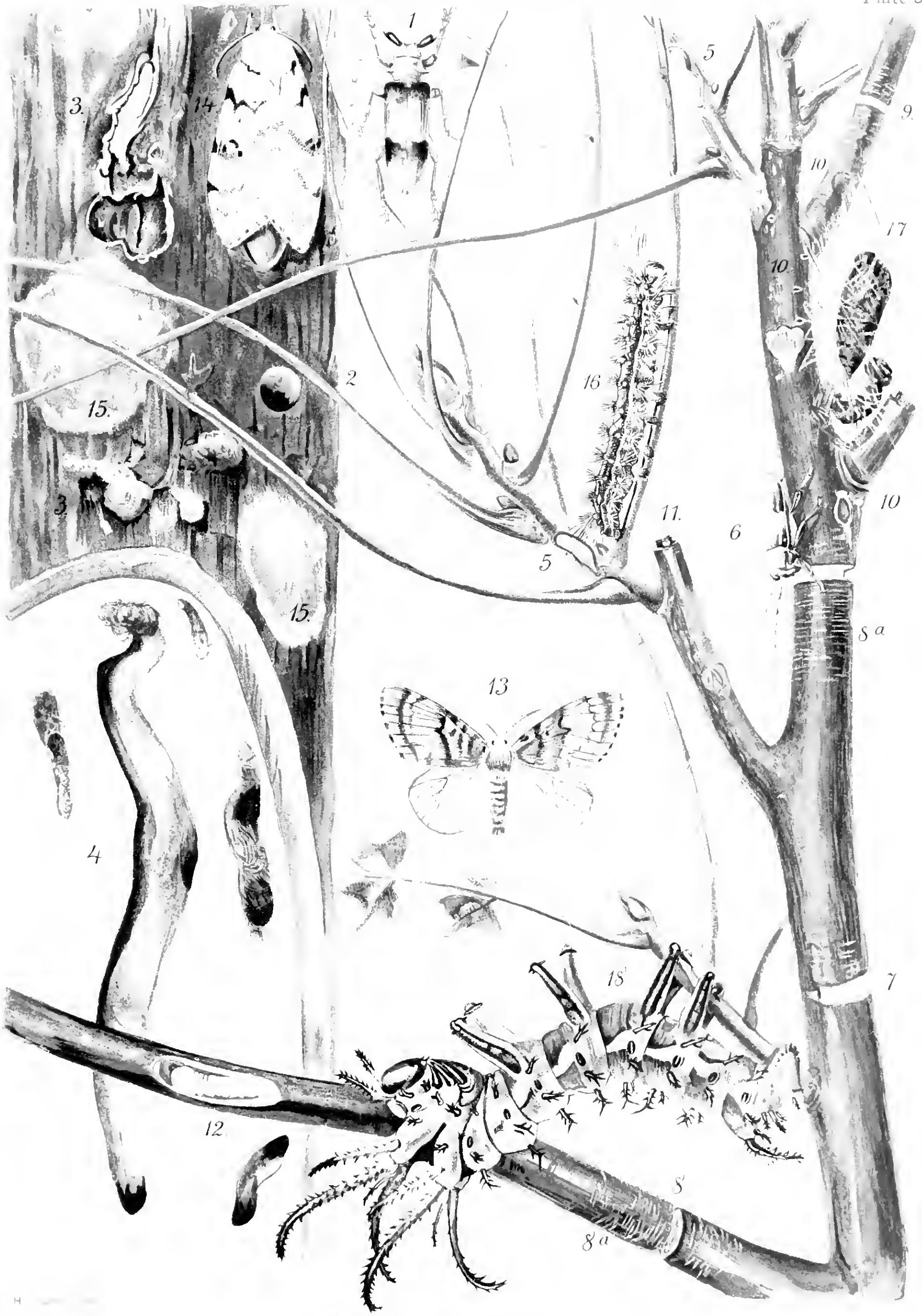
15 Characteristic egg masses

16 Side view of full grown larva

17 Pupa of same and cast larval skin in the characteristic scanty webs

Hickory horned devil, *Citheronia regalis* Fabr.

18 Side view of partly grown larva



GIPSY MOTH AND HICKORY INSECTS

PLATE 10

a 355

Fall web worm, *Hyphantria textor* Harr.

1 Cluster of eggs, natural size

2 Dorsal views of full and partly grown larvae and also a side view of a full grown caterpillar

3 Pupa, natural size

4 Pupa, more enlarged

5 White form of moth in resting position, natural size

6 Spotted form of moth with wings expanded, natural size

Figures 2, 5 and 6 are on a small web showing within the partly skeletonized, discolored leaves and the frass or excrement of the caterpillars.

Spiny elm caterpillar, *Euvanessa antiopa* Linn.

7 Cluster of eggs on a leaf stem, natural size

8 One egg, much enlarged

9 Caterpillar feeding, natural size

10 Chrysalis hanging from a leaf stem, natural size

11 Butterfly with wings spread, natural size

The figures of the egg and caterpillar are on a twig of elm representing the characteristic work of the caterpillar.

FALL WEB WORM AND SPINY ELM

PLATE 11

a 357

Aphids or plant lice

Painted maple aphid, *Drepanosiphum acerifolii* Thos.

1 Infested leaves of silver maple

2 Adult winged specimen very much enlarged

3 Nearly full grown nymph very much enlarged

4 Younger nymph very much enlarged

Chaitophorus ? aceris Linn.

5 Infested leaves of Norway maple

6 Wingless female very much enlarged

Two-spotted lady beetle, *Adalia bipunctata* Linn.

7 Larva

8 Pupae

9 Adult

Woolly beech leaf aphid, *Phyllaphis fagi* Linn.

10 Infested beech leaf

11 Nymph much enlarged

Elm leaf aphid, *Callipterus ulmifolii* Mon.

12 Infested elm leaf

13 Nymph very much enlarged

14 Winged female very much enlarged

Transverse poplar stem gall, *Pemphigus populi-transversus* Riley

15 Galls

16 Section of one showing plant lice within

Periodical cicada, *Tibicen septendecim* Linn.

17 Side view of adult

18 Twig showing oviposition scars


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PLATE 12

a 359

Scale insects

Maple phenacoccus, *Phenacoccus acericola* King

1 Clusters of male cocoons on sugar maple bark

2 Females and young on underside of leaf

Black-banded lecanium, *Eulecanium nigrofasciatum* Perg.

3 Badly infested soft maple twigs

4 Young along sides of leaf veins

10 Male very much enlarged

11 Full grown female scales showing characteristic markings much enlarged

12 Young very much enlarged

Golden oak scale, *Asterolecanium variolosum* Ratz.

5 Infested oak twig

Tuliptree scale, *Eulecanium tulipiferae* Cook

6 Badly infested tulip branch

8 Recently hatched young very much enlarged

9 Young scales very much enlarged

White flower cricket, *Oecanthus* sp.

7 Oviposition scars


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PLATE 13

a 361

San Jose and other scale insects

San Jose scale, *Aspidiotus perniciosus* Comst.

1 Badly infested piece of thorn. Scurfy scale, *Chionaspis furfura* Fitch also present, natural size

2 Male San José scale very much enlarged

3 Female very much enlarged

4 Group of female and young much enlarged

5 Young white and black scales on green twig, showing the surrounding purplish discoloration

6 Cherry twig badly infested with young, some in the white and many in the black stage

7 Young very much enlarged, a number of white, one grayish and a black scale

8 Group of young in the black stage very much enlarged

Oyster scale, *Lepidosaphes ulmi* Linn.

9 Infested twig, natural size

10 Female very much enlarged

11 Underside showing whitish eggs

12 Male scale very much enlarged

13 Group of old female scales, one with hole from which parasite has emerged and three half grown scales

14 Female of oyster scale

Scurfy scale, *Chionaspis furfura* Fitch

15 Group showing females and males, much enlarged

16 Female scale very much enlarged, with a portion torn away showing the purplish eggs beneath

17 Male scale very much enlarged

18 Group of old scales somewhat enlarged

SAN JOSE AND OTHER SCALE INSECTS

PLATE 14

a 363

Rose and other scale insects

Rose scale, *Aulacaspis rosae* Sandb.

1 Stem of rose badly infested, males predominating, slightly enlarged
2 Stem of rose showing clusters of scales somewhat enlarged
3 Cluster of female scales and young very much enlarged
4 Two male scales very much enlarged

Putnam's scale, *Aspidiotus ancylus* Putn.

5 Piece of mountain ash infested with Putnam's scale
6 Portion of same very much enlarged, showing young which had settled under the old scales
7 Female scale very much enlarged
8 Male scale somewhat enlarged
9 Female scales on birch, showing their close connection with the outer bark, the scale being almost continuous therewith

Euonymus scale, *Chionaspis euonymi* Comst.

10 Euonymus stem thickly incrusted with scales
11 Green stem badly infested with young scales
12 Under surface of leaf thickly dotted with young and male scales and a few females
13 Upper side of leaf showing discoloration
14 Male scales very much enlarged
15 Male scale partly broken, showing insect beneath, very much enlarged
16 Full grown female scale, very much enlarged
17 Group of male and female scales, much enlarged
18 Winged male, very much enlarged
19 Crawling young, very much enlarged

Plate 14

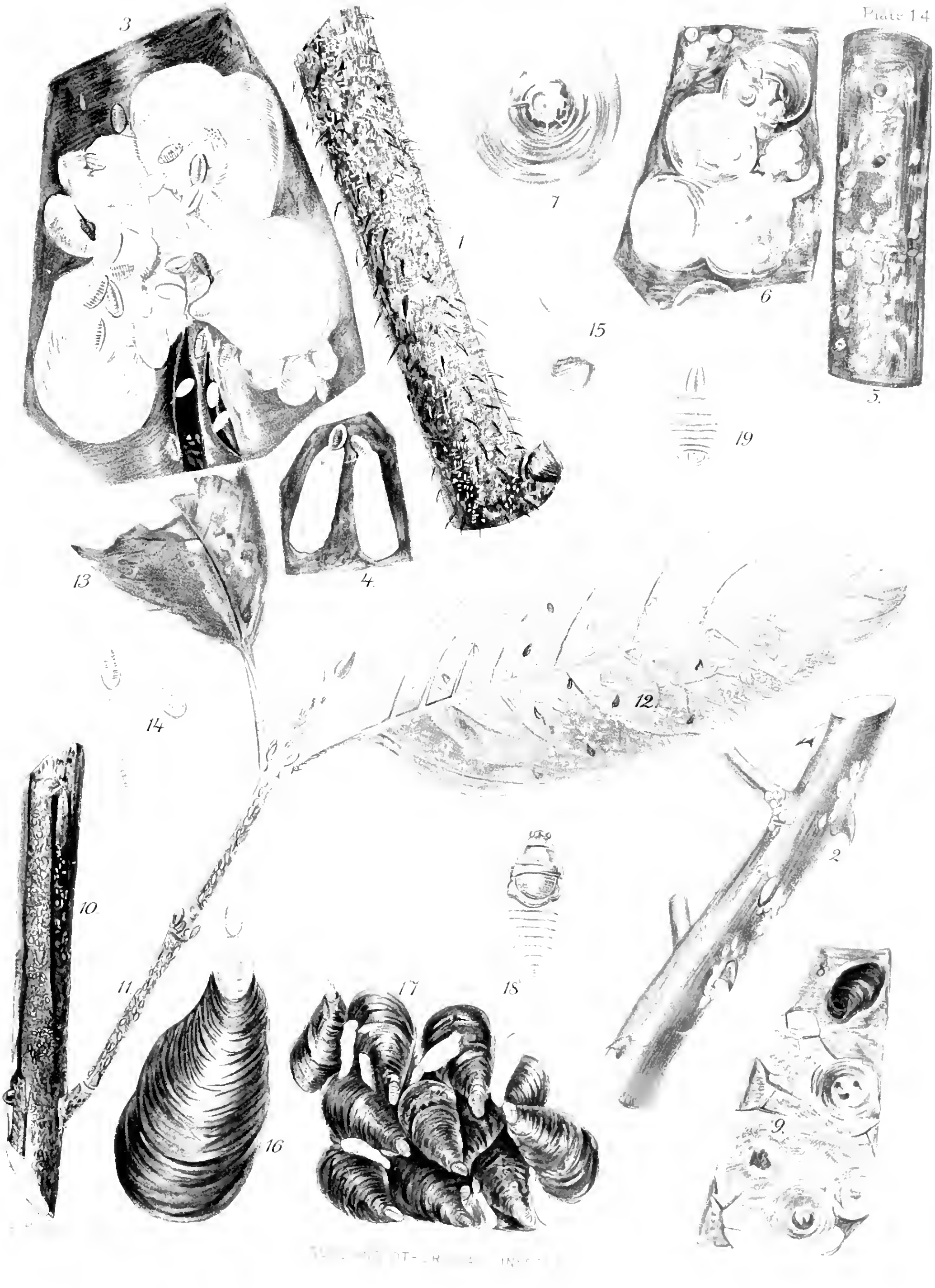

PLATE 15

a 365

Hickory insects

Black walnut caterpillar, *Datana integerrima* Gr. & Rob.

1 Bunch of cast skins
2 Side and dorsal views of full grown larvae
3 Silk spun by larvae on molting place
4 Parent moth

Hickory tussock moth, *Halisidota caryae* Harr.

5 Side view of full grown larva
6 Parent moth with expanded wings

Painted hickory borer, *Cyllene pictus* Drury

7 Piece of hickory showing work
8 Larval galleries in sapwood
9 Pupal chamber containing pupa
10 Adult
11 Sawdust stopping exit from pupal chamber
12 Exit hole. This pierces the bark in nature.

a 366

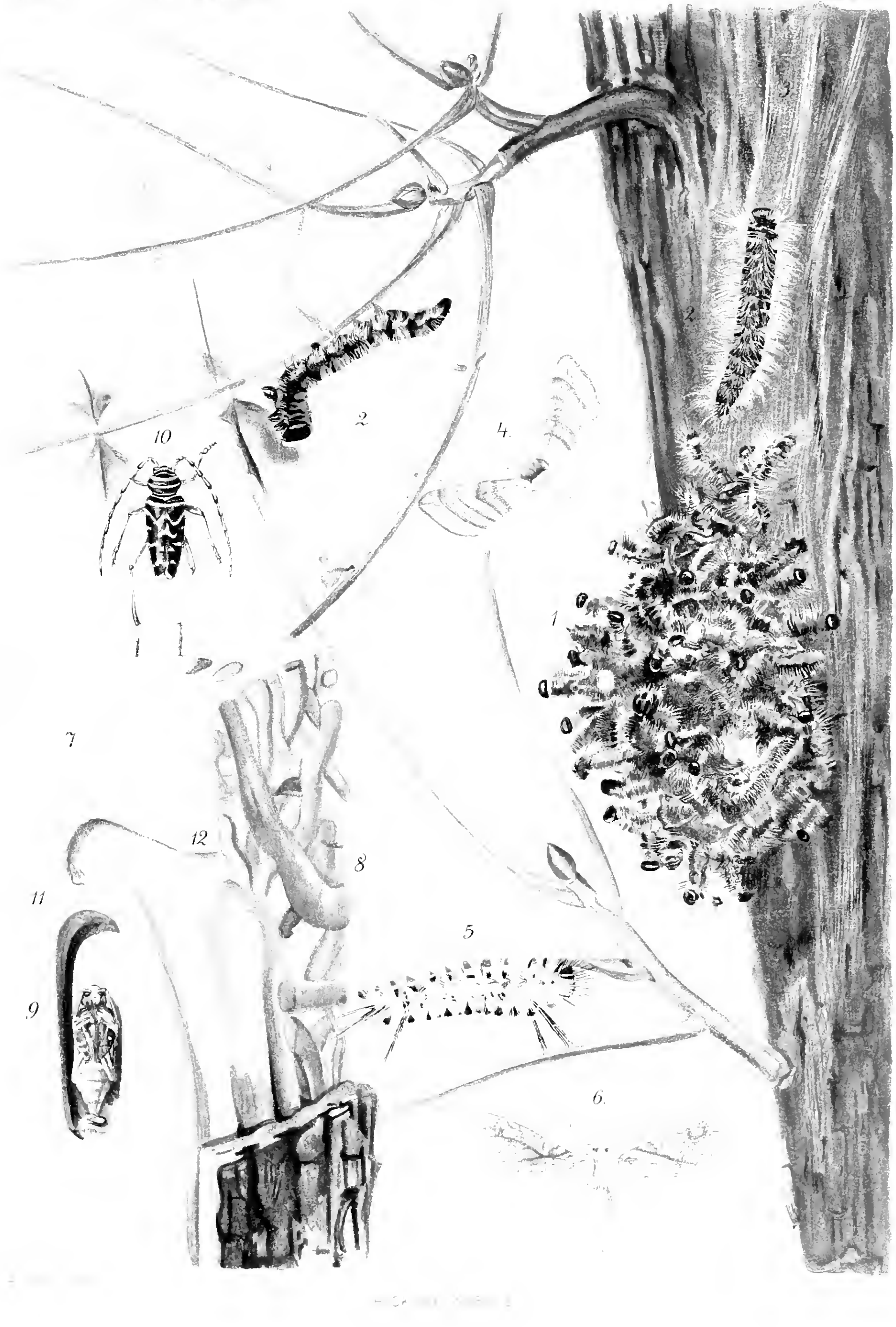
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PLATE 16

a 367

Poplar and willow insects

Poplar tent maker, Melalopha inclusa Hübn.

1 Larva on its nest

2 Moth of same

Elm sawfly, Cimbex americana Leach

4 Larva

5 Adult of same

6 Cocoon

Mottled willow borer, Cryptorhynchus lapathi Linn.

7 Portion of willow branch cut to show work

8 Adult, dorsal aspect

9 Shrunken, discolored area over larval galleries

Puss moth, Harpyia sp.

10 Side view of larva

11 Eggs

12 Cocoon from which moth has emerged

Sesia albicornis Hy Ed.

13 Pupal cases

Cottonwood leaf beetle, Melasoma scripta Fabr.

14 Eggs

15 Full grown larva

16 Group of larvae

17 Young larvae

18 Beetles or "hard shells" showing variation in marking

19 Pupa or "hanger"

20 Badly eaten leaves showing characteristic method of feeding

POPLAR AND WILLOW INSECTS

PLATE 17

a 369

Yellow striped oak caterpillar, *Anisota senatoria* Abb. & Sm.

1 Egg mass on underside of oak leaf

2 Eggshells on partly eaten leaf

3 Leaf stalk bearing shrunken larvae infested by parasite and showing the characteristic feeding of nearly full grown caterpillars

4 Side view of nearly full grown larvae

5 Recently hatched larvae feeding side by side and showing the skeletonizing in the earlier stages

6 Male, natural size

7 Female depositing eggs

Buck or Maia moth, *Hemileuca maia* Drury

8 Side view of full grown larva

9 Male, showing wings of one side only

10 Egg mass

Archips fervidana Clem.

11 Adult, enlarged

12 Nest composed of partly eaten, curled leaves

Serica trociformis Burm.

13 Beetle on leaf, natural size

14 Same enlarged

Two spotted tree hopper, *Enchenopa binotata* Say

15 Side view of adult

Archasia galeata Fabr.

16 Side view of adult of a peculiar tree hopper

Thelia acuminata Fabr.

17 Side view of another tree hopper

Dog day cicada or harvest fly, *Tibicen tibicen* Linn.

18 Side view of adult in resting position

Acorn weevil, *Balaninus nasicus* Say

19 Adult on twig, natural size

20 Same enlarged


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PLATE 18

Larch insects

Woolly larch aphid, *Chermes strobilobius* Kalt.

1 Young on leaf, showing the cottony filaments and near by the egg of a predaceous syrphus fly, very much enlarged

2 Young aphid, very much enlarged

3 Woolly females on leaves, natural size

4 Egg mass at base of a whorl of leaves, very much enlarged

Larch case bearer, *Coleophora laricella* Hübn.

5 Mined tips of larch needles, showing hole through which the caterpillar feeds, much enlarged

6 Caterpillar partly out of its peculiar case, much enlarged

7 Larva very much enlarged

8 Cocoon much enlarged

9 Moth much enlarged

10 Case bearers on the leaves, natural size

Larch sawfly, *Lygaeonematus erichsonii* Hartg.

11 Larvae on foliage, showing characteristic positions

LARCH [illegible]

PLATE 19

White pine insects

Imperial moth, *Basilona imperialis* Drury

1 Side view of nearly full grown larva

Pine bark aphid, *Chermes pinicorticis* Fitch

2 Masses on the stem of a young pine

White pine weevil, *Pissodes strobi* Peck

3 Pupal cells under bark of pine log

4 Burrows of larvae in bark

5 Portion of dead shoot killed by the insect, showing the circular exit holes, the borings of the insect in the upper part and the shrunken area extending down on the affected portion of the twig

6 Pupal cells of white pine weevil within the wood, showing method of escape and also a few exit holes in the shrunken affected bark

7 Adult weevil, enlarged

LeConte's sawfly, *Lophyrus lecontei* Fitch

8 Larvae in resting position on needles, showing below the stubs of devoured foliage

Pine leaf scale insect, *Chionaspis pinifoliae* Fitch

9 Numerous scales on pine needles


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PLATE 20

a 375

Insects affecting hard pine

Pitch twig moth, Evetria comstockiana Fern.

1 Pitch mass with pupal shell protruding therefrom in one case, the other shows old and recent pitch.

21 Adult, enlarged

Pitch midge, Cecidomyia resinicola O. S.

2 Pitch mass showing protruding pupal cases

Nantucket pine moth, Evetria frustrana Scudd.

3 Infested shoot showing the abortive growth

Pine needle gall fly, Cecidomyia pini-rigidae Pack.

4 Needles deformed by this insect

4a Work on needles of the previous year

Pine leaf miner, Paralechia pinifoliella Chamb.

5 Affected needles, note the brown tips

23 Adult, enlarged

Fir sawfly, Lophyrus abietis Harr.

6 Larvae in natural position on the needles; below are stubs of eaten foliage

6a Cocoon of same at base of pine needles

Pine chrysomela, Glyptoscelis pubescens Fabr.

7 Adult, much enlarged

Pales weevil, Hylobius pales Herbst.

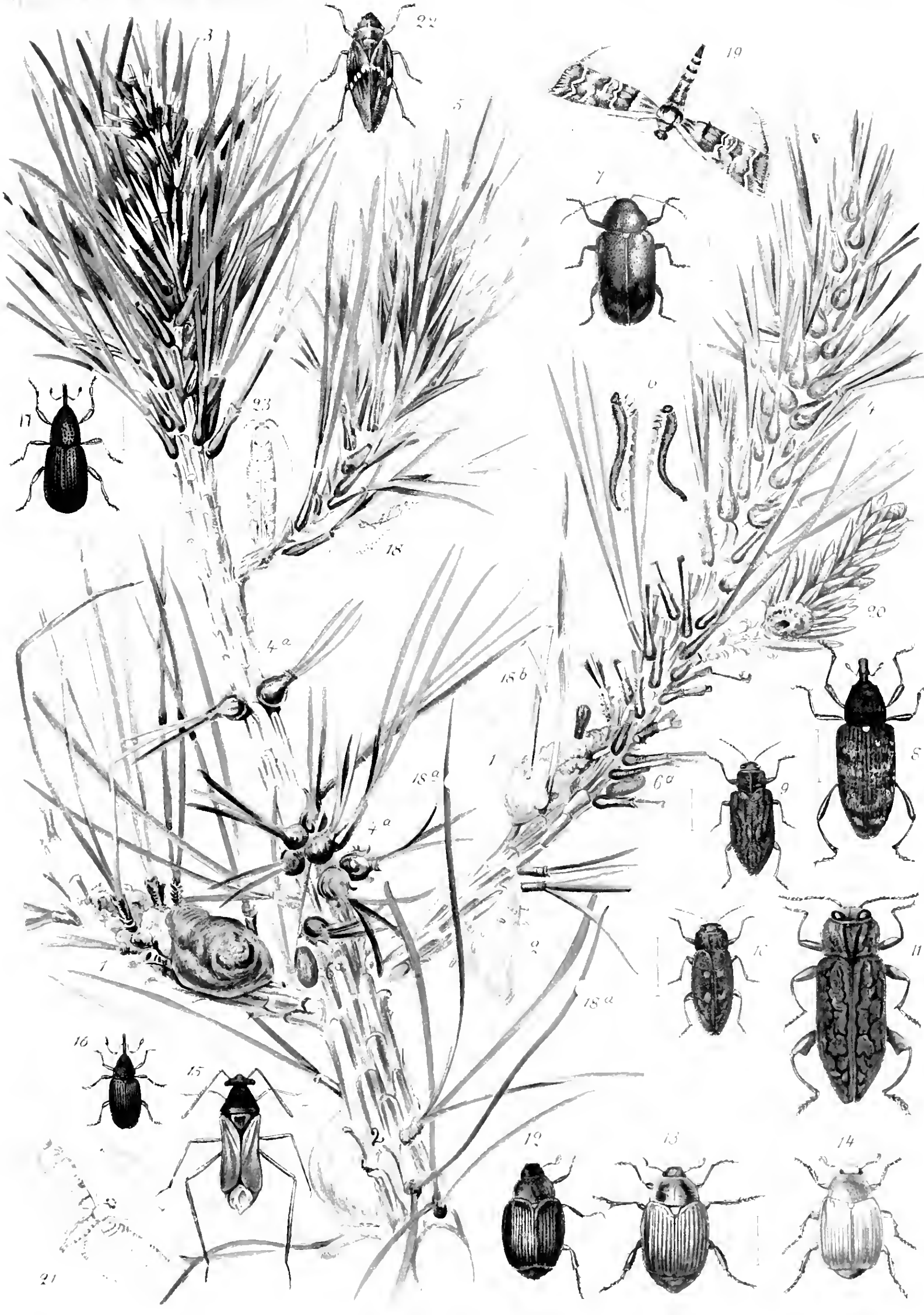
8 Adult, much enlarged

Chrysobothris pusilla Lap. & Gory

9 Adult, much enlarged

Chrysobothris floricola Gory

10 Adult, enlarged



Chrysobothris dentipes Germ.

11 Adult, much enlarged

Light loving grapevine beetle, *Anomala lucicola* Fabr.

12, 13 and 14 Varieties of this beetle, a species very abundant on hard pines, much enlarged

Pilophorus crassipes Uhl.

15 Adult, much enlarged

Magdalis alutacea Lec.

16 Adult, much enlarged

Magdalis perforata Horn.

17 Adult, much enlarged

Lace-winged fly, *Chrysopa* sp.

18 Side view of adult

18*a* Cocoons of same on needles

18*b* Stalked eggs of lace-winged fly

Pine tip moth, *Pinipestis zimmermani* Grote

19 Adult

20 Work in a shoot, showing its abortive character and the peculiar small pitch mass near its base

Spittle insect, *Aphrophora parallela* Say

22 Adult, enlarged

PLATE 21

a 379

Power spraying outfit at work in an Albany park

a 380

Power spraying outfit in operation

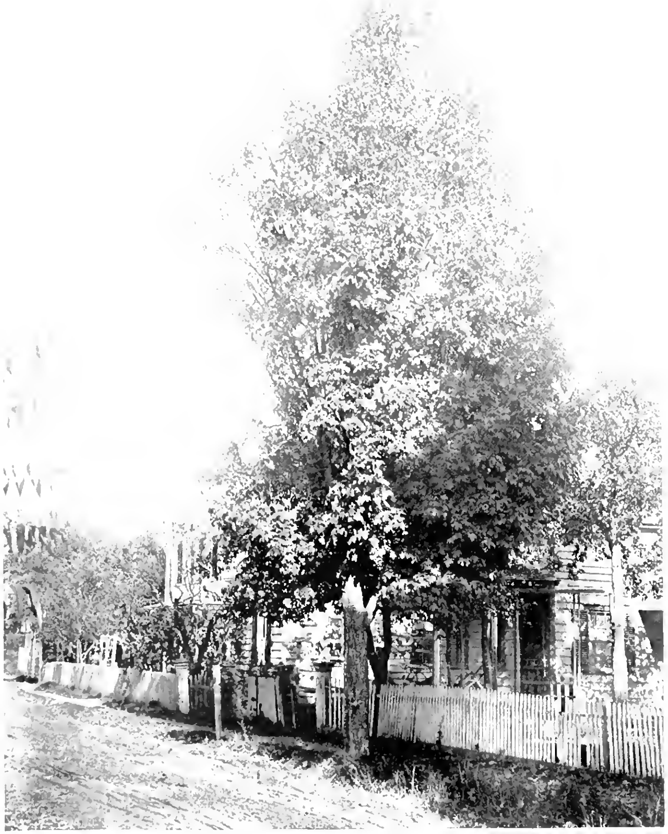
PLATE 22

a 381

Sugar maple borer. Plagionotus speciosus Say

1 Maple in leaf showing dead branches killed by the borer

2 Maple in winter showing broken tips of branches killed by the borer



1 Work of sugar maple borer 2

Nassau N. Y. 1901

PLATE 23

a 383

Sugar maple borer, Plagionotus speciosus Say

1 Ridges of bark formed over recent borings

2 Exposed dead area showing the conspicuous grooves made by the grubs

3 Ridging and cracking of bark over a badly wounded area

4 Section of dead trunk showing borings and exit holes of the pigeon Tremex, Tremex columba Linn. and the smaller holes of its parasite, the lunate long sting, Thalessa lunator Fabr.

1 2 3 4

Work of sugar maple borer

PLATE 24[1]

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[1] Figures 1, 2, from plate 24 and figure 1 from plate 25 from photographs taken June 28, 1904, by Dr W. W. Williams, Hilton N. Y.

Sugar maple borer, *Plagionotus speciosus* Say

1 Portion of trunk of living maple, showing recent galleries which have been exposed by cutting

2 Upper portion of galleries more enlarged

a 3-6

1 Work of sugar maple borer in living trees 2 Hilton N. Y. 1904

PLATE 25

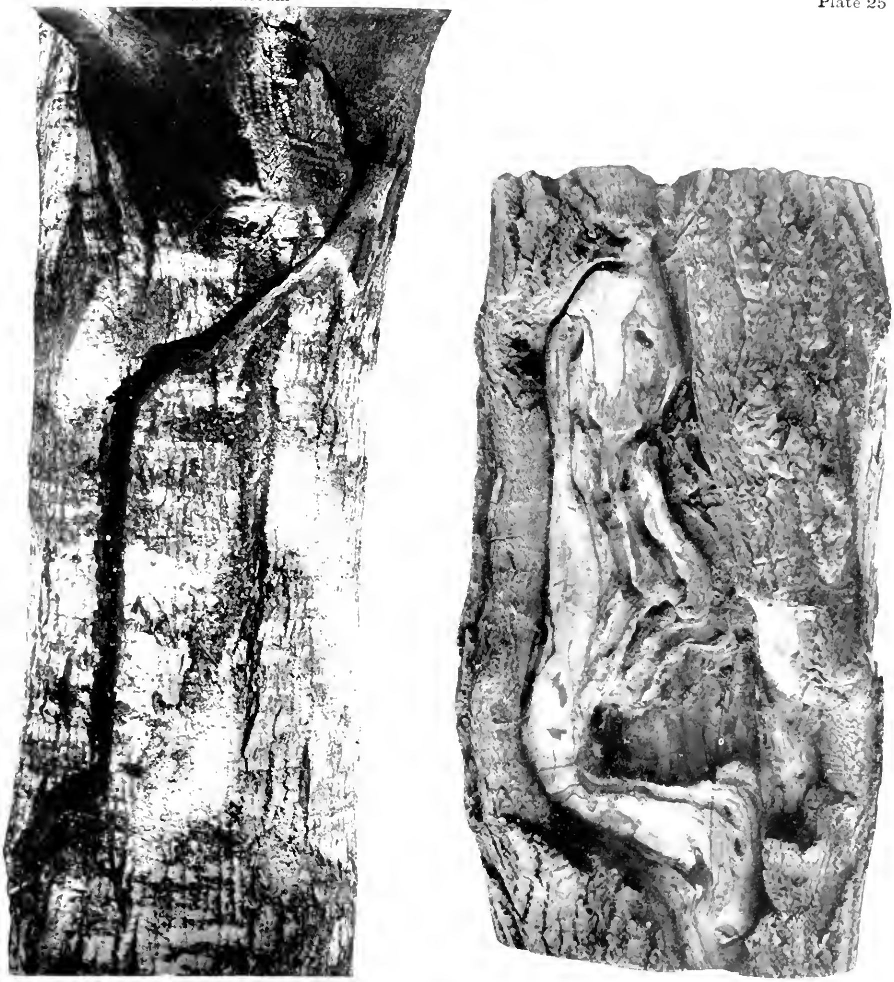
a 387

Sugar maple borer, Plagionotus speciosus Say

1 Lower portions of galleries shown on plate 24, figure 1, more enlarged

2 Portion of exposed trunk badly scored by the grub. The overlying bark died, cracked and fell off, exposing the wood to the weather and decay

Memoir 8 N. Y. State Museum Plate 25



1 2

Work of sugar maple borer in living trees

PLATE 26

a 389

Elm borer, Saperda tridentata Oliv.

Two young elms in a long row, killed by the elm borer in association with the elm snout beetles Magdalis armicollis Say and M. barbita Say

Photograph taken June 1903, by J. A. Otterson, Berlin Mass.

a 390

E elm Mass June 1903

Work of elm borer and elm snout beetles

PLATE 27

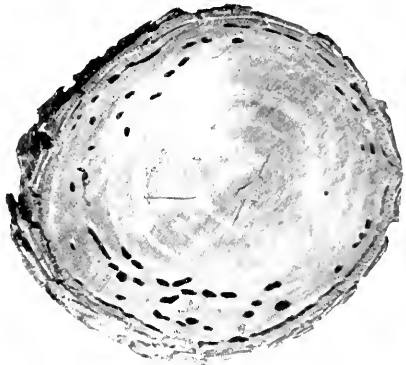
a 391

Elm borer, *Saperda tridentata* **Oliv.**

1 Section of badly infested limb

2 Wood surface of badly infested limb

a 392



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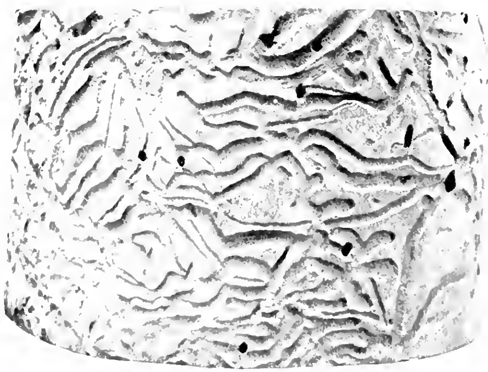

2

Work of elm borer

PLATE 28

a 393

Leopard moth, *Zeuzera pyrina* Fabr.

1 Row of soft maples badly injured by this pest

2 A single tree showing limbs broken as a result of weakening by the borers. Both from Astoria L. I., 1900

a 394

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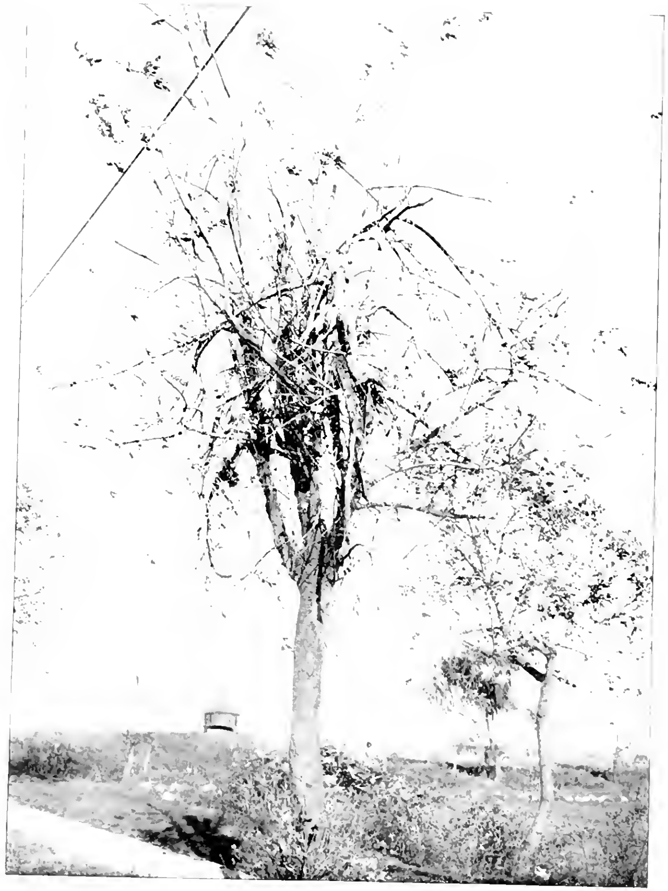

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Work of leopard moth

PLATE 29

a 395

Leopard moth, *Zeuzera pyrina* Fabr.

1 Portion of trunk of soft maple, showing the large scars made by this borer

2 Another stump exhibiting a more advanced stage of the work of the same insect

3 Trunk of a soft maple, illustrating the tendency of affected trees to throw out suckers at the base, and also showing masses of borings lodged in the young growth. All from Astoria L. I., 1900

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Work of leopard moth

PLATE 30

a 397

Carpenter worm, Prionoxystus robiniae Peck

Work of same in ash, showing a very large dead area with numerous irregular galleries

a 398

Work of carpenter worm in ash

PLATE 31

a 399

Large black carpenter ant, Camponotus herculaneus Linn.

1 Work in balsam, showing the regular galleries, probably modified by the alternate hard and soft lamellae in the wood

2 Work of the same insect in elm, showing the extremely irregular character of the galleries

1

2

Operations of large black carpenter ant

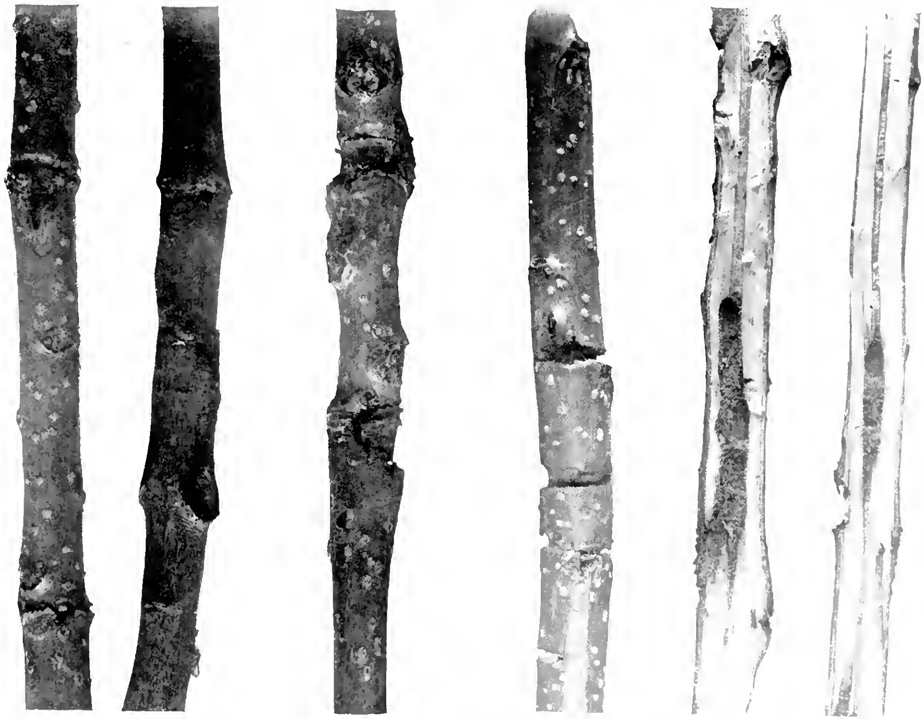
PLATE 32

Mottled willow borer, *Cryptorhynchus lapathi* Linn.

1 Small Carolina poplar twigs showing the work of this insect

2 A more advanced stage of the same, with two twigs sectioned to illustrate the character of the galleries

a402



1 Work of mottled willow borer 2

PLATE 33

a 403

Forest tent caterpillar, Malacosoma disstria Hübn.

Defoliated sugar orchard in Arkville, Delaware county, photographed July 8, 1898

A 404

Work of forest tent caterpillar

PLATE 34

a 405

European elm case bearer, Coleophora limosipennella Dup.

1 Elm twig with leaves, showing the irregular rectangular mined areas

2 Portion of leaf much enlarged, illustrating the character of the skeletonizing and the circular hole through which the larva eats out the tissues

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Work of European elm case bearer

PLATE 35

a 407

Elm leaf beetle, *Galerucella luteola* Müll.

Work on Elm street, Albany. Photographed June 15, 1898

Photo, [illegible]

Work of elm leaf beetle on Elm street, Albany

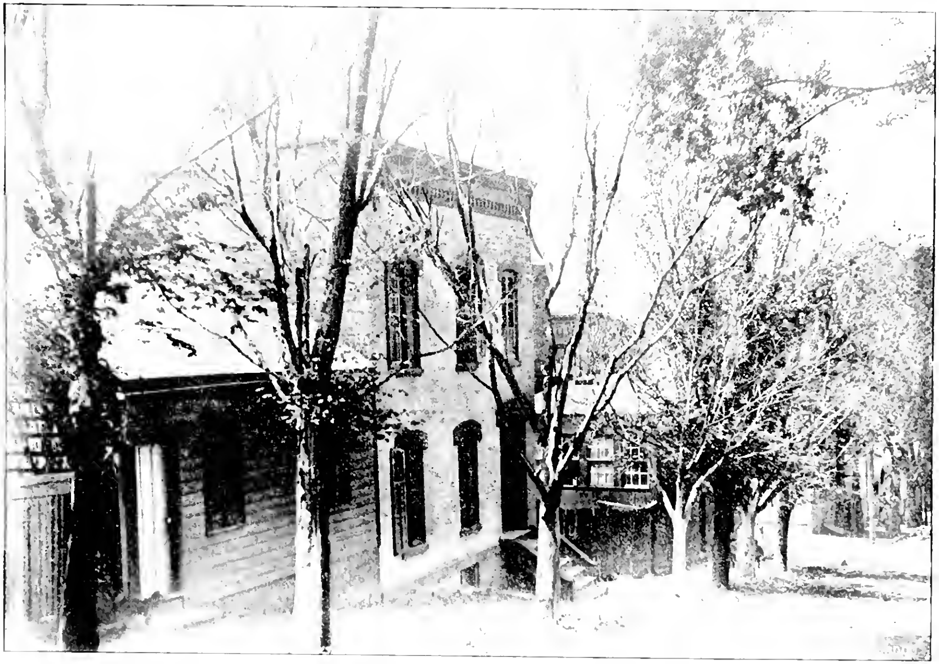
PLATE 36

a 409

Elm leaf beetle, Galerucella luteola Müll.

Work on Jacob street, Troy. Photographed June 15, 1898

a 410



Work of elm leaf beetle on Jacob street, Troy

Photo, June

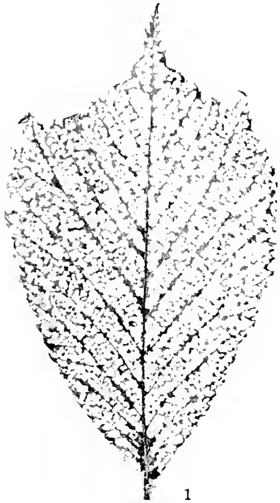
PLATE 37

Elm leaf beetle, *Galerucella luteola* Müll.

1 Leaf badly skeletonized by grubs

2 Leaves showing holes eaten by beetles

a 412



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Elm leaf beetle work

PLATE 38

a 413

Rustic borer, *Xylotrechus colonus* Fabr.

1 Work in hickory trunk about 15 inches in diameter

Obrium rubrum Newm.

2 Work in ash

1 2

Work of wood borers

PLATE 39

a 415

Minute oak bark beetle, *Pityopthorus minutissimus* Zimm.

1 Work in red oak, upper part showing galleries, the lower exit holes

Eyed Elater, *Alaus oculatus* Linn.

2 Adult

Large carpenter bee, *Xylocopa virginica* Drury

3 Work in siding, the ½ inch galleries being made in a ⅝ inch board. The enlargements in the gallery represent cells and the exit is seen at the upper part of the under portion.

Hickory bark borer, *Scolytus quadrispinosus* Say

4 Work in hickory, the upper portion showing the scored wood, the lower part the exit holes

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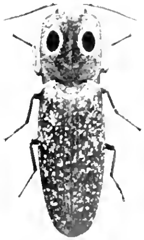

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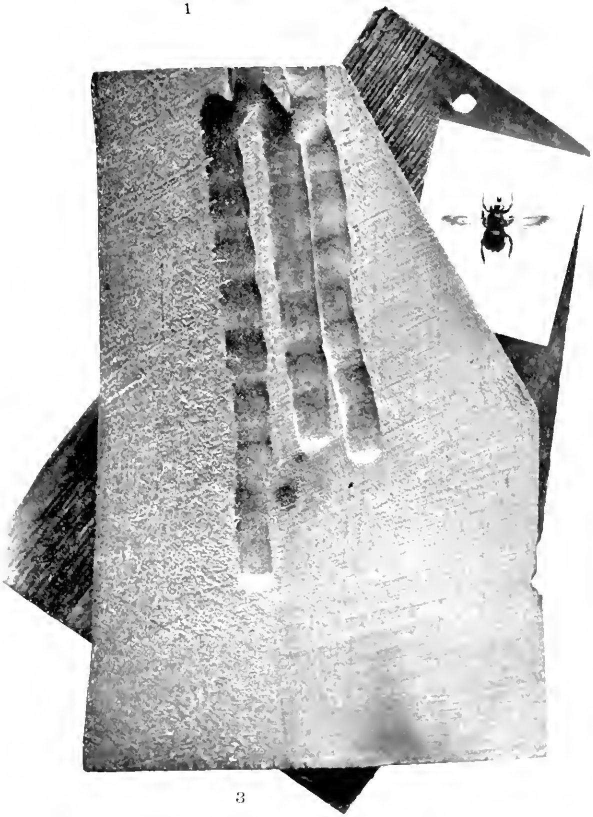

3

Wood borers and their work

PLATE 40

a 417

Bronze birch borer, *Agrilus anxius* Gory

1 Dying tree

2 Section of limb showing anastomosing galleries in inner bark. Both from photos by M. F. Adams

a 418

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Work of bronze birch borer

PLATE 41

a 419

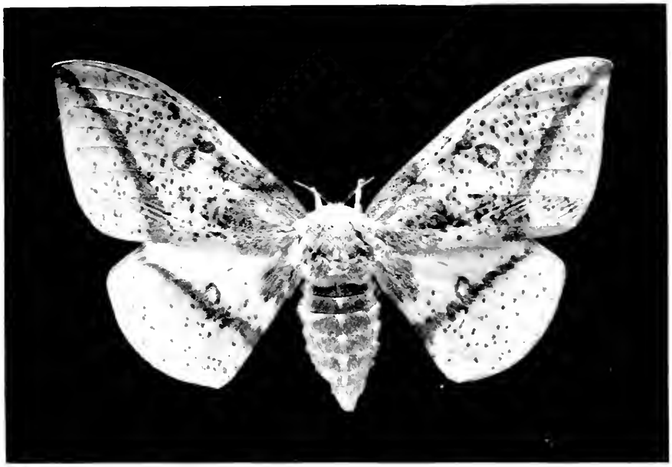
Imperial moth, Basilona imperialis Drury

1 Female

Luna moth, Tropaea luna Linn.

2 Male

a 420



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Parents of leaf feeders

PLATE 42

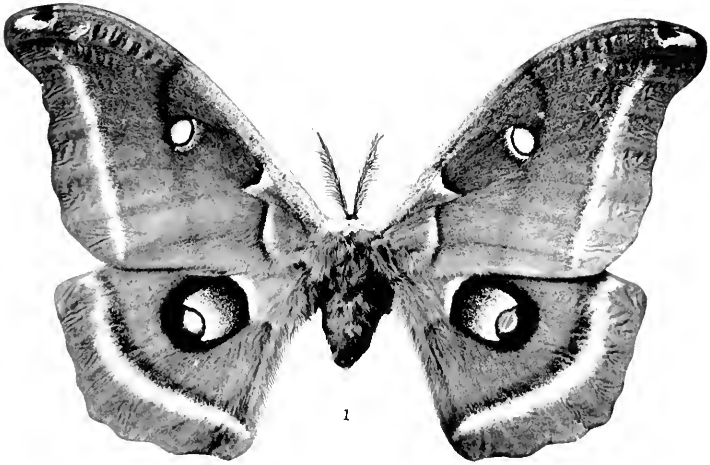
Polyphemus moth, Telea polyphemus Cramer

1 Male

Cecropia moth, Samia cecropia Linn.

2 Male

a 422



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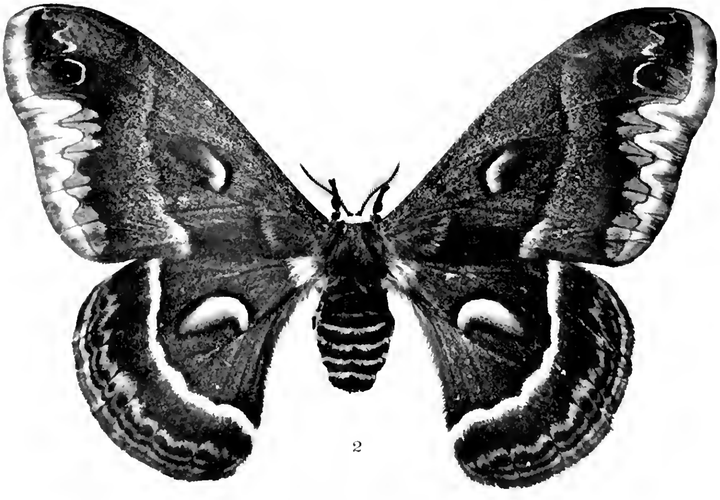


2

Parents of leaf feeders

PLATE 43

a 423

Io moth, Automeris io Fabr.

1 Female

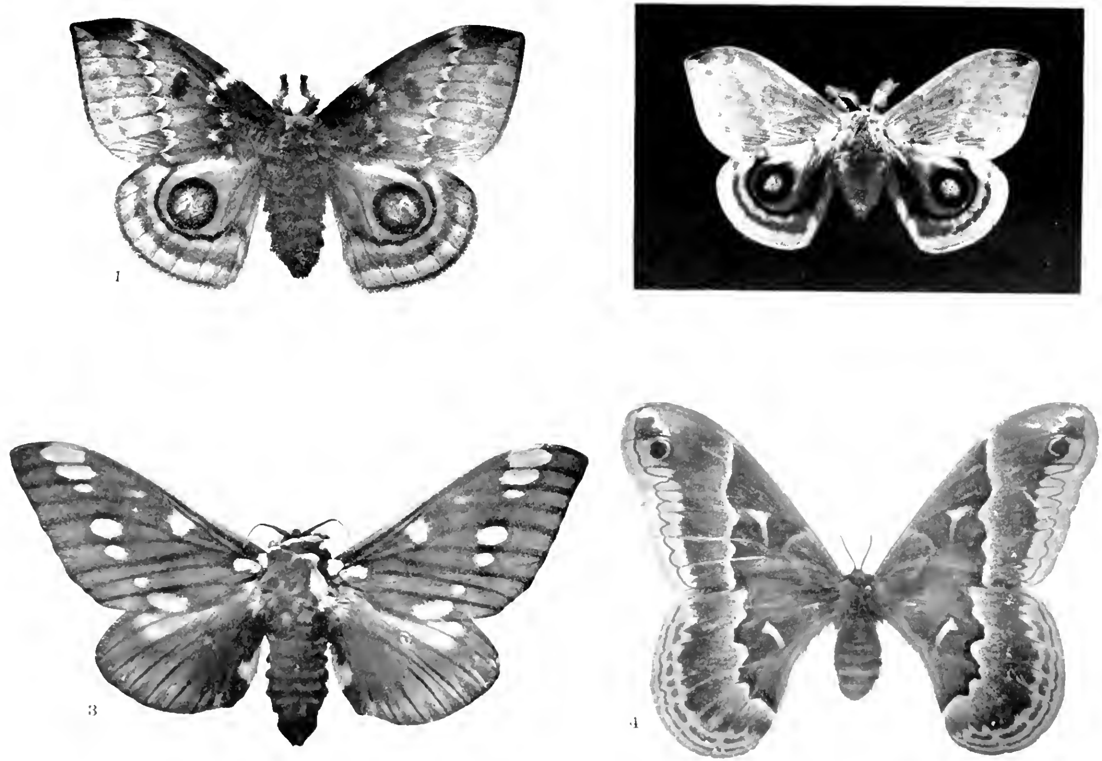
2 Male of same

Regal moth, Citheronia regalis Fabr.

3 Female

Promethea moth, Callosamia promethea Drury

4 Male



Parents of leaf feeders

PLATE 44

a 425

Cossus querciperda Fitch

1 Female, reproduced from a photograph of the type

Tomato worm, Phlegethontius celeus Hübn.

2 Larva bearing numerous parasitic cocoons

Hickory tussock moth, Halisidota caryae Harr.

3 Male

Pale tussock moth, Halisidota tessellaris Abb. & Sm.

4 Female

Buck or maia moth, Hemileuca maia Drury

5 Male

Xylina antennata Walk.

6 Female

Harpyia cinerea Walk.

7 Male

Black walnut caterpillar, Datana integerrima Gr. & Rob.

8 Female moth

1

2

3

4

5

6

7

8

American Lepidoptera

PLATE 45

a 427

1 Work of sawfly on willow leaves

Locust leaf miner, *Odontota dorsalis* Thunb.

2 Work of beetles

Brown tail moth, *Euproctis chrysorrhoea* Linn.

3 Two characteristic nests

Pitch-mass borer, *Parharmonia pini* Kell.

4 Pitch mass with empty cocoon protruding

1

2

3

4

Brown tail moth nests and other insect work

PLATE 46

(429)

Dog day cicada or harvest fly, *Tibicen tibicen* Linn.

1 Adult

Periodical cicada, *Tibicen septendecim* **Linn.**

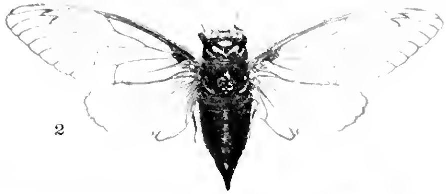
2 Adult

Alder blight aphid, *Pemphigus tessellata* Fitch

3 Portion of alder twig badly infested

4 Twig infested with young

1



2

3

4

Cicadas and alder aphids

PLATE 47

a 431

Gouty oak gall, Andricus punctatus Bass.

A red oak at Loudonville badly infested

a 432

Loudonville, Photo, April 1902

Red oak bearing numerous gouty oak galls

PLATE 48

a 433

Oak fig gall, *Biorhiza forticornis* Walsh

1 Infested leaves and twig

2 Same more advanced and largely on twigs

Pine cone oak gall, *Cynips strobilana* O. S.

3 A gall at the end of a twig

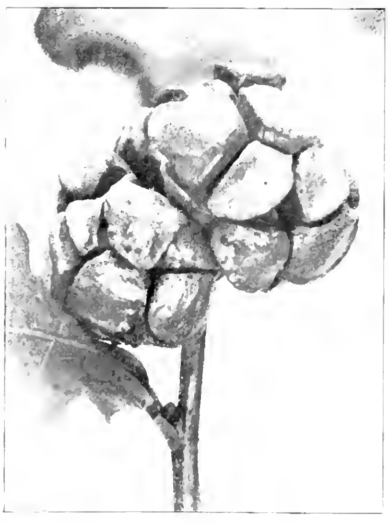
Gouty oak galls, *Andricus punctatus* Bass

4 Badly infested twigs

a 434

1

2



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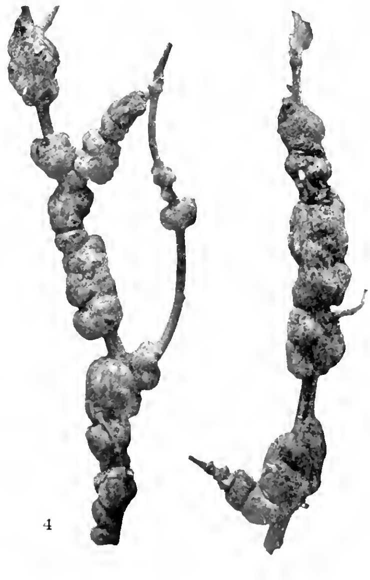

4

Insect galls

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