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University of the State of New York

NEW YORK STATE MUSEUM

57th ANNUAL REPORT

1903

VOL. 1

PART 2

TRANSMITTED TO THE LEGISLATURE JAN. 6, 1904, BY THE REGENTS OF THE UNIVERSITY

194443

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
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Published monthly by the
University of the State of New York
BULLETIN 304 DECEMBER 1903

New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 72

ENTOMOLOGY 19

GRAPEVINE ROOT WORM

BY

EPHRAIM PORTER FELT D.Sc.

University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 72

ENTOMOLOGY 19

GRAPEVINE ROOT WORM

PREFACE

The grapevine root worm has proved itself such a destructive enemy of vineyards in the Chautauqua grape belt, and so little success has attended efforts to control it, that it was deemed advisable in 1902 to undertake an investigation of this insect. The work of last year was embodied in Museum bulletin 59, and the material additions to our knowledge of this pest, gained in 1903, have rendered it advisable to issue an extended and revised edition of our previous publication, because the subject is of such vital importance that our growers should have all available information at their disposal. Many valuable facts have been ascertained during the last two seasons; and the additional data gained in 1903 demonstrate the value of timely cultivation and prove that collecting the beetles is practical, the most reliable and probably the most economical method of controlling this very serious enemy of the vine.

Through the courtesy of the Hon. C. A. Wieting, commissioner of agriculture, the entomologist has been able to avail himself of the services of nursery inspector J. Jay Barden who has cooperated with the writer very efficiently, and most of the field investigations were carried on with the assistance of this gentleman. Acknowledgment is due Mr D. K. Falvay of Westfield, who kindly placed a portion of his excellent vineyard at our disposal and cooperated with us most efficiently, thereby not only benefiting himself but aiding materially in demonstrating a practical method of controlling this pest, after it had become well established in a vineyard. The breeding cage and other office experiments have been conducted under the writer's direction by his first assistant, Mr C. M. Walker, aided by the second assistant, Mr D. B. Young. The author is also under obligations to Prof. Percy J. Parrott, entomologist of the Ohio Agricultural Experiment Station, and Prof. A. F. Burgess, chief San José scale inspector of Ohio, who kindly accompanied him in his investigation of conditions in that state in 1902 and supplied additional information in 1903.

E. P. FELT

Albany N. Y. September 1903

GRAVEVINE ROOT WORM

Fidia viticida Walsh

Ord. *Coleoptèra* Fam. *Chrysomelidae*

INTRODUCTION

The control of this pest in the Chautauqua grape belt is a serious problem which we have attempted to solve. The insect has, in recent years, caused enormous damages in the Ohio grape belt and now occurs in large numbers in Portland, Westfield and Ripley and has obtained a foothold over a large area. Messrs Walter Northrop and F. A. Morehouse estimated in the spring of 1902 that over 80 acres of magnificent vineyards had been destroyed or ruined by the pest in the vicinity of Ripley, and our investigations at the present time show that the area of severe injury and damage is constantly increasing, and is liable to much greater extension in the next few years. We consider this insect a much more serious enemy of the vineyard than the well known grapevine leaf hopper or white fly,[1] the work of which was so apparent and destructive in 1902 and the preceding two or three years. This leaf hopper undoubtedly causes much mischief, but, as its operations are confined to the leaves, the amount of damage is easily seen and, when necessary, steps may be taken to control it. The root worm on the other hand inflicts its most serious injuries under ground, where its operations can not be readily observed, and in a great many instances a vine or an entire vineyard is entirely ruined before the grower observes any trouble. This pest only requires two or three years to ruin a vineyard; and this, in connection with the secrecy of its work and the feeding of the grubs on the large roots, where a small amount of girdling is fatal, renders it a most dangerous enemy. Worst of all, this insect exhibits a decided preference for the more thrifty vineyards and is found most abundantly on or beneath the most vigorous vines. We believe that 15 or 20 grubs about a vine or as many beetles on its foliage are sufficient to warrant the adoption of vigorous measures for the suppression of the pest, though we are well aware that many more are fre-

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[1] Typhlocyba comes var. vitis Harris

quently seen in a vineyard still alive. The marvelous prolificacy of the insect, as demonstrated by our studies, justifies the belief that even a relatively small number are sufficient to threaten the welfare of a vineyard.

The season of 1902 was unusually favorable to vine growth, and the same is true of the past summer, a condition for which the grower should be thankful, since it has enabled the vines to withstand insect attacks more successfully.

Area infested. Ripley appears to be the original center of this insect's most destructive work, though it has been found generally present in small numbers in many vineyards where little evidence of serious injury occurs. The pest very probably made its way into the Chautauqua grape belt from Ohio; and our investigations in 1903 show that it is present in greater or less numbers from the state line as far east as Sheridan, if not farther and from the lake shore to the top of the adjacent hills. We have also found it in small numbers in Hudson river valley vineyards at Highland and Milton.

Signs of the insect's presence. The more destructive work of this pest is somewhat difficult to detect, and is usually indicated by a weakness in vines and a marked decrease in the amount of new wood. The indications of the presence of the beetles are so characteristic that there should be little trouble in locating them. The peculiar chainlike eaten areas, represented in numbers on plate 6, are very characteristic of the insect and differ so much from the work of most other pests that no difficulty should be experienced in identifying it. The beetles show a decided preference for leafy vines, and the general appearance of some very badly eaten ones is shown on plate 5. The feeding of the beetle is usually the first visible indication of its presence and is not accompanied at the outset by signs of material injury. As the attack progresses and the work on the roots becomes more injurious, the development of the fruit is severely checked and the bunches may be less than half their normal size. The growth of wood is also much reduced, and vines which are very badly infested may die in midsummer. Cases were brought to the writer's attention where plants which had grown over 6 feet of wood the preceding summer, wilted in June and died. Infested vines as a general thing become less thrifty, develop less and less wood yearly till finally there is not enough to tie up. A portion of a vineyard very seriously injured and where there is not wood enough to tie up is represented on plate 3. This condition rapidly becomes worse, and soon, usually in two or three years after the insect has been present in numbers, there is no wood, and the vines are simply a small mass of foliage resting on an old stump as represented on plate 4.

The depredations of this pest are much more serious and usually first apparent on light sandy or poor soils, and in particular on gravelly knolls, though we have found the beetles much more abundant in rich, low, though not wet hollows. The insects seem to thrive under such conditions, and a deficient growth should lead to immediate investigation. Vines on rich clay soils in our experience are less injured by this pest, due probably to their greater resistant powers; and this appears to be the case in Ohio. It should be remembered that vineyards on heavy clay lands are not exempt from attack and should be closely watched and, if necessary, active measures employed to keep the number of beetles below the danger point.

The roots also afford a clue to the identity of the depredator. The young grubs eat away the small feeding branches, while the larger individuals gnaw the bark, particularly from the underside of the larger roots. They frequently eat away long strips, as represented on plate 1, figure 5, though occasionally a single grub may work along a somewhat sinuous path.

A native species. This serious pest of the vineyards is not, like many of the forms so injurious to agriculturists, an imported insect. It has long been known to occur in this country and its work on wild grapevines was observed before its depredations attracted notice in our vineyards. This insect may develop into a general pest of the grape and perhaps in time come to be as well known as the very destructive Colorado potato beetle, which is familiar to almost every farmer. It is very probable that this grape enemy was able to exist only in relatively small numbers on wild vines and hence was rarely very injurious. It seems to have developed a great fondness for some of our cultivated varieties, and the growing of these in large areas has enabled it to increase to an almost unparalleled degree. This may perhaps be cited as one of the cases where the devotion of extensive tracts to one crop has resulted after years in a species formerly harmless becoming very destructive.

It is interesting to note in this connection that the insect is by no means new to New York State. There are examples of the beetles in the private collection of the late J. A. Lintner, which were taken in Schenectady in 1880 and on Virginia creeper at Albany in 1882, and yet so far as known there is no record of the species proving destructive in this section. The writer also met with the insect at Albany in considerable numbers on Virginia creeper in 1901, and, though he has frequently visited vineyards in the vicinity, no signs of the insect were observed. It is very possible that the death of vines in early years here and there may have been caused by this beetle and attributed by growers to other agencies, as was the case before Professor Webster discovered the identity of the depredator in Ohio.

Allies. This species belongs to the large family of leaf-eating beetles, known as the Chrysomelidae, a group which comprises some of our most destructive insects. To it belongs the notorious elm leaf beetle,[1] a species which has destroyed thousands of magnificient shade trees in the Hudson river valley, and may in a few years become a most serious enemy to elms in other sections of the State. The two asparagus beetles,[2] are well known enemies to the grower of this succulent vegetable. The familiar yellow and black striped squash bug[3] is another ally of this destructive grape pest, which is sometimes aided in its deadly work by the steely or grapevine flea beetle,[4] a species which has caused great injury in some New York vineyards during recent years. A number of other related forms, nearly as injurious as those named, could be easily listed. These destructive allies are mentioned in this connection simply that the grape grower may have some idea of what related species can do; and, while this pest may not prove so generally injurious as any of these, it has already demonstrated its ability to cause much mischief. We see no reason at present for thinking that the history of this

[1] Galerucella luteola Müll.
[2] Crioceris asparagi Linn. and C. 12-punctata Linn.
[3] Diabrotica vittata Fabr.
[4] Haltica chalybea Illg.

insect in Ohio may not be duplicated in the Chautauqua grape belt, and perhaps in other sections of the State where this fruit is largely grown.

Present conditions in Ohio. The destructive work of this serious pest has been known in Ohio for some years. It was first brought to the attention of Professor Webster in 1893. The similarity of conditions existing between the Ohio grape belt and the Chautauqua region led the entomologist to believe that valuable data could be secured by personally investigating the present status of the insect in Ohio. This interesting section was visited about the middle of September 1902, and much valuable information secured through the kindly cooperation of Prof. P. J. Parrott, entomologist of the Ohio Agricultural Experiment Station, Prof. A. F. Burgess, chief San José scale inspector, and a number of prominent growers. The local knowledge of conditions possessed by the two gentlemen named enabled us to visit the sections of most importance with very little loss of time. Some very precise and significant statements were obtained in 1902 from Mr T. S. Clymonts of Cleveland O., who is not only a grower but also a dealer and one who undoubtedly has as good a general knowledge of local conditions as any one in that section. He stated that in the Ohio belt, extending east and west of Cleveland, from Painesville to Avon and reaching back 5 miles from the lake, there had been a reduction in shipments of fully two thirds during recent years. In 1894, 2000 carloads of grapes were shipped from that section. This was reduced in 1900 to 900 and in 1901 to 600. Mr Clymonts estimated the output for 1902 at not over 500 carloads.

He stated that this reduction is due to various causes, the principal ones being the ravages of the grape root worm, the destruction caused by rot, and the prevailing low prices. He attributed fully one third of the entire reduction to the beetles' work and instanced a number of cases where vineyards of considerable size had been killed by the operations of this pest. He mentioned one vineyard of 60 acres, another of 25 acres, and stated that innumerable small pieces had been destroyed by the work of this insect, and added that the yield of one 60 acre vineyard had been cut from 10–12 carloads to 35–40 tons by its operations. Mr Clymonts's observations led him to think that as a rule the younger vineyards, specially those planted in the last 10 or 12 years, suffered most, and that the old ones escaped with comparatively little harm. The most destructive work observed by him had been on sandy soil, or on ridges in other pieces. He also stated that vines set in an infested vineyard to fill vacancies do not thrive and are usually killed by the insect. A recent communication, Aug. 27, 1903, states that nothing has developed the present year to make it advisable to modify any of the above statements.

Mr J. W. Maxwell of Euclid stated in 1902 that 50% of the vineyards were dead in that section, and that in his opinion a large proportion of them died as a result of the operations of this insect. His crop of grapes in a large vineyard was reduced fully one fourth, the most of which he attributed to this pest. He stated that the Wordens and Brightons were killed first, while the Concords and Catawbas were not so badly injured. He also adds, in a letter dated Aug. 29, 1903, that renewing a vineyard with Niagara vines seems to be quite a success, since 800 roots set two years ago in vacancies all lived and have done well. We hope this will continue to be the case, but in the writer's opinion these recently set vines have just reached a very attractive condition, so far as the beetle is concerned, and he is afraid that injury may result in a year or two.

Mr W. H. Slade of East Cleveland estimated in 1902 that one fourth of the vineyards in that section had been destroyed by this insect pest, and according to his observations the Wordens and Catawbas suffered more than the Concords. The most serious damage in his experience was met with on the lighter soil of knolls.

Mr W. W. Dille of Nottingham was of the opinion in 1902 that there has been a decrease in recent years of 40% in the area devoted to grapes. He attributed this shrinkage about equally to the rot, which had been very prevalent, to the operations of the grape root worm, and prevailing low prices. He stated that the insect injuries had been limited mostly to the bluff and to vineyards in the near vicinity of the lake shore, those back and just under the bluff escaping with comparatively little damage. He considers the Concord as one of the most resistant varieties.

A number of other growers were interviewed in 1902, and some disparity of opinion naturally prevailed. It will be seen, however, that there are a number of well informed men in that section who attribute very serious injuries to this insect; and, while the estimates of some may be excessive, there can be no doubt that the pest has caused very serious losses. The season of 1902 was unfavorable for observing the work of this pest because the repeated rains enabled the vines to sustain much greater injury than they would in times when there was less moisture. These conditions prevented the making of personal observations on the destructiveness of the insect, and most of our data relating to this had to be obtained from the evidence of others.

Considerable attention was also given to the various remedial measures employed by different growers, and some diversity of opinion existed. A number had sprayed their vines with arsenate of lead and also with bordeaux mixture. A few were of the opinion that spraying with arsenate of lead is a very efficient check on the increase of the insect, while others believed that it was of comparatively little value. Mr T. S. Clymonts stated that spraying with the bordeaux mixture alone affords some protection, as the beetles migrate to untreated vines. This subject will be discussed more at length under "Remedial measures." Most of the growers agree that thorough cultivation assists the vines greatly in resisting the depredations of the grubs. Those on whose premises carbon bisulfid was used were not favorably impressed with the substance. They state that in any event the cost of application is excessive considering the prevailing low prices for grapes. Considerable injury was caused in certain vineyards by carbon bisulfid, and it is very doubtful if this measure can be used to advantage.

Early history. This insect was first brought to notice in 1866 when specimens were sent from Kentucky to Mr B. D. Walsh, afterward state entomologist of Illinois. This gentleman stated at the time that he had taken the beetle in small numbers in both north and south Illinois, and later in the same year described the species. He also received the insect the following year from St Louis and Bluffton Mo., where the adults were said to be eating both foliage and fruit. Prof. C. V. Riley, in his first report on the *Injurious and Beneficial Insects of Missouri,* characterizes this species as one of the worst foes to the grapevine in Missouri. This condemnation was based solely on the operations of the beetle on the leaves, an injury which is now regarded as of little importance compared with the work on the roots. Professor Riley received specimens from Bunker Hill Ill. in 1870, and in 1873 Mr G. R. Crotch described the insect[1] and gave its recorded distribution as the Middle and Southern states. The identity of the species described by Mr Crotch and this insect was pointed out by Dr Horn in 1892, when he recorded its distribution as the "Middle states to Dakota, Florida and Texas." He also states that the insect described by Lefevre[2] belongs to this species. This pest was received from the vicinity of Iowa City Ia. by Prof. H. F. Wickham in 1888, and Professor Riley has recorded this form and an allied one[3] as injuring grape leaves at Vineland Ark.

Nothing further was known regarding this species till 1893, when specimens were sent to Prof. F. M. Webster, then of the Ohio Agricultural Experiment Station, who made an exhaustive study of the insect and published a detailed account of his investigations in 1895.

Injuries by this insect in the state of Arkansas were recorded by Prof. J. T. Stinson in 1896, and in the same year Professor Webster notes a decrease in the numbers of the pest in Ohio vineyards and attributes it as possibly due to the efficient work of two egg parasites and a small mite.[4] The following year Messrs Webster and Mally reported, as a result of a series of experiments, that tobacco dust and kainit were practically ineffective against this insect, and two years later these gentlemen record the unusual abundance of the pest in Ohio vineyards, and state that serious injuries occurred at Bloomington Ill. The presence of this beetle in destructive numbers in the Chautauqua grape belt was recorded by Prof. M. V. Slingerland in 1900, who at that time published a general compiled account of the insect. Dr J. B. Smith, in his *Catalog of the Insects of New*

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[1]Fidia murina Crotch
[2]Fidia lurida Lefevre
[3]Fidia longipes Melsh
[4]Heteropus ventricosus Newport

Jersey states that this species occurs throughout New Jersey on the grape and Virginia creeper or Ampelopsis, and he also records it from Staten Island. A brief note published by Dr L. O. Howard in 1901 states that the depredations of this insect at Bloomington Ill. continue unabated and severe damage to vineyards is recorded. The writer, in the early spring of 1902, published a brief notice of the extent of the injuries in the Chautauqua grape belt with a summary of the life history of the pest and outlined a series of experiments for that year, which are reported on in detail in this bulletin together with the results obtained in 1903.

DESCRIPTION

The perfect insect is a small, brown, rather robust beetle about $\frac{1}{4}$ inch in length and rather densely covered with short grayish white hairs. It may be recognized by aid of plate 1, figure 1.

The egg is about $\frac{1}{25}$ inch in length with a transverse diameter about one fourth as great. Form, nearly cylindric, tapering a trifle at each end. The shell is flexible, and, when a number of eggs are crowded in a small space, they may become somewhat distorted. The eggs are white when first deposited, but soon assume a yellowish cast. On the fourth day a narrow semitransparent band appears near each end. The eggs of the clusters normally have a somewhat concentric arrangement, and range in number from 1 to 125. Several clusters are represented on plate 1, figure 3.

The young larva is creamy white, about $\frac{1}{17}$ inch in length and tapers somewhat posteriorly. The head is a pale, yellowish color with the mouth parts ranging from light to dark brown, the sutures and tips of the mandibles having the most color. The head is somewhat flattened, bilobed and with the posterior angles rounded. The mandibles are distinctly toothed. The body is slightly smaller than the head, convoluted and distinctly segmented. Each segment bears a transverse row of small tubercles, from each of which a long hair arises. The spiracles, or breathing pores, are darker than the body and usually light yellow.

The nearly full grown grub resembles the newly hatched individuals very much in general form and color. It is then about $\frac{5}{8}$ inch in length, with a yellowish brown head and the mouth parts and adjacent sutures dark brown or nearly black. The body has a greater transverse diameter than the head, is distinctly segmented and bears numerous irregular transverse rows of small setae, which are relatively much shorter than in recently hatched individuals. The spiracles are well marked and range in color from yellowish brown to light brown. The general appearance of the grub is shown on plate 1, figure 4. Its white color and curled form suggest the common white grub, in spite of its much smaller size.

The pupa ranges in length from about $\frac{1}{4}$ to $\frac{1}{3}$ inch and its general features are represented on plate 1, figure 6. It may be recognized by its white color with a pinkish tint about the head, thorax and posterior extremity. The head is adorned with a semicircular row of four spines, the middle two being larger and nearly erect, the others smaller and more divergent. There is a similar row near the anterior margin of the thorax, though the curve is not so pronounced as on the head. Just behind this latter row there is a cluster of four smaller, nearly erect spines placed in pairs, the posterior being more widely separated. The anterior femora is armed at its tip with a stout hook, while above and at one side is a single straight, hair-tipped spine with sometimes a second one below. The posterior femora is likewise armed with a stout hook and with two hair-tipped spines. At the posterior extremity, there are two flattened, stout spines projecting dorsally. The penultimate segment is armed with a pair of small, median spines with a smaller pair of closely placed ones on each side, and on the antepenultimate there is a median cluster of four closely placed, hair-tipped spines, the inner two being smaller. There is also a lateral spine on each side [fig. 1]. The other segments are each provided with a single transverse row of minute, short bristles, and on the scutellum there is a median pair of larger ones.

FIG. 1 Posterior segments of pupa (original)

This pupa may be known by its general form and coloration, and by the peculiar arrangement of the spines at its posterior extremity, as shown in the figure.

LIFE HISTORY

The life history of this insect may be summarized as follows: The winter is passed by the nearly full grown grubs in oval cells in the soil, and so far as our observations go the great majority of them occur from 10 to 12 inches below the surface and mostly near or in the subsoil. On the approach of warm weather, the grubs work upward, probably early in May in most years, and are then mostly within a few inches of the surface and usually within 15 to 24 inches of the stem of the grapevine, though some, and occasionally large numbers, may be found near the middle of the row. Usually very little feeding is done in the spring. The transformation to the pupa occurs in normal seasons from about June 1 to 20, the adults issuing approximately two weeks later or from about June 20 onward. The great majority of the beetles appear the last of June or early in July, though some do not emerge till the last of the month and in rare instances much later. A pupa was met with Aug. 15, 1902, and the adults have been found in New York vineyards as late as September and even in October. The latter are probably from belated larvae. The eggs are mostly laid in July and August under the loose bark of last year's wood and require a period of about two weeks to hatch. The young grubs make no attempt to crawl down but drop, and working under the loose soil make their way to the small feeding roots, where under favorable conditions they grow rapidly and after increasing considerably in size attack the larger roots, eating away long strips of the bark [pl. 1, fig. 5]. The latter, when a large number of grubs are present, may rest simply on a bed of borings. Many of the grubs attain nearly full size the latter part of August or early in September. Late in the fall the larvae descend to considerable depths, as previously noted, construct their oval cells and pass the winter within them.

Habits of the beetle. The habits of the beetle are of special interest because it is practicable to collect these insects and thus in a large measure prevent egg-laying and consequent damage from the grubs. Professor Webster states that the beetles normally begin to appear in northern Ohio about June 20. This agrees closely with our observations. The season of 1902 was remarkably late, and very few beetles were observed previous to

July 2, while in 1903 a few were taken June 19. Their first appearance was on light soil, and the insects did not begin to emerge in numbers on heavy land till nearly a week later. Our cage experiments [*see* table on p. 27] show that over 92% of the beetles appeared within two weeks after the first were taken, and practically none after July 21. In other words, out of 506 bred from under two vines, 477 emerged by July 21. The issuing of the insects is undoubtedly considerably modified by temperature, as demonstrated by the beetles appearing in unusually large numbers on the 26th, which was a bright, warm day. The time of appearance and the fact that a large proportion of the insects issue from the ground within two weeks are of much importance, if anything is to be done by collecting the insects. The beetles appear to emerge and remain on the foliage, particularly around buds, several days before they feed to any extent. Breeding cage experiments have fixed this period at from one to four days. Two beetles which actually emerged under observation refused food till the fourth day, and it is very probable that this period is nearly the normal time between the emergence of the beetles and feeding. A considerable number may be found before any feeding has taken place, as is evidenced by Mr Barden taking 12 from a vine which bore practically no marks of their eating. The insects may be found in a field over an extended period, which is not surprising in view of the fact that a beetle may live over nine weeks, as demonstrated by us this year. Some were observed by Mr T. T. Neill Sep. 4, 1902, in a vineyard at Fredonia, and Mr F. A. Morehouse states that he met with individuals in October 1902.

Oviposition does not occur till some days after the appearance of the perfect insects, and according to breeding cage observations this period may range from 10 to 17 days. Our breeding cage experiments also indicate that the insect may feed from 6 to 13 days before eggs are deposited. This period was carefully ascertained by isolating a series of males and females and providing them with as nearly natural conditions as possible. Both of these periods are much longer than normal, since eggs were found by Mr Barden in the Northrop vineyard July 9, 1902, where beetles were present in very small numbers on the 2d. This allows a maximum of only seven days between the appearance of the earliest insects and the laying of eggs; and, if, as can hardly be questioned, the insects remain without taking food for two or three days, then the time of feeding before the deposition of eggs can hardly exceed an equal period. The first beetles were observed in 1903 on June 19, and a few contained nearly developed eggs July 2, at which time it was very warm and there were many pairing, and eggs were deposited a day or two later, making about two weeks between the appearance of the first beetles and the deposition of eggs. This period is a little longer than was the case in 1902, but even then does not equal our breeding cage records. This matter is of considerable importance because it shows how quickly collecting must be done or poisons must act in order to prevent the deposition of many eggs.

The feeding of the beetles occurs almost entirely on the upper surface of the leaves and, as described by Professor Webster, "is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upwards, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way, they move to another place and begin again, thus eating out numerous chainlike rows of silk net" as shown on plates 5 and 6. "The insects usually eat only to the lower epidermis on foliage having a velvety undersurface, but on others they eat entirely through the leaf." The beetles are shy and retiring by nature and feed largely in sheltered places or among the growing tips, both difficult places to hit with a spray. A favorite retreat of the insects is among the tendrils clinging to the top wire. Many of those feeding on the leaves are easily frightened, and when alarmed usually fold up their legs and fall to the ground, where they remain quiet till all danger appears to have passed. They can spring readily either with the legs or when inverted by suddenly opening the wing covers and projecting themselves from the hand or other support. The beetles on the canes, however, are not so easily disturbed. They can frequently be picked from the vine, and it requires repeated jarring to dislodge all. This is of considerable importance when collecting beetles with any machine, and the persistence with which some hang to the wood is an objection to this method of controlling the insect. They are, however, much more easily jarred from the vines on warm days.

The tendency of this species to remain in a locality for a time, at least, is well shown in a certain vineyard at Ripley. It had suffered very severely in earlier years from the depredations of this pest and a portion of it was uprooted in the spring of 1902. A small area was allowed to remain in the hope that it could be brought back to a normal condition. A few rows next to the uprooted area were fed on to a very great extent by the beetles, which had evidently emerged from the adjacent soil and made their way to the nearest vines, where they were content to remain and feed. The extensive injury inflicted on these vines is well illustrated on plate 5, which shows how badly many of the leaves were riddled. A curious fact in connection with the abundance of the beetles on these small vines is that few or no eggs could be found, probably due to the small amount of wood. Observations have shown that while there is undoubtedly a connection between the amount of feeding and the number of eggs laid, such is not necessarily true of the feeding and the number of eggs or grubs on particular vines. This is a matter of some importance because many growers are inclined to estimate the number of grubs at the roots by the amount of feeding on the foliage, whereas it frequently occurs that more grubs are found under vines with foliage but little eaten than under those which bear evidence of excessive feeding. This tendency of the insects to remain in a locality for a time is favorable to local control, since it gives an opportunity to destroy them by collecting before there is much dispersion. Such opportunities should be embraced promptly, because it is well known that at times the beetles fly to a considerable extent. Mr Schonfeldt has called the writer's attention to an instance where numbers of the insects suddenly appeared on some vines close to his house. They were so numerous that the rattling as they struck the foliage attracted the notice of Mrs Schonfeldt, who called her husband's attention to the sound. The day was warm, and consequently the beetles flew rapidly. As a rule, we believe, dispersion occurs more by a wandering individual flight than by movements in swarms. There is a marked tendency among the beetles to desert unthrifty vines, probably because of the poor shelter they offer, and to attack the more vigorous, thrifty vineyards. It may be that a slight over-crowding, as in the case of some other insects, impels the beetles to flight. This means that poor vines are relatively safe, while the better ones are liable to injury and are consequently the places where it is most important to control the insect. These inflying beetles will lay eggs if conditions are favorable, and the earlier they appear the more eggs will be deposited.

Eggs. The eggs of this insect are deposited almost entirely under the loose bark of last year's wood, many being found as high as the top wire. Professor Webster states that over 700 have been taken from a single vine, and from a section 16 inches in length and an inch in diameter he took 225 eggs. Once he found a few eggs pushed down between the earth and the base of the vine, but we have failed to find eggs in any such position. Beetles in confinement deposited eggs in crevices and cavities of the wood and even on leaves. Eggs were found in the field in 1902 as early as July 9, and oviposition was still in progress Aug. 15, and, though beetles were less abundant than three weeks before, it was still easy to find individuals which contained fully developed eggs. The first deposited in 1903 were found about July 3, and in our indoor breeding cages oviposition continued till into September. Experiments were planned, both this year and last, to determine the duration of the period of oviposition, the time when the eggs were laid and the total number deposited by females. A number of pairs of beetles were isolated and provided daily with fresh food. The work in 1902 demonstrated that a number of beetles might continue to deposit eggs for a period of over 40 days, and certain individuals from seven to 13 days. These records gave totals of 187, 141 and 106 eggs for individuals. This was interesting, but it was felt that the limit had not been reached, and consequently the studies were conducted on a more extended scale this year, and the results more than justified the labor, as will be seen by the appended table.

Oviposition experiments with Fidia 1903

Beetles taken at Westfield July 2

		Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant
July	4	30	....	....	(40♀)	(17♀)	(4♀)
	5	20	....	....	77	....	....
	6	21	....	....	25	....	....
	7	26	....	....	225	....	....
	8	20	....	....	30	75	....
	9	25	....	35	450	150	145
	10	35	....	....	300	175	40
	11	25	....	....	400	150	....
	12	30	....	10	650	100	....
	13	25	....	10	200	250	50
	14	....	....	....	150	40	25
	15	31	....	....	175	45	....
	16	....	140	....	30	....	150
	17	....	....	....	100	....	....
	18	33	25	....	175	125	25
	19	....	....	....	120	....	25
	20	....	....	....	20	....	50
	21	24	....	....	62	175	70
	22	....	....	75	25	10	40
	23	41	....	....	30	35	....
	24	30	....	26	200	50	75
	25	....	....	....	264	50	85
	26	24	....	....	185	300	160
	27	30	....	....	70	25	25
	28	....	....	....	62	....	....
	29	20	....	....	50	....	50
	30	....	....	....	130	50	50
	31	10	25	....	185	115	128
August	1	42	60	....	25	105	54
	2	....	....	....	....	50	70
	3	....	20	....	150	....	75
	4	11	....	All dead.	....	76	....
	5	....	....	....	75	....	130
	8	....	....	....	75	....	....
	10	56	....	....	58	18	....
	12	a16	72	....	73	....	95
	13	2	....	....	123	....	83
	14	36	....	....	25	....	....
	15	....	....	....	36	....	....
	17	42	....	....	90	23	36
	19	....	....	....	60	....	....
	20	45	....	....	75	....	....
	21	....	....	....	35	....	35
	22	36	....	....	70	....	166
	24	25	All dead.	....	40	15	28
	26	....	....	....	39	....	....
September	2	56	....	....	....	....	....
	4	14	....	....	....	....	....
	6	31	....	....	....	....	....
	11	♀ dead...	....	....	....	....	....
Totals.....		902	342	156	5 664	2 199	1 955
Average per female........		....	....	....	141	192	488

a 4.30 p. m.

An examination of the above record shows that one female taken July 2 began laying eggs July 4 and from then to the 13th deposited from 20 to 30 daily, and from the latter day onward the eggs were laid usually at intervals of one to several days, the periods of deposition being interspersed by intervals of feeding. There seems to be a very direct connection between the amount eaten and the number of eggs laid, which would be expected when it is remembered that a single female lived upward of two months and during that time deposited the enormous number of 902 eggs. This record is a striking testimony to the care bestowed on the insects by Mr Walker, who had charge of the breeding cage work. Analysis shows that 257, or over one fourth of the total number, were laid during the first 10 days, and 416, or nearly one half of the total number, in the first three weeks. This record is undoubtedly exceptional and probably approaches the maximum capacity of the insect, particularly in the field. It will be seen, however, that one other female deposited 342 and another 156 eggs, while averages of beetles kept in certain stock jars ranged from 141 to 192 and 488 to each female, and an average based on the entire record gives nearly 175 for each female. This indicates that our highest record, 902, may not be so very exceptional. A study of the entire number of eggs is not without interest, as it shows when the greatest number are deposited and consequently the time when the beetles should be destroyed in order to obtain the maximum benefit. A summarized table is given below.

Summary of oviposition record 1903

DATE	Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant	Total	Per cent of total
July 4–18	321	165	55	2 987	1 110	435	5 073	45
July 19–31	179	25	......	1 403	810	758	3 175	†28
July 4–31	500	190	55	4 390	1 920	1 193	8 248	†73
Totals, July–Sep.........	902	342	156	5 664	2 199	1 955	11 173	....
Average per female........	902	342	156	141	192	488	....	....

It will be seen from an examination of this that 5073 eggs were deposited by all of the different beetles in the various jars between July 4 and 18 (or the first two weeks) making a total of

45% of the entire number, and that only 3175 were deposited between July 19 and 31 (or the following 12 days). It will also be observed that 8248 eggs were deposited by all the beetles during the month of July, and this amounts to over 73% of the entire number produced by the beetles under observation. In other words, a very large per cent of the eggs are deposited under normal conditions during the first two weeks after the beetles begin to lay, or during the first three or three and one half weeks of their existence. There is then a decided drop during the next 10 or 12 days, and a much greater falling off in the following weeks. This record probably represents very closely indeed what actually occurs in the field and emphasizes the necessity of destroying the insects early in their career, though it will be observed that considerable protection results even if the pests are not killed till three or four weeks after they appear above ground.

The beetles which made the records both this year and last were confined in jelly tumblers or fruit jars and were daily supplied with small pieces of cane and fresh leaves. Careful records were kept of all insects taken from the individual tumblers as well as the large breeding jars, and, while the conditions were by no means normal, it is manifest that valuable results were obtained. In nature, it is probable that natural causes would result in the death of many individuals early in their career, and the same is true in the breeding jars, though deaths in the latter are usually the result of confinement and unnatural conditions. One to a certain extent offsets the other, and the above records may be considered as giving a fair idea of what actually occurs in the field.

Our observations on eggs laid in breeding jars showed that they are deposited in masses of from 1 to 125, the latter being the largest number observed in one cluster. A normal egg mass measures about $\frac{1}{5}$ inch in length and less than one half that in breadth. The somewhat concentric arrangement of the eggs is shown on plate 1, figure 3. The rows of eggs often overlap each other like shingles, and in the center of the mass there is frequently an appearance of two or three layers. The egg clusters are sometimes deposited so that two thirds of the branch is encircled, and in each case the whole mass is covered with a sticky substance, which glues each egg to the other in such a manner that the whole may be easily detached from the vine, as is often the case when a strong wind is blowing.

The duration of the egg stage was determined by repeated observations both last year and this as from 9 to 12 days, about one day being required for an entire mass of eggs to develop after hatching commenced. We were also able to verify Professor Webster's observation on the appearance of a narrow semitransparent band or line near each end of the egg four days after oviposition. Small numbers of empty egg shells, indicating that hatching had begun, were found in Mr G. L. Hough's vineyard July 24, 1902; and it is very probable that in Mr Clyde Dean's vineyard at Portland, where conditions are about a week earlier, young grubs had appeared some time before.

Habits of the grubs or larvae. The young larvae, after they hatch from the eggs, drop to the ground, as observed by Professor Webster and corroborated in our own experience. There seems to be very little or no attempt on the part of these tiny creatures to crawl down the stalk. A recently hatched grub is such a small creature that it rapidly makes its way into any crevice or crack, and when it drops on loose earth soon disappears from sight. Earlier writers have recommended the covering of the roots of grapevines as deeply as practicable at the time the young hatch, so as to present more obstacles to the grubs when making their way to the roots. This suggested to the writer some experiments to determine the burrowing and traveling powers of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during that entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial, and under such unfavorable conditions lived about three days. This would seem to indicate that the little creatures can make their way over many obstacles if not confronted by very unfavorable conditions.

Some tests were also planned to ascertain the burrowing powers of these little grubs. A glass tube 17 inches long and ½ inch in diameter was bent so that 4 inches were vertical. It was then filled with loosely packed earth, and on July 29, 40 recently hatched grubs were placed on the surface of the soil in the 4 inch vertical portion. One grub had made its way through the entire mass of soil by July 31, another by Aug. 1, and 11 others by the 3d, making a total of 13 which had traveled the whole length of this tube in a period of four days.

Another $\frac{1}{2}$ inch tube, 10 inches long with $3\frac{1}{2}$ inches vertical and $6\frac{1}{2}$ inches of its length horizontal was similarly packed and 13 grubs placed on the surface of the soil July 29. Four of these had made their way throughout the entire length of the tube by Aug. 3. Another tube 12 inches long, $\frac{1}{2}$ inch in diameter, with $2\frac{1}{2}$ inches of its length vertical and the remainder horizontal was filled with tightly packed soil and a number of grubs placed in it Aug. 1. On the 7th one grub had made its way through $7\frac{1}{2}$ inches of this tightly packed material. It would seem from the above experiments that, while a great many grubs undoubtedly perish in making their way from the vine to the succulent roots on which they feed, they are capable of overcoming great obstacles, and the facts ascertained above at least raise a question as to the advisability of attempting to interpose barriers between the grub and the roots on which it feeds.

The young larvae or grubs are undoubtedly able to exist for some time without food. They soon make their way when possible to the young feeding roots, where they may sometimes be found in considerable numbers. The writer, in the middle of August 1902, succeeded in finding eight of these little creatures under a small bunch of feeding roots. They were less than one quarter grown, and under larger roots near them several others were found which were about half grown. Aug. 18, 1903, quarter and nearly full grown grubs were found in some Westfield vineyards. The occurrence of few half grown larvae and of considerable numbers of nearly full grown individuals the middle of September 1902 indicates that these creatures develop very rapidly after they have found suitable roots on which to feed. The finding of a small grub scarcely $\frac{1}{16}$ inch long July 2 shows that some do not attain their full growth in the fall, since this individual could not have hatched from an egg laid in 1902, as the beetles had hardly begun to appear, and that such individuals must feed to some extent in the spring. It seems probable that these very small grubs produce the later emerging beetles and are therefore responsible to a limited degree for the very extended period during which adults are found abroad. Most of the grubs complete or nearly complete their growth in the early fall, and on the approach of cold weather descend deeper in the earth. Professor Webster records finding the grubs a foot below the surface in the spring, and our own observations indicate that they descend nearly to that depth, where they pass the winter in small oval cells. Their ascent in the spring occurs after the appearance of warm weather and probably some time in early May. Experiments in 1903 with grubs collected the latter part of April demonstrated the ability of full grown and apparently half grown larvae to complete their transformations with no more nourishment than is found in ordinary garden soil in which there are no grape roots. Those about quarter grown were not able to survive the test. On the other hand, some nearly full grown individuals were observed last spring feeding on the roots to a slight extent in our breeding cage.

Pupa. Professor Webster records the finding of a very few pupae as early as the first week in June, and Mr Barden states that in 1902 he observed the first pupae at Ripley June 7, though Mr Hough is of the opinion that the larvae began to transform as early as June 4. The great majority of the insects had transformed to this stage by June 23. The present season was considerably more advanced than that of last year, and 90% of the insects were in the pupal stage May 29, 1903, on light sandy loam. The cells are almost entirely within 2 or 3 inches of the surface and usually within 2 or 3 feet of the base of the vine.

The duration of the pupa stage has been stated by earlier writers as about a fortnight and actual observations with breeding cage material have enabled us to determine this period as from 13 to 14 days. These observations were made in the office, where temperature conditions were uniform and rather high, and it would not be surprising if this period was materially extended out of doors in unusually cool weather.

The oval cells occupied by the larvae can be broken repeatedly, and the grubs will make others, but such is not true of the pupae. The insects are so delicate in the latter stage that the writer has experienced great difficulty in transmitting them through the mails, even with most careful packing. This is shown by the fact that out of 58 mailed to Albany only 15 arrived alive; a number were carefully packed in their cells or laid on moist cotton, otherwise the fatalities would have been much higher. Cage experiments in the field show that from 50% to 75% or even a larger proportion may be destroyed by timely cultivation [*see* p. 27]. These facts have a very important bearing on remedial measures, as will be pointed out under that head.

EXPERIMENTAL WORK IN 1903

This is a very convenient heading under which to group a number of records of work carried on under similar conditions, yielding data which can be readily tabulated and which should be discussed under various headings. This work was conducted in the vineyard of Mr D. K. Falvay of Westfield, who contributed not a little to its success.

Eight large, thrifty Concord vines of as nearly uniform size and conditions as could be determined by examination were carefully covered by wire cages [pl. 7, 8] so arranged that no insects such as Fidia could escape, nor could any enter from outside. The cages were numbered respectively from one to five, running from east to west. Numbers 1, 2 and 5 contained two vines each and numbers 3 and 4 but a single vine. Number 1 was a check cage, which was watched carefully for the purpose of comparing with conditions obtaining in other cages. Number 2 included two Concord vines around which the soil had been carefully hoed at the time the majority of the insects were in the pupal stage. The work was not more thorough than could have been done by a horse and cultivator. The vine in number 3 was sprayed with arsenate of lead, 1 pound to 50 gallons of water. The first application was made June 19 and the second June 27. The work was done by Mr Barden, who used a small hand atomizer and took special pains in each instance to cover every portion of the foliage so far as was possible. The vine in number 4 was sprayed with a poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and ¼ pound of paris green being used to 40 gallons of water. The spraying was done by the same person and in the same manner as in the case of cage 3. The vines in number 5 were reserved for the purpose of determining exactly when the beetles appear above ground, and it was visited at intervals of a few days to a week or thereabout and the beetles removed till practically all had emerged. The tabulated record is as follows:

Record of cage experiments 1903

Date		1 Check	2 Cultivation	3 Arsenate lead 4 lb to 50 gal.	4 Poisoned bordeaux mixture	5 Beetles collected
June	5	....	Carefully hoed to depth of 3 in.	....	....	....
	19	....	....	Sprayed thoroughly	Sprayed thoroughly	....
	22	8 beetles	2 beetles	24 beetles	18 beetles	22 beetles
	24	19 beetles	7 beetles, practically no feeding	36 beetles, some feeding	32 beetles, some feeding	75 beetles
	25	....	....	....	....	50 beetles, 6 p. m.
	26	41 beetles	10 beetles, much recent feeding	56 beetles, more feeding	56 beetles, more feeding	50 beetles, 11 a. m.
	27	....	....	Sprayed second time	Sprayed second time	....
	28	....	....	....	....	31 beetles
	30	....	....	....	....	123 beetles
July	1	141 beetles, considerable feeding	45 beetles	72 beetles, 1 recently dead, considerable feeding	90 beetles, 5 wing cases (representing 3 beetles), 1 hanging dead	41 beetles
	2	....	....	....	....	33 beetles
	6	....	....	None dead	None dead	57 beetles
	7	....	....	....	....	6 beetles
	14	....	....	None dead, few living, 3 egg clusters	None dead, few living, 5 egg clusters	8 beetles
	21	Fewer beetles than in 2, 3 or 4 and fewer eggs than in 3 or 4	Beetles more numerous than in 3 or 4, less feeding than in 1, 3 or 4	6 egg clusters and more beetles and more feeding than in 4	Very few beetles, 6 small and 5 fair sized egg clusters	13 beetles
Aug.	1	7 beetles	1 beetle	None	None	2 beetles
	18	None	None	None	None	No beetles. Total 511

It will be seen, on comparison between the cage in which cultivation occurred and the number of beetles observed in cages 1, 3, 4 and 5, that a large proportion of the insects must have been destroyed by this means. In all probability over 50% and possibly 75% or even more, were killed by cultivation, because we find that on July 1 there were 141 beetles in cage 1, and in cages 3 and 4, which should be added together as each contains but a vine, there were 162, while in cage 5 we had obtained at that time nearly 400 insects. In cages 3 and 4, it will be observed that there were 72 and 90 beetles respectively living July 1, 12 days after the first application of poison. One dead insect was found in cage 3 and five wing cases, representing three individuals, and another hanging in cage 4. The conditions, however, in these two cages, as compared with the others at the same time, were so similar that we could not be certain that the relatively few insects found dead had been killed by poison, and the same was true on July 6, 14 and subsequent dates. A study of the record of captures in cage 5 showed that a very large proportion, 92%, of the beetles appeared above ground within two weeks after the first insects were observed abroad. In other words, we bred from the soil about two vines 511 beetles, 477 appearing in the first two weeks.

The experimental vineyard,[1] which was selected only after extensive examinations in different vineyards in the Chautauqua grape belt, appeared to be a place where the insects were rather abundant and yet had not caused very serious injury unless it was in the immediate vicinity of the cages. The plot selected

[1] The cultivation of this vineyard is of interest, and data relating thereto, kindly placed at my disposal by Mr Falvay, is as follows: Ap. 28 the vineyard was gang-plowed, and was horse-hoed the 30th; May 4 it was hoed by hand; May 7 harrowed with a spring-tooth harrow; May 11, 350 pounds of kainit to an acre applied; May 14,* one furrow on each side of the row was turned toward the vines; May 22, the space between the furrows was cultivated; June 5,* horse-hoed for Fidia, following with the cultivator; June 16, cultivated for Fidia. Each process required about a day, and the cost for 5 acres was placed at $27. The additional cultivation (*) for Fidia amounted to $8.50. The vineyard since Aug. 1, in addition to that given above, has been gang-plowed, harrowed with a spring-tooth harrow and cultivated, each operation twice in a row and one after the other and followed by cultivation with an acme harrow. The vineyard is showing the effects of good treatment and has developed a very satisfactory amount of wood in spite of previous root worm injury.

was the portion just south of Mr Falvay's packing house, extending over a gravelly knoll into a loamy hollow. The region next to the packing house contained comparatively few insects, which was probably due in considerable measure to a neighbor's chickens working in that section. The first 24 rows south of the packing house were reserved largely for demonstrating the effectiveness of collecting, and no cultivation for the destruction of pupae was allowed on its six southern rows and also on the next six rows of the adjacent plot. The next plot of 13 rows was sprayed with arsenate of lead, 5 pounds to 50 gallons of water. The application was made July 26 and special pains were taken to cover the vines as thoroughly as possible. The 11 rows south of the arsenate of lead plot were sprayed the same day and in the same manner with poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and $\frac{1}{4}$ pound of paris green being used to 40 gallons of water. The next two rows were not sprayed, but were left as checks, and the following 11, namely those just north of the cage except one, were sprayed with an arsenate of lead mixture as described above. The spraying with poisoned bordeaux was thorough, though not quite so carefully done as in the case of the arsenate of lead. At the time the application was made there was a considerable evidence of feeding in the section next the cages and also in that sprayed with the poisoned bordeaux mixture. The row just north of the cage and that on which the cages stood received no poison.

Insects taken by the beetle catcher. The operation of the beetle catcher over 5 acres resulted not only in capturing a large number of Fidias but also in taking a number of other species. The list is of interest because it indicates in a measure the excellent cultivation and care which this vineyard has received. It will be observed that no species appeared in any numbers compared with those of Fidia, which fact alone is of considerable value in indicating the care and clean culture given the vineyard. A few caterpillars and other soft bodied larvae were taken but in relatively no larger numbers, and no attempt was made to count them. The list follows, and it will be seen that the number taken of any species is so small that practically all may be neglected, as regards either beneficial or injurious powers.

NUMBER OF VARIOUS INSECTS TAKEN IN BEETLE CATCHER

COLEOPTERA

1 Calathus gregarius *Say*, July 7, 14, 26
1 Bradycellus rupestris *Say*, June 26
2 Megilla maculata *DeG.*, spotted lady bug, July 7
1 Coccinella 9-notata *Hbst.*, nine spotted lady bug, June 26, July 7
1 Chilocorus bivulnerus *Muls.*, twice stabbed lady bug, June 26
10 Brachyacantha ursina *Fabr.*, June 26, July 7
2 Tenebrioides corticalis *Melsh.*, June 26
1 Melanotus communis *Gyll.*, June 26
2 Asa hes baridius *Say*, June 26
2 Pyropyga nigricans *Say*, June 26, July 7
1 Telephorus carolinus *Fab.*, June 26
1 Hydnocera *sp.*, June 26
1 Macrodactylus subspinosus *Fab.*, rose beetle, June 26
1 Pelidnota punctata *Linn.*, spotted grapevine beetle, July 1, 14
1 Xylotrechus colonus *Fab.*, July 1
1 Euderces picipes *Fab.*, July 14
1 Eupogonius tomentosus *Hald.*, June 26
1 Doryphora 10-lineata *Say*, July 14
1 Disonycha xanthomelaena *Dalm.*, June 26
6 Haltica chalybea *Ill.*, steely flea beetle, June 26, July 14
1 Crepidodera helxines *Linn.*, June 26
1 Doryphora clivicollis *Kirby*, June 26
4 Systena taeniata *Say*, pale striped flea beetle, June 26
1 Notoxus monodon *Fab.*, June 26
20 Otiorhynchus ovatus *Linn.*, ovate snout beetle, June 26
1 Phytonomus punctatus *Fab.*, punctured clover leaf weevil, July 1
1 Conotrachelus nenuphar *Hbst.*, plum curculio, June 26
1 Hylobius pales *Hbst.*, Pales weevil, July 7

HEMIPTERA

1 Canthophorus cinctus Beauv., July 14
1 Euschistus tristigmus *Say*, July 1
1 Nezara hilaris *Say*, July 1, 7
8 Lygus pratensis *Linn.*, tarnished plant bug, July 14
1 Thamnotettix clitellaria *Say*, June 26

Observations showed that the red-headed flea beetle, Systena frontalis Fab., was somewhat abundant in Sheridan vineyards July 21 and relatively much more so than in and about Westfield, where most of our experimental work was done.

Food plants. This beetle has a comparatively restricted food habit. It was early observed by Mr Walsh on grapevines, and the late Professor Riley recorded its feeding on the American redbud, Cercis canadensis. It is also known to feed on the native Virginia creeper, Ampelopsis quinquefolia.

Varieties affected. The Concord, as is well known, is almost universally grown in the Chautauqua region, and consequently is one that has suffered to the greatest extent from injuries by this pest, though our observations convince us that the Niagara is even more liable to injury, and in the cases we have seen the difference was quite marked. Referring to Ohio reports, it will be seen that Mr Maxwell states that Wordens and Brightons were killed first, while Concords and Catawbas were not so badly injured, and in a later report he states that renewing a vineyard with Niagara vines seems to be quite a success. This latter point, we think, needs further demonstration. On the other hand it will be observed that Mr Slade considers that the Wordens and Catawbas suffer more than the Concords. The relative liability of different varieties to injury is probably influenced to a considerable extent by location and character of the soil, specially the latter, and it is therefore not surprising to meet with some discrepancies as to the relative amount of injury they suffer. Extended observations and probably careful experiments are necessary before authoritative conclusions can be reached.

GRAPEBERRY MOTH

(*Polychrosis botrana* Schiff.)

This species is present in more or less numbers in most vineyards, and as it was met with in the course of our experimental work on Fidia, and since this latter gave some valuable results on methods of controlling this fruit pest, a brief notice of it is included. This species is specially destructive in the vicinity of forests or in vineyards near which bushes of various kinds, particularly sumac, are allowed to grow. It is believed to have two generations in this country, the larvae of the first feeding on the blossoms and those of the second in the fruit. There is possibly a third brood. It is gratifying to state that we have obtained excellent results in controlling this pest with arsenate of lead and also the poisoned Bordeaux mixture. The spraying, done shortly after blossoming and while the fruit was not larger than a small pea, was primarily for the purpose of killing Fidias; but investigation this fall shows that it was much more effective in destroying young of the grapeberry moth, since there is certainly 50% less damage to fruit on sprayed than on unsprayed rows, even when the two are side by side. The difference was so marked that it was easily observed, and in walking between the treated and untreated areas, it was not hard to find infested clusters on the one side while on the other they were much less abundant. It was also observed that not only was this insect checked by spraying but the foliage was benefited by the treatment, having a better color and remaining on the vines a longer time.

Our experiments were in Mr D. K. Falvay's vineyard, and he informs us that last year a section of six or seven rows in his vineyard next to a lot of sumac and other bushes, was so badly infested by this worm, that no attempt was made to pick it. The wild growth was cut away last winter and burned, and the fruit on these rows was no more infested this year than that of any other section of the vineyard.

We therefore advise clean culture, specially the destruction of bordering hedges and adjacent miscellaneous forest growths and the burning of debris in a vineyard, in order to lessen shelters where the insect may pass the winter. It is advisable to locate vineyards when possible at some distance from woods, and wherever they are infested to any extent by this pest, spray with an arsenical at least once after blossoming.

NATURAL ENEMIES

This serious grapevine pest is subject to attack by several natural enemies. Two interesting species of egg parasites, bearing the scientific names Fidiobia flavipes Ashm. and Brachysticha fidiae Ashm., were bred from eggs of this insect by Professor Webster in 1894, and in 1896 he expressed the belief that a marked decrease in numbers of the Fidia was possibly due to the work of these parasites. Professor Webster also observed a small brown ant, Lasius brunneus var. alienus, feeding on the eggs, and a small mite, provisionally identified for Professor Webster by Dr George Marx, as Tyroglyphus phylloxerae P. & R., extracting the contents of several eggs in succession, and also a smaller mite resembling Hoplophora arctata Riley. Another mite, Heteropus ventricosus Newport, was met with by Professor Webster in 1896 who credits it with being quite destructive to the eggs of this pest. One of these small mites, probably a species of Tyroglyphus, was observed in our breeding cages feeding on the pupae, one being almost entirely destroyed.

Several predaceous insects were found by us during field work, specially when digging for larvae in the early spring. The grubs of some carabid beetle were observed to be about two thirds as numerous as those of Fidia during the last of April, and it is very probable that they prey on this species. We were unable to bring any of the carabids to maturity. A small beetle, Staphylinus vulpinus Nordm., was associated with Fidia grubs and possibly preys on them. The larva of an aphis lion, Chrysopa species, was observed by the writer investigating under loose bark where eggs were present, and it is not at all improbable that these insects destroy many.

REMEDIAL MEASURES

It was felt when this study was undertaken that there was a lack of definite knowledge regarding methods of controlling this insect and it was accordingly planned to make a thorough test of those advised as well as to experiment in other directions. Some of these investigations gave results which appear to have a positive value, while others only proved certain measures comparatively useless.

Destroying the pupae. There is no doubt as to the benefits of cultivating vineyards for the purpose of destroying the pupae, if the operations are properly carried out. In the first place, plan to have a moderately high ridge of firm earth about the base of the vines the latter part of May, so that the grubs will come well above the roots before transforming to the pupal or " turtle " stage. Then adjust operations so that horse-hoeing away from the vines will come early in June, thus avoiding special cultivation for the purpose of destroying the insects. It may be found, however, that some adjustment of the cultivator, so that it will work a little deeper, or a little extra care in keeping the implement close to the vine, will materially increase the efficiency of this operation. In 1902 our attention was called in the early part of June to a vineyard where there were from 50 to 60 grubs about many of the vines, while repeated search the latter part of the same month failed to discover more than three or four pupae under a vine and in many cases not a specimen. In the interval this vineyard had been carefully cultivated for the purpose of destroying the pupae, and we are of the opinion that this practice was largely responsible for the scarcity of the insects. This is further substantiated by our cage experiments in 1903 [*see* p. 27] which show that from 50% to 75% or more of the pupae can be killed by cultivation no more thorough than that given by horse implements. These data lead us to believe that much can be accomplished by planning cultural operations so that the vineyard will be horse-hoed at the time when the majority of the insects are in the pupal or "turtle" stage. This operation may well be deferred till some of the more advanced insects begin to brown a little or even till a very few have changed to beetles, and its efficiency can be further enhanced by repeating the cultivation, with a spring-toothed harrow, about a week or 10 days after in order to catch some of the later transforming individuals. There may be a difference of a week or more in the development of the insects in a vineyard, and this means that each grower should know the pupa and watch for its appearance. This variation is due largely to the character of the soils, as some warm up much more rapidly than others, and the final changes to beetles occur correspondingly quick.

Collecting beetles. This method of controlling the grapevine root worm did not promise much when it was first attempted. Professor Webster had either not considered it worth trying or had found it of comparatively little value, and Dr Marlatt did not even mention it in his recommendations. Professor Slingerland made the guarded statement in 1902 that it may be practicable in some cases to jar the beetles into a collecting apparatus, but he apparently had little faith in the plan, except when the insects could be jarred to the ground where they would be eaten by chickens.

Mr J. J. Barden, working under the writer's directions in 1902, found that, even with a plain cloth-covered frame several feet square and with a small slit in one side, so that it could be slipped under a vine, large numbers of the insects could be collected. With this crude apparatus he was able to capture a quart of beetles in about two hours. This indicated that much better results could be secured with a more elaborate apparatus; and with the aid of Mr G. L. Hough he constructed a modified form of the Curculio catcher, which is represented on plate 9. The machine is 6 feet long and 3 feet wide at the top, with vertical ends and the sides sloping to a trough about 3x3x72 inches. A central slit about 3 inches wide was cut in the side opposite the handles and the whole mounted on a two wheeled frame. The long trough is subdivided by a few transverse partitions, and these spaces are partly filled with kerosene and water. The sides, ends and trough are constructed of galvanized iron and strengthened with iron straps as shown in the figure. The wheels are from a toy cart and the handles and frame are homemade. The method of operation is simply to wheel the machine between the rows, and then, elevating the handles, to slip the farther side under the wire, and the trunk of the vine entering the slit permits the placing of the machine directly under the vine. It then remains for the operator to jar the insects off. Mr Barden found that it required several shakings to dislodge all the beetles. In one case he succeeded in catching 64 by jarring a vine once. It was found advantageous to have three machines operating together and placed simultaneously under adjacent vines. This arrangement facilitated the work very greatly and reduced to a minimum the beetles jarred from vines before a machine could be placed under them.

This method appealed so strongly to Mr Hough, who by the way is a very practical business man, that he used it daily for a time on certain badly infested vines, and found that, in the case of the third jarring, he did not get over three or four beetles to a vine, whereas at the first operation 40 to 50 were secured and 15 or 20 at the second jarring. An examination in this vineyard July 24 showed that the beetles were not nearly so abundant as two weeks before, largely due to four collectings in two weeks. The Hough beetle catcher was further tested in 1903, with the result that 1343 beetles were taken June 26 from approximately 110 vines, or an average of over 12 to a vine. The principal difficulty with this device is the relatively large amount of time consumed in placing it under a vine and making the necessary jarrings.

Collecting beetles, if rapidly done, appeared to be a feasible method of checking this pest and our plans contemplated a rigid test of its possibilities in 1903. Mr F. A. Morehouse of Ripley designed an improved form of catcher, the essential idea of which is continual motion and jarring. We arranged to have one built and thoroughly tested, believing the situation justified the experiment, and the results have been most gratifying. This machine, illustrated on plates 10, 11, 12, is essentially a pair of troughs on wheels and is drawn through the vineyard astride the row. The troughs are connected over the vine by bracing arms and wires (placed high enough to clear all posts) and are hung by ½ inch iron rods, which permit the side springs to push the troughs under the vines so that their inner edges are close to the stems or posts as the case may be. The outer slope of each trough is a 3 foot strip of oilcloth stretched over a frame, while the inner is a 10 inch rubber belt 11 feet long. These sloping sides guide the insects so that they fall into the eaves trough, which is divided into small sections by a number of water-tight compartments each of which contains a quantity of water with a small amount of kerosene floating on its surface. The whole machine, as will be seen by the illustrations, is a home-made affair, and was built simply to test the practicability of the idea. The dimensions are as follows: length 12 feet, width 5 feet, hight 7½ feet, length of trough 11 feet, of runners for same 12 feet, diameter of wheels 2½ feet. It can undoubtedly be made considerably more efficient; the troughs, for example, should be broader in order to accommodate more insects and debris. The common wooden springs could be replaced by steel ones and the rough wooden wheels by well made wooden or iron ones, and, instead of being on a fixed axle, it would be a decided advantage if they were on a swivel axle. All these improvements can be easily made later in case the machine commends itself to growers. This device was drawn over two rows of approximately 120 vines and took therefrom 1583 beetles, or an average of about 13 to a vine. This was at a time when not over 17 could be counted on a vine, though there were probably more. The entire operation consumed less than 20 minutes, and, somewhat to our surprise, the efficiency of the machine appears to be a little higher than that of the Hough beetle catcher. It was also operated over nine other rows and 3300 beetles secured, an average of about six to a vine. These rows were not quite so badly infested as the two mentioned above. The record of collecting with this machine, in addition to that above, is of interest and is given herewith.

July 2, 2650 beetles were taken from two check rows, which were in reality but one and one half rows, owing to many of the vines being very small and some missing. June 30 and July 1, 72,000 beetles were captured with this machine from all the experimental plots. July 7, 34,550 and July 14, 8380. Comparing the last three catchings, which were all from the entire area, it will be seen that there is a decrease of over 50% between the catch of July 1 and 7 and that the catch of the 14th was less than 25% of the catch on the 7th. About 154,900 beetles were taken from this area of approximately 5 acres, 3 of which were much less infested than the 2 next the experimental cages. This means that an average of 59 beetles was secured from each vine in spite of the fact that a considerable proportion of the area had been previously cultivated for the special purpose of destroying the pupae. These figures give some idea of the immense number of insects which must have been in the vineyard when work was begun last spring.

As further evidence of the value of collecting for this insect, it may be interesting to state that last spring, sample diggings under different vines in the experimental area, gave from 8 to 50 or more grubs or as calculated from 60 to 400 or more to a vine, in one case it was estimated that there were fully 1000 under a single vine. Sample diggings in October resulted in obtaining no grubs from three vines, one only from each of three, and two only from two others, indicating that there were very few which had more than 12 or 15 grubs, and that, in all probability, the number to each vine would hardly exceed eight or nine. In other words, cultivating and collecting in one season reduced the number of grubs about 98%. These figures are sufficiently striking, so that no further comment is necessary on the efficiency of collecting and destroying the beetles; in fact, this vineyard after one season's work may be considered more free from the pest than almost any other in that section, and it will compare very favorably with those in places where Fidia has caused practically no injury.

Our experience with collectors has demonstrated the practicability of catching the beetles, and we recommend this operation for all badly infested sections, and that the collecting be begun as soon as the beetles appear on the vines in any number, say, when there are 12 or 15 on one. The operation should then be repeated at intervals of five to seven days till the vines have been gone over two, three and possibly four times, dependent somewhat on the number of insects which are captured. It will be found that it is much easier to catch the beetles on warm days, when it should be done, than in cool weather.

It may be added that the efficacy of a machine of this character could be materially increased by the adoption of various devices which would tend to lessen the open spaces under the vines and to increase the length of the catching surface. It is interesting in this connection to note that vineyardists in Missouri have been resorting to various catching devices for the protection of their vines from this pest. Many of them employ simple sheets and jar the beetles on them, while others are using a wheelbarrow arrangement on the suggestion of Professor Stedman.

Mr R. S. Blowers, of Portland, after examining the work of our beetle catcher at Westfield, constructed a very effective and cheap device [pl. 13], which is at least worthy of illustration and comment in this connection.

Its essential features are two long frame troughs covered with oilcloth, which hangs over an eaves trough divided into watertight compartments, as in the ordinary catcher. These two sections are each 24 feet long, the outer edge about 3 feet high, while the inner edge is approximately 18 inches high, and each is braced so that a man can pick it up at the center and move it toward or away from the vines. The original plan was to carry it through the vineyard and place it between the posts, jarring the vines and continuing in this manner. This was found rather laborious, and the work was made lighter by the construction of a pair of low bobsleds, fastened together by wires so that each was about 6 feet from the end of the trough, which at this point was provided with a transverse broad base so that it would rest on the bob without tipping. The inner edge of each bob was also provided with a small roll, so that the operator, by tipping the trough slightly toward the row, could roll the entire structure under the vines and, after jarring was completed, could roll it back. A horse was used to draw each half of the collector, and in this way about 3 acres a day could be gone over. This collector has the advantage of being comparatively cheap, since the outside expense for it would not exceed $9 for each half, or a total of $18. Most of the material, except the oilcloth, can usually be found around a farm, and the actual outlay, if the vineyardist made it himself, would be very little.

The late Prof. C. V. Riley, in his report for 1868, calls attention to the fact that one man whose vineyards were very badly infested by this insect had trained his chickens to go between the vines and pick up the beetles as they were dislodged by jarring. Mr F. A. Morehouse of Ripley, who has many chickens in the near vicinity of his vineyard, has practised the same thing with excellent results. The only trouble is that this method has a comparatively limited application, since it is not always practical to have chickens in large vineyards.

Arsenical poisons. A number of experiments were tried with arsenical poisons in 1902 for the purpose of ascertaining their efficiency in controlling this species. Two brands of arsenate of lead and paris green were used. Breeding cage experiments with arsenate of lead, using 2 pounds to 50 gallons of water, showed that seven days were required to kill 9 out of 10 beetles, and that, when 4 pounds of the poison were used to the same amount of water, all of the insects were killed within eight days. The spraying in both instances occurred July 5, and the record is as follows:

2 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 6 beetles dead	July 10, another beetle dead
3 alive	July 11 "
1 missing	July 12 "

4 POUNDS ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 4 beetles dead	July 10, another dead
July 9, 4 more dead	July 13 "

It will be seen by examining the above records that in the case of the first over half were killed within 48 hours after the spraying, and in the second less than half within 48 hours and four fifths within four days. It should be added that in the above experiments the leaves were sprayed very thoroughly and the poison allowed to dry before the treated foliage was placed in the cage.

The breeding cage experiments with paris green were less successful than those with arsenate of lead, and, though in one experiment 20% of the beetles were killed within 48 hours after spraying the leaves with 1 pound of the poison and 1 pound of lime to 100 gallons of water, and 40% more died within four days after the spraying, the general results were not at all satisfactory, and the reason therefor can not be given.

The breeding cage experiments with arsenate of lead would lead one to expect most excellent results in the field, but such was not the case last year, though this may have been due to the fact that the spraying was done shortly before considerable rain fell, and was followed by nearly daily precipitations. The initial application was made July 8, 1902, and repeated the 9th, the rain of the preceding day making it advisable to go over the entire field a second time. The ground at the time the spraying was done was so wet that it was almost impossible to drive a team slowly enough to do good work. Careful search in the vineyard eight days after failed to reveal a single dead beetle. July 31 there were plenty of beetles and many eggs in Mr Northrop's vineyard, where the vines had been sprayed. The necessity of two sprayings resulted in the application of considerable poison, and about five weeks after the treatment it was seen that the sprayed vines had developed very little new growth as compared with untreated ones. There was no perceptible burning, yet the edges of the leaves were somewhat crumpled, and it is very probable that the poison checked the development of the more tender shoots.

The breeding cage experiments in 1902 led us to expect excellent results in the field, and our not obtaining the same after making two applications was attributed largely to the excessively wet weather, which not only washed off the poison but interfered with work in the vineyard. Similar experiments in 1903 gave even less satisfactory results than the year before. It required nine days to kill three out of five beetles. Arsenate of lead and poisoned bordeaux mixture were severely tested in caged outdoor vines, as detailed on page 26, 27. It will be seen by consulting the record that, though the vines were sprayed thoroughly on both June 19 and 27, there were fully as many living beetles on both July 1, 13 days after the first application, as on the two vines in the check cage, and the same was true July 21. Careful observation, during the remainder of the period when beetles were to be found in cages, failed to disclose any substantial difference between the insects on the poisoned vines and those on the untreated ones. These cage experiments were further supplemented, as detailed on page 29, by extensive spraying. This was done June 25, and July 1 no difference could be detected between the sprayed and the unsprayed vines. This, in connection with our cage experiments, led us to abandon reluctantly further outdoor tests, and the poisoned areas were collected over in order to prevent what we deemed would be an extensive deposition of eggs. In other words, no experiments, other than those confined to small tumblers where the beetles could obtain absolutely nothing except poisoned foliage, gave results which are at all decisive. The reasons for this are several: the beetles do not succumb readily to poison, and being more or less secretive by nature, feed to a considerable extent on under leaves and in concealed situations where it is difficult to throw the spray. In addition they have a marked tendency to feed on the more tender leaves, which at the time spraying should be done appear almost daily on vigorous vines. These factors make it very difficult to control the insect.

The most decisive results obtained with an arsenical spray are those published by Mr John W. Spencer of Westfield, in the issue of the *Grape Belt* for July 24, 1903, in which he gives some definite figures in favor of spraying. Our only regret in this connection is that his experiments were not conducted on rapidly growing vines, because in our judgment these need protection much more than those in poor condition and on which the insects, as previously pointed out, can not be controlled nearly so readily.

Several vineyardists sprayed their vines in 1903 for the purpose of controlling this insect, and as it was stated by various growers that the poison applications had been successful, at their request these vineyards were inspected by us the first week in October, and much to our regret, we found that the reported good results were more apparent than real.

An examination in the vineyard of Mr Frank Monfort, of Brocton, resulted in finding 5, 45, 10 and 9 grubs respectively under as many Concord vines. The first record relates to a vine which had very poorly developed roots, and consequently was not a fair sample of conditions in the vineyard. Mr Monfort not only sprayed his vineyard twice with a power sprayer, making the first application at the time the beetles appeared and the second a week later, but went to the additional trouble of going over the entire area carefully with a hand pump for the purpose of spraying any which the machine might have missed. He certainly tried to do a thorough job, and yet sample diggings in an adjacent vineyard belonging to Mr Morse gave respectively 3, 6, 3, 6, 16 and 9 grubs under different vines. The two latter records could hardly be compared with those in Mr Monfort's vineyard because they were fully ¼ mile distant and relate to vines which were much more healthy and vigorous. It may be claimed that this is not a fair test of the poison and to a certain extent this is true, yet these are results obtained by a practical man in an earnest effort to reduce the pest, and as they agree with our own experience are not without value. The difference between 75 and 150 grubs under a vine, and 5 to 12 or thereabouts, represents in our mind the relative efficiency of collecting and poison sprays, and our judgment is that these figures mark the difference between protection and serious injury.

The evidence concerning the efficacy of poisons in Ohio, as pointed out on a preceding page, is somewhat contradictory. Reporting on work done in 1899 Professor Webster states that an examination of sprayed fields showed nothing to indicate that arsenate of lead would not prove entirely effective. This differs from some later experiments performed under his direction by Messrs Newell and Burgess, the unpublished records of which through the kindness of Prof. P. J. Parrott have been placed at my disposal. The summary of this later work is as follows:

"Where beetles were abundant last year and vines seemingly badly injured and the arsenate of lead or disparene used this year (1900) few vines have died and all appear in a more healthy condition, but this is true also where none of these insecticides were used, beetles appearing later and in less numbers than for several years." Professor Webster, at the writer's request, has commented on the above experiments as follows. He states that early results, though satisfactory, were not thought by him to be conclusive, and that a marked decrease in the number of the beetles vitiated later experiments to some extent, so that he did not consider them as either conclusive in themselves or as disproving the earlier work of Mr Mally. He states that arsenate of lead must be tried thoroughly several times where conditions are such as to enable one to obtain decisive results either one way or the other before it will be safe to make definite statements. Professor Stinson reports only fair success in destroying the beetles with poisons in Arkansas.

It seems very probable, therefore, that some of the Ohio growers have been led to attribute the relative scarcity of these beetles to the use of poison whereas it may have been due almost entirely to natural conditions.

Mr T. S. Clymonts states that in his experience spraying with bordeaux mixture has proved of some benefit, since the beetles prefer untreated vines and will migrate to them if near by.

Mr J. W. Maxwell, Euclid O., writing under date of Aug. 29, 1903, states that he called Prof. F. M. Webster's attention to the insect in 1893 and adds that in all his experience, now extending over a decade, he has not found a poison that will "exterminate" the insects, or, in other words, that has given satisfactory results.

Prof. F. M. Webster has recently called our attention to a case in Bloomington Ill., where the owner of a badly infested vineyard, began spraying thoroughly with arsenate of lead. He says that the vineyard at the outset was in very poor shape, that now it is returning to somewhere near its normal condition, and that he fails to find the slightest indication of beetles except on one or two vines. This has been accomplished within two or three years; and the owner, Mr J. L. Lampe, attributes it to the use of the insecticide, with which Professor Webster is inclined to coincide. Our experience with the pest suggests that possibly many of the insects may have forsaken this vineyard because of its poor foliage and gone to others where there was better shelter, and that therefore the protection afforded by the arsenate of lead may have been overestimated. In a later communication, Professor Webster states that he has found great numbers of dead beetles under sprayed vines and none under those free from poison, a fact that shows that some protection is afforded. This, however, was in a vineyard which had been seriously injured and was therefore not making much growth.

We have been to considerable pains in looking up evidence both for and against arsenical poisons and the above summary of results obtained in Ohio, in connection with the work done in New York and elsewhere, leads us to the conclusion that, while the arsenical spray may, under certain conditions, give some protection from this insect, either by driving away the beetles or possibly killing them, we are by no means certain that this will result, specially in the case of more thrifty vineyards, and we are inclined to believe that in some instances the benefits resulting from poison applications have been greatly overestimated. We do know, on the other hand, that collecting and killing the insects, if it be done early enough, means protection, and for the present we prefer to recommend the latter method of fighting the pest rather than to indorse the use of a poison, the general utility of which has not been proved for Fidia. Enough has been done to warrant more extended work with poisons and it may be that another year or two will enable us to determine their true value.

Destruction of the eggs. This seemingly difficult operation was accomplished by Mr William Barden of Ripley by rubbing the canes with a gloved hand. He found that most of the eggs were deposited on the middle shoots, and that the great majority of them were crushed by rubbing. The operation, though slow, is not necessarily very expensive, as a man could go over approximately an acre a day without difficulty.

We have also conducted some experiments to test the resistance of the eggs to insecticides and have learned that a whale oil soap solution, 1 pound to 4 gallons of water, has no effect on them. It is doubtful if they can be destroyed with a spray. The extended period during which eggs are deposited, however, renders Mr Barden's method of controlling the insect of somewhat questionable value, and its employment can be advised only when a vineyard is found to be badly infested with eggs, and there is, therefore, no other method of getting at the insects before the grubs commence their operations.

Pulverizing the soil and mounding. Prof. F. M. Webster, as a result of his studies, advised thorough cultivation of the soil during the hatching period, taking special pains to keep it banked up over the roots. Professor Webster's idea was that the young insects dropping in the dry sand would be quickly destroyed wherever exposed to the sun, that the looseness of the surface layers would prove a serious hindrance to their burrowing, and that the increased depth over the roots would also provide an additional barrier to the grubs. Thorough cultivation is undoubtedly a most excellent thing, and the additional vigor arising therefrom is a valuable asset in enabling the vine to withstand very serious injury. Our experiments on the traveling and burrowing powers of these little grubs, however, lead us to believe that this measure, so far as preventing access to the roots is concerned, is not of much value. This is confirmed somewhat by the experience of Mr T. S. Clymonts, who states that a seriously injured vineyard can be renewed by thorough cultivation, and that he has experienced no difficulty in doing this with flat cultivation. In fact, Mr Clymonts is of the opinion that mounding the earth about the vines is injurious in other ways and therefore does not advise it. He recommends cutting back the vines to the living wood, enriching the land liberally with stable manure and applying about a barrel of salt to the acre. Then he cultivates with a disk harrow or other tool which will not stir the earth to a great depth, since he believes that deep plowing cuts off a large number of roots and is very injurious to the vines. He states that in several cases known to him where this has been done and flat culture adhered to, badly damaged vineyards have been restored to a very satisfactory condition.

Carbon bisulfid. Prof. F. M. Webster instituted some rather extensive experiments with carbon bisulfid against this insect, and the summary of his results is as follows. He found that the substance could not be used to advantage in soil that was very dry or saturated with water, and that it must be used in that which is damp. He states that the most satisfactory results will probably follow its use in the spring, in a damp soil, when it is applied in such a manner as to fumigate the roots without the fluid coming in contact with them. He recommends from 4 to 6 ounces for each vine and states that it is not possible to kill every worm about a vine, and that it is doubtful if the low price then current for fruit would justify its use. Growers in the vicinity of Cleveland have not used this insecticide to any extent since the time Professor Webster made his experiments, and they give the high cost as the reason for its not being adopted. It should also be added that considerable care is necessary or the vines will be severely injured.

Kerosene emulsion. Several writers have advised killing the grubs at the base of the vines by the use of a kerosene emulsion, which is to be washed to a greater depth by copious watering or subsequent rain. We have seen very few cases where the grubs were congregated sufficiently to warrant any attempt at killing them in this manner, and it hardly appears practical in a large vineyard.

Crude petroleum. It was hoped that it would be possible to destroy the grubs of this pest by the application of this substance to the soil, and there seemed a chance of using it to prevent the young larvae from making their way to the roots. Some experiments in the office, however, demonstrated that the grubs easily penetrated soil which had the surface layers moistened by a fine spray of the oil, specially if placed on the soil 30 minutes to half a day or more after treatment. This substance appears to have very little value in controlling this insect.

Effect of calcium carbid refuse on grubs. Our attention was called to this substance by the statement that it had proved very valuable against the Phylloxera in France. Some of the material was kindly sent us from the Union Carbide Co.'s plant at Niagara Falls, and various experiments with the grubs were tried. One part of this substance mixed with 10 pounds of soil was placed in a box and some grubs added. One was dead the next day after having burrowed about $\frac{1}{4}$ inch and two others went to the depth respectively of $1\frac{1}{4}$ and 2 inches. No additional fatalities occurred even after 10 days. Several other experiments gave the same general results, and apparently we can have no hopes of this substance being of value in this particular case.

Recommendations. Apparently no one method can be relied on to control this insect, and our recommendations may be summarized as follows. Plan cultural operations so that a firm ridge of earth may be horse-hoed from the vines or otherwise cultivated or disturbed when the great majority of the insects are in the pupal stage and take special pains to stir the soil thoroughly in the near vicinity of the stem. Thorough cultivation and well enriched soil will do much in aiding the vines to withstand attack. This, supplemented by collecting beetles, particularly with a device which will catch them without the delay incident to stopping at each vine, is advisable on badly infested areas during the first two weeks after the adult insects appear in any numbers. The latter may possibly be supplemented or replaced by thorough spraying with an arsenical poison, preferably arsenate of lead, when the beetles begin to appear. Evidence at hand regarding spraying for this insect is not satisfactory, and for the present we prefer to limit our indorsement to above named methods of known value. We believe that these two courses, intelligently applied, afford a most feasible and thoroughly practical solution of the difficulty.

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EXPLANATION OF PLATES

Plate 1[1]

1 Beetle, much enlarged

2 Leaf badly riddled by the beetle

3 Eggs on last year's wood; the loose bark has been lifted so as to expose them

4 Larva or grub, much enlarged

5 Work of larva or grub on larger roots

6 Pupa or "turtle stage" in cell

7 Same much enlarged

Plate 2

1 Vineyard somewhat injured by Fidia, August 1903

2 Healthy vineyard with vigorous foliage, August 1903

Plate 3

Vineyard badly injured by the grapevine root worm. Observe that very few of the vines extend to the top wire. The wires and posts would ordinarily be concealed in a thrifty vineyard.

Plate 4

Vineyard more seriously infested than the preceding. A portion of this was uprooted last spring, and the area shown was kept simply for experimental purposes.

Plate 5

Portion of two vines represented on the preceding plate and showing how badly the beetles may eat the foliage when abundant.

Plate 6

Leaves from badly eaten vine, illustrating the peculiar, chain-like eaten areas

Plate 7

Breeding cages, distant view, showing also the general condition of the experimental area, June 1903

Plate 8

Breeding cages, near view, showing general condition of the vines near by, June 1903

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[1] Executed from nature under the author's direction by L. H. Joutel.

Plate 9

Beetle catcher devised by Messrs Hough and Barden

Plate 10

Morehouse beetle catcher

Plate 11

Morehouse beetle catcher

Plate 12

Morehouse beetle catcher in operation, June 30

Plate 13

Blowers collecting machine

L. H. Joutel, 1902

Grapevine root worm

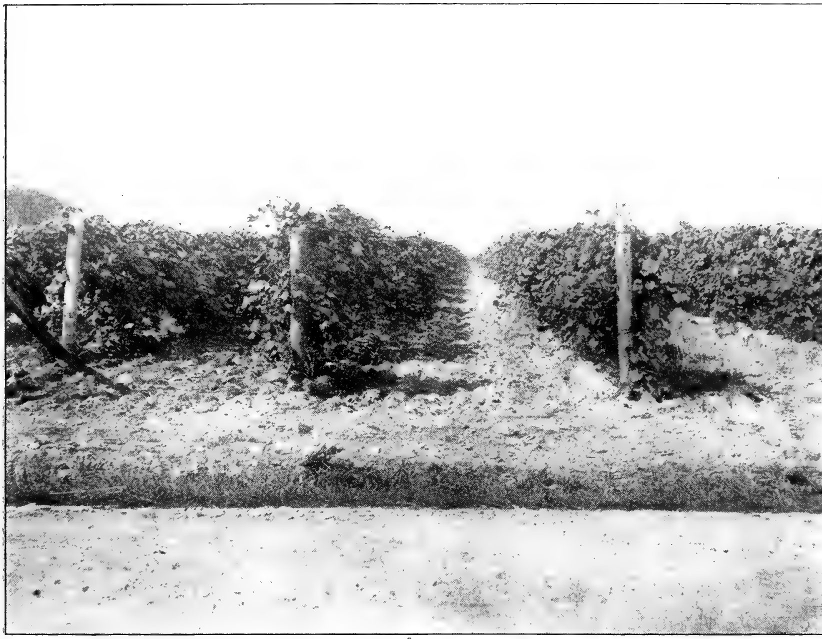


Photo August 1903

1 Vineyard somewhat injured by root worm

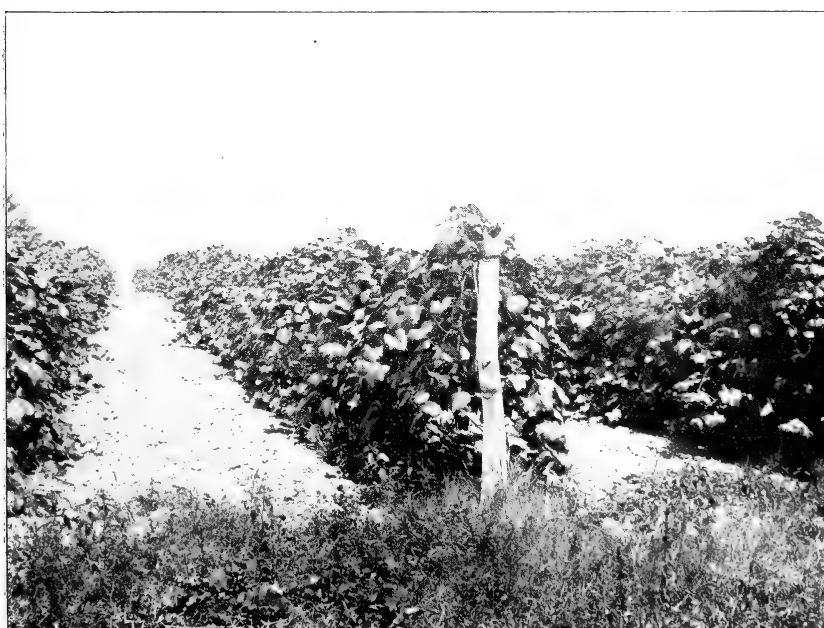


Photo August 1903

2 Healthy, vigorous vineyard

Plate 3

Photo Aug. 15, 1902

Vineyard badly injured by grapevine root worm (The vines should cover the wires and posts.)

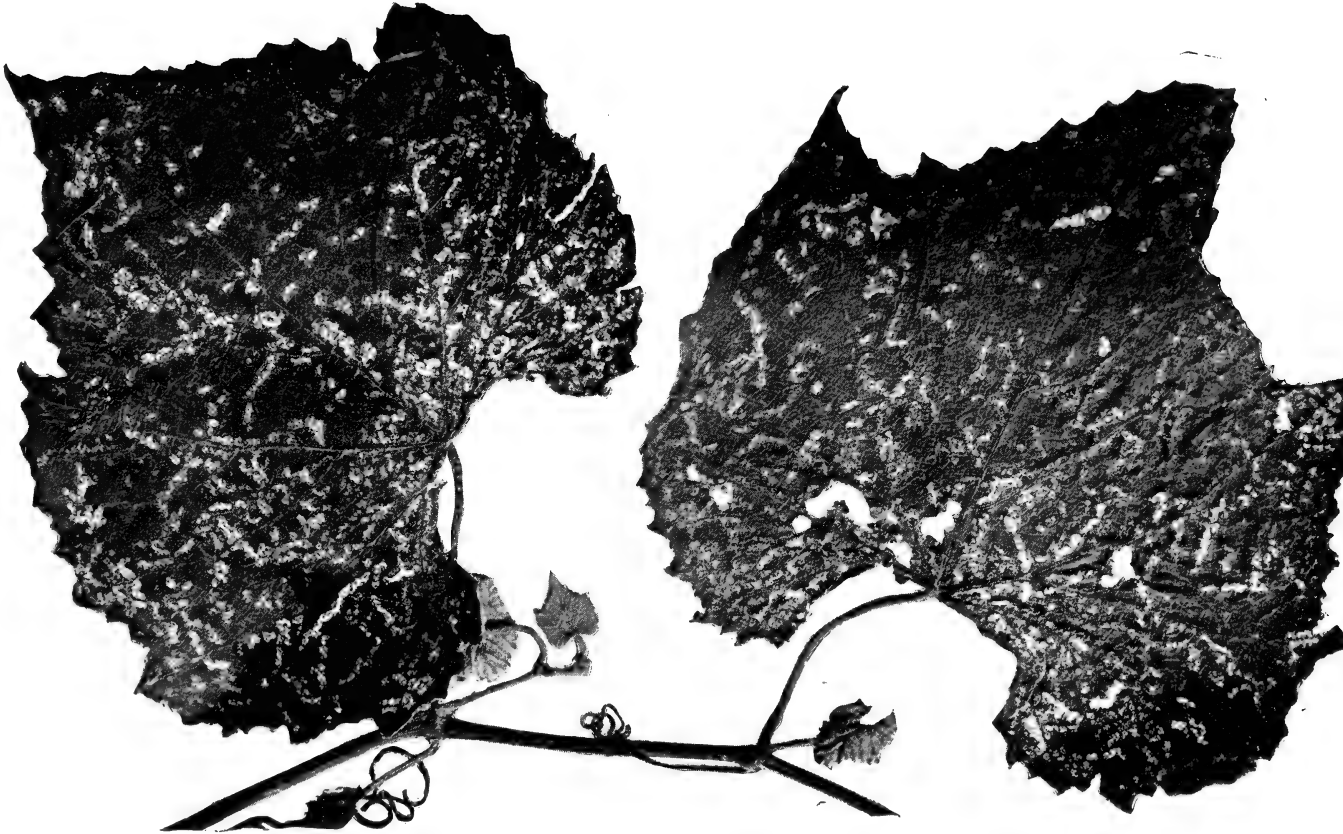
Photo Aug. 15, 1902

Vineyard very badly injured by grapevine root worm (This piece was torn out by the owner as worthless.)

Plate 5

Puoto Aug. 15, 1902

Foliage badly eaten by beetles



Leaves from badly eaten vine, illustrating the peculiar chainlike eroded areas

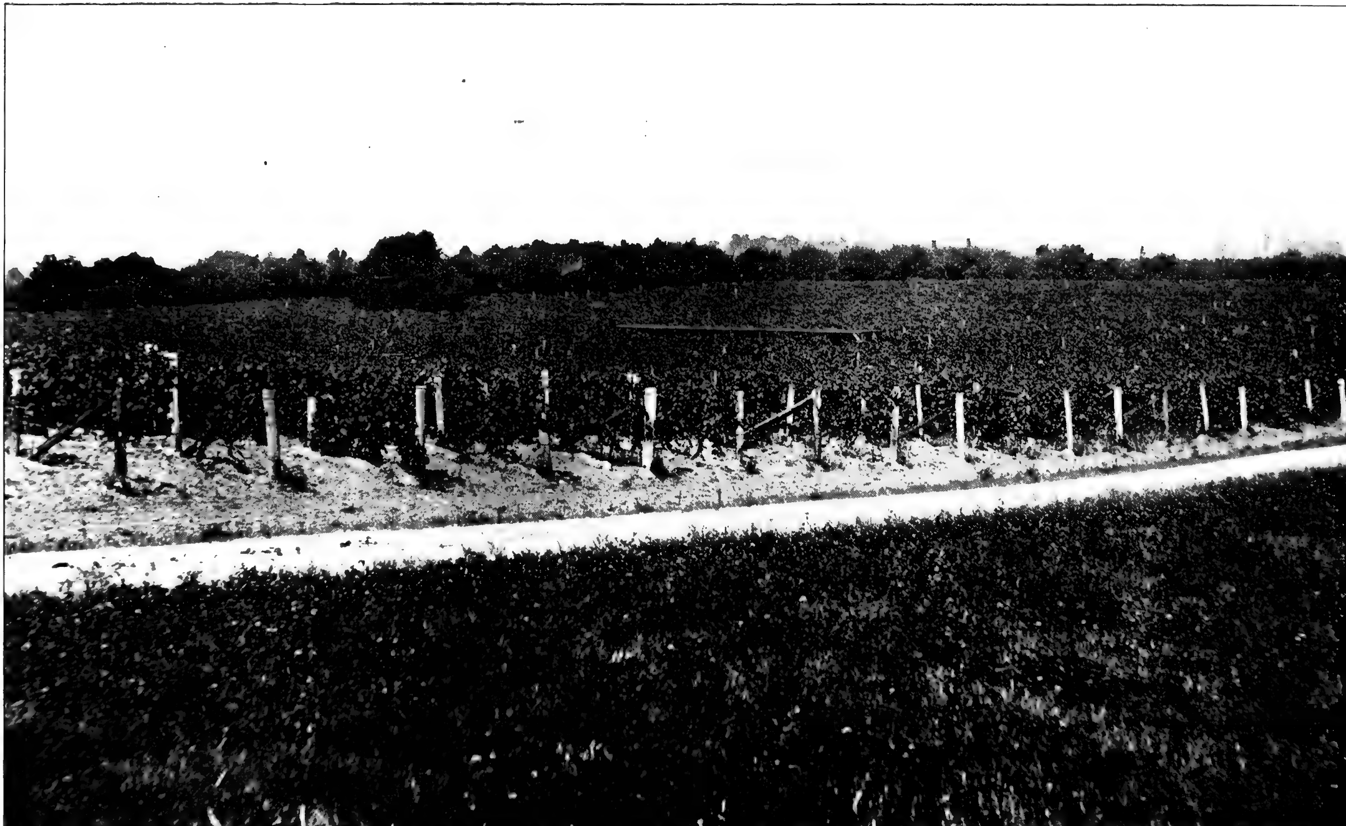


Photo June 1903

Experimental vineyard and breeding cages near center

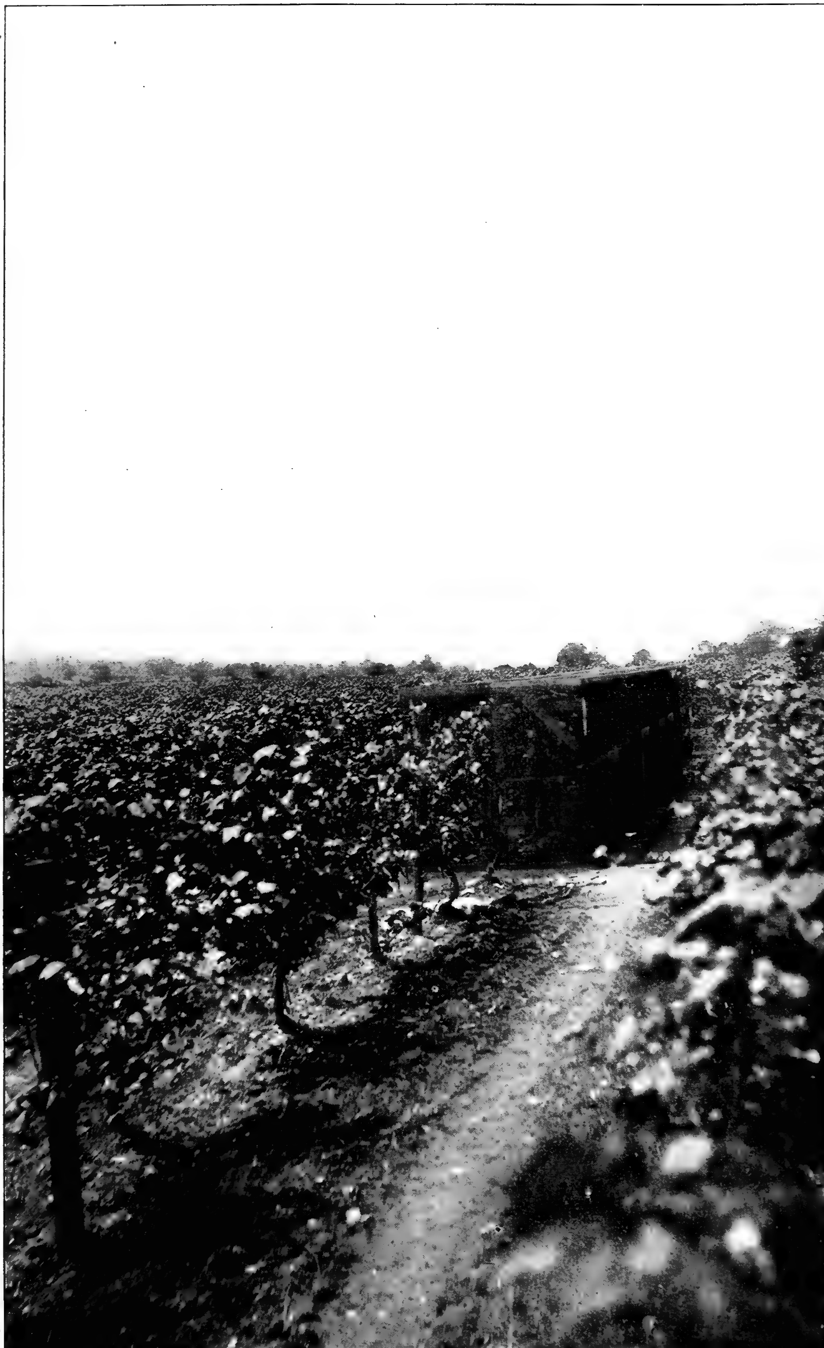


Photo June, 1903

Nearer view of breeding cages

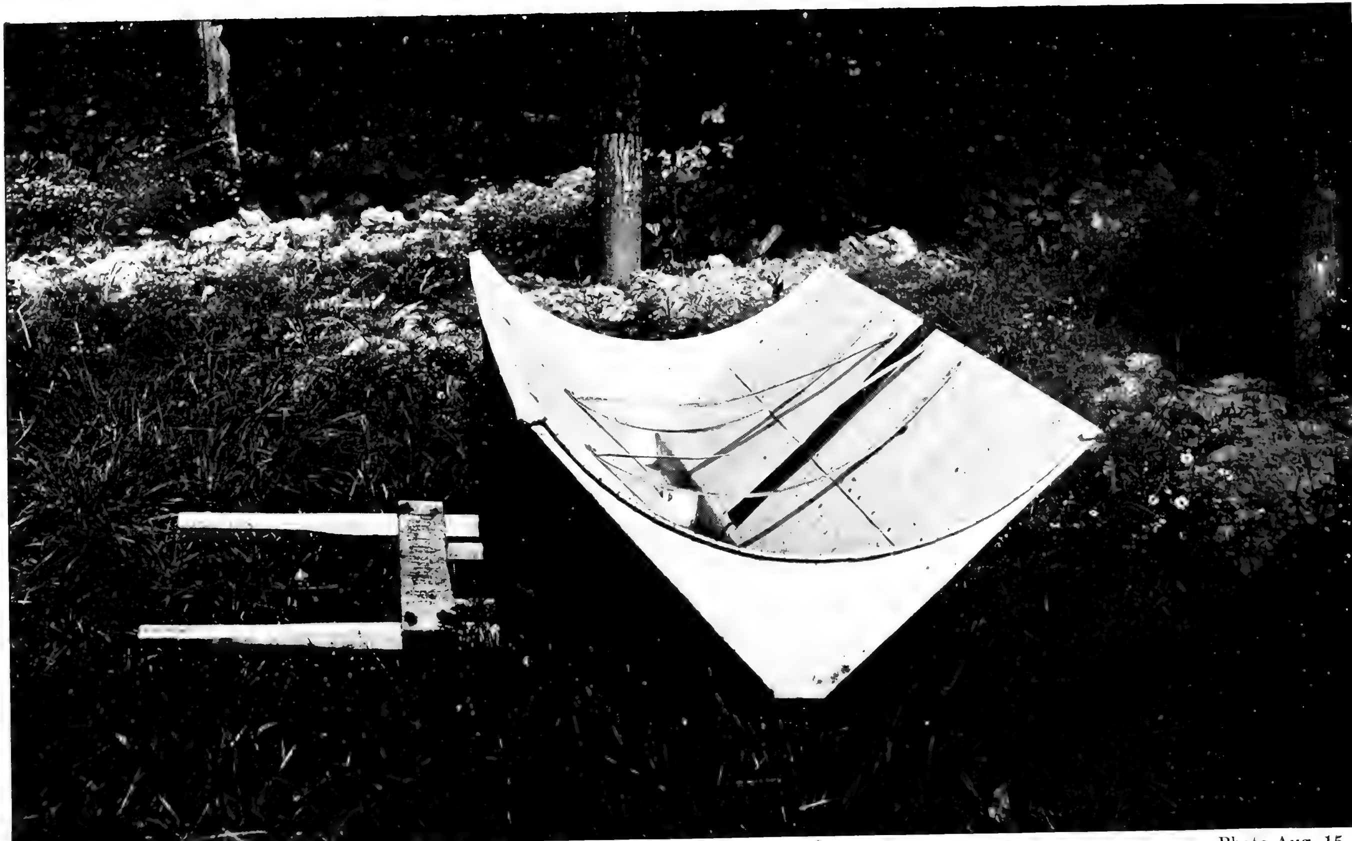


Photo Aug. 15, 1902

Hough beetle catcher

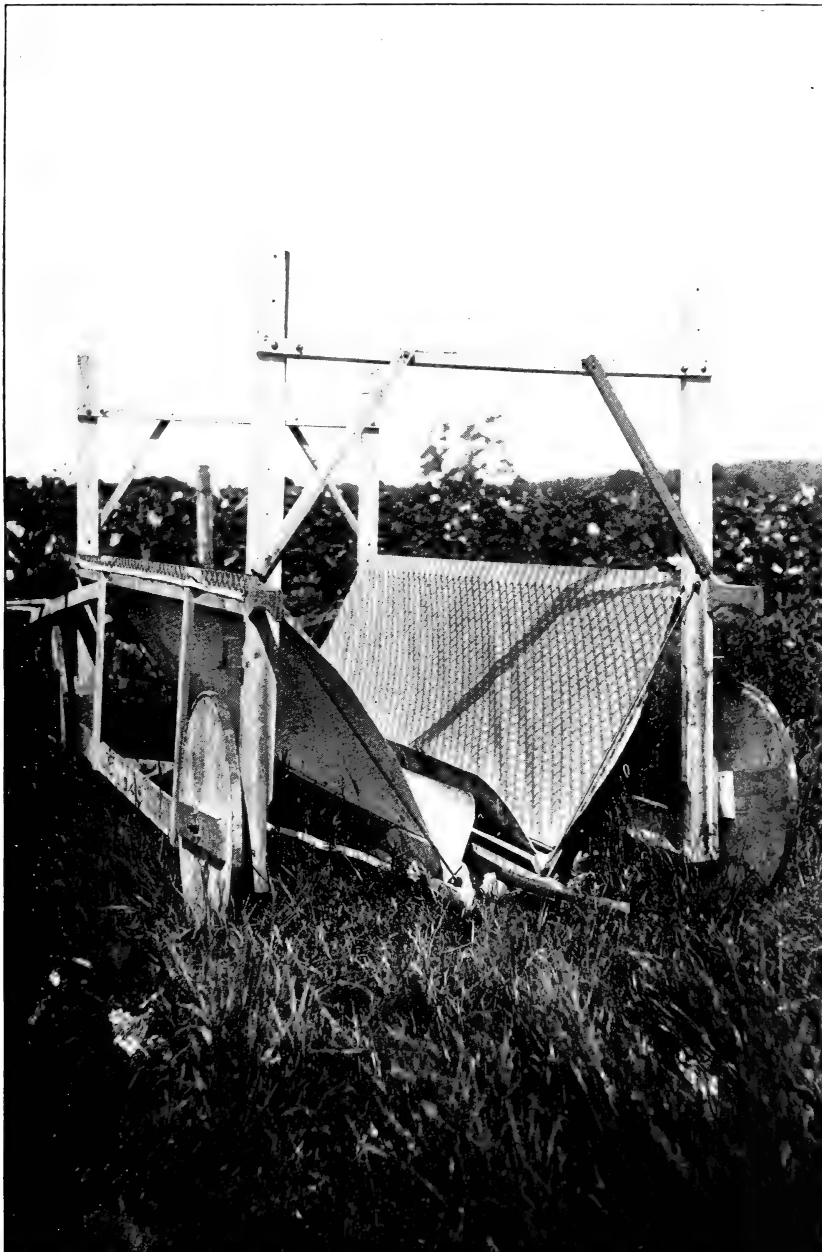


Photo June 1903

Morehouse beetle catcher

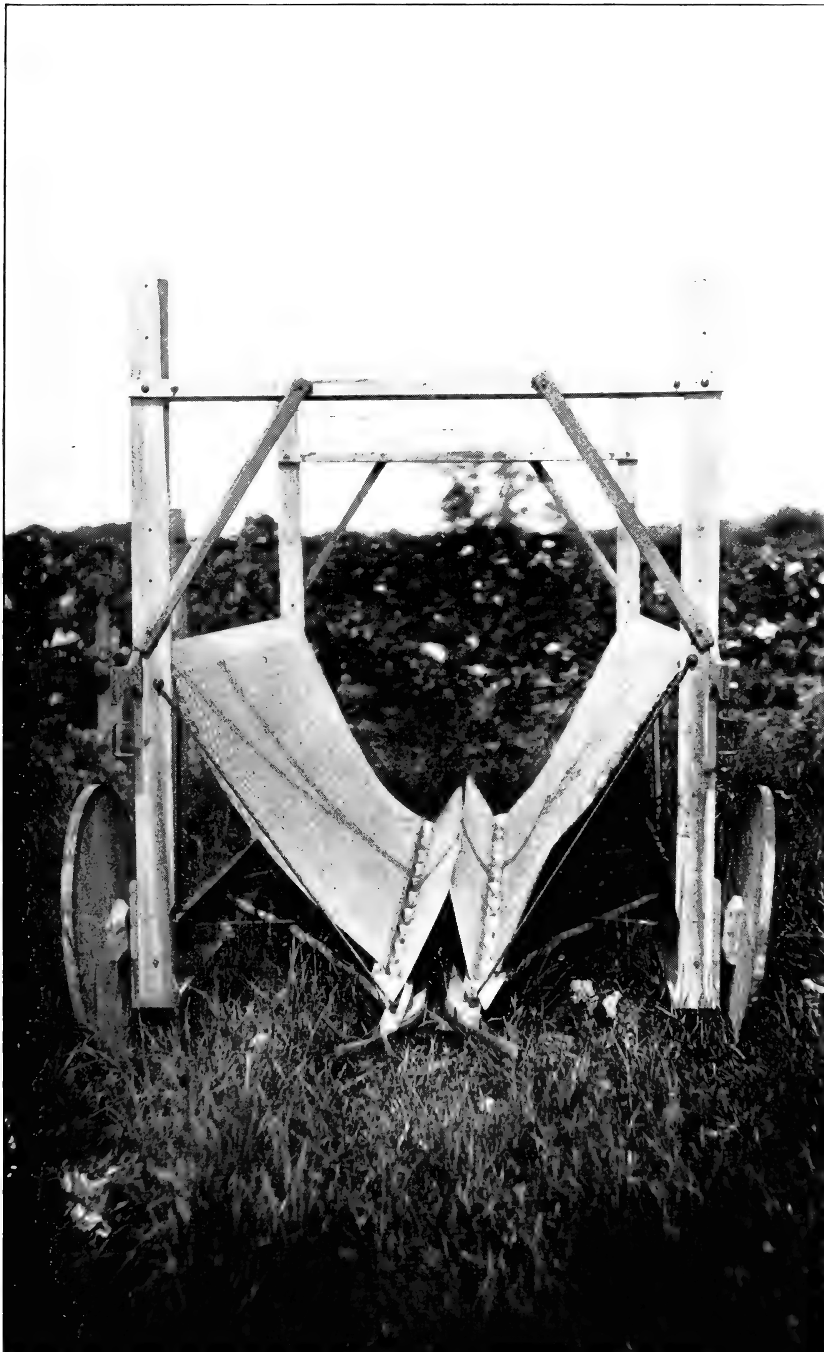


Photo June 1903

Morehouse beetle catcher

Photo June 1903

Morehouse beetle catcher in operation

Photo August 1903

Blowers beetle catcher

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Published monthly by the

University of the State of New York

BULLETIN 311 JUNE 1904

New York State Museum

Bulletin 74

ENTOMOLOGY 20

MONOGRAPH OF THE GENUS SAPERDA

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Bulletin 74

ENTOMOLOGY 20

MONOGRAPH OF THE GENUS SAPERDA

PREFACE

In the preparation of this paper all the original descriptions of the various species have been carefully examined, and as many of the types as were in this country have been studied. Most of our species are so well marked that there was little trouble in identifying them, and only tridentata and forms of populnea presented difficulties. The first mentioned has a species which resembles it very closely, and the question was, which had been described by Olivier. The original description was so vague that it applied equally well to either; but fortunately Olivier had figured the form described, and this proves beyond doubt that our common eastern borer of the elm is his species. Several forms, which could not be referred to any of our species, were found, one of which presented all the characters of the European populnea, and there is no doubt that it has long been established in California, Oregon, Washington and British Columbia, having evidently made its way into this country through Alaska.

The writers take great pleasure in acknowledging assistance from the following gentlemen: Dr Henry Skinner and Mr H. W. Wenzel, who employed their kind offices in procuring the loan of specimens from the collections of the American Entomological Society and afforded facilities for the study of material in the Horn collection, Mr Samuel Henshaw of the Museum of Comparative Zoology, who granted the privilege of studying the LeConte and other collections at Cambridge, Dr H. G. Dyar, who procured the loan of material from the National Museum, Mr E. A. Schwarz, who furnished facilities and aid in studying the collections at Washington, and also the following gentlemen, who rendered various services, Messrs Charles Schaeffer, Frederick Blanchard, F. C. Bowditch, Germain Beaulieu, H. G. Klages, Charles W. Leng, C. V. Piper, W. S. Marshall, J. J. Rivers, Charles Fuchs, Dr D. M. Castle, E. D. Harris, Philip Laurent, F. E. Watson, C. W. Woodward, H. C. Fall, William T. Davis, C. J. S. Bethune, F. M. Webster, Charles Palm, W. Knaus, A. F. Winne, Dr R. E. Kunze, Charles Stevenson and C. J. Oeillet. Dr Henry C. Van Dyke kindly contributed notes on localities of hornii, and a number of New York collectors kindly allowed us the privilege of examining the material in their collections.

The junior author has collected members of this genus for a number of years and has made many trips about New York city to secure their workings, often in the company of his friend, William T. Davis, who took much interest in securing desirable specimens. All of the species have been bred but the typical populnea, mutica, hornii and cretata, though we have had workings of the latter.

The junior author has undertaken the illustration and systematic study of the species; while his associate has studied the insects more particularly from an economic standpoint and has summarized the literature and compiled the bibliographies.

GENUS SAPERDA OF FABRICIUS

This genus is one of great economic importance, since it contains two species which are very injurious to appletrees and another which may possibly acquire this habit. One species is known as being very destructive to the American elm, one often seriously injures hickory, another sometimes destroys large numbers of our lindens, and a fourth is exceedingly injurious to poplars; the latter are also attacked by several other species of the genus.

This group is also of interest to the systematic student, since it shows in a limited number of species great divergence and specialization from a common type. Much confusion has hitherto existed concerning the identity of our western species, and this was only partly cleared up by the characterization of hornii. Our study has brought out the interesting fact that, among the so called western forms of moesta, one is identical with the European populnea, and can not be differentiated in any particular from that species. We find that two species have been included under the name tridentata, as well as a distinct variety of lateralis. All but three American species occur in New York State, and our study has on that account been monographic.

Series of all American species have been examined, and several characters not noted or seen by former students have been found. The European and Asiatic species have all been studied, except a few Siberian forms which are probably only varieties. Since both sexes were not obtainable of all the exotic forms, it has not been possible to include a discussion of them in this paper. They are mentioned wherever it is necessary to show the close relationship existing between the two faunas.[1] The 13 species and one variety listed by Samuel Henshaw in 1885 have been increased by us to 15 species and five subspecies or varieties.

The species are so closely related, though differing greatly from each other in several characters, that subdivision of the genus is not considered advisable and would not be practicable, as whatever characters might be used, disappear so gradually that the species could not be as well arranged as in the present grouping, and it would tend to bring widely separated forms close together.

The exotic species have been divided into a number of genera and subgenera on characters which we consider, from our studies of the entire group, degrees of specialization.

Mr Mulsant divided the European species on the relative size of the metathoracic episterna, the form of elytra and on the antennae

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[1]In studying the two faunas together, the indications are very strong that they were derived from common ancestors; and, while the two are quite distinct in many ways, they have evidently specialized along different but parallel lines, and their characters are intermediate.

The fact that the American species are all of eastern origin (except those few that show their immigration into the Pacific fauna through Alaska) and the Old World ones of western origin would tend to show that at some remote epoch there was a connection between the two continents.

being annulated or not. Species not closely related to each other occur in his subgenera, as they do in any other attempt to divide them. His genera are not now generally recognized. The Asiatic species have been placed in several genera. The genus Thyestes erected by Mr J. Thomson for a Japanese species has no character not found in one or the other of our Saperdas; and we consider his species pubescens allied to puncticollis with some characters also of lateralis; and its annulated antennae connects it with the more highly specialized ones. Another point that shows its close relation to puncticollis is the possession of a process on the anterior claw of the middle pair of legs only; and the form of this process also resembles that of puncticollis. Another genus, Eutatrapha, has been erected by Bates for those Asiatic species with the sides of the elytra carinated. We consider this character a sign of specialization and not of generic value, as we find it in an advanced rudimentary state in our tridentata, where it is not equally marked in all specimens. It is formed by the arrangement of the punctures and is quite different in appearance from the extreme form found in Eutatrapha (Saperda) metallescens. Eutatrapha (Saperda) 16-punctata and varicornis (S. carinata) have this character also, but not so strongly marked. It can be traced in some other of our species, as S. discoidea ♂ and S. hornii, where a straight line of punctures, more or less pronounced in different examples, shows the most primitive form of this character; and its entire absence in some individuals of discoidea robs it of any generic value it seems to possess in its more highly specialized form. To show the slight value of this and other characters taken separately, we would call attention to Paraglenea fortunei from China, which has the elytra carinated and has both claws of all the legs armed with a spine as in lateralis. It is closer to Saperda than any other genus. Glenida suffusa has the elytra carinated but lacks the process on the claws, and is only distantly related to Saperda. Several other genera were desired for study but material was not obtained in time for this bulletin. The males of metallescens have the claws armed as in tridentata. Males of the other carinated species were not obtained. Should this genus be accepted our S. tridentata would be included in it.

Subgeneric grouping. One character that could be used for a subgeneric division is the presence or absence of the process[1] on the claws of the males. Though we consider this character of little value except to show the relation of the species and really a sign of specialization and not of much generic importance, as its occurrence in genera[2] not very closely related to Saperda shows, its use as a basis of division would group the species as follows.

Group 1	Group 2	Group 3	Group 4
Process on anterior claw of front and middle tarsi	Process on both claws of all tarsi	Process on anterior claw of middle tarsi	Process wanting
obliqua mutica hornii candida calcarata tridentata cretata discoidea vestita imitans fayi	lateralis	puncticollis	populnea and its forms concolor

[1]LeConte and Horn, in their classification of the Coleoptera of North America, make the erroneous statement that this process is wanting in the European species. It is however very prominent in carcharias, punctata, 8-punctata and probably in others of which we did not see males. Lacordairé, in *Genera of Coleoptera,* also seems to imply that it is wanting in the European species. LeConte, in *New Species of North American Coleoptera,* part 2 [Smithsonian Miscel. Coll. 264. 1873. p.239] overlooks the process on the claw of the middle tarsi of puncticollis and the armature of all the claws of lateralis. Subsequent authors have committed the same errors.

[2]In the species of Thyestes which we have seen, the males are armed as in puncticollis. The males in the genus Eutatrapha are armed as in the first group. Those of Paraglenea fortunei are like those of lateralis. The males we have seen of the European species group as follows. To the first group belong carcharias, punctata, 8-punctata, and to group 4 populnea and scalaris. The males of the other species we were not able to obtain.

This grouping separates populnea and concolor from the closely allied mutica and hornii, and brings together some that are not so closely allied, but it shows fairly well the degree of specialization of the species, as will be shown later.

If our species only are considered, a more natural grouping can be made on antennal characters, the species having annulated antennae being more closely related to each other than to those with unicolorous ones; but, when the foreign species are taken into account, this character loses its value, as we find S. perforata and some of the species that have been referred to Eutatrapha and Thyestes with the antennae annulated, though the other characters would lead us to look for unicolorous ones, they being very close to our tridentata and but distantly related to the species this character would place them with. Using the antennae, the species would divide as follows.

Antennae annulated	Antennae unicolorous
obliqua	candida
mutica	calcarata
hornii	tridentata
populnea	cretata
moesta	discoidea
tulari	vestita
concolor	imitans
	fayi
	lateralis
	puncticollis

The foreign species, carcharias, scalaris, perforata, similis, quercus, Eut. varicornis, 10-punctata and T. pubescens would come in the first group; the others in the second group.

The development of the head usually follows that of the process on the claws; but there are exceptions to this rule, as is seen in the case of scalaris of Europe, where the flat front of the head would place it near calcarata instead of with populnea, where it more naturally belongs. In fact, whatever character is taken, it will be found to be unevenly developed in its relation to the others possessed by the species.

Other characters such as elytral form, shape of thorax and abdomen, etc., seem from our studies to have little if any constant value in grouping the species, as, when they are used, species are brought together that have very little direct affinity with each other.

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Distribution. The genus is confined to the temperate parts of the northern hemisphere. The distribution of some of the species is somewhat erratic, and all but three American forms appear to have originated in the East and occur in the State of New York. Our common calcarata, found through the East and Middle West, also occurs in Texas as well as the state of Washington, and has been recorded from intervening territory. On the east coast tridentata has much the same range and is likewise found in Texas, but not in the northwest. Obliqua, candida, cretata, fayi, vestita, discoidea, lateralis, punct i collis and moesta have about the same range, being found in Canada, in the eastern states and also in the Middle West. The typical populnea is found only on the Pacific coast, tulari occurs in the same localities and also in Colorado and Arizona. Concolor is found in Arizona and Colorado. The variety unicolor has the same general range as moesta. Hornii is confined to the western coast from Los Angeles Cal. to British Columbia.

Specific relationships. Before attempting to group the species according to their natural affinities, a few remarks on their specific characters may be of interest. The antennae of most species are unicolorous. In some, obliqua, mutica, hornii, populnea, moesta, tulari and concolor and its variety, they are more or less annulated with gray, (brown and black in obliqua), and two of these species have the first joint enlarged. The length of the antennae also varies in the different species, being very short in mutica.

The shape of the last segment of the female abdomen presents an excellent character for the separation of some species. The pygidium of some is broad with the apex blunt and in others it is long. The tip may be more or less divided into two lobes, the upper surface may be either marked by a median depression or may be convex as in mutica.

The angle formed by the sides varies in different species. The front claws of the anterior and middle tarsi of the males are armed with either a blunt process or tooth, which is lacking on the front pair in puncticollis, wanting on all claws in populnea, moesta, tulari and concolor and present on both claws of each pair of legs in lateralis. This process is subject to variation as to size and form in individuals of the same species, and it has been used as a specific character as little as possible. The shape of the thorax, whether cylindric or narrowed in front, affords a good character. The form of the apex of the elytra is of value in determining species, as they may be rounded, obliquely narrowed, armed with a spine or truncate. The shape of the head and eyes varies greatly in different species. The punctures of some species are quite constant; but in others, populnea, moesta, tulari, they vary so much that little dependence can be placed on them. The species range in size from calcarata, which is from ⅞ to 1⅛ inch long, to populnea ⅜ inch in length, but occasional specimens may be much smaller than the normal. The color and markings are quite constant, and only lateralis shows marked variations. Calcarata has a variety, adspersa, which is entirely brown. The legs of most species are black, covered with a gray pubescence, yellow in vestita; those of obliqua, cretata and discoidea are reddish brown with gray pubescence.

Arrangement indicates the degree of specialization. The salient characters of the various species having been given, it now remains to use them in a natural grouping of the forms. It is very apparent that the usual arrangement is arbitrary and based almost entirely on color and markings. It is not to be supposed that the following grouping means that the species are derived or descended from each other. It represents simply our idea of the degree of removal or specialization from an ancestral type and is based on a study of characters of unequal value. It is very evident that our own species have specialized along different lines and have probably originated from several type forms.

The least specialized of our native species is evidently concolor, since it is unicolorous, has no striking characters and presents fewer differences from its nearest allies in other genera, than any of the other species. It has no process on the claws of the male and the rather few elytral punctures are merely shallow depressions without definite edge and are punctate like the remainder of the elytra. The species diverging most widely from it, and therefore the most specialized, is obliqua, since it has characters not possessed by any of the others. It has the elytra separately narrowed and armed with a spine. The thorax is narrowed in front, and the head is small, and deeply impressed between the eyes. The annulated antennae have the first joint swollen and dark, and the elytra are embossed to match the color pattern. The process is very highly specialized as can be seen by reference to figure 3. The species which possesses the greatest number of these characters is m u t i c a. It is true that it lacks the spine at the apex of the elytra, but it has the narrowed thorax, small head and the antennae with an enlarged, dark basal joint. These two species form a group by themselves closely approached by h o r n i i (which is nearly related to the European s i m i l i s); it has the annulated antennae, but the first joint is normal and the thorax is nearly cylindric, in some specimens entirely so. The color and maculation are much like those of m u t i c a. We then come to the European c a r c h a r i a s, with its narrowed thorax and annulated antennae. The humeral angles are quite prominent and the elytra tapering. The nearest American representative is c a n d i d a, an insect which at first would not seem to belong here, but that is due more to the color and markings, characters of the smallest value, since, if we omit the color from consideration, we shall find that the shape and structure are very similar to c a r c h a r i a s, as represented by the narrowed thorax, small head, prominent humeral angles and tapering elytra. The unicolorous antennae show c a n d i d a to be less specialized than this European species. C a l c a r a t a, our next species, is also somewhat related to c a r c h a r i a s and leads naturally to t r i d e n t a t a, which is of the same general shape and has in addition the elytra truncate and weakly sinuate at tip, evidently an early stage of the sutural spine found in c a l c a r a t a. T r i d e n t a t a has a character (a submarginal carina beginning at the humeral angle and continuing to the apex) not present in any other of our forms, but which, strange to say, has its counterpart in some old world species.[1]

The remaining species appear to follow in regular order as given in Henshaw's list, except that f a y i would more naturally follow l a t e r a l i s, since it has the rounded head possessed by the species that follow and the same gall-making habit. The spine on its front claws is very small and rudimentary, approaching the condition of

[1]This character is made use of by Bates to form the genus Eutatrapha, to which he refers 16-p u n c t a t a, v a r i c o r n i s and m e t a l l e s c e n s. It would also include t r i d e n t a t a. [*See* p. 6]

puncticollis, where it is entirely absent. Imitans is close to lateralis and fayi and presents more characters in common with the last than with tridentata, though its markings are much like the latter.

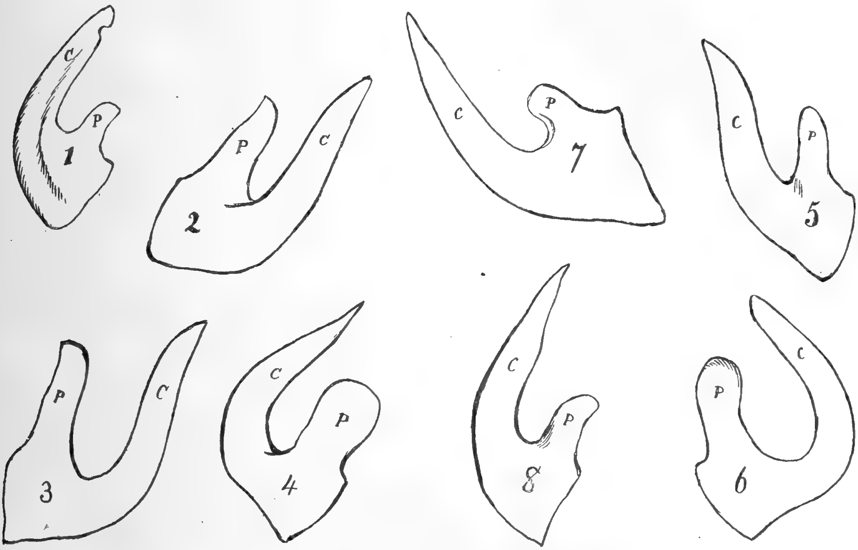

Fig. 1 Front claw of first and middle tarsi of the following species: 1 and 2, Saperda imitans; 3 and 4, Saperda tridentata; 5 and 6, Saperda discoidea; 7 and 8, Saperda vestita. C= claw, P= process.

Systematic list of American species of Saperda

obliqua *Say*
mutica *Say*
hornii *Joutel*
candida *Fabr.*
calcarata *Say*
    var. adspersa *Lec.*
tridentata *Oliv.*
cretata *Newm.*
discoidea *Fabr.*
vestita *Say*
imitans *n. sp.*
lateralis *Fabr.*
    var. connecta *n. var.*
fayi *Bland.*
puncticollis *Say*
populnea *Linn.*
subsp. moesta *Lec.*
subsp. tulari *n. subsp.*
concolor *Lec.*
    var. unicolor *n. var.*

The development of the process on the claws follows the foregoing arrangement better than any other, and we find that the degree of development is somewhat different from published accounts of earlier workers, who probably lacked sufficient material.

Process moderate on anterior claw of front and middle tarsi: obliqua, mutica, hornii, candida.

Process long on anterior claw of front and middle tarsi: calcarata, tridentata, cretata.

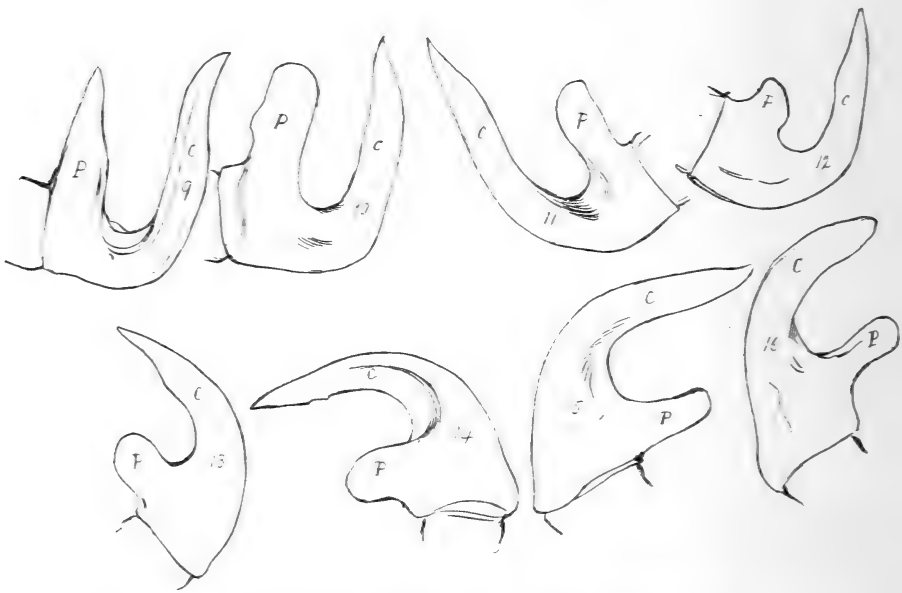

Fig. 2 Front claw of first and middle tarsi of the following species: 9 and 10 Saperda cretata; 11 and 12 S. candida; 13 and 14 S. hornii; 15 and 16 S. calcarata. C=claw, P=process.

Process shorter on anterior claw of front than middle tarsi: discoidea, vestita, imitans.

Process small on both claws of all tarsi: lateralis.

[1] Process very small on anterior claw of front and small on middle tarsi: fayi.

Process wanting on front and large on middle tarsi: puncticollis.

Process wanting: populnea, moesta, tulari and concolor.

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[1] As this process shows considerable variation in shape and size in different specimens of the same species, we have taken the most common shape and size as the normal for each species.

Key to species

a Antennae plainly annulate
  b Head deeply impressed between the eyes
    c Antennae with first joint normal and gray .... hornii
    cc Antennae with first joint enlarged and dark
      d Elytra obliquely narrowed, ending in a spine at the tip .... obliqua
      dd Elytra slightly narrowed and without a spine .... mutica

Fig. 3 Claws of following species: 17 Both claws of front tarsi of S. lateralis; 18 Both claws of middle tarsi of S. lateralis; 19 Front claw; 20 Posterior claw of middle tarsi of S. lateralis; 21 claw of middle tarsi of S. puncticollis; 22 and 23 Claws of hind tarsi of S. lateralis; 24 and 25 Claws of front and middle tarsi of S. fayi; 26 and 27 Claw of front and middle tarsi of S. obliqua; 28 and 29 Claw of front and middle tarsi of S. mutica.

  bb Head rounded in front
    c Antennae with first joint black and normal in size
      d Upper side strongly punctate and confluent with few punctulations between, sparsely covered with gray or light fulvous hairs, several spots of dense yellow or fulvous hair on elytra; fulvous stripe on side of thorax .... populnea
      dd Upper side with punctures not so numerous, and sparsely covered with gray hairs, unicolorous, punctulations on intervals more numerous; light stripe on thorax nearly obsolete .... subsp. moesta
      ddd Upper side with fewer but larger and deeper punctures, more densely punctulate on the intervals and densely covered with red or fulvous hairs; thorax with stripe on sides and top .... subsp. tulari

dddd Upper side finely punctulate and with small shallow punctures and uniformly covered with a dense layer of light gray or yellowish gray hairs; thorax with lateral stripe
concolor

e Punctures much more numerous, hair dirty gray; lateral stripe wanting or nearly so..................var. **unicolor**

aa Antennae unicolorous

b Elytra rounded with spine at suture

c Gray with yellow patches.......................... **calcarata**

cc Color uniform fulvous........................var. **adspersa**

bb Elytra with marginal or submarginal stripe

c Thorax and elytra brown or yellowish brown with two white stripes; under side white............................ **candida**

cc Thorax yellow with four black spots on dorsum and one on each side; elytra bordered with bright yellow with a black spot in front; under side gray...................... **puncticollis**

ccc Thorax and elytra gray and with an orange red lateral stripe

d Second and third cross bands on elytra oblique, a dark spot usually on each side of the first and one behind the third; front of head very flat; elytra more or less truncate
tridentata

dd First and second cross bands on elytra oblique; front of head flat; elytra rounded at apex...................... **imitans**

cccc Thorax and elytra black

d Sutural and lateral stripe on elytra orange red; head somewhat rounded; under side gray...................... **lateralis**

dd Sutural stripe usually wanting and with one to three cross bands; lateral band reaching to margin; under side gray
var. **connecta**

bbb Elytra with spots, rarely concolorous

c Cinnamon brown with a white stripe on each side of the thorax

d A large white spot in center of each elytron and a smaller one near its apex, neither reaching to margins; sides and under surface white .... **cretata**

dd White stripe on thorax continuing on elytra at humeral angles; the elytra with two white spots, one at the middle, the other near the apex and almost sutural; sides and under surface white; the spots are more or less obsolete in the male..**fayi**

cc Cinnamon brown, sometimes nearly black, with a transverse, undulate, yellowish olive fascia across the middle of the elytra; sometimes with an additional spot both before and behind this fascia; thorax and apex of elytra and scutellum olive; legs light reddish, under side lighter.................... **discoidea** ♀

ccc Uniformly reddish brown, sometimes black; legs reddish; under side lighter.............................. **discoidea** ♂

cccc Olive yellow with three denuded black spots on each elytron, some or all occasionally wanting................. **vestita**

Grouping and summary of the food habits of the larvae

The larvae of this genus may be divided by their food habits into three classes: (1) those that bore in the large branches and trunks of living trees and feed on the sap, calcarata, candida, cretata, vestita and possibly hornii and mutica; (2) those that live in small branches and usually produce galls, subsisting on sap, and not making the extended galleries of the first group, fayi, populnea, obliqua, concolor; (3) those that feed on living and dead tissues of dying or recently killed trees, tridentata, discoidea, lateralis, imitans and puncticollis. The manner of feeding and the portion of the tree attacked vary with different species, and most of the forms have special food plants.

S. obliqua feeds close to the ground at the collar of the black alder, where it often entirely girdles the stem, forming a knot or gall and ultimately killing it; and, when not entirely girdled, the tree is so weakened that the stem soon breaks. A walk through an alder swamp where this insect is common will show a great number of prostrate stems in all stages of decay.

S. mutica. This species is said to live on the willow and is the only eastern form that we have not bred and of which we have been unable to secure workings.

S. hornii feeds on the willow according to Dr H. C. Van Dyke, who has taken the insect on that plant.

S. candida is usually very common in apple and attacks several allied trees. It is quite destructive to seedlings and young trees, where it works at the base of the trunk and roots, and, as several generations follow in the same wound, the tree is soon killed.

S. calcarata works in the trunk and larger branches of the silver poplar in particular and soon kills the trees. It is surprising to see the quantity of sawdust around a badly infested tree, thrown out by the larvae when making their pupal chambers.

S. tridentata works in and under the bark of the trunk and branches of the elm, and has also been recorded in other trees.

S. cretata lives in the thorn and apple, usually in the trunk and larger branches, and works somewhat like S. calcarata, but the burrow is longer and more tortuous.

S. vestita attacks the linden and in our experience works mostly at the base and roots. We have never found it more than 12 inches from the ground, and that seldom. It can always be found in exposed roots and at the base of the tree close to the ground. In either case the larvae usually work in the subterranean parts. Prof. F. M. Webster has also noted this habit.

S. discoidea lives under and in the bark of hickory, specially dying trees or those recently killed by Scolytus quadrispinosus Say. It can be easily bred from a piece of dead bark.

S. imitans is not known in its early stages but probably bores in hickory and not in elm.

S. lateralis works in hickory at some injured place near the root and is partial to the base of sprouts that grow around stumps on recently cleared land.

S. fayi makes a gall very simlar to that of concolor, but breeds in the thorn.

S. puncticollis works in the dead branches of Virginia creeper, eating the inner bark and pupating in a chamber excavated in the wood.

S. populnea feeds on the willow and poplar. S. moesta makes a gall on the balm of gilead, and this, we believe, is its only food plant, and the form tulari lives in willow.

S. concolor makes a gall on poplar and willow shoots.

Saperda obliqua Say

Alder borer

This species, while rarely met with in the adult form, appears to be very common in New York State, judging from the condition of some of the alder swamps we have visited.

Life history and habits. This insect's method of working is quite characteristic [pl. 5, fig. 3], and the badly girdled stems with gall-like enlargements, are not difficult to find. The insect works close to the ground in black alder, frequently girdling the trunks, and in infested swamps large numbers of prostrate stems in all stages of decay may be found. There are usually two or three borers in each trunk, one of which is very apt to work downward to the depth of 3 or 4 inches and often below the ground level and the others in an opposite direction. The young grubs bore just beneath the bark, much like those of S. candida Fabr., and the nearly full grown individuals work near the center of the stems and not infrequently fairly riddle the base, causing it to break in the wind. In fact, the general method of work is very similar to that of the round-headed appletree borer, and the perfect insect emerges from a hole very similar to that made by the species infesting the apple.

The beetle [pl. 5, fig. 6] is generally found near the top of alder branches. Mr Fred Knab, of Chicopee Mass. states that it easily escapes notice on account of its great resemblance to a withered leaflet. He adds that it differs from others of its genus, which are also shy insects, in that it remains perfectly motionless, clinging tightly to the branch and with the antennae extended forward. He has also found this insect on birch. Dr Packard records the beetle as occurring on alder; Dr Smith states that it is rare throughout New Jersey, where it breeds in black alder; and the late Dr Lugger records it as breeding in hazel shoots.

Distribution. This species was described by Say from Missouri; it has been collected about Buffalo by Zesch-Reinecke; Dr Smith records it from New Jersey; and Dr LeConte from Pennsylvania. The following localities for this species have been given by Messrs Leng and Hamilton: Wisconsin, Mississippi, Canada, Massachusetts, New York, New Jersey, Pennsylvania and Missouri. It has been found in various localities about New York city, such as Bronx park, Fort Lee and Staten Island and has also been recorded from Alabama and Montreal. We have seen specimens taken in Illinois in the Bolter collection.

Description. Light reddish brown with darker bands; antennae annulate, with the first joint dark and swollen; thorax narrowed in front; a dorsal stripe of darker brown continuing on the head; a subdorsal stripe that converges and continues on the elytra around the scutellum; a lateral stripe that connects at the humeral angle with the first of four oblique bands on the elytra. The spaces occupied by the darker portions are depressed and less pilose. The elytra are separately narrowed at the apex and armed with a spine. The head is strongly impressed between the eyes. The work of the larvae is well represented on the plate.

Natural enemies. No literature on this subject exists; but we have found a number of affected alders which showed the work of woodpeckers, and evidently these valuable birds are very efficient factors in reducing the numbers of the borers. In one short limb we found four good sized holes made by the birds in their search for grubs [pl. 14]. We have also found many of the larvae destroyed by a dipterous parasite which pupated in the burrows after destroying the maker; several larvae or pupae of this Tachinid are usually found in each working.

Another small dipterous larva is sometimes found in considerable numbers feeding on the larva or pupa but we have not been able to rear it.

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Saperda mutica Say

Life history. Very little is recorded concerning the life history of this species. Beetles were taken by Mr W. H. Harrington on May 15 and captured by him in the open on June 29. He records this species as living on decaying willow.

Distribution. This beetle has been recorded from the following localities: Missouri [Say], Buffalo [Zesch-Reinecke], New Jersey [Smith], Ottawa Can. [Harrington], Canada, New York, New Jersey, Missouri, Kansas and Nebraska [Leng-Hamilton], Philadelphia Pa. [Wenzel]. Dr LeConte thought that this species was probably the S. populnea of Fabricius and Olivier. Its work is unknown to us.

Description. Black, sparsely covered with a gray or fulvous vestiture which is denser in places, forming numerous spots on the elytra [pl. 7, fig. 2]. These denser places are usually yellower in color. Antennae short, annulate, with first joint enlarged. Thorax narrowed in front with a fulvous line on dorsum, continuing on the head, also lateral line on sides. Head impressed in front between the eyes.

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1899 **Smith, J. B.** Ins. N. J. State Bd Agric. Sup. 27th Rep't, p.296 (On willow)

1902 **Joutel, L. H.** Ent. News, 13:33-34 (Saperda hornii, compared with)

Saperda hornii Joutel

This species [pl. 7, fig. 3] has been mistaken for S. m u t i c a, but can be easily separated from it by the first joint of the antennae being normal in size and also by the fact that the last abdominal segment of the female has a deep longitudinal impression along the middle of the upper side, while m u t i c a has that part convex. The punctures of this insect are also much larger and deeper, and fewer in number.

Some specimens have lost the yellow marks and are entirely gray.

Distribution. Oregon, Los Angeles Cal.,[1] Humboldt county, Cal., Nevada county, Cal., Yosemite Cal., Goldendale Wash.

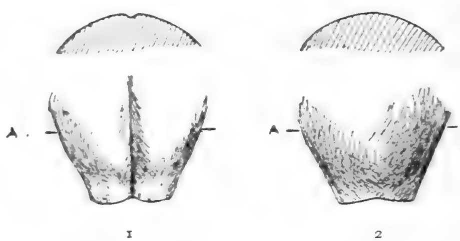

Fig. 4 Last dorsal segment with transverse section at A: 1 S. h o r n i i; 2 S. m u t i c a

Description. Black; shining, entirely covered with a dense layer of light yellowish gray hair, lighter beneath, and diversified above with irregular blotches and streaks of dark yellow arranged on the elytra in broken and irregular longitudinal lines, the line nearest the outer margin and just below the humeral angle unbroken except by the punctures, and continuing nearly to the tip. Elytra obliquely narrowed at apex. Thorax cylindric, sometimes slightly narrowed in front, with a longitudinal stripe of dark yellow hair on each side and on top, under side yellow. Scutellum yellow. Entire insect covered by rather large and deep punctures, slightly smaller beneath. Head: hairs yellow, changing to gray at labrum. Legs and under side of body light yellowish gray with glabrous punctures. Antennae annulate except first joint, which is entirely gray and

[1]In the original description, the locality of the type male in the national museum was wrongly given as Yosemite Cal. It should be Los Angeles Cal.

moderate in thickness. The pygidium of the female has a deep longitudinal depression along the median line, dividing it into two lobes.

Its work is unknown. Mr J. J. Rivers and Dr H. C. Van Dyke have both taken it from willow.

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1902 **Joutel, L. H.** Ent. News, 13:33-34 (Original description)

Saperda candida Fabr.

Round-headed appletree borer

There is perhaps no better known enemy of appletrees than the above named insect. The common designation, apple borer, usually refers to this insect, though by common consent it is gradually becoming known as the round-headed appletree borer in contradistinction to the destructive flat-headed species, Chrysobothris femorata Fabr., which is frequently very abundant in appletrees. The round-headed appletree borer is particularly injurious to young trees, and it is probably responsible for the death of more of these than all other natural agents combined.

Early history. This species was very early known as a notorious pest throughout New England and the Middle states according to Dr Harris. Mr Philip Heartt of Troy lost in 1825 several hundred young appletrees which he valued at $2000, many of them being so seriously affected that the base of their trunks was literally honeycombed by the galleries. The late Dr Asa Fitch stated that, of $10,000 worth of trees sold in Washington county in 1851, fully one half were destroyed within eight years. Not infrequently the borers were so abundant as entirely to girdle the tree. Mr William Couper, in 1862, attributed the great destruction of appletrees about Quebec to the ravages of this insect. Mr D. B. Wier, of Wisconsin, writing of this species in 1872, characterizes it as one of the worst enemies of fruit trees and states as his opinion, that it would destroy 5000 out of 10,000 young trees within three years. Dr

J. B. Smith considers this borer very destructive to young appletrees in many parts of New Jersey and states that it is a more serious enemy of the quince. Miss Mary Treat, of Vineland N. J., writing of this insect in 1893, stated that it was unusually abundant in that section and threatened to kill the trees in spite of all efforts, 10 to 12 borers being found in one. Mr G. T. Powell, of Ghent N. Y., reports taking 30 grubs from a tree in 1889, a year when they were unusually abundant.

The work of this insect is so insidious that it is difficult to gain an adequate idea of its great destructiveness, specially as the sickly condition of the trees is frequently attributed to some other than the true cause.

The above brief records will give some idea of how dangerous an enemy this beetle is; and it is very likely that in future years appletrees will have to be guarded more closely than in the past, if they are to be protected from serious injuries by this pest.

Life history. The adult beetles have been observed abroad during June, July and August. Dr Fitch states that the beetles begin to appear in Washington county, N. Y., about June 20. They are secretive in habit and deposit eggs in the bark near the ground. Mr Zimmerman records the appearance of the beetle June 2 and 3, 1878, and adds that this date is 20 days earlier than usual. Prof. Cyrus Thomas, writing of this pest in 1877, states that it appeared in May in Illinois, and Mr D. B. Wier, of Wisconsin, gives the date of the appearance of the beetles from the middle of May to the middle of June. Mr Tallman has recorded finding this species in copulation on elm June 7. Dr J. B. Smith, state entomologist of New Jersey, gives the date of the occurrence of the beetles from May 20 to July 15.

The egg of this borer is a pale, rust-brown color, about ⅛ inch long, one third as broad in the middle and somewhat flattened, so that its depth is about one third its width. It is rather easy to find eggshells in the oviposition scars [pl. 1, fig. 2], and it will be seen that they are fairly tough, without any sculpture and sufficiently plastic to receive impressions of wood fibers between which they may be placed.

The oviposition scars [pl. 1, fig. 2; pl. 8, fig. 1] may be readily detected as longitudinal slits in the bark, ranging from ¼ to as much as ¾ inch in length. These scars have somewhat irregular, dried edges, and in early spring usually have small, rust-red borings hanging therefrom [pl. 8, fig. 2]. Their location is made more apparent by the adjacent discoloration and shrinking of the areas where the young grubs are at work in the underlying green tissues [pl. 8, fig. 3]. These scars are sometimes very abundant on young trees. The writer observed 11 of them on a portion of a smooth trunk less than 6 inches long and 1½ inches in diameter [pl. 8], and all were within 6 inches of the ground, two being close to its surface. The importance of these marks lies in the fact that they indicate the location of the young grubs, which may be reached and destroyed in the fall or early spring without material injury to the tree. The splitting of the bark is primarily caused by the female in preparing for deposition of her eggs, and the orifice is further enlarged by the consequent shrinkage and drying following the operations of the grub. On cutting into one of these scars [pl. 8, fig. 3] in early spring, young grubs, ranging in size from ⅛ to ¼ inch in length, may be found in the shallow cavity in the inner bark and outer sapwood, and in some cases remains of the eggshell may be observed. The method of oviposition has been described by Dr C. V. Riley as follows:

> The female beetle makes an incision in the bark, causing it to be split from ⅕ to sometimes ½ an inch. The incision is often made entirely through the bark, and the egg is thrust between the bark and the liber at right angles to one side of the slip, from ⅛ to ¼ of an inch from the aperture. Sometimes the bark is but partially penetrated, in which case it is pried open on one side of the aperture for the reception of the egg. In either case the egg is accompanied by a gummy fluid which covers and secures it in place and usually fills up the aperture. In young trees, with tender bark, the egg is usually thoroughly hidden; while in older trees it is sometimes so shallowly embedded as to be readily seen.

Mr W. Junkins, in the *New England Homestead* of Jan. 3, 1885, has also described this interesting process, as it occurs on twigs set in moist sand in a jar: June 15 he observed one of four females deposit an egg. "She first made an incision in the bark close to the sand; then, turning her head upward, with her ovipositor she placed the egg in the bark nearly ¼ of an inch from the incision, the bark having been started from the wood."

Mr D. B. Wier states that the beetles copulate from 10 days to two weeks after reaching maturity, and soon after the females commence to lay eggs. They are mostly deposited by night, usually from 1 to 10 inches from the ground. He observed that, where the beetles are numerous, several females will often lay their eggs on the same tree at different times, sometimes as long as two or more months apart. He has found as many as 27 young borers of eight different sizes in one tree in September. The eggs are said by Professor Chambers to hatch in about 14 days, and Professor McMillan gives the time as 18 days. The period observed by Mr Junkins, June 15 to July 7, was 22 days. Mr Buckminster believed that the females lay about 10 eggs, which hatch in about eight days, as stated by Gay. Dr Saunders, in his *Insects Injurious to Fruit,* states that the beetle bores into the bark and deposits an egg in the cavity thus made; and Dr Dimmock, writing of this species in the *Standard Natural History,* observes that the cavity is filled with a cementlike secretion.

The young borer, or larva, almost invariably works downward just under the bark, making a somewhat sinuous channel with an oval enlargement at a variable distance from the point where the egg was laid. This oval chamber is evidently where the winter is passed. The presence of the insect is readily detected later, or in spring, by the rust-red borings which are ejected or forced out of the galleries [pl. 1, fig. 3]. There has been some discussion as to whether the larva actually ejects the borings. Dr Fitch was of the opinion that they commonly had the aspect of not having been forced out by the worm but of being thus crowded out because the mass under the bark swelled when dampened by rain soaking through the dead tissues and saturating the contents of the galleries. This explanation did not satisfy us. Our observations have been that the older larvae of this species always have more or less clear gallery space to travel about in and this they keep clear for the time being. They connect the interior workings with the chambers under the bark where they fed on the sap. When gnawing in the interior galleries they throw the debris behind and void their excrement from time to time while working; when tired or with hunger satisfied they take this frass in their mandibles and pack it in the galleries and corners of the "bark" chamber out of the way occasionally removing and repacking in some other place. They will also carry it to openings in the bark of their feeding chambers, and push it out, using the mandibles only. When at work in the "bark" chamber they void their excrement through one of the openings, ejecting it so that it will fall outside. This is usually done when the voided matter is soft and watery.

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 burrow will allow and remains inactive till the following spring, when it begins operations anew, and on the approach of the second winter it is about half grown and still living in the sapwood. It is at this period that the most damage is done, for, 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 finished its larval growth, continues this passage to the bark, sometimes cutting entirely through a tree to the opposite side and sometimes turning back at a different angle. Several borers in one tree will fairly riddle its base [pl. 9]. The upper end of the passage is stuffed with fine borings and the lower part with long wood fibers [pl. 1, fig. 5, 6]. After this the larva remains unchanged through the winter, transforming to a pupa the following spring, and the beetle appears some time during the summer, leaving through a circular exit hole [pl. 1, fig. 7; pl. 9]. The latter frequently becomes overgrown, as represented in plate 8, figure 4.

Habitat. This species is said by Dr LeConte to occur in the Middle, Western and Eastern states. Professor Cook states that it is widely distributed in Michigan, and Rev. C. J. S. Bethune, writing of the insect in 1877, records it as very abundant in the Niagara district and in the vicinity of Montreal and Quebec. Professor McMillan stated in 1888 that every orchard in Nebraska was infested.

It has been recorded specifically by various writers, from Canada, all of New England, Delaware, Maryland, Michigan, New York, New Jersey, Pennsylvania, Ohio, Missouri, Iowa, Kansas, Texas, Alabama, Mississippi, Oklahoma, Virginia, Arkansas, West Virginia, District of Columbia, and Mount Desert Me. [Harris].

Food plants. This pernicious borer is apparently limited to relatively few food plants. It is specially injurious to the quince and nearly as much so to the apple. Its native food plants are the thorn, mountain ash, chokeberry (Pyrus arbutifolia) and shad bush. It has been recorded by Walsh as rare on pear and by Beutenmuller as attacking plum and cherry.

Description. Brown above with two white bands joined at the front and extending to the apex of elytra, under side and front of head white. Antennae light gray, legs lighter gray [pl. 1, fig. 1].

Natural enemies. Not very many enemies of this insect have been discovered. An undetermined carabid larva was found preying on the borers by Walsh and Riley in 1866. Promachus saperdae Riley M. S., now known as Cenocoelius populator Say, was bred from borers received from Indiana by Messrs Riley and Howard in 1890. The downy woodpecker and the great golden woodpecker have been seen in infested orchards by Miss Mary Treat of Vineland N. J. but none of them were observed at work around the base of the trees. Dr Fitch in his first report states that the downy woodpecker, which is frequently seen in the orchards, is one of the means provided by nature for keeping this insect in check, and adds that a neighbor, who had devoted much attention to birds and their habits, informed him that he had repeatedly noticed this woodpecker remaining for a considerable time down at the very root of appletrees, busily occupied in some operation. This would seem to be very good evidence that this bird does prey on this borer. That woodpeckers do this is conclusively proved by specimens recently collected in the vicinity of Albany, which show the characteristic work of these birds, but unfortunately give no clue to the identity of the operator.

Preventive and remedial measures. The control of an insect pest of this character may be brought about in two ways: (1) the insect may be prevented from infesting the tree in some manner, or (2) destroyed after it has obtained entrance.

Dr Fitch had his attention called to the beneficial effect of soap applications, and he states that, if the bark of the trees be rubbed with soap the latter part of May, no borers will attack them. This was tested by him with the result that treated trees were free from the pest, while almost all of the untreated ones were infested with borers. One of the latter, only $3\frac{1}{2}$ inches in diameter, contained 15 of the grubs. Mr Fowler has proposed the use of 2 quarts of whale oil soap and $\frac{1}{4}$ pound of sulfur and enough clay to give the mixture the consistency of paint, and advises applying the compound early enough to prevent the deposition of eggs. Professor Cook in 1881 thought washing the trunks and larger branches of the trees in May and the last week in June with soap would protect them from the borers, and Prof. C. M. Weed has advised the use of what we know as the carbolic soap wash and observes that it is very effective when thoroughly applied. Some observers, however, state that soap applications, and similar preventive measures, are of comparatively little value, and a few consider the alkaline washes more effective than soap. A band of tarred paper, or bands of newspaper, wrapped tightly around the base of young trees during the period the beetles are abroad, affords considerable protection and is used rather extensively in some fruit-growing sections. The bands should extend from the soil about 2 feet high, should be tied at the top so that the beetles can not get behind the band and should make a fairly tight connection with the ground. Professor Slingerland has recently advised trying a coating of coal tar, first testing to see if the trees were injured by this substance. Whitewashing the trunk has also been advised by certain writers and appears to have a somewhat deterrent effect. The application is comparatively inexpensive and, in absence of anything else, may well be employed. Dr J. B. Smith has advised the use of a poisoned whitewash. The use of ashes about the roots is also good, since, if they are heaped somewhat, they will protect the lower portions of the tree from injury. The idea of these applications is to coat the bark or protect the base of the tree with some substance which will deter the beetles from depositing their eggs and therefore prevent infestation. These applications should be made in this latitude by the latter part of May and again early in June, or, in the case of permanent bands, the application of them at the earlier date is sufficient. Dr Fitch states that, in his observation, the worst infested trees are shaded and choked by suckers, and he therefore urges keeping the base of the trees clean. It is undoubtedly a good practice to observe this advice, since it at least permits the ready detection of the borers. We believe that suckers at the base of the tree are frequently caused by serious injuries by the larvae, and our experience indicates that a tree with an unprotected trunk is almost as likely to be attacked by the insect as one with its base shaded.

Thomas Say in 1825 recommended covering infested trees the latter part of April or early in May with mortar in order to prevent the emergence of the borers. This, so far as we can learn, has never been extensively tried and is of doubtful value. After the insect has once made its way into the tree, there is nothing better than cutting out the borers and destroying them, or killing them with a wire while in the tree. Either operation is best carried out in September or October or in early spring, because the work of the young borers is apparent at this time, and the recent borings facilitate their detection. A young tree will recover if the bark be extensively cut with a knife, and the over-cautious operator should remember that the borer is very likely to cause more injury if allowed to remain. The use of the wire will undoubtedly avoid considerable cutting in some instances, and it should be employed wherever practicable. Dr Fitch has advised cutting into the upper part of the boring, removing the sawdust and then killing the pest by pouring in a considerable quantity of hot water. This is undoubtedly efficient; but it appears to have a limited application, and in most cases it is probable that cutting out or destroying with a wire is to be preferred.

The quince suffers most from this borer, and perhaps the best method of controlling the pest in quincetrees is that described by Mr Woodbridge Strong in the issue of the *Country Gentleman* for Mar. 20, 1890. His plan consists in providing the quince with a trunk which is practically borer-proof, and he accomplishes this by first taking stocks of English hawthorn and grafting on them varieties of Crataegus crus-galli or coccinia, which are worked on the hawthorn at the surface of the ground, and a year later hawthorn is worked back onto the native stock about a foot above and then quince on that a few inches higher. This compound tree is then set so that the hawthorn stock is below the surface of the ground and the Crataegus occupies the first foot. Mr Strong states that such trees make very satisfactory growth and fruit readily, and that, while the work of preparing them is difficult and involves considerable labor, the results amply justify the expense.

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Saperda calcarata Say

Poplar borer

This is the largest of our native species and is equaled in size only by the European S. c a r c h a r i a s. This species is of considerable economic importance on account of its serious injury to the trunks and larger branches 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 serious injury is inflicted. This applies not only to neglected trees along road sides and in forests but also to magnificent specimens grown for ornamental purposes in parks. In Washington park, Albany, this species has recently caused a great deal of damage, breeding in large numbers in a group of magnificent white poplars. We have also observed similar injury in New York city and Brooklyn.

Early history. Dr Harris, in his classic report, *Insects Injurious to Vegetation,* states that this species in conjunction with the broad-necked Prionus, Prionus laticollis, nearly destroyed the lombardy poplars in the vicinity of Cambridge Mass. in the early 40's. In 1880 Mr Shelby Reed, of Scottsville N. Y., lost two fine trees on a lawn through the depredations of this pest. Dr Packard reports it as very injurious to poplars along the shores of Casco bay, Me., in 1884, and in 1892 it had caused great depredations among the silver poplars of Cincinnati O. 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, in his paper, "The Insect Enemies of Ornamental and Shade Trees," states that this borer is by far the most destructive enemy of poplars and cottonwoods in the west. He further adds that it is almost impossible to grow these trees of any size in cities and towns of Nebraska away from the friendly care of birds and parasitic insects.

Life history. The recorded life history of this insect is very meager indeed. Dr Harris states that the beetles [pl. 2, fig. 1] occur on the trunks and branches of various forms of poplar in August and September, and other writers notice the life history of the insect in a very brief manner.

The most obvious signs of infestation are the numerous blackened, swollen scars along the surface of the trunk and limbs. Sometimes these are open, and in early summer large quantities of borings are expelled from the inhabited galleries, and frequently occur in considerable piles about the base of the trees. This is very evident during the latter part of May and in early June. Our observations show that pupae [pl. 2, fig. 2] may be found in considerable numbers in early June in the vicinity of Albany, and that adults appear in early July and continue to emerge throughout that month and probably also during August and into September. In early June we have found full grown larvae [pl. 2, fig. 3] which apparently were nearly ready to pupate, and many pupae, though no beetles breed therefrom till into July. This would therefore prove that the pupal stage lasts three or four weeks as a general rule. The pupal chamber [pl. 2, fig. 2] is invariably near the center of the smaller limbs and at some distance from the surface in trunks. The top is smoothly cut, and the other end is closely packed with coarse fibers which are attached to the side of the gallery at one end, and the portion next the pupa is packed with much finer borings and then coated with very fine sawdust. This pupal chamber appears to be made the previous season, but transformation to the pupa does not occur, as in other species, till spring. There are no records regarding oviposition habits, but this species, like S. c a n d i d a, makes a small slit in the bark and deposits its eggs just underneath the surface. The young larva [pl. 10] works in the inner bark and the outer sapwood for a short time and before the approach of cold weather sinks its burrow to a greater depth. The borings of the second year are confined very largely to the interior of the wood, and during this stage the limb or trunk may be honeycombed by very large, somewhat irregular galleries. In the latter stages of their existence, the larvae not infrequently excavate broad shallow galleries in the sapwood and inner bark and appear to subsist to a considerable extent on the sap collected in such cavities. This insect probably requires three years to complete its transformations.

Food plants. This borer has been recorded as destructive to lombardy poplar [Emmons], cottonwood [Walsh], P o p u l u s t r e m u l o i d e s, the common aspen [Jack], cottonwood, poplars and willows [Lugger], is not rare on diseased Populus [Hamilton], on cottonwood and other poplars [Adams], very common [Provancher].

Description. Covered with gray hairs, diversified with patches of yellow hairs on the elytra, which latter end in a sutural spine. Thorax with a yellow stripe on top and sides, extending on the head, which is yellow in front; scutellum yellow; underside gray with yellow; legs gray; antennae gray. Sometimes the insect is entirely yellowish brown (var. a d s p e r s a).

Distribution. This species has been recorded by Leng and Hamilton, from the following localities: Canada, Wisconsin, Lake Superior, Michigan, Ohio, Pennsylvania, New York, Massachusetts, New Jersey, Missouri, Kansas, Nebraska, Iowa, Vancouver island, British Columbia, and from Yakima Wash. by Professor Piper. We have seen specimens from Texas, South Carolina, Illinois, Black hills, and Bismarck N. D. It has been found by us at Fort Lee N. J., in New York city and also Brooklyn and Glendale.

Saperda adspersa Lec., a uniformly brown form described from Michigan, is a variety of this species. This variety has also been found at Albany [Joutel] and at Brandt lake in the Adirondacks [J. Doll].

Remedies. It is manifestly impossible to attempt to control this insect on other than valuable trees, and in such situations, digging out the borers, with possibly recourse to the use of repellent washes described on page 29, is about all that can be done and in the majority of instances should afford considerable protection.

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Saperda tridentata Oliv.

Elm borer

This species is of considerable economic importance, since it is sometimes very injurious to our American elms, where it may work in association with two small curculios, Magdalis barbita Say. and M. armicollis Say. We believe that this species is responsible in a large measure for the dying condition of some of our elms, though the curculios mentioned above undoubtedly aid materially in the work of destruction.

Early history. The earliest record of injury by this insect is that given by Harris in his report, *Insects Injurious to Vegetation.* He states that trees on Boston Common "were found to have suffered terribly from the ravages of this insect. Several of them had already been cut down as past recovery; others were in a dying state; and nearly all of them were more or less affected with disease or premature decay." Dr S. A. Forbes, state entomologist of Illinois, in his 14th report, states that, from the rapid progress which this pest has made among the elms during the last two or three years, it seems extremely likely that it will totally exterminate the trees unless it be checked by general action. Dr J. A. Lintner, late state entomologist of New York, in writing of this insect in 1893, characterizes it as being generally destructive throughout the State and one worthy of close attention in order to check or to prevent its causing serious injuries. Professor Garman, entomologist of the Kentucky Agricultural Experiment Station, records an instance of serious injury by this pest to trees about the streets of Frankfort. Several trees were dead and a number of other valuable elms dying, those affected being among the largest and the finest in the city. A more recent outbreak at Berlin Mass. was brought to the writer's attention in 1898. Two long rows of rather young elms were seriously injured by this insect and the associated Magdalis armicollis Say and M. barbita Say, and a number of the trees were killed.

Signs of attack. The presence of this insect is not easy to detect till it has become well established, and the first signs are usually seen in the lighter, thinner foliage followed by a dead limb here and there. Indications of boring soon appear, and the dark sawdust collects in crevices of the bark, and, after the attack has progressed for some time, large portions of the bark may be easily pulled from the tree, revealing a condition beneath very much like that represented on plate 11, figure 2. The inner portion of the bark may be literally a mass of mines or burrows, and, if the work has not gone too far, numerous whitish, flattened, legless grubs may be found in the channels they have excavated. The junior author is of the opinion that this species normally feeds on dead or badly diseased tissues, and that from them it may invade living bark. A small portion of the work of this insect is shown on plate 3, figure 1, where it is seen that the grubs have made incursions into the living bark, working back to that which is dead. It is also able to live in the thick bark of older trees for a portion of its life. This is undoubtedly true in some cases at least, and in others it certainly appears as though this species was the initial 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 attribute the primary injury to this species.

Life history. The time necessary for this insect to complete its life cycle is unknown, but from our breeding experiments it seems that probably only one and possibly two years are necessary. The larvae commence transforming to pupae in New York State 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 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 and making a serpentine burrow. The boring increases in size with the growth of the larva [pl. 3, fig. 1], 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 we found it comparatively easy to separate those taken from a badly infested piece of limb in a similar manner. But in our breeding from such infested bark all larvae transformed the same season. We have also found it working in dead as well as living tissues and have proved its ability to complete its transformations in the former.

Food plants. This insect appears to infest the white elm almost exclusively, though Dr Fitch records it as breeding in the slippery elm. We have seen no indications of its attacking the English or Scotch elms, so common in Albany. There is a record of this species having been reared from maple, but it would seem that the infestation must have been abnormal or else the record was founded on an erroneous observation.

Description. Black, sometimes fawn color, densely covered with a gray pubescence [pl. 3, fig. 3]. Thorax: twin black spots below lateral orange red bands which are joined together at the base and reach to the head, where each divides and encircles an eye; sometimes ornamented with two black spots on each side of median line. Elytra: submarginal ridge reaching from the humeral angle to near the apex, giving them an angulated appearance; ornamented by a more or less distinct submarginal, orange red band, from which arise three crossbars of the same color, the one nearest the base of the elytra nearly transverse, except at the tip, where it is sometimes oblique, it rarely reaches to the suture and has a black spot on either side where it joins the submarginal band; the middle band oblique and usually joined at suture; the apical one also oblique, with a black spot at its posterior side, usually reaches the suture and continues to the apex, where it joins the submarginal band. The apex is truncate and usually sinuate in well developed examples.

Distribution. The elm borer is generally distributed in New York State and has been recorded by various writers from the following additional localities: provinces of Ontario and Quebec, Massachusetts, Rhode Island, New Jersey, Pennsylvania, Ohio, Kentucky, Illinois, Michigan, Wisconsin and Iowa. It was collected by Professor Bolles in Texas and at Tyngsboro Mass. by Blanchard. We have also seen specimens from the District of Columbia. It probably occurs in a number of other states.

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. The latter process was carried out on 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 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 pint of crude carbolic acid, or ½ pint of the refined, and allow it to set over night. The next day add 8 gallons 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 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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1898 ——— N. Y. State Mus. Bul. 20, p.19-20, fig. 6 (Brief notice)

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1899 **Lugger, Otto.** Minn. Agric. Exp. Sta. Bul. 66, p.215 (Mention); same in Ent. State Exp. Sta. 5th Rep't, p.131

1899 **Smith, J. B.** Cat. Ins. N. J. State Bd Agric. Rep't, sup. p.297 (On elm)

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Saperda cretata Newm.

Spotted appletree borer

This insect is the more common appletree borer in Michigan, where it inflicts serious injuries according to Professors Cook, Riley and Osborn. It is probably this insect that Mr L. J. Templin had in mind in 1877 when writing of the appletree borer in the *Practical Farmer* for Nov. 17. He states that in the West a "majority of the specimens have a spot on each elytron on the shoulder," and shows that it was quite injurious even at that early date. It also works in the lower limbs of Crataegus, as stated by Dr Hamilton. Professor Osborn has recorded this insect as inflicting considerable injury in Iowa.

Description [pl. 4, fig. 2]. Cinnamon brown with a white band on the side of thorax, and a large, oblong white spot twice as long as wide, at middle of each elytron, and another small spot before apex; neither reaching to suture or margin. There is sometimes a minute white spot at middle of base of thorax as well as at the humeral angles. The sides are white; underneath, brown.

Distribution. This species has been recorded from the following localities: Paris Ont. [E. B. Reed], New York and Pennsylvania [Hamilton], New Jersey and Ohio [Chittenden]; Mr Chittenden states that there are specimens of this insect in the United States National Museum from northern Illinois and Texas; Leng and Hamilton record it from the following localities: Massachusetts, Canada, Michigan, Wisconsin, Iowa, Illinois and Pennsylvania; and Mr Wenzel informs us that he has recently taken it at Philadelphia. Mr Blanchard took it at Tyngsboro Mass.

Food plants. This species, in addition to the apple, attacks wild crab apples, and it has been observed on Juneberry [Chittenden].

Life history. Professor Osborn has observed the work of this insect quite closely. He states that its attack is usually confined to branches of moderate size, and that its plan of work is somewhat peculiar. At intervals of half an inch or more along the branch double incisions are made in the bark; and, on cutting these away, it was found that they led to excavations of considerable size under the bark, in some of which small grubs could be found at work. The borers had the appearance of the common appletree borer and were evidently of one year's growth. This insect makes a longer, more tortuous burrow than calcarata, in our experience. Its work in thorn is represented on plate 4, figure 1.

The pupa as described by Professor Osborn is similar to that of S. candida but smaller and occupies the central portion of the branch. He further observes that the beetles issue about the middle of June, and, after pairing, the female lays her eggs in the bark, two in a place, distributing them along the branch at distances of half an inch to an inch. On hatching, the grubs work in opposite directions around the branch, living for the first year just beneath the bark and afterward entering the solid wood. Here, after becoming full grown, they pupate and in due time complete their transformations.

Remedies. The remedial measures advised by Professor Osborn are cutting out and destroying the grubs with as little injury to the bark as possible; and, as he observes, if this is done soon enough, two grubs may be killed at every incision. He also states that some of the smaller woodpeckers are likely to prove most effectual allies in controlling this insect, and their presence in an orchard should be encouraged. Professor Cook has advised the use of the carbolic soap wash, which he states should be applied about June 10.

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Saperda discoidea Fabr.

Hickory saperda

This species is remarkable in having the sexes so unlike that one unacquainted with it would certainly consider them distinct species. In a long series of males, however, there will be found individuals having the same color and markings as the females, and some very poorly developed females lack entirely the characteristic markings of the sex. This is a common insect and breeds abundantly in hickory, frequently following the work of the destructive hickory bark borer, Scolytus quadrispinosus Say. It is sometimes so abundant that a piece of bark 6 inches square may contain a dozen or more larvae.

Life history. The beetles have been taken 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, in our experience, enter either the bark or the wood and transform to beetles. The work of this species is shown on plate 3, figure 2. Dr Hamilton has found more than 20 larvae, pupae and immature beetles, in the bark of a large hickory that had been killed about two years before. All were on the north side of the tree and none over 15 inches from the ground. In our experience they are equally abundant on all sides of the tree but appear to avoid any part infested by a dense white fungus growing between the bark and wood and often into the wood, and as very often only one side of the tree is so affected, this may account for the experience of Dr Hamilton. Dr Horn states that the larvae fed on the outer layers of the wood till they had attained nearly full growth and then retired into the bark, closing their burrows and transforming like a species of Urographis in oak.

Food plants. This insect appears to confine its attack to diseased or dying trees. We have reared it from trees killed by Scolytus quadrispinosus Say. It has been recorded on the hickory by Mr Harrington and as common on hickory and walnut in southwestern Pennsylvania by Dr Hamilton.

Description [pl. 3, fig. 5, 6]. Color above varies from black to light reddish brown in some examples; thorax and elytra strongly punctate; legs reddish brown, darker toward the tarsi. The under side is white in the males and light yellowish gray to light gray in the females.

Female. Head and thorax covered with olive yellow hair; scutellum yellow; the elytra denuded, except a small spot above and one below; a crescent-shaped fascia in the middle of each elytron, composed of dense yellow hair, which also forms a marginal band spreading over the apical end of the elytra.

Male. Uniformly ferruginous, black above, covered by a sparse gray pubescence that forms a whitish line on the sides and dorsum of the thorax, which is bordered by a denuded area.

Distribution. Middle states [LeConte]; Buffalo N. Y. [Zesch-Reinecke]; never plentiful about Hamilton Ont., though the females are usually the more numerous [Moffat]; very rare at Ottawa Can. [Harrington]; locally not rare throughout New Jersey [Smith]; and from Canada, New York, Pennsylvania, New Jersey, Louisiana, Kansas, Nebraska, Illinois, Michigan [Leng-Hamilton].

Natural enemies. Mr Harrington has observed a species of Arotes ovipositing in infested hickories and it is possibly a parasite of this borer.

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Saperda vestita Say

Linden borer

This species is a serious enemy of lindens in this country and is therefore one of considerable economic importance.

Early history. Dr Harris has recorded extensive depredations on linden trees in Philadelphia by an insect supposed to belong to this species, but, as the workings are very different from any we have met with, we question the identity of the depredator. The trouble was so serious that 47 trees were cut down by order of the authorities. The nature of the injury may be judged by the following. One of the infested lindens was very large, the trunk measuring 8 feet, 5 inches in circumference 5 feet from the ground. A strip of bark 2 feet wide at the bottom and extending to the top of the trunk was destroyed, and the exposed surface of the wood pierced and grooved with countless numbers of holes where borers had bred and where swarms of the beetles were supposed to have issued in past times. Some of the larger limbs and a portion of the tree broke off, apparently the consequence of the ravages of this insect. This pest has been very injurious to the European linden at Cambridge Mass., and Professor Webster has recorded it as damaging young lindens in nursery rows.

Life history. The beetles appear toward the end of the summer (we have taken them in August) and feed on the bark and the leaf petioles and also the larger veins on the under side of the leaves and on the green bark of the growing shoots, often killing the tips of the branches. When the beetles are very abundant, the injury caused by them is quite noticeable. Professor Smith has observed this beetle abroad in New Jersey during July, and Dr Packard states that one female may contain as many as 90 eggs. A female is said to deposit her eggs, two or three in a place, on the trunk and branches, specially about the forks, making slight incisions and punctures for their reception with her strong jaws. The larvae undermine the bark for a distance of 6 or 8 inches from the place where they hatch and often penetrate the wood to an equal extent, as stated by Dr Packard, who adds that this insect works at the base of young lindens, gouging two parallel rings around the trunk and forming annular swellings. We have observed the work of this species and seldom found it more than 12 inches above the ground; and in our experience it occurs very largely in exposed roots and subterranean parts, though Mr D. B. Young states that he has taken this beetle from galleries in the lower limbs of a large tree. The method of work is shown on plate 5, figure 1, which represents the broad galleries of the larva and the exit hole of the beetle. Our observations are confirmed by Professor Webster, who also states that the pupal cell is made at about the level of the ground and is cut diagonally across the grain of the wood and at an angle of about 45° to the channel the larva makes when ascending to this level.

Food plants. Linden is the greatest sufferer from the ravages of this insect, though it has been recorded by Dr Packard as infesting poplar, as occurring on ? elm by Riley and Howard, and Rev. J. L. Zabriskie has taken the insect from appletrees. It is doubtful, in our judgment, if the insect breeds in other than the various lindens.

Description [pl. 5, fig. 5]. Black, covered by a dense olivaceous pubescence, usually with three denuded spots on each elytron, two placed obliquely above the middle and one below. One or all of these spots may occasionally be wanting.

Distribution. This insect has been recorded from localities as follows: Lake Michigan [Say]; rare in Massachusetts [Harris]; very abundant in Lancaster county, Pa. [Rathvon]; Middle and Western states [LeConte]; Amherstburg Ont. [E. B. Reed]; Buffalo [Zesch-Reinecke]; L' Original and Grenville Can. [Harrington]; rather common in New Jersey [Smith]; not rare on linden in southwestern Pennsylvania [Hamilton]; very common [Provancher]; Canada, Vermont, New Hampshire, Massachusetts, New York, Pennsylvania, Michigan, Wisconsin, Iowa, Illinois, Ohio, New Jersey [Leng-Hamilton]. We have also seen specimens from Missouri.

Natural enemies. Two enemies have been bred from this species, one, Bracon pectinator Say? from the insect in ? elm and another, B. charus Riley, which is given by Dr Packard on the authority of Riley's unpublished notes, and, as no food plant is given, it is possible that the latter is but a different name for the insect previously mentioned.

Remedies. It is manifestly impossible to attempt to control this insect on other than valuable trees, and in such situations, digging out the borers, with possibly recourse to the use of repellent washes described on page 29, is about all that can be done and in the majority of instances should afford considerable protection.

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Saperda imitans n. sp.

This interesting species resembles our common elm borer, S. tridentata, with which it has frequently been confused. The junior author bred this insect some years ago from wood collected near the city of New York, but he did not notice that it was distinct from our common elm borer till too late to examine its workings. He had no elm in the breeding cage at the time, and so presumes that it lived in hickory, of which he had a quantity.

Description [pl. 3, fig. 4]. Black, densely covered with a gray pubescence, whiter below. Thorax: twin black spots below a lateral orange red band, extending on the head to the eyes, where it joins the line of the opposite side; median line light. Elytra: submarginal band of orange red running to the apex, from which arise three crossbars of the same color, each obliquely inclined toward the suture, the middle band usually not connected to the submarginal, the apical band usually rudimentary and then only transverse; apex rounded.

Types in collection of L. H. Joutel and New York State collection.

This insect is often mistaken for tridentata, but can be easily separated by the following characters, which show it to be distinct and not even closely related. It is longer in proportion to its width than tridentata. The sides are parallel, while in tridentata the humeral angle is quite pronounced. The first crossbar is oblique, there are no spots on each side of it, and the spot is also lacking behind the apical crossbar; it also wants the submarginal carina present in tridentata, which has the first crossbar at right angles. The pygidium of the female is broader at the top, and the sides make a wider angle than that of tridentata.

Distribution. This species has been received from Montreal Can.; and Mr Fred Blanchard has taken a specimen at Tyngs-

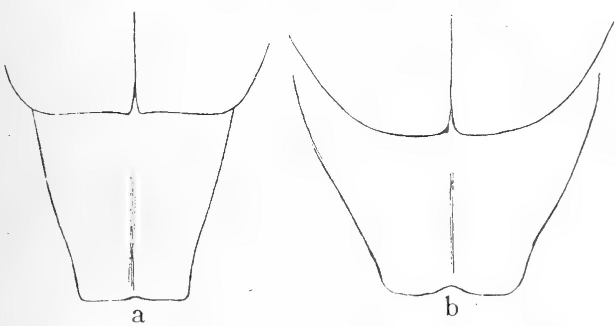

Fig. 5 Last dorsal segment and apex of elytra of S. tridentata (*a*) and S. imitans (*b*)

boro Mass. Mr Roland Haywood has taken it near Boston; specimens have been seen from Virginia, Michigan, Pennsylvania and Wisconsin; and we have bred it from New York city and vicinity.

Saperda lateralis Fabr.

Red-edged Saperda

This species is about the same size as S. tridentata Oliv. and like it occurs in elm. Its principal food plant is hickory, on which it is partial to injuries near the roots and to the base of sprouts on recently cleared lands. It is rarely abundant enough, however, to cause serious injury.

Life history. Comparatively little has been published concerning the life history of this species. The beetles may be taken in June in northern localities, and, like most other Saperdas, feed on the bark and petioles of the leaves at the ends of the shoots. Mr Tolman found them pairing in June on a fallen hickory near Philadelphia. We have bred this species from hickory stems in which the larvae lived at the juncture of the dead and living bark. Mr S. T. Kemp records the fact that he found the larvae of this species inhabiting the base of dead shoots of hickory, and, on breaking off the shoots, the borers were almost entirely exposed, sometimes falling to the ground. The infested shoots were invariably those which had been broken off 3 or 4 feet above the ground by the larvae of Elaphidion villosum Fabr. the previous season. The grubs of these work at the very base of the tree and burrow almost laterally and slightly upward. In addition to food plants mentioned above, Dr Packard records breeding the species from alder, but this appears to be exceptional.

Description [pl. 7, fig. 8]. Black, sometimes brownish black, coarsely punctured and covered with brownish black pubescence above and gray below. Antennae black; thorax with two black spots below, a lateral orange red band that extends on the head to the eyes and joins at the apex; the elytra have a submarginal band that connects with the thoracic one at the humeral angle and at the rounded apex joins a sutural band, which is sometimes wanting. This species is remarkable in that the male possesses a tooth or process on all its claws.

Connecta n. var. [pl. 7, fig. 9]. Like the species in color but lacks the sutural line; the submarginal band extends to the margin; and it has three oblique lines on the elytra, the apical one rudimentary and the middle one broad. Dr Fitch has described two varieties, abbreviata and suturalis, which are characterized simply on the width of the sutural and submarginal stripe. Types in the collection of L. H. Joutel.

The variety connecta is connected with the species by intermediate forms in all stages of development, from those that have a slight mark at the marginal band or at the sutural one or both, to those that have the two bands in various stages of development [fig. 6].

Like imitans, this variety has been confused with tridentata, which it somewhat resembles. It can be easily separated from that species and imitans by the punctures, the brownish black pubescence above, the shape of the elytra and the rounded head. This form occurs with the type and is more common westward.

Distribution. This insect has been recorded from the following localities: Cliftondale Mass. [Henshaw], Buffalo N. Y. [Zesch-Reinecke], Philadelphia Pa. [Tolman], Hull and Ottawa Can. [Harrington], Montreal Can. [Caulfield], Providence R. I. [Packard]; is not rare in southwestern Pennsylvania [Hamilton]; Canada, Vermont, Massachusetts, New York, Pennsylvania,

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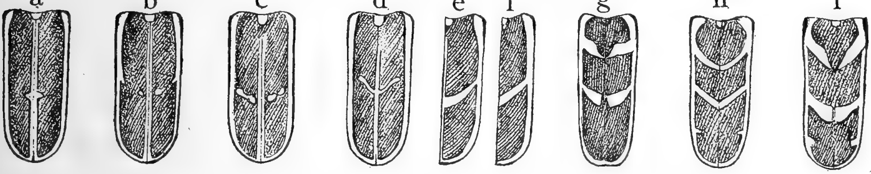

Fig. 6 *h*, *i* S. lateralis var. connecta. *a-g* intermediate variations between S. lateralis and var. connecta

New Jersey, Virginia, West Virginia, Ohio, Michigan, Wisconsin, Illinois, Iowa [Leng-Hamilton]. We have taken or bred it from Fort Lee N. J., Bronx park New York city, and Brooklyn N. Y.; it is also found in Nebraska and Massachusetts, and is common in Kansas. The variety connecta is occasionally found in New York and Massachusetts and in numbers in Kansas, Nebraska, Illinois and Wisconsin.

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Saperda fayi Bland.

Thorn limb borer

This species breeds in the small limbs and stems of wild thorn (Crataegus crus-galli and C. tomentosa), creating gall-like, gnarly swellings and weakening the branches so that they sometimes break off in the wind. This insect is widely distributed in New York State, though quite local. It displays a marked fondness for certain trees, in which it will breed year after year while others near by will be practically unaffected. Should this species, like its allies, acquire a taste for our cultivated fruit trees, it would never prove as dangerous an enemy as the round-headed appletree borer (S. c a n d i d a Fabr.) as the galls would indicate the injury and could easily be cut off.

Life history. The beetles [pl. 6, fig. 4] appear in New York State during the month of June, the exact date varying according to the season, the males preceding the females by three or four days. They do not appear to eat and are short-lived, while the whole brood, excepting the stragglers, appear and disappear within the space of 10 or 12 days, so that close observation is necessary in order to capture many. The late Dr J. A. Lintner has taken this species June 25 at Schenectady, and Mr Moffat collected beetles at Hamilton Ont. June 15, while Mr Zimmerman records the capture of a female Aug. 15.

The males watch for the appearance of their consorts and pairing usually lasts three or four hours, according to Dr Hamilton. The beetles fly but little and usually oviposit on the tree they inhabited as borers, which explains the local character of the species. The insects are sluggish and, when suddenly approached, drop to the ground and endeavor to conceal themselves. Egg-laying probably occurs during the night, though the process has not been observed. Small limbs, varying in size from $\frac{1}{3}$ to $1\frac{1}{4}$ inches in diameter, are selected for this purpose, and, according to the thickness of the limb, the female uses her mandibles to make from three to six longitudinal insertions through the bark, each being about $\frac{3}{4}$ inch in length, parallel to one another and dividing the circumference of the trunk or limb into nearly equal sections. An egg is deposited in each of these slits, and as soon as hatched the larva at once makes a burrow beneath the outer layer of the wood, perhaps $\frac{1}{8}$ inch in length, and uses this as a retreat from which it issues to feed on the wounded tissue caused by the irritation. These slits and the irritation caused by so much cutting produce an increased flow of sap to the wound and a consequent thickening of the portions between the slits, so that the affected part soon assumes a gall-like appearance.

The work of this species is shown on plate 6, which represents a twig on the lower portion of which are two old galls with irregular, decaying, overgrown cavities [fig. 1], which are quite different from more recent galls [pl. 6, fig. 2]. The borings of the larva in a young gall are shown in section on plate 7, figure 2, and the manner in which the stem may be eaten by a larva working in its center at figure 2a [*See also* pl. 13].

The larvae are ¼ inch long on the approach of winter, according to Dr Hamilton's observations, when they retire into the wood a little farther and close the opening of their burrows with borings. One of the larvae, and in thick limbs two or three, bore obliquely till one of them reaches the center of the limb, up which it proceeds often two or three inches. The others parallel this gallery but maintain a partition between the burrows. The larvae near the center are much larger, often twice the size of those inhabiting the outer wood, and are the only ones that produce beetles, as stated by Dr Hamilton. In our experience the different sized larvae indicate male and female and unless parasitized all emerge.

We can not entirely agree with the following observations regarding this species also by Dr Hamilton:

The whole of the interior of the limb is now dead wood inclosed by a growth of living but unsound woody tissue, through which some openings remain. Many of the larvae in the outside wood perish during the winter, and the survivors, after feeding a while in the spring, likewise die, their mission seeming to have been merely to insure a sufficiency of dead wood to sustain the life of the favored few destined for full development.

The larvae in the deep wood return in the spring and feed on the dead tissues, which are now abundant enough for all their wants, and by autumn they are nearly full grown. Some of the larvae do not return in the spring of the second year to feed on the dead wood at the entrance of the burrow, but bore directly up and down the center of the limb for a distance of 16 to 24 inches before pupating. Those which feed on the dead wood near the entrance to the wound are nearly full grown by autumn. They again retire for the winter and in the spring, after opening up communication with the outside world, feed for a short time and when full grown measure about ¾ inch in length. They now return to their burrows for the final transformations. Some of them bore for at least six inches, while others scarcely go from the entrance more than twice their own length. The outer ends of the burrows are closely packed with borings without and soft fibers within, which also fill the inner ends. The head of the larvae may be either toward or away from the opening, seemingly a matter of indifference. In the former case the beetle emerges from the place of entrance and in the latter, from a round hole at right angles to the burrow, probably made by the beetle itself, as no such hole has been detected in the many limbs Dr Hamilton examined, containing pupae with their heads turned from the opening. Pupation occurs after the middle of April. We have found them transforming at Albany Ap. 16. The beetles may be found in the limbs about the first of May, though but few of them emerge till the latter part of the month.

Description [pl. 6, fig. 4]. Cinnamon brown, below gray, white at sides, being of the same color as cretata. Thorax with lateral white band that extends on to the base of the elytra, which also have two crescent-shaped, white spots at middle, divided by the suture, and two smaller circular ones near the apex, also divided by suture. These spots may be nearly or quite obsolete, usually in the male. The antennae darker than cretata.

Distribution. This insect has been recorded from Buffalo N. Y. [Zimmerman]; Hamilton Ont. [Moffat]; and Dr Hamilton reports it as common in Crataegus limbs in southwestern Pennsylvania. The types were described from Ohio; Dr Smith has recorded it from Greenwood Lake and Delaware Gap N. J., and it has been listed by Messrs Leng and Hamilton from Canada, New York, New Jersey, Pennsylvania and Ohio.

This species is not related to cretata, which it resembles in color, but has more of the characters of the less specialized species, as is shown by the short, rounded head and the but slightly developed process on the claws, that on the first pair being very rudimentary. This relationship is further emphasized by its gall-producing larva working in the same way as concolor.

Natural enemies. There are no records of any, but the species appears to be a favorite with some woodpeckers, since we have found a number of empty galls showing the characteristic work of these useful birds [pl. 13, fig. 1]. We have no clue to the identity of the species.

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Saperda puncticollis Say

Woodbine borer

This is one of the smallest and also the prettiest species belonging to this important genus. It is a rare form in most collections in spite of the fact that the insect lives in the dead branches of the common Virginia creeper, pupating in the wood. The manner in which the larva works just under the bark is shown on plate 6, figure 6. The entrance to the pupal chamber is stopped with a plug of borings [pl. 6, fig. 8, 8a]. The general appearance of the larva is also represented. This species seems to be somewhat retiring in habit, and, while it has been collected on the leaves of its food plant, specimens are much more easily obtained by rearing the insects from infested twigs. We have often bred the species from Virginia creeper and have frequently examined much poison ivy where the insect was abundant, but have been unable to find it in that plant. We have taken it in June and July, and Mr Zimmerman records its capture at Buffalo in June. It is probably abroad during most of the two months.

Food plants. It has been recorded on poison ivy [Zimmerman], grape and probably Virginia creeper [Harrington], Rhus toxicodendron and R. radicans [Smith], as not common on Rhus radicans in southwestern Pennsylvania [Hamilton], as bred from the larger living stems of Virginia creeper [Harrington], and as in the stems of poison ivy and oak [Lugger].

We find that the larvae feed on the inner bark of the branches and stems of Virginia creeper. This species is very subject to attack by woodpeckers, and we have seldom found the workings without evidence that a number had been destroyed by the birds.

Description [pl. 6, fig. 9]. Black, with a sparse black pubescence above and a dense gray one underneath. Head yellow with a round black spot in front and one on the vertex, antennae black; thorax yellow with a black spot at the side and four quadrately arranged on its dorsum; elytra with a broad, yellow marginal and a sutural band. The process is found only on the anterior claws of the middle pair of legs.

Distribution. It was described by Say from Arkansas; it has been taken about Buffalo by Zimmerman; about Ottawa Can. by Harrington; is reported by Smith as occurring throughout New Jersey; and by Hamilton as not common in southwestern Pennsylvania. LeConte gives its distribution as the Middle, Eastern and Western states; and Leng and Hamilton record it from the following localities: Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Louisiana, Arkansas, Kansas, Nebraska.

We have bred it from stems of Virginia creeper gathered in and around New York city and also at Fort Lee N. J. It was described from Cambridge Mass. as S. trigeminata by Randall.

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Saperda populnea Linn.

This European species is found on the Pacific coast, and the examples from different localities now before us can not be distinguished in any particular from European specimens. With this species we include as subspecies the S. moesta of LeConte and a new form that differs from either, under the name tulari.

They differ from populnea as well as from each other in the punctures on the elytra as well as in the punctulations on the intervals, also in color and vestiture, and while some specimens come very close to each other, we have seen no intergrades of color and vestiture. Tulari in character seems to us to be intermediate between moesta and concolor.

It may be well at this point to remember that our species have originated in the East, where all are found except two, populnea and hornii. Of these, populnea has not specialized from the Old World form, as has hornii, which is evidently descended from and is still closely related to similis. Calcarata is the only one of our species that extends to the west coast, where it has been found by Professor Piper in Washington.

Bearing this in mind and remembering that moesta, as a

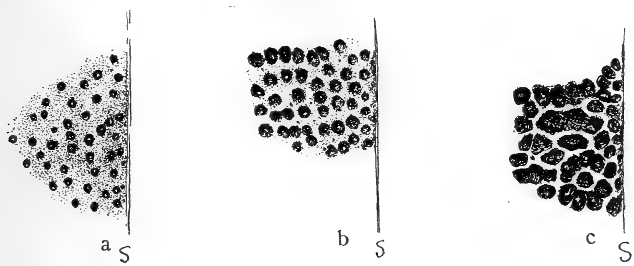

Fig. 7 Elytral characters of females: *a* tulari, punctures scattered; *b* moesta, punctures contiguous; *c* populnea, punctures confluent

unicolorous form, as we know it in the East, has not crossed the Sierras and has not yet been found on the coast, there can be no question of its being distinct.

Tulari, like moesta, is evidently of American origin and not an emigrant from the Old World. The punctures and dense punctulations in the elytra show a wider divergence from populnea than moesta and connect that species and moesta with concolor.

Description S. populnea Linn. [pl. 7, fig. 4]. Black, shining, coarsely and deeply punctured, the punctures often contiguous and confluent on the elytra; a few punctulations which are sometimes wanting occurring between the punctures; sparsely covered with a light gray or fulvous pubescence; thorax with a lateral band of dense fulvous or yellowish gray hairs; elytra with eight small spots of dense fulvous or yellowish hair, arranged in pairs, the first and third nearer the suture, the third pair being the largest; one or more pairs often obsolete, the third pair being the most permanent; antennae black, annulated with gray, first joint black.

S. moesta Lec. like populnea; but the vestiture is a uniform light gray without spots, and the lateral line on the thorax only faintly shown.

The punctulations on the intervals between the punctures are more numerous than in populnea.

S. tulari n. subsp. [pl. 7, fig. 6] like populnea and moesta; but the punctures, which are larger and deeper and usually with an edge, are not so numerous as in the other two species and seldom confluent; the intervals are densely punctulate as in concolor. It is densely covered with red or fulvous hair. Thorax with a stripe on side and a median band on top. Types in collection of L. H. Joutel and National Museum, Washington.

The above discriptions apply more particularly to the females.

Distribution. S. populnea, moesta and tulari. With the material before us, it may be well to revise the distribution of these species, which have been confused. As stated, moesta does not occur on the Pacific coast and so must be dropped from the lists of that section.

S. populnea. Well marked examples have been seen from Washington, Oregon, California, Spokane Wash. and Los Angeles county, Cal. In Europe it feeds in poplar and willow stems forming galls.

S. moesta. Canada to Wyoming, Idaho, Montana, Colorado, New York, Wisconsin, Pennsylvania, Buffalo, Montreal, Toronto, Lake Superior. It feeds in balsam poplar. Moesta has never been found in the vicinity of New York city to our knowledge; and the one from Staten Island cited by Smith in *Insects of New Jersey*, was probably concolor.

S. tulari. Tulare county, Cal., Yosemite Cal., Arizona, Nevada, Oregon, Washington.

Saperda moesta Lec.

This insect [pl. 7, fig. 5] confines its operations to the balsam poplar or balm of Gilead so far as known, and occasionally it is quite injurious to this tree.[1]

Life history. The beetles appear in June. Two sizes of larvae in gall-like swellings from 1 to 2 inches apart and in shoots about ½ inch in diameter were found by Mr Harrington in June. The late Dr D. S. Kellicott bred Sciapteron tricincta Harr. from enlargements in the branches and stems of the balm of Gilead and the common willow[2] which were caused by this species and its associate, Saperda concolor. Mr Saunders states that he received a bundle of balm of Gilead twigs on Mar. 25 which were infested with this insect. The larvae were very thickly set in the branches, in many places not more than an inch or two apart, and located chiefly at the base of the buds, where the presence of the occupant was indicated by a swelling in the branch which was surmounted by a dark brown patch of partly decayed bark. The castings and debris of the borer were of a light orange color and were pushed forward, stuffing the swollen part. The whole length of the excavation made by each larva did not usually exceed an inch, and so much of this was filled with debris that the clear space left was very little larger than its body. Mr Saunders describes the larvae as follows:

Body above deep yellow, with a glossy surface, sprinkled with very minute, short yellow hairs, invisible without a lens. Second segment above and below a little deeper in color and more horny looking than the other segments; interspaces between segments strongly indented. There was a depressed dorsal line not different in color from the rest of the body, but sunken, and on each side of it the projecting rings of the body were somewhat flattened. Spiracles pale brown, rather small. Terminal segment a little more hairy than the others.

[1] Mr Charles Stevensen, of Montreal, kindly sent us some fresh galls of Saperda moesta, from which the illustrations were made and a number of specimens reared.

[2] Moesta probably caused the galls in balm of Gilead, and concolor those in the willow.

The bunch of twigs received Mar. 25, as above stated, were examined by Mr Saunders May 2, when he found that no pupal inclosure was to be seen, though the head, antennae and legs of the beetle were fully developed, while the wings and wing cases were only partially so. On May 16 the wing cases of one beetle were full length but not fully expanded, while in another case they were fully developed. The twigs containing these insects had been kept in a dry room and hence they were quite dry and brittle. Fresh twigs received May 24 showed that a considerable number of the occupants had been eaten by woodpeckers, though some five or six specimens were found in pupal cells, one of which was occupied by the pupa of a parasite. The pupa of this Saperda has been described by Mr Saunders as follows:

Body semitransparent; color uniform pale yellow, except the eyes and mandibles, which were black; the jaws were faintly tipped with brown and a faint brown line down each side of the scutellum. All the parts of the insect were plainly visible throughout the pupal case. The wings were very small and diverged to each side of the scutellum.

May 29 two of the pupae from the fresh lot of twigs had become perfect beetles, and early in June all had completed their transformations and escaped through neat round holes.

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[1] This also comprises what was formerly referred to moesta and includes populnea and tulari.

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Saperda concolor Lec.

This species, which requires but one year to complete its transformations, so far as our observations go, girdles the trunks of sapling poplars by running a mine around them, which causes a swelling often nearly twice the size of the diameter of the tree, as described by Dr Packard. It infests dwarf willow canes as stated by Dr Hamilton; and the following is from his account of the insect.

Life history. The beetles appear from the last week in May till after the middle of June. The smaller canes, ¼ to ¾ inch in diameter, of *Salix longifolia* growing along water courses are usually selected by this insect for breeding places. The beetle gnaws a longitudinal incision through the bark, about ¾ inch in length, and deposits an egg in each end. Several are usually made in the same cane some distance apart and these often cause its death the following year. A warty, gnarly swelling occurs around each incision [pl. 6, fig. 14]. The young larvae [pl. 6, fig. 12, 13] follow the same course as those of *S. fayi*, only they burrow deeper into the woo[illegible] there are no supernumeraries, as there is no need of them, since the wood of the willow dies much more quickly than that of Crataegus.

The beetle, however, does not always select the smaller canes for oviposition, sometimes choosing those from 1½ to 2 inches in diameter, when the larvae pursue a different course, for, instead of boring up and down, they take a transverse direction and girdle the stem ⅓ to ½ its circumference, causing a rough annular swelling and frequently killing the cane.

The head of the pupa is toward the opening from which the perfect insect emerges. Salix concolor appears to be its natural food, and, did this beetle confine its attention to this shrub, it could hardly be classed as injurious; but in the vicinity of Providence R. I., at least, it has inflicted considerable damage on the common poplar. Two parasites, Pimpla pedalis and a species of Bracon, have been reared from the galls of this insect by Professor Davis.

Description. Black, finely punctulate, and with numerous small, shallow punctures; entirely covered by a dense gray or yellowish gray pubescence except at the top of the thorax, where it is less dense, this giving it a darker appearance and increasing the effect of the lateral band; a slight median line on the thorax; antennae black, annulated with gray. Var. unicolor n. var. [pl. 6, fig. 15]. Like type, but pubescence uniformly dark gray and finer. The punctures are much more numerous than the type and are apt to be confluent. This variety is the eastern form and is named as we believe it to be the ancestral form of the species.[1]

Distribution. This insect has been thus recorded: Sante Fe N. M. [LeConte], Cliftondale Mass. [Henshaw], Buffalo [Zesch-Reinecke], Providence R. I. [Packard], Allegheny Pa., Texas, Michigan, Canada and New York [Hamilton], New Jersey [Smith], Ohio [Kellicott]; rare [Provancher], Canada, Massachusetts, New York, New Jersey, Pennsylvania, Michigan, New Mexico [Leng–Hamilton] Arizona.

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[1] This insect is often confused in collections with moesta and Mecas inornata. The type form is from New Mexico, and the same form h[illegible]een received from Arizona. Var. concolor is from the other [illegible]s above and also from Idaho, from which an intermediate form has been received. There is no question of their being forms of one species, the change being due entirely to climatic influences. It is very close to tulari.

Remedies. Dr Lugger advises the use of a soft soap and paris green wash as a preventive of oviposition. He states that the presence of the larvae is also easily discovered by the discolored blotch on the bark and by the little heaps of sawdust that are pushed out by them during their boring operations.

The grubs may be killed by means of a wire or with a pruning knife.

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EXPLANATION OF PLATES[1]

PLATE 1

Saperda candida

Appletree borer

1 Beetle at rest on the bark

2 Scar indicating the presence of a young grub beneath and also showing a characteristic oviposition slit

3 Sawdust or borings ejected by half or two thirds grown larva. This is usually found very close to the base of the tree.

4 Exit hole of the beetle, in section

5 Borer or grub preparing its pupal chamber

6 Pupal chamber with exit hole of beetle shown at 7

8 Blackened old burrow seen in trees attacked a year or two earlier

PLATE 2

Saperda calcarata

Poplar borer

1 Beetle at rest on the bark

2 Pupa in its chamber, and below it a mass of long fibrous tissues, partly torn from the sides of the burrow

3 Larva or borer in its gallery. This illustration shows the expanded character of the burrow near the orifice through which the larva ejects its numerous borings. The blackened appearance of old galleries is also represented, as well as their occurrence at different depths in the wood.

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[1] Executed from nature by the junior author, L. H. Joutel, New York.

PLATE 3

1 Portion of elm bark illustrating the work of the larva of the elm borer, Saperda tridentata. It will be seen that many of the borings are in dead tissues, and that a few extend into the living bark, which apparently gradually dies and permits the insect to extend its operations over a considerable area.

2 Piece of hickory bark illustrating the work of the larva of S. discoidea. The white sawdust excavated from a pupal chamber made in the wood is shown at *a*, and a pupal chamber in the bark is represented at *b*.

3 S. tridentata

4 S. imitans

5 S. discoidea, female

6 S. discoidea, male

PLATE 4

Saperda cretata and **concolor**

Spotted appletree and *willow borers*

1 Work of S. cretata in thorn, showing the irregular character of its galleries, and the different depths at which they occur

2 Adult beetle

3 S. concolor, enlarged

4 Work of this species or possibly S. tulari in Arizona willow. This illustration represents the peculiar gall, the general form of the galleries and pupal cell, with the exit hole in section.

PLATE 5

Saperda vestita and **obliqua**

Linden and *alder borers*

1 Portion of the base of a linden, showing the work of the larva of S. vestita, and at *a* the circular exit hole of the adult

2 A small alder stem, showing the enlargement produced by the larva of S. obliqua a year after the stem had been deserted

3 An alder stem showing the external appearance, indicating recent operations of the larva of S. obliqua and at *b* the pupal cell with the mass of borings blocking one end

4 Section of alder stem showing the method of work of the larva of S. obliqua

5 S. vestita, female

6 S. obliqua

PLATE 6

Saperda fayi

Thorn borer

A Branch of the thorntree showing the galls and work of this species

1 An old gall with a larger one just below it

2 Section of a fresh gall showing the work of the larva

2a Borings in the stem

3 Exit hole of the beetle in section

4 Adult, enlarged

Saperda puncticollis

Virginia creeper borer

B Portion of Virginia creeper, representing the galls and work of this species

5 Section of the stem, showing the pupal chamber

6 Larva at work under the bark

7 Exit hole in section

7a Exit hole

8 Section of thin bark and sawdust stopper closing opening to pupal chamber

8a Same shown in a surface view

9 Beetle, enlarged

Saperda concolor var. unicolor

Willow borer

C Branch of poplar, showing the galls and work of this insect

11 Fresh galls and exit holes of beetles

12 Fresh gall cut open and showing the pupal cells: one empty, one occupied, and one extending up and the other down

13 Section of old gall showing the internal appearance of the tissues

14 External appearance of old galls

15 Beetle, enlarged

PLATE 7

1 Saperda calcarata var. adspersa
2 S. mutica
3 S. hornii
4 S. populnea, enlarged
5 S. moesta. The long line at its side shows the average length of Idaho specimens, the short one, that of New York, Canadian, and west of Wisconsin to Michigan specimens.
6 S. tulari, enlarged
7 Galls of S. moesta
  A Young gall shows wound caused by female
  B Exit hole
8 S. lateralis, enlarged
9 S. lateralis var. connecta, enlarged
10 Galls of S. moesta, with one cut open showing the pupal chamber
  A Oviposition scar
  B Exit hole of the beetle

PLATE 8

Early work of **Saperda candida**

Appletree borer

1 Oviposition scars made by the female
2 Borings or frass thrown out by young grubs working under the bark
3 Bark cut away, showing the young larva in its gallery and its method of work
4 Scar showing old, overgrown exit hole
5 Upper portion of the wound caused by the insect, which emerged several years before at 4

The number of grubs in this small stem, which is only about $1\frac{1}{4}$ inches in diameter, is sufficient to kill a tree.

PLATE 9

Advanced work of **Saperda candida**

Appletree borer

This represents the appearance in section and lower portion of a very badly infested stem of a young tree, and shows that it may be practically riddled before death ensues. The exit holes seen in the upper portion are by no means unusually abundant and such severe injury is certain to result in the death of the tree.

PLATE 10

Advanced work of **Saperda candida**

Appletree borer

1 Base of two year old tree killed by borers

2 Young tree entirely girdled by two borers, showing two exit holes, and at *A* the only connection with the root

3 Young tree killed by borers: *AA* shows the only connection with the root and *B* is a bare area which the tree has tried to cover with living tissue.

PLATE 11

Early work of **Saperda calcarata**

Poplar borer

1 This represents the early galleries and illustrates how a few larvae can easily girdle a young tree, because of their running a portion of their burrows transversely in the inner bark and outer sapwood.

2 Advanced work of S. tridentata, elm borer

PLATE 12

Advanced work of **Saperda calcarata**

Poplar borer

This illustration shows the irregular character of the galleries, the closed pupal cells with the coarse fibers stopping the free end, and the expanded character of the burrows about the exit.

PLATE 13

Saperda fayi

1 Gall in thorn branch, also holes made by woodpeckers searching for grubs

2 Typical, fully developed gall

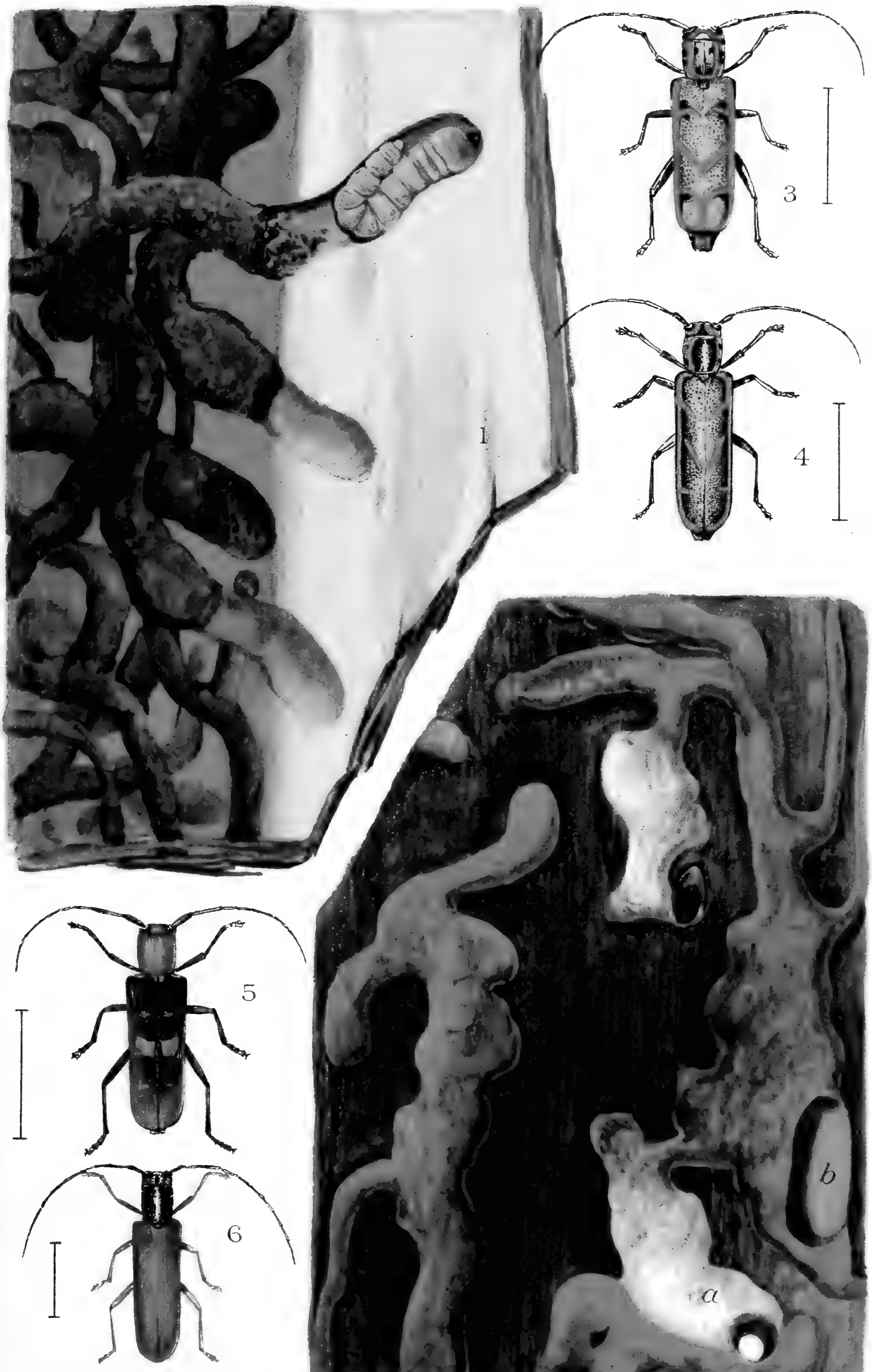
PLATE 14

Holes of woodpeckers in alder, made in search of the larvae of Saperda obliqua

L.H.JOUTEL 1902

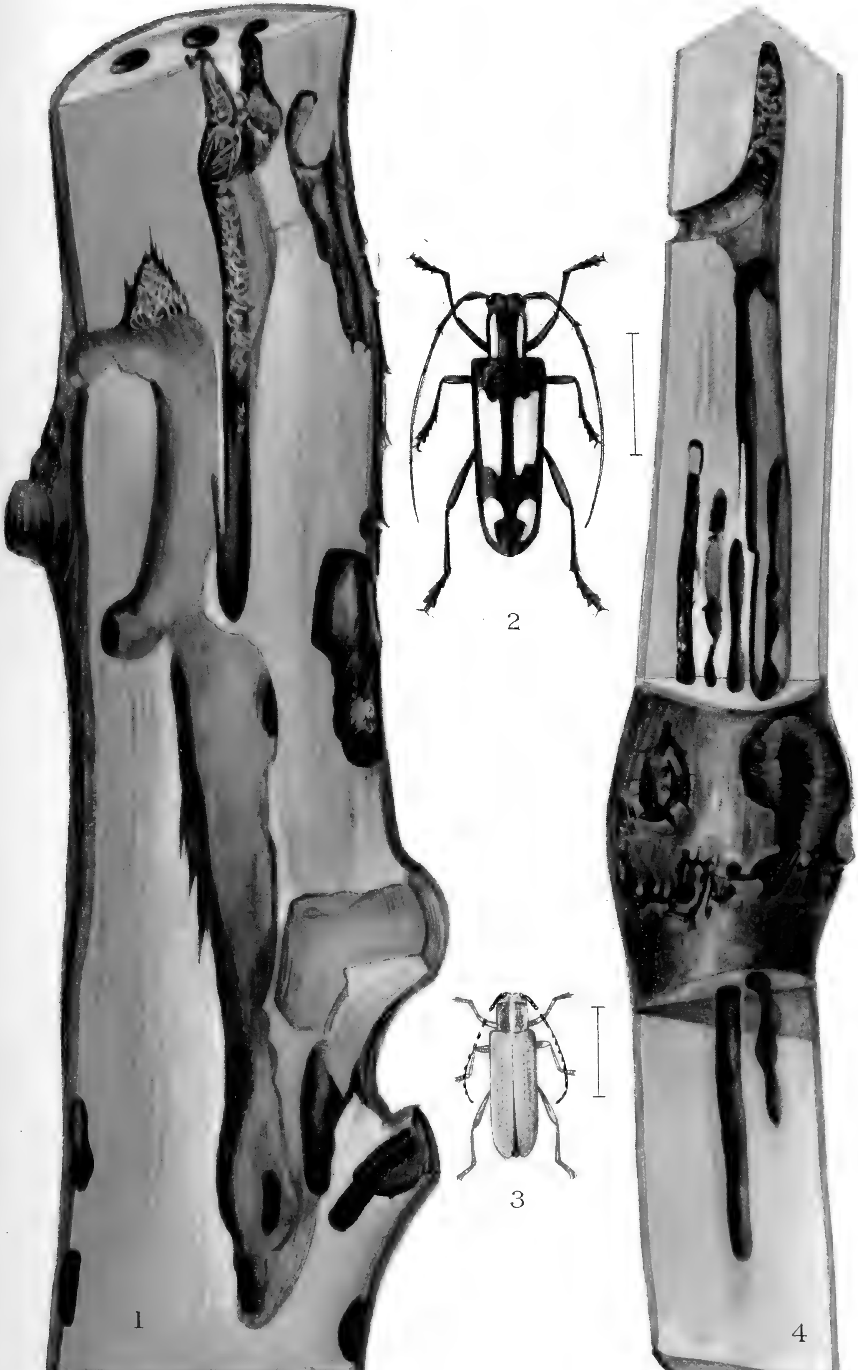
Saperda candida, appletree borer

Saperda calcarata, poplar borer



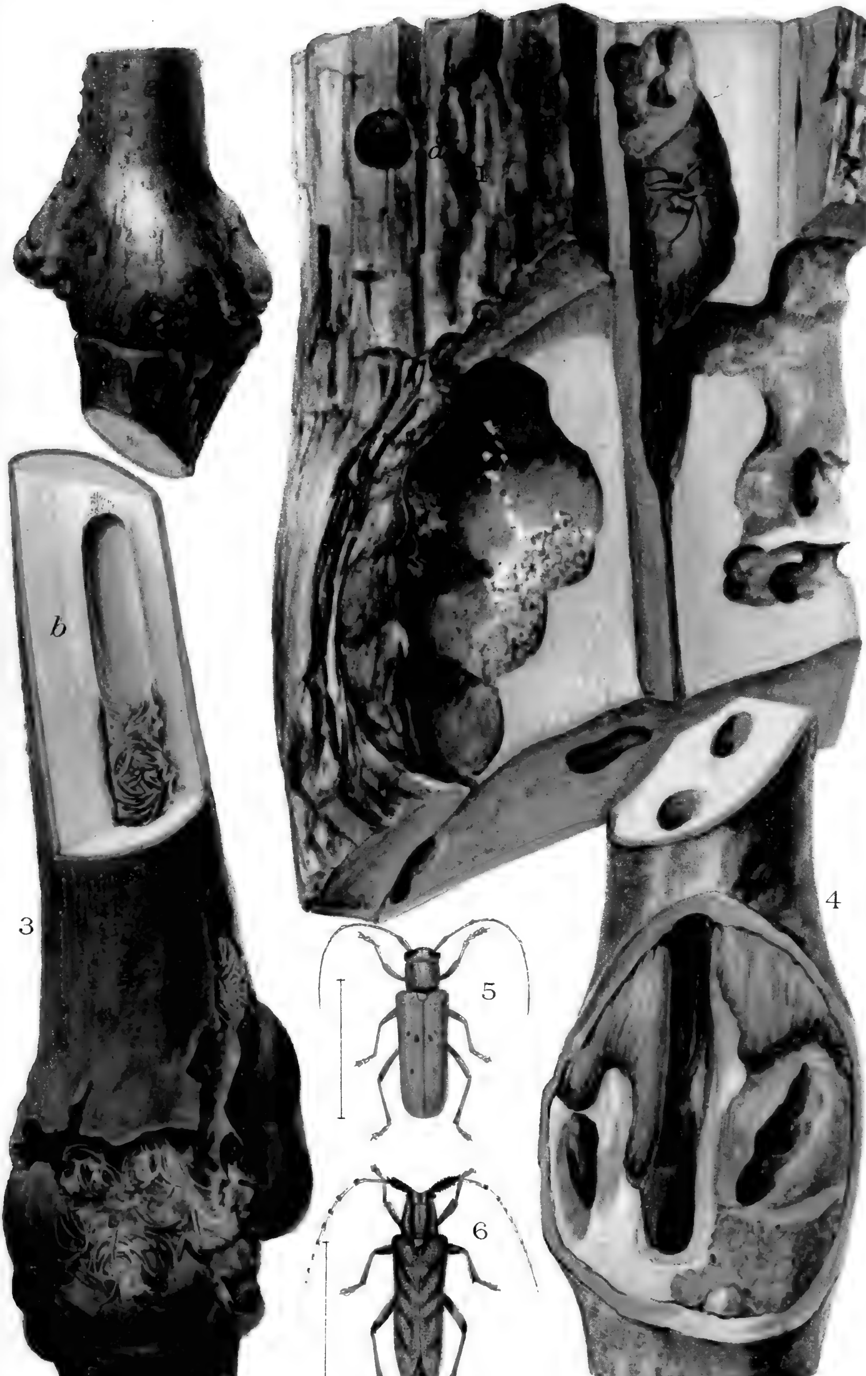
L.H.JOUTEL 1902

Saperda tridentata, imitans and discoidea
Elm and hickory borers



L.H.JOUTEL 1902

Saperda cretata and concolor
Spotted appletree and willow borers

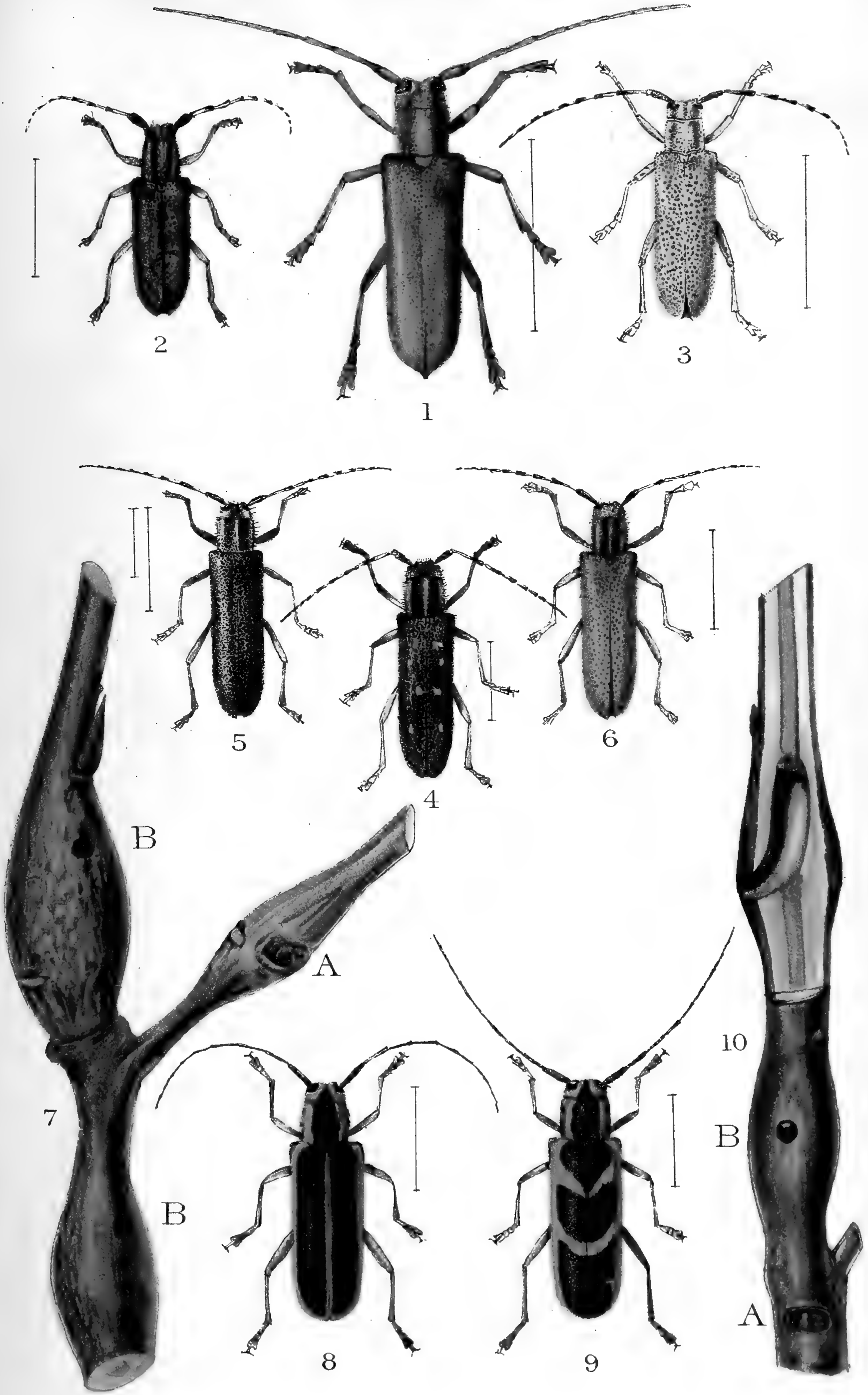


L.H.JOUTEL 1902

Saperda vestita and obliqua
Linden and alder borers

PLATE 6

Saperda fayi, puncticollis and concolor
Thorn, virginia creeper and willow borers



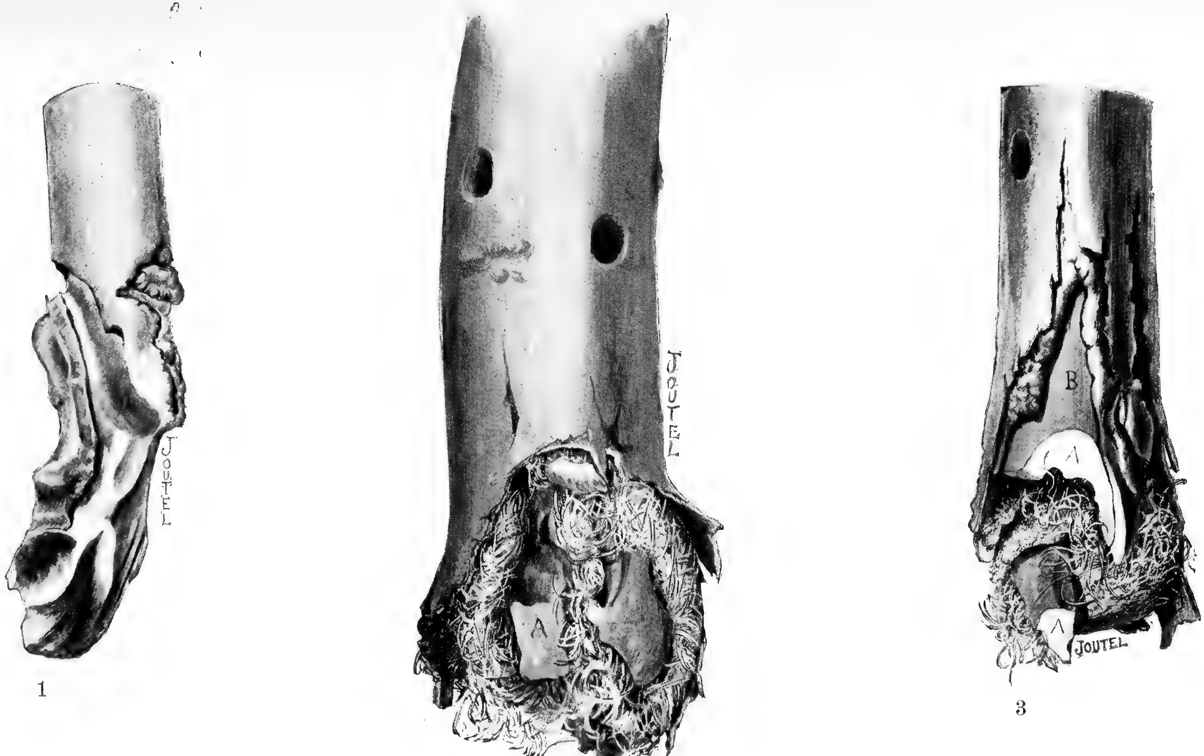
Saperdas

Plate 8

Early work of Saperda candida, appletree borer

Advanced work of *Saperda candida*, appletree borer

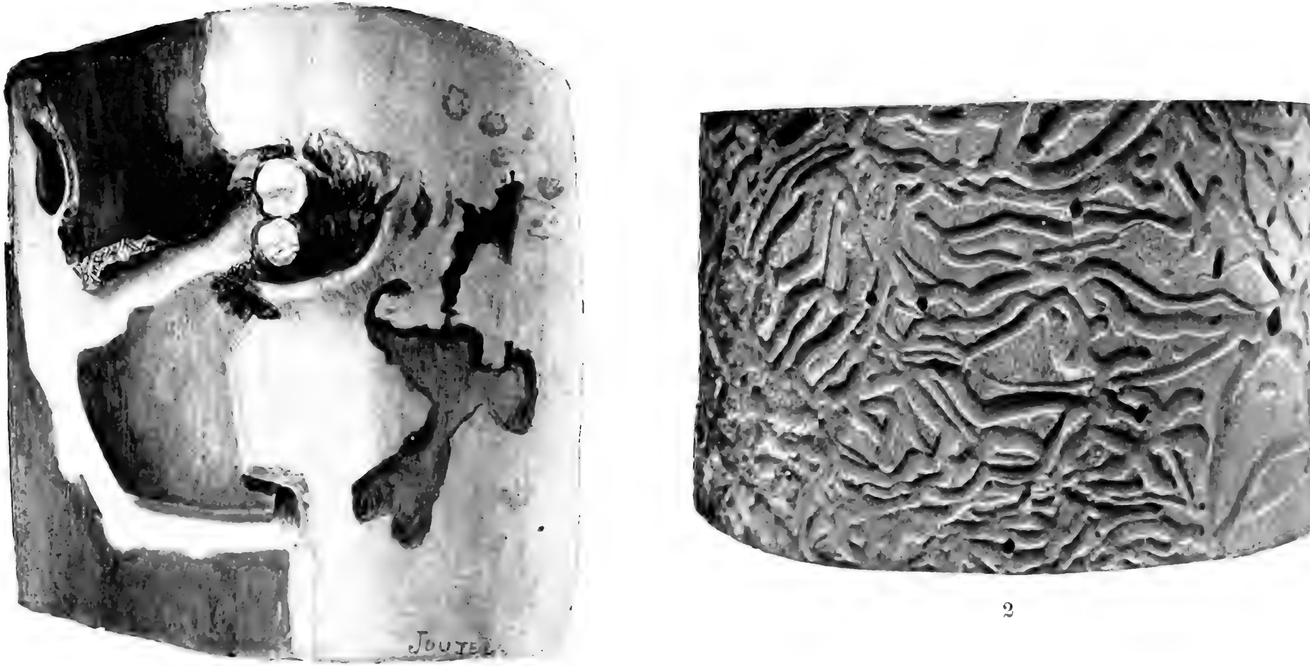
Plate 10



1 2 3

Advanced work of Saperda candida, appletree borer, at base of young trees

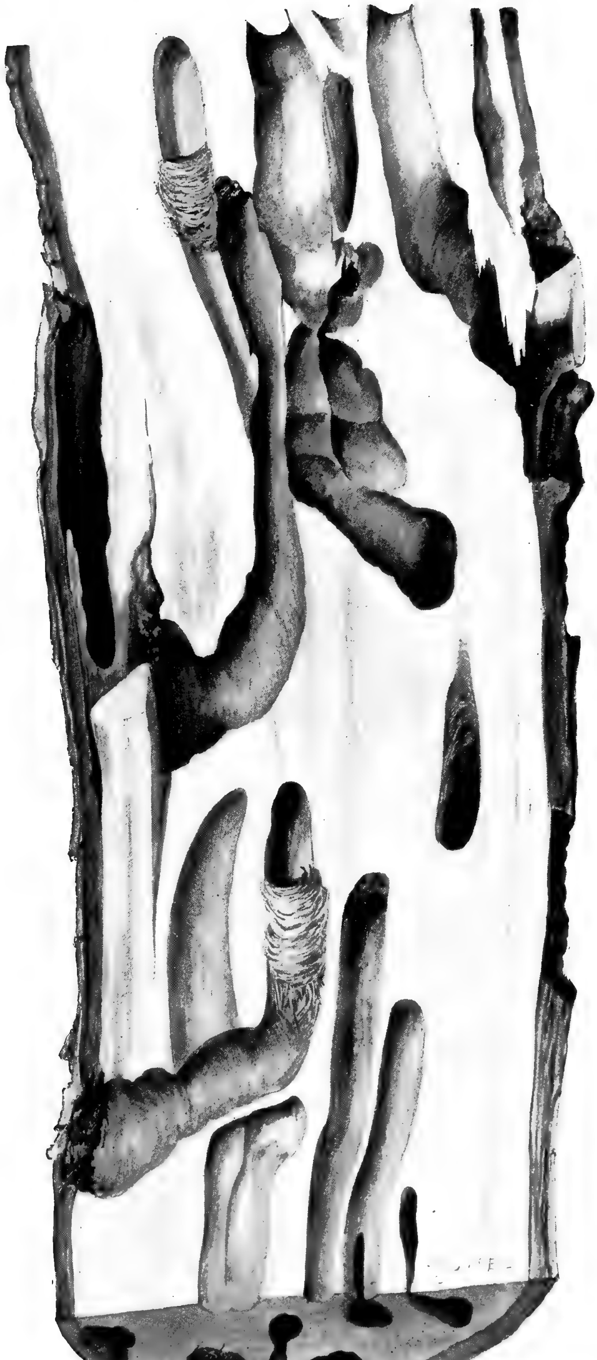
Plate 11



1

2

1 Early work of Saperda calcarata, popular borer; 2 Advanced work of Saperda tridentata, elm borer



Advanced work of *Saperda calcarata*, poplar borer

Plate 13

1

2

Woodpecker work and galls of *Saperda fayi*, in thorn

Plate 14

Woodpecker work in alder stem bored by Saperda obliqua

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Page numbers referring to descriptions of species are printed in black face type.

(*Pages 87–88 were bulletin cover pages*).

Published monthly by the

University of the State of New York

BULLETIN 316 1904

New York State Museum

Ephraim Porter Felt State Entomologist

Bulletin 76

ENTOMOLOGY 21

19th Report of the State Entomologist

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1903

University of the State of New York

New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 76

ENTOMOLOGY 21

19th REPORT OF THE STATE ENTOMOLOGIST 1903

To the Regents of the University of the State of New York

I have the honor of presenting herewith my report on the injurious and other insects in the State of New York for the year ending Oct. 15, 1903.

General entomologic features. The season of 1903 will long be known on account of the abnormal abundance of plant lice of various species, which have not only been exceedingly destructive to fruit trees in particular but the prolongation of their depredations far beyond the usual date was specially injurious to young or recently set trees. The latter part of the summer the San José scale, Aspidiotus perniciosus Comst., bred so excessively that many trees were literally covered with half grown scale insects toward the end of the season. The depredations of the elm leaf beetle, Galerucella luteola Müll., have continued in the Hudson river valley though the spraying operations of recent years have reduced their numbers very largely in Albany and Troy. An interesting feature of this insect's history was its presence in excessive numbers at Saratoga Springs, where it would undoubtedly have caused severe injury had it not been for the prompt spraying instituted by the village authorities. The white marked tussock moth, Notolophus leucostigma Abb. & Sm., has caused less damage than usual in recent years though it was generally present at Buffalo on a great many horse-chestnut trees, partially defoliating thousands. The fall web-worm, Hyphantria textor Harr., has, as a rule, been less injurious than in preceding years, except in a few localities.

Office work. The general office work has been conducted as in preceding years and has been marked by many more demands for information, indicating an increased interest. The determinations of scale insects for the commissioner of agriculture, in connection with the nursery inspection work of his department, has made somewhat extensive demands on the time of Assistant C. M. Walker, who has also had charge of most of the breeding cage work. Many photographs of living insects or specimens of their work have been taken and a number of lantern slides added to the collection, greatly increasing its effectiveness in illustrating popular lectures. It is gratifying to record that there have been no changes in the office staff during the past year, and consequently the work has proceeded without interruption from this cause. Correspondence indicates a continued and healthy interest in our work, as is evidenced by the following figures: 2035 letters, 784 postals, 490 circular letters and 1109 packages were sent through the mail during the past year. The reduction from last year in the number of postals and packages is due to the fact that but three publications were issued during the present year against four in 1903, and the last issued was not available for distribution till very late, consequently a portion of the copies will be sent out next year. Mailing expenses have also been reduced by sending two or more publications by express, wherever that was economical, a total of 114 packages being shipped.

Special investigations. The lines of work begun in earlier years have been continued and considerable progress made. The grapevine root worm, Fidia viticida Walsh, has been the subject of more extended investigations than last year, a large amount of exceedingly valuable data has been secured and we have demonstrated that collecting the beetles was a practical, the most reliable and probably the most economical method of controlling this pest. The details of this work will appear in a revised and extended bulletin on this insect. The experiments with insecticides for controlling the San José scale have been carried on in the same orchard as in the past three years, and our earlier results with crude petroleum have been confirmed. Extended experiments with lime-sulfur washes have also been conducted at Warwick with very gratifying results. An extensive series of experiments with summer washes was made, Mr Walker having direct charge of the work and being responsible for most of the observations. A second instalment of the beneficial Chinese ladybeetle, Chilocorus similis Rossi, which may prove of value in suppressing this pernicious scale insect, was obtained from the United States Department of Agriculture last August and established in an infested orchard at Kinderhook. It is hoped that they will survive in this latitude and prove of great value in controlling this dangerous pest. The extended forest fires in the Adirondacks early in the season offered an excellent opportunity for investigating the connection between them and insect attack. The results of this work are given on a subsequent page. Our general studies of forest and shade tree insects have been continued and a number of valuable observations made.

The present year has been marked by the appearance of a second report by Dr Needham on aquatic insects, which consists of a series of valuable original articles by himself, supplemented by important papers from Messrs MacGillivray, Johannsen and Davis. Another report by Dr Needham, is now in preparation and will be devoted largely to a consideration of the May flies and midges (Chironomidae) of the State.

Investigations on our native mosquitos have been continued, resulting in material additions to our knowledge. Collections of these little insects have been made in different sections of the State, and it was possible for Assistant D. B. Young to spend two weeks at Long Island, working in cooperation with the North Shore Improvement Association, which has become well and favorably known to all interested in this line of effort on account of its very efficient operations in subduing these pests in the vicinity of New York city.

Publications. The principal publications of the entomologist, to the number of 70 are listed under the usual head. The more important of those issued during the past year are the following: *Grapevine Root Worm* (Museum bulletin 59), *18th Report of the State Entomologist 1902* (Museum bulletin 64) and *Aquatic Insects in New York State* (Museum bulletin 68). In addition, the entomologist has contributed an important paper on insects injurious to pine and oaks, for the seventh report of the Forest, Fish and Game Commission, and one on insecticides for the report of the Colorado State Board of Horticulture for 1902.

Other important publications, which are either in the printer's hands or practically completed, are as follows: *Grapevine Root Worm,* a revised and extended edition of Museum bulletin 59, mentioned above. A monograph of the genus Saperda, which includes some of our most destructive borers, has been prepared by the entomologist in association with Mr L. H. Joutel of New York city, and will form a small bulletin of about 80 pages illustrated by 7 colored plates. Dr Needham's third report, mentioned in the preceding paragraph, is practically completed and will be an extended work about the same size as Museum bulletin 68. There is also a memoir on insects injurious to forest and shade trees, an extensive publication illustrated with many halftones and 16 colored plates, treating specially of those forms which are destructive to shade trees.

Collections of insects. Very large additions have been made to the state collections during the past season. They are specially desirable because a considerable proportion have come from other sections of the State. Mr Young spent several weeks in the Adirondacks in special work on forest insects, and he has collected at intervals throughout the season in cooperation with the Vassar Brothers Institute, at Poughkeepsie, and also at Long Island while engaged on mosquito investigations. The results have been large and exceedingly valuable additions to the state collections. Much progress has been made in arranging insects previously collected. The Lepidoptera, which are in the care of Mr Walker, have all been referred to the principal groups and many determined specifically. He has also arranged the Coccidae, now represented by 98 species and a host of specimens, while Mr Young has been able to do considerable systematic work on the Tenthredinidae, Ichneumonidae, Syrphidae, Tachinidae and Capsidae, besides making material progress in arranging the Coleoptera which, it is gratifying to state, are already in a fairly satisfactory condition. The exhibit collection has received valuable additions from time to time, and in all of our collecting an effort has been made to secure material desirable for this purpose. The museum was kindly remembered during the present year and bequeathed a small collection of insects by Miss Ellen L. Baker of Middle Granville N. Y.

The past season a system of exchange was inaugurated with most excellent results. The museum possesses large series of certain species. Lists were prepared and sent to entomologists in different sections of this and other countries with a request for exchanges, and as a result some exceedingly valuable additions have been made to the collection with practically no cost to the museum. The details of these exchanges together with a list of species available for this purpose will be found under a separate head.

Nursery inspection work. Owing to the Virginia authorities refusing in the fall of 1902 to accept nursery inspection certificates issued by the State Department of Agriculture, even though officially indorsed by us, other means had to be devised to aid those who wished to ship nursery stock into Virginia. The state entomologist of Virginia was willing to accept a certificate based on inspection by an assistant working under our direction, and as an accommodation to our nurserymen, it was arranged to send an assistant to make supplementary inspections of only that stock which was destined for Virginia, the parties benefited to pay his traveling expenses. Mr C. M. Walker was detailed for this work, which occupied nearly two weeks. It is very gratifying to state that the regular inspectors, in whom we have utmost confidence, kindly aided Mr Walker in his work. Mr H. C. Peck and Mr J. J. Barden, in whose territory most of the inspecting was done, were specially helpful. The following is a list of firms to whom these nursery certificates were issued between Oct. 21 and Nov. 1, respectively: Mt Hope Nurseries, Western New York Nursery Co., Thomas Bowman & Son, A. L. Wood, Allen Nursery Co., H. S. Taylor & Co., Charlton Nursery Co., all of Rochester; Sheeren

Wholesale Nurseries, George A. Sweet Nursery Co., Rogers Nursery, all of Dansville; Brown Bros. Co., Chase Bros. Co., First National Nurseries, Perry Nursery Co., J. B. Nellis & Co., all of Brighton; Lewis Roesch, T. S. Hubbard Co., G. S. Josselyn Co., all of Fredonia; Knight & Bostwick, Emmons & Co., and C. W. Stuart & Co., all of Newark.

Voluntary observers. The work of the voluntary observers begun in 1899 has been continued, but owing to an unusually dry spell in the early part of the season followed by excessive rains, there has been comparatively little to report except injuries by plant lice, a group of insects on which the voluntary observers are not well qualified to report. As a consequence, there are not so many records as have been made in earlier seasons, though the sum total of their observations amounts to a material addition to our knowledge concerning some very important injurious insects. Summaries of these reports are published under the usual head.

Acknowledgments. The untimely death of our highly esteemed and gifted associate, the late Prof. V. H. Lowe of the State Agricultural Experiment Station at Geneva, is a source of deep regret and a severe loss to the science he loved so well. The entomologist has been favored by the cooperation of a number of professional workers. To Dr L. O. Howard, chief of the division of entomology, United States Department of Agriculture, and his staff, special acknowledgments are due for the determination of a number of insects and for information regarding different species. Mr E. P. VanDuzee, of Buffalo, a well known authority on Hemiptera, has kindly identified all our Pentatomidae and a number of related forms, and we are indebted to Prof. Mel. T. Cook, of De Pauw University, Greencastle Ind., for the determination of many insect galls. The appreciation of our work by the many friends of the office is a source of pleasure, and the support given by those in authority is very gratifying.

Respectfully submitted

EPHRAIM PORTER FELT

State Entomologist

Office of the State Entomologist

Albany, Oct. 15, 1903

BENEFICIAL INSECTS

SYNOPSIS OF CERTAIN GENERA OF THE OPHIONINI

The following account of species belonging to various genera of this group is the result of a study, extending over some years, originally begun at Cornell University under the auspices of Prof. J. H. Comstock, to whom the writer is under deep obligations for assistance. The original assignment covered the species placed in this genus by Cresson, and owing to many other matters demanding attention, we have reluctantly decided to publish our results without attempting to extend our studies so as to include all the members of this group, particularly because of lack of time, and specially since a number of genera are represented only by foreign species. We also take this opportunity to express our obligations to Dr W. H. Ashmead, curator of the Hymenoptera, United States National Museum, who in recent years has kindly loaned us specimens and afforded material aid in our systematic study.

This group includes some of our larger and more common parasites, and to the species comprising it much credit is due for material aid in controlling a number of our insect pests. For example the long-tailed Ophion, Eremotylus macrurus Linn. is a common parasite of large cecropia larvae and allied species. These large caterpillars are rarely abundant enough to attract attention by their ravages, and one reason for this is undoubtedly the activity of their parasites, foremost of which stands the long-tailed Ophion.

Value as parasites

The other species of this group have been reared from a large number of hosts, and there is no reason for regarding several of them as of less value than Eremotylus macrurus Linn. The following statistics will give some idea of their abundance and, as the life of the host with its attendant possibilities is destroyed as each develops, they also give some idea of the economic value of the species. Six trap lanterns were in operation during the entire season of 1889 at Cornell University for the purpose of ascertaining the value of lights for destroying insects, and nearly

600 examples of ophionids were taken. Two species were well represented in this lot. There were none of the long-tailed Ophions, hence the figures give no idea of the relative abundance of this parasite or of the other species not represented. The one by far the most abundant was Ophion bilineatum Say, the two-lined Ophion, which was represented by 450 examples. The species next in abundance was Ophion tityri Pack., which was represented by 118 examples, while Eniscopilus purgatus Say was represented by but 23 individuals. It will be noticed that the two species taken most abundantly are not well represented in most collections and but little is known of their habits. This record does not in the least reflect on the value of these two as parasites. It is possible that both are equally efficient in their own fields and it is most probable, seeing that they are crepuscular or nocturnal in habit, that they breed largely in larvae which rarely fall into the hands of the collectors. The two-lined Ophion has been reared mostly from arctians or noctuids. Though records of this character are still far too scarce to permit the formation of a positive opinion, it is likely that this species does material service in keeping larvae belonging to these two families in check. The observations are even more meager regarding Ophion tityri. Here is certainly a field for investigation.

General habits

The different members of this group may usually be seen flying slowly about shrubbery and in the grass during bright days from early May till into October. In cloudy and wet weather they seek some sheltered place—at least this is true of the diurnal species. The long-tailed and the purged Ophions are the two taken most commonly in the day, and they are the best represented in most collections examined. The trap lantern record would appear to indicate a great preponderance of the two-lined Ophion. This must be ascribed to the crepuscular or nocturnal habits of the latter form. The females are the more active and are more abundant in collections. This might be expected, as on her devolves the labor of searching out a suitable nidus for her eggs. The large proportion of females is well shown in the trap lantern record, where but 87 males were taken to 485 females. The great activity of the females and the large number of them attracted to lights must diminish materially the value of the trap lantern as a means of destroying insect pests.

Oviposition and larval habits

The females possess a sharp ovipositor which is capable of inflicting a slight wound. Its sharpness appears to be mainly for defensive purposes, as the eggs are deposited usually on the skin of the host, to which they firmly adhere by means of a cement or glue extruded at the moment of oviposition. The deposit of the egg by Eremotylus macrurus has been graphically described by Trouvelet as follows[1]: "When an Ichneumon detects the presence of a worm, she flies around it for a few seconds, and then rests upon the leaf near her victim; moving her antennae very rapidly above the body of the worm, but not touching it, and bending her abdomen under the breast, she seizes her ovipositor with the front legs, and waits for a favorable moment, when she quickly deposits a little oval white egg upon the skin of the larva. She is quiet for some time and then deposits another upon the larva, which only helplessly jerks its body every time an egg is laid." Eight to ten eggs are laid in this manner. A few days later they hatch and the larvae make their way under the skin of their victim, feeding on the fatty portions of the host at first, but later most of the tissues are devoured. The miserable victim of these parasites drags out a weary existence and usually perishes in the pupal state, rarely before. As a single larva will provide sustenance for the development of but one or two parasites, the weaker ones perish.

There is on the front tibia of Ophion an articulated, apical spine, a structure common to many Hymenoptera, which is possibly connected with the method of oviposition narrated above. This articulated spine is curved toward the tarsus near the apex, and might consequently be used for holding the ovipositor, be-

[1] 1868 Am. Nat. 1 :89-91.

cause when apposed to the tarsus the bend is such as to allow the ovipositor to pass easily through a space between the two. It is worthy of note in this connection, as showing the method of depositing eggs by an insect belonging to the same family, that Thalessa has been seen ovipositing in a similar manner by reliable observers.[1]

Pupation and final transformations

The larva of Eremotylus macrurus usually pupates within the cocoon of its victim. As this species preys largely on the saturnians, the larvae of which spin stout cocoons, the grub of the parasite on emerging from the remains of its victim finds itself in a well protected cocoon, and consequently has no need of looking for a more secure place in which to undergo its final transformations. The same habit is probably common to other species infesting hosts spinning a stout cocoon, as, for example, Erem. arctiae when preying on these moths. The cocoons of Eniscopilus purgatus are found in the soil or under shelter near where its host has transformed. From the lack of evidence to the contrary, it may be presumed that such is the general habit of all the species infesting larvae that do not spin stout cocoons before pupation.

Very few notes exist on the duration of the pupa state in this genus. Riley states that the imagos of Erem. macrurus commonly emerge in the spring, and rarely come forth in the autumn. This would apparently indicate that the normal habit of this insect is to pass the winter in the pupal stage. An example of Enis. purgatus has been known to pupate July 24, the imago emerging Sep. 13.

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[1] 1888 Lintner. Ins. N. Y. 4th Rep't, p.40-41.

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These are references to the genus only, as defined by Cresson in 1887.

Synopsis of genera treated

a Cubitodiscoidal nervure irregularly thickened, never appendiculate
  b Yellowish chitinous spots in cubitodiscoidal cell.....Eniscopilus *Curtis*
  bb No such spots in cubitodiscoidal cell.............Eremotylus *Forster*
aa Cubitodiscoidal nervure never irregularly thickened, usually appendiculate
  b Face normal.............................Ophion *Gravenhorst*
  bb Face elongated.................................Genophion *Felt*

Synopsis of species of Eremotylus

a Cubitodiscoidal vein usually strongly sinuate; hooks of hind wings 13-15; male clasps rather long, subrectangular, obtusely rounded at the apex...macrurus Linn.
aa Cubitodiscoidal vein nearly arcuate; first and second recurrent nervures nearly equal; hooks of hind wing 7-9; male clasps subrectangular, acutely rounded.............................arctiae Ashm.
glabratus Say[1]

Eremotylus macrurus Linn.

Long-tailed Ophion

This, the largest American species of the genus, is closely allied to Erem. arctiae Ashm., which has been confused with it in collections. The two species are easily separated from the others of the genus by their considerably larger size; the smallest being perceptibly larger than the largest of the other species, excepting

[1]See account of this species, p.106.

Ophion fuliginipennis Felt, which belongs in a different group. Erem. macrurus may be separated from Erem. arctiae by its larger size, by the fulvous tinge of the wings and veins, by the second discoidal nervure being nearly twice the length of the first, and by there being from 13 to 15 hooks on the hind wings. Other differences are detailed in the description of Erem. arctiae.

Habits and life history. This species is an active, diurnal insect, being rarely if ever attracted to lights. It is the one most commonly bred from the large saturnians, and is frequently referred to as a parasite of one or more of them. Its egg-laying habits and life history, so far as known, have been described in a preceding paragraph. It has also been recorded as bred from some of the arctians, but it is probable that some of these records really pertain to Erem. arctiae. Dr C. M. Weed has recorded an instance in which 30 out of 50 pupae of Samia columbia Smith were parasitized by this insect. The unusual abundance of Callosamia promethea Dr. is recorded in *Insect Life*, 2:383, and also the interesting fact that fully two thirds of the pupae harbored this parasite. The observations of Dr Riley show that this insect usually emerges in the spring, though occasionally individuals come forth in the autumn.

This parasite has been reared from the following insects: Isia isabella Abb. & Sm., Philosamia cynthia Drury, Callosamia promethea Drury, Samia columbia Smith, Samia cecropia Linn., Telia polyphemus Cram., Automeris io Fabr. and Apatelodes torrefacta Abb. & Sm.

Description. Fulvo-ferruginous, stigma almost obsolete; marginal nervure sinuate, thickened toward the stigma; size large; body 31 to 38 mm long; wing spread 43 to 56 mm. Head small, antennae nearly as long as the body; ocelli prominent, black; head yellowish posteriorly; eyes black, rather small; mandibles bidentate, tipped with black. Mesothorax convex; scutellum and postscutellum prominent; anterior portion of metathorax depressed; posterior portion rugose, limited anteriorly by a transverse carina; lateral carinae present. Wings hyaline; marginal nervure thickened, sinuate near the small stigma; cubitodiscoidal nervure never appendiculate, usually strongly sinuate; third discoidal cell considerably wider at apex than base; hooks on hind wings 13 to 15. Legs long, honey yellow. Abdomen long, strongly compressed, usually darker at tip. Male claspers rather long, subrectangular, obtusely rounded at apex.

Described from 10 examples.

Cocoon. The larva leaves the shriveled remains of its victim when full grown and pupates within the cocoon spun before the demise of its host. The cocoon is tough, oval, about 32 mm long and 17 mm broad, and occupies the larger portion of that spun by its prey. It is composed of silk agglutinated by a dark secretion. Exteriorly it is a dark brown color, with a faint yellowish or golden band around the center. The interior is thinly lined with a transparent substance and possesses a brilliant metallic luster.

Distribution. The recorded distribution of this insect is from New England to California and from Canada to Texas, indicating that the species ranges over practically the whole of the United States and north into Canada. It has been reported from the following localities: Canada, New England, New York, New Jersey, Pennsylvania, District of Columbia, Virginia, Louisiana, Illinois, Missouri, Nebraska, Colorado, Texas, Nevada and California.

Specimens have also been examined from the following localities: Ottawa, Canada [Harrington]; New York city [Joutel]; Dutchess county, N. Y. and Rock Creek park, Washington D. C. [U. S. Nat. Mus.] and from Malden and Amherst Mass. [Fernald].

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1883 —— —— 13th Rep't, p.17, fig.11 (Same as preceding)
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Eremotylus arctiae Ashm.

This species is by no means rare, though not recognized as a distinct form till 1890 owing to its having been confused with Erem. macrurus, which it closely resembles. A critical examination of the material in the state collection, Dr Lintner's private collection, and that from Cornell University, lent by Professor Comstock, has resulted in the finding of several examples of this species. Two specimens were taken in the trap lanterns at Cornell; one Aug. 3 and the other Aug. 22, 1889. Owing to the kindness of Messrs Howard and Ashmead, we have been permitted to examine a type of this species.

Hosts. This species is parasitic mostly on some of the arctians, though it has also been reared from saturnians. The following hosts are known: Ecpantheria deflorata Fabr., Diacrisia virginica Fabr., Automeris io Fabr. and Callosamia promethea Drury.

Description. The following is Mr Ashmead's description:

In Erem. macrurus, the wings have a decided fulvous tinge and the veins are fulvous; the second recurrent nervure is about twice as long as the first recurrent nervure, the third discoidal cell, therefore, is much wider at apex than at base; in Erem. arctiae, the wings are entirely without the fulvous tinge and the basal nervure, tips of median and discal nervures vary from brown to black, or piceo-black; the second recurrent nervure is only slightly longer than the first recurrent nervure, the cubital nervure being arcuate and the third discoidal cell, therefore, is about as wide at apex as at base; in Erem. macrurus, the transverse metathoracic carina is always more or less distinctly sinuated at the middle, in Erem. arctiae it is straight. In Erem. arctiae the hooks on the hind wings vary from seven to nine; in Erem. macrurus they are from 13 to 15; in the former the claws are pectinate; in the latter simple.

Male 26 mm long, wing expanse 35 mm; female 20 to 28 mm long, wing expanse 36 to 40 mm.

Figure 6 on plate 2 represents the wing characters of Erem. macrurus. In Erem. arctiae the cubitodiscoidal nervure is arcuate; in the type examined it was a nearly perfect arc, but in other specimens there was a slight tendency to the sinuous course usually so marked in Erem. macrurus. The form of the third discoidal cell in the type was a little more regular than in our specimens and the first and second recurrent nervures were more nearly of an equal length. The wings of Erem. arctiae appear to be proportionately wider than in Erem. macrurus. In a study of examples of Erem. macrurus, I find the claws pectinate as well as in Erem. arctiae. The claspers of the male in the former species are rather long, subrectangular and obtusely rounded at tip, while in the latter they are subtriangular and acutely rounded at tip.

Distribution. This species is probably as widely distributed over this county as is Erem. macrurus. It is known to occur in New York, New Jersey, District of Columbia, Alabama, Mississippi and California, and specimens are before the writer from the following localities: Ottawa, Canada [Harrington]; Malden and Amherst Mass. [Fernald]; Michigan, Onaga Kan., Santa Cruz mountains and bred from Halisidota agassizii by Coquillett, Los Angeles Cal. [U. S. Nat. Mus.] There is a specimen from Pennsylvania and one from Texas in the Museum of Comparative Zoology, Cambridge Mass.

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Eremotylus glabratus Say

This species is apparently quite closely related to Erem. arctiae Ashm. and it is possible that this latter is a synonym of Say's species but that can be determined with certainty only by examining the type, which is apparently not in existence. A small example of Erem. arctiae corresponds very well indeed with the original description of this rare form. There is a cocoon in the Harris collection in the rooms of the Boston Society of Natural History, labeled "Ophion glabratum" but no adult accompanies it though a specimen of O. bilineatum Say was in close proximity to the cocoon. There is apparently nothing in that collection which can be used in the identification of this species. A specimen in the United States national collection has been labeled by Dr Ashmead as Eremotylus glabratus Say. It corresponds very closely with the description of Erem. arctiae. The most apparent differences are in its small size and the comparatively slender marginal or radial nervure with no distinct angle or tooth near the stigma, a character which is usually well marked in both Erem. macrurus Linn. and Erem. arctiae.

This species has undoubtedly been erroneously identified in a number of collections and the following references, except that of its original describer, in all probability relate to something else. Prof. G. C. Davis some years ago informed me that but one individual of this species was known to be in existence and that was in his possession. Say's original description of this insect is reproduced below:

Honey yellow; a glabrous spot in the large cubital cellule.

Body dull honey yellow; head bright yellow; antennae, mouth and stemmata honey-yellow; eyes blackish; wings, first cubital cellule beyond its middle with a longitudinally oval glabrous space, but destitute of any opaque spot; metathorax transversely wrinkled near the petiole of the abdomen.

Length about $\frac{4}{5}$ inch.

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Table for separation of species of Eniscopilus

a Larger chitinous spot in glabrous area of cubitodiscoidal cell, not appendiculate..purgatus Say

aa Larger chitinous spot in glabrous area of cubitodiscoidal cell, appendiculate *b* Chitinous process extending from larger chitinous spot along the posterior margin of the glabrous area and partly around its distal portion. Male clasps obtusely rounded.................arcuatus Felt

bb Chitinous process from the larger spot not extending beyond the middle of the glabrous area. Smaller chitinous spot nearly circular and slightly posterior to the center of the glabrous area....
appendiculatus Felt

Eniscopilus purgatus Say

This species is easily recognized by the two opaque, chitinous spots in the cubitodiscoidal cell. The great tenuity and length of the basal two abdominal segments is very marked, and is frequently of service in identifying the insect, though this is also true of the much rarer Enis. arcuatus and Enis. appendiculatus. It is the species of this genus most frequently found in the East while collecting in the daytime and the one most common in collections.

Life history and habits. The imagos fly from the last of June till the last of September. They are diurnal and probably crepuscular in habit since they are attracted to lights to a certain extent, as is shown by the trap lantern experiments conducted at the Cornell University Agricultural Experiment Station in 1889.

Trap lantern records

	1889																			1892			
	JUNE				JULY							AUG.				SEP.			Total	JULY		AUG.	Total
	20	22	26	28	1	5	18	20	21	23	24	15	20	21	27	8	11	14		12	30	19	
Male.....	1	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	3	....	1	......	1
Female..	1	1	2	1	...	1	1	2	2	...	1	1	1	2	1	1	1	1	20	1	....	2	3

It will be seen by examining the record for 1889, that there are three distinct periods, separated by a space of about two weeks, in which this species was taken. Thus none were captured between July 5 and 18, July 24 and Aug. 15. These two nonproductive periods may have been caused by climatic conditions, though it is hardly probable that unfavorable weather of any kind would prevent the species from flying by night for 13 consecutive days, to say nothing of the other period of three weeks. It may be that this periodicity indicates three broods or at least periods when the imagos are more abundant, but in the absence of more data nothing but a surmise can be advanced.

The large number of females taken in the trap lantern reduces its value as a means of destroying noxious insects. Dr Packard observed that the bean-shaped egg of this insect was attached to the skin of the larval host by a pedicle, and that the newly hatched grub does not entirely leave the eggshell till it has eaten a hole into the side of its victim. It would therefore appear as though the sharpness of the ovipositor was largely for defensive purposes. The females can inflict a slight sting that will smart for half a minute or more, but the pain is by no means severe.

Hosts. This insect has been most frequently brought to notice as a parasite of the very destructive army worm, Heliophila unipuncta Haw. on which it is a very efficient check. The army worm was abundant in many localities throughout the country in 1896, when the numerous oblong, silken cocoons of this parasite attracted Professor Lugger's attention in Minnesota fields infested by army worms. This is the best evidence obtainable of its value as a parasite. We have reared it from the zebra caterpillar, Mamestra picta Harr. another injurious species, the grub emerging from the larva and pupating July 24, the adult appearing Sep. 13. Records indicate this to be one of the most valuable species of the genus, since it preys on several insects of considerable economic importance. It has been reared in addition to those named above, from Mamestra trifolii Rott, Scoliopteryx libatrix Linn., Schizura concinna Abb. & Sm., and S. unicornis Abb. & Sm. It has also been bred from a dipterous Solidago gall and several unidentified lepidopterous larvae. It probably has a number of other hosts. We have also seen a specimen reared from the Polyphemus caterpillar, Telea polyphemus Cram., in the Museum of Comparative Zoology at Cambridge Mass.

Description. Fulvo-ferruginous; stigma small; two subtriangular, opaque chitinous spots in the cubitodiscoidal cell.

Head medium; antennae nearly as long as the body; ocelli black, about equidistant from each other and the eyes; dorsal and posterior portions of head yellow; mandibles bidentate and tipped with black. Thorax sericeous; mesothorax convex; scutellum and postscutellum prominent; metathorax slightly depressed anterior of the transverse carina; lateral carinae distinct. Wings hyaline; marginal nervure thickened and slightly sinuate near the stigma; cubitodiscoidal nervure usually strongly sinuate but not appendiculate, its bulla scarcely one fourth the width of the third discoidal cell from its apex; two subtriangular opaque spots occur in the glabrous area of the cubitodiscoidal cell, the larger one with no arcuate continuation along the margin of the glabrous area, though a small chitinous line may be seen near the smaller spot.

Legs honey yellow; abdomen strongly compressed, darker at the tip; first and second segments remarkably long and slender; claspers of male subtriangular, obliquely truncate, acute posteriorly.

Length about 22 mm, wing spread about 26 mm. Described from numerous examples.

The cocoon is a silken, brown, tough, oblong oval object.

Distribution. The recorded distribution of this insect is as follows: New England, New York, New Jersey, Pennsylvania, Virginia, Carolinas, Florida, Alabama, Illinois, Indiana, Missouri, Iowa, Colorado, Arizona, Nevada, California and Canada. Examples of this species from Georgia, Oregon and Washington, in addition to some of the states named above, occur in the collection of the Academy of Natural Sciences at Philadelphia. Specimens of this species are now before the writer from the following localities: Kansas; California; Virginia; Fox Point, Alaska [Harriman Expedition '99]; Flatbush N. Y., Victoria Tex., St Louis Mo., Durham N. H., and Arizona, all being in the collections of the United States National Museum. Specimens from Colorado, Las Vegas N. M., Cheyenne Wy., and Michigan were lent to the writer by Professor Gillette. Specimens from New York were received from Mr L. H. Joutel, and Mr W. W. Harrington kindly sent examples from Grimsby Ont. (taken June 6), Toronto (taken July 27, Aug. 24 and Sep. 3), Winnipeg (taken in June), Osoyoos B. C. (taken in May) and from Ottawa, Canada. Specimens from Malden and Amherst Mass. (taken Aug. 1, 2, 12 and 21) were lent to us by Prof. C. H. Fernald. The species is doubtless distributed over the whole of the United States and the larger portion of Canada.

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1878 —— Mass. State Bd Agric. 25th Rep't, p.252 (Parasite of H. unipuncta)

1883 —— U. S. Ent. Com. 3d Rep't, p.128, pl.2, fig.5 (Parasite of H. unipuncta; eggs, habits of larva described)

1888 —— N. J. State Bd Agric. 15th An. Rep't 1887, p.523, fig.1 (Mention)

1875 **Cresson, E. T.** Geog. and Geol. Sur. Ter. Rep't. Zool. 5:708 (From eastern Nevada)

1879 **Provancher,** *L'Abbé* **L.** Nat. Can. 11:117 (Table of species of Ophion description)

1887 —— —— 16:34

1889 —— —— 19:248

1884 **Caulfield, F. B.** Can. Ent. 16:122-23 (Parasite of Mamestra picta; cocoon described)

1885 —— Ent. Soc. Ont. 15th Rep't, p.41 (Same as preceding)

1887 **Fletcher, James.** Cen. Exp. Farm (Can.) Rep't, p.29 (Parasite of Schizura concinna)

1888 **Lugger, Otto.** Univ. Minn. Bien. Rep't Regents, p.366-67, fig.31 (Parasites of H. unipuncta)

1896 —— Ent. Minn. Agric. Exp. Sta. 2d Rep't, p.17, fig.10 (Abundant in fields with army worm)

1896 —— Minn. Agric. Exp. Sta. Bul. 48, p.45, 46 (Same as preceding)

1890 **Webster, F. M.** U. S. Dep't Agric. Div. Ent. Bul. 22, p.46 (Reared from Scoliopteryx libatrix)

1893 —— O. Agric. Exp. Sta. Bul. 45, p.169

1890 **Ashmead, W. H.** Col. Biol. Ass'n Bul. 1, p.43 (Listed)

1890 **Riley, C. V. & Howard, L. O.** Insect Life, 2:382 (Reared from Scoliopteryx libatrix)

1890 —— —— 2:155 (Bred from Mamestra trifolia, Schizura unicornis et al)

1890 **Packard, A. S.** U. S. Ent. Com. 5th Rep't, p.269 (Parasite of Schizura unicornis)

1890 **Smith, J. B.** Cat. Ins. N. J. p.25 (Listed)

1900 —— Ins. N. J. List, p.580, fig.274 (As Enicospilus)

1891 **Harrington, W. W.** Ent. Soc. Ont. 21st Rep't, p.67 (Parasite of army worm)

1892 **Osborn, Herbert.** Part. Cat. Animals Ia. p.15 (Listed)

1896 **Evans.** Can. Ent. 28:10 (Listed)

1897 **Panton.** Ent. Soc. Ont. 27th Rep't, p.51 (Parasite of army worm)

Eniscopilus arcuatus Felt

This comparatively rare species may be easily separated from E. purgatus Say, with which it has heretofore been confused, by the well marked chitinous, usually yellowish, arcuate continuation of the larger opaque spot in the cubitodiscoidal cell. This structure extends along the posterior border of the glabrous area in that cell to a point beyond the smaller opaque spot. It may also be recognized by the bulla of the cubitodiscoidal cell being at a distance equal to one half the width of the third discoidal cell from the apex of the same [pl. 1].

This species was described in the February issue of *Psyche,* 1902, page 307–8, and its characterization is reproduced herewith:

Light fulvo-ferruginous, the larger opaque chitinous spot of the cubitodiscoidal cell with a distinct arcuate continuation extending along the hinder margin of the glabrous area and partly around the smaller chitinous spot.

Head medium, yellowish posteriorly, face yellowish, antennae slightly longer than the body; ocelli black, equidistant; mandibles bidentate, fuscus apically. Thorax, sericeous; mesothorax, convex; scutellum and postscutellum, prominent, the former yellowish; metathorax slightly depressed in front of the transverse carina; lateral carinae distinct. Wings hyaline, having hardly a trace of the fuscus visible in Ophion (Eniscopilus) purgatus Say; marginal nervure slightly thickened and sinuate near the small stigma; cubitodiscoidal nervure, weakly sinuate, not appendiculate; its bulla one half the width of the third discoidal cell from its apex; two subtriangular opaque spots in the glabrous area of the cubitodiscoidal cell, the larger one with a chitinous, usually yellowish continuation along the hinder margin of the glabrous area to a point beyond the smaller chitinous spot, which latter is anterior and lateral of the center of the glabrous area. Legs, honey yellow. Abdomen, strongly compressed, slightly darker at the tip, the first and second segments being very slender. The claspers of the male are rounded apically.

Length about 23 mm. Wing spread from 30 to 35 mm.

Habitat, Albany N. Y. May 6, 1876 [W. M. Hill]; Ithaca N. Y., July 16, 1889 [J. M. Stedman]; New York city [L. H. Joutel]; Malden Mass. [C. H. Fernald]; Poughkeepsie N. Y. [Young, collector]; South Britain Ct. 1884 [G. F. Pierce].

There are examples of this species from Cambridge Mass. in the collection of the Museum of Comparative Zoology, and from Georgia and New Hampshire in the collection of the Academy of Natural Sciences of Philadelphia. There is a specimen in the collections of the United States National Museum labeled "Coll. C. V. Riley," and one in the Bolter Collection at the University of Illinois from Illinois. Types are in the New York State Museum and also at Cornell University.

Eniscopilus appendiculatus Felt

This form is even rarer than the preceding. It was originally described from one specimen which came into my possession through the kindness of Dr J. B. Smith, New Brunswick N. J. This specimen probably came from New Jersey and is deposited as a type in the New York State Museum. A study of the collections of others has revealed two specimens in the collections of the United States National Museum, one marked " Collection C. V. Riley " and the other " From Selma, October 1880, W. H. Patton." This form is evidently southern in its habitat and it may be separated from the preceding species by the following characteristics which were given in the February issue of *Psyche,* 1902, page 308:

Light fulvo-ferruginous, larger opaque spot of the cubitodiscoidal cell with a small extension on its posterior angle. The smaller chitinous spot is nearly circular, light yellow in color and slightly posterior to the center of the glabrous area [pl. 2, fig. 4].

This species differs in addition to the above characteristics from the preceding one in having the cubitodiscoidal nervure slightly angled and not sinuate. It is a smaller form, having a length of 18 mm and a wing spread of about 27 mm.

Table of species of Ophion

a Wings hyaline
- *b* Body usually strongly compressed, eyes large, extending nearly to the base of the mandibles
  - *c* Medium size, metathorax not areolated, male clasps subtriangular . . . . bilineatum Say
  - *cc* Small, metathorax usually strongly areolated, male clasps short, rounded apically. . . . . tityri Pack.
- *bb* Body stout, not strongly compressed, eyes small, distant from base of mandibles

c Cubitodiscoidal nervure usually not appendiculate
d Ferruginous or fulvous................b i f o v e o l a t u m Brullé
dd Ferruginous varied with black and venter of mesothorax usually black ....n i g r o v a r i u m Prov.
cc Cubitodiscoidal nervure appendiculate, appendix extending into second discoidal cell ....a b n o r m u m Felt
aa Wings subhyaline
b Wings distinctly ferruginous ....f e r r u g i n i p e n n i s Felt
bb Wings yellowish, fuscous along apical costal margin. .c o s t a l e Cress

Ophion bilineatum Say

Two-lined Ophion

This species, next to the long-tailed and purged Ophions, is the most abundant in collections and the one most frequently noticed in entomologic literature. It may be easily separated from the other more common forms by its medium to large size, strongly compressed abdomen, by the subtriangular, obliquely truncate male clasps and the appendiculate cubitodiscoidal nervure.

Life history and habits. Very little is recorded concerning the life history and habits of this species. Its comparative rarity in collections is probably explained by its crepuscular or nocturnal habits, since our trap lantern record indicates that it is one of the most abundant forms attracted to light.

Trap lantern records

	1889																														
	JUNE		JULY	AUGUST											SEPTEMBER																
	4	30	3	1	4	21	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	11	12	13	14	15	16	17	18	19
Male.....	...	1	....	..	..	..	1	..	..	..	..	1	1	2	..	2	..	1	..	1	..	4	2	..	..	1	..	2	..	4	..
Female..	1	...	1	1	1	1	3	1	4	4	4	1	1	5	12	20	6	8	9	1	3	13	3	8	37	32	14	12	59	17	25

	1889																	1892											
	SEPTEMBER											OCT.				AUG.	Total	MAY	JUNE	SEPTEMBER									Total
	20	21	22	23	24	25	26	27	28	29	30	1	2	5	10	22		20	28	11	14	16	19	20	23	24	25	30	
Male....	..	1	..	..	..	2	3	..	..	..	..	1	..	..	..	......	30	......	1	1	..	..	..	..	..	..	..	..	2
Female	21	14	2	1	7	18	17	2	3	3	11	9	1	1	1	2	420	3	....	..	2	1	1	1	1	2	1	1	13

It will be seen by the above, that there is some indication of periodicity in the captures, though nothing but what might be caused by more or less favorable weather or the relative abundance of the insects. There is certainly no indication of more than one brood. It will be noticed that this species flies most abundantly from about the middle to the last of September, and may be found on the wing till nearly the middle of October.

Hosts. Very little is known regarding the species on which this insect preys. The record is so meager that one can only surmise as to the economic value of this parasite. It has been reared from *Diacrisia virginica* Fabr. *Feltia gladiaria* Morrison, and *Glaea inulta* Grote. Dr Howard has recorded this species as possibly a parasite infesting *Notolophus leucostigma* Abb. & Sm. to a limited extent. This brief record suggests that this species may be parasitic on some of the arctians and noctuids, and while the former are not of much economic importance, such is not true of many of the latter, and in the control of these, this species may play an important part.

Description. Fulvo-ferruginous, stigma well developed, medium size to rather large; length of body about 19 mm; wing spread about 30 mm.

Head medium, antennae as long or longer than the body; eyes and ocelli black; lateral ocelli a little distant from the eyes; dorsal and dorsocaudal aspect of head yellowish; mandibles bidentate and tipped with black. Mesothorax convex; scutellum and postscutellum prominent; metathorax with inconstant raised lines. Wings hyaline with a glabrous elliptic spot near the stigma in the cubitodiscoidal cell; cubitodiscoidal nervure appendiculate [pl.2, fig.3], legs honey yellow. Abdomen rather strongly compressed, frequently a little darker at the extremity; male claspers subtriangular, obliquely truncate, and acute posteriorly.

Described from numerous specimens.

There are some very small representatives of this species from the Adirondack mountains that approach closely in size and general appearance the following form. They may be separated, however, by the relatively shorter, more compressed abdomen and by the thorax being as dark as other portions of the body.

Distribution. This insect has a wide distribution over the United States and the southern portion of Canada, though it has not been reported from every state in the Union. Its recorded distribution is as follows: New England, New York, New Jersey, Virginia, Maryland, District of Columbia, Florida, Louisiana, Michigan, Iowa, Missouri, Colorado, Texas, Montana, Nevada, Lake Winnipeg and Sudbury, Ontario.

Bibliography

1828 **Say, Thomas.** Macl. Lyc. Arts Sci. Contrib. p.75 (Original description)

1835 —— —— Bost. Jour. Nat. Hist. 1:248 (Mention)

1883 —— —— Compl. Wr. LeConte ed. 1:378 (Habitat Indiana)

1862 **Cresson, E. T.** Ent. Soc. Phila. Proc. 1:206 (Listed)

1873 —— Am. Ent. Soc. Trans. 4:169 (In Texas)

1875 —— Geog. and Geol. Sur. Ter. Rep't Zool. 5:708 (From eastern Nevada)

1863 **Norton, Edward.** Ent. Soc. Phila. Proc. 1:358 (Distribution)

1863 **Sanborn, F. G.** Mass. State Bd. Agric. Rep't, p.169 (Bilineatus mentioned)

1871 **Riley, C. V.** Ins. Mo. 3d Rep't, p.69 (Parasite of Spilosoma virginica)

—— N. Am. Fauna no.7, p.247 (Sonoma county, Cal.)

1879 **Provancher,** *L'Abbé* **L.** Nat. Can. 11:117-18, fig.4 (Table of species, description)

1887 —— —— 16:34 (Listed)

1882 **Packard, A. S.** Bost. Soc. Nat. Hist. Proc. 21:19 (O. tityri separated from this species)

1883 **Saunders, William.** Ins. Inj. Fruits, p.273, fig.282 (Parasite of Spilosoma virginica)

1888 **Lintner, J. A.** Ins. N. Y. 4th Rep't, p.205 (At Coeyman N. Y.)

1889 **Scudder, S. H.** Butterflies of N. Eng. 3:1880, pl.88, fig.8 (O. tityri supposed to be a variety)

1890 **Riley, C. V. & Howard, L. O.** Insect Life, 3:155 (Bred from Glaea inulta and Agrotis morrisoniana, *habitat*)

1890 **Ashmead, W. H.** Col. Biol. Ass'n Bul. 1, p.43 (Listed)

1890 **Perkins, C. H.** Vt. State Bd. Agric. 11th Rep't, separate, p.10 (Mention)

1890 **Smith, J. B.** Cat. Ins. N. J. p.25 (Not common at Caldwell)

1891 **Harrington, W. H.** Ent. Soc. Ont. 21st Rep't, p.67 (Parasite of white miller moths)

1892 **Osborn, Herbert.** Part. Cat. Animals Ia. p.15 (Common)

1896 **Evans, J. D.** Can. Ent. 28:10 (Listed)

1897 **Howard, L. O.** U. S. Dep't Agric. Div. Ent. Bul. 5, Tech. Ser. p.30 (Possibly a parasite of Orgyia leucostigma)

Ophion tityri Pack.

This species resembles O. bilineatum Say closely in its general appearance, and it may be an earlier occurring dimorphic form but we have no evidence of this and for the present it must be regarded as a distinct species. It may be separated from the preceding by its smaller size, relatively shorter and flatter abdomen, and by the difference in the form of the male genitalia.

Life history and habits. Comparatively little is known of the life history and habits of this insect, since it has been so frequently confused with O. bilineatum. There appears to be but one published notice of this parasite since its description in 1882, and in that it is not recognized as a distinct form. This species can hardly be regarded as rare, since over 100 individuals were taken in the trap lantern experiments at Cornell University and it has been frequently collected by the writer and also met with in other collections.

Trap lantern records

	1889																		
	MAY																		
	5	7	8	9	10	11	14	15	16	17	18	19	20	21	22	24	25	26	28
Male	....	....	1	....	....	1	2	1	2	2	4	10	2	1	2	1	3	2	1
Female	1	1	1	3	1	1	3	1	9	4	1	7	3	4	1	3	3	3	....

	1889																				
	JUNE													JULY					AUG.		
	2	3	4	5	6	8	11	13	16	17	19	27	29	1	2	3	23	31	1	2	17
Male	....	1	...	...	...	2	...	...	...	...	...	...	...	......	......	...	1	...	....	....	....
Female	2	2	1	1	2	1	1	1	2	2	1	1	2	1	1	1	3	1	2	1	1

	1889			1892																	
		SEP.	Total	MAY	JUNE								JULY							AUG.		Total
	27	30		26	1	2	4	5	9	19	21	28	1	6	16	17	25	26	28	2	6	
Male	...	......	39	......	1	1	1	1	1	...	...	...	...	...	2	...	...	...	...	...	...	7
Female	1	1	79	1	...	1	1	...	...	3	1	1	1	1	...	1	1	1	1	1	1	16

A glance at the above table will show that this insect has a well defined period of flight, and one that does not overlap the time O. bilineatum is abroad, except in the case of scattering individuals. This species appears early in May, is most abundant the latter part of the month, and occurs somewhat rarely during June with belated individuals in July, August and September, while O. bilineatum does not occur till August and then only in scattering numbers till the latter part of the month. This marked difference in the time of flight between these two parasites indicates that either they are two broods of the same insect or else that they are distinct species. The structural difference to be described later must be regarded as proofs of their distinctness. The large eyes and many individuals taken in the trap lantern indicate a crepuscular or nocturnal habit.

Hosts. This parasite has been reared from Epargyreus tityrus Fabr. Prof. G. C. Davis, when at the Michigan Agricultural College Experiment Station, wrote us that he had bred the insect repeatedly from Halisidota caryae Harris and Symmerista albifrons Abb. & Sm. It is probably parasitic on a number of other related insects.

Description. Ferruginous or fulvo-ferruginous with frequently a decidedly fulvous tinge on the thorax, which latter is shorter and the abdomen considerably shorter than in O. bilineatus.

Face ferruginous, or laterally fulvous; head medium; mandibles bidentate, tipped with dark brown, clypeal fossae deep, antennae usually longer than the body; the fossae at their bases not deep; eyes large, reaching nearly to the base of the mandibles. Ocelli black, nearly contiguous and the posterior close to the eyes. Thorax short, ferruginous or fulvo-ferruginous; mesothorax convex; scutellum and postscutellum prominent; metathorax usually with very prominent carinae inclosing deep, four sided areas, and the pedicel of the abdomen surrounded by a high carina. Wings hyaline; cubitodiscoidal nervure strongly appendiculate. First recurrent nervure only about one third the length of the second; bulla of the latter close to the cubitodiscoidal nervure, and that of the latter nearer the second discoidal nervure than the appendix. Legs long, fulvo-ferruginous; abdomen much shorter than in O. bilineatus, very strongly compressed and the posterior segments usually darker in color. Clasps of male subtriangular, obtusely rounded, length 14 mm, wing spread 26 to 30 mm. Described from numerous specimens of both sexes.

Distribution. This species is widely and probably generally distributed in the northern United States and southern Canada. It was described from Massachusetts, has been met with in numbers at both Albany and Ithaca N. Y. and was repeatedly reared by Professor Davis in Michigan. In addition we have specimens before us from New York city [Joutel]; Ottawa, May 19, 24 and June 8, Toronto, August 24, Grimsby, June 6, Port Hope, May 5, and Vancouver Island, May 3, all from Canada through the kindness of Mr W. H. Harrington.

Bibliography

1882 **Packard, A. S.** Bost. Soc. Nat. Hist. Proc. 21:19 (Original description)

1889 **Scudder, S. H.** Butterflies N. Eng. 3:1872, 1880, pl.88, fig.8 (As O. bilineatum; parasite of Epargyreus tityrus)

Ophion bifoveolatum Brullé

This species is one of the more common forms belonging to the genus and if one may judge from trap lantern records, it is largely diurnal and not crepuscular or nocturnal as in the case of some of its close allies. This conclusion is further borne out by the reduced size of the eyes, being decidedly smaller than in related species and distant from the mandibles. This species occurred in the trap lantern material taken at Ithaca in very small numbers compared to those of the closely allied Ophion bilineatum Say. It has a somewhat exceptional host in white grubs, compared with other members of the genus and so far as known to us has not been reared from any other species.

Description. Fulvo-ferruginous with small eyes distant from mouth; costal vein inclined to black; cubitodiscoidal nervure rarely appendiculate; bulla of the second recurrent nervure usually close to tip of cubitodiscoidal nervure and abdomen less compressed than in its close allies.

Head medium; face frequently fulvous laterally, broad; mandibles stout with black tips; clypeal fossae deep and usually black; antennae dark brown, stout and not as long as the body; ocelli black and equidistant. Thorax sometimes dark brown, finely punctured and with sutures more or less black; mesothorax convex; scutellum and postscutellum prominent, the former sometimes a light ferruginous; dorsum of metathorax is usually smooth. Wings hyaline; stigma well developed; costal and adjacent veins inclined to black; cubitodiscoidal vein usually smoothly arched and rarely appendiculate; bulla of second recurrent nervure usually close to tip of cubitodiscoidal nervure [pl. 2, fig. 2]. Legs uniformly ferruginous; claws pectinate. Abdomen sometimes slightly darker at tip and not strongly compressed but relatively thicker and shorter. Male clasps stout, rather long, obliquely rounded and rather acute at tip.

Length about 15 mm. Wing spread about 28 mm.

This species occurs abroad during the latter part of May and very early in June. Specimens are at hand from Ottawa, Canada taken May 30 and June 6 [Harrington]; Fort Lee N.J. taken May 29 [Joutel]; Malden Mass. taken May 4 [Fernald]; Belfrage Tex., Washington D.C., taken in May [United States National Museum] besides various New York localities. This species has been recorded from the following localities: Mt Washington N. H., New Jersey, New York, Illinois, Iowa, Colorado and Texas. The record of captures in trap lanterns at Ithaca in 1889 and 1892 is given below:

Trap lantern records

	1889								1892									
	MAY		JUNE					Total	MAY	JUNE								Total
	24	26	3	4	8	21	26		30	1	2	3	8	11	16	25	28	
Male											1			1	1			3
Female	1	1	1	1	1	1	1	7	3	2	1	2	1	1	1	1	1	13

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1846 **Brulle, Auguste.** Hist. Nat. Ins. Hymenopt. p.138 (Description)

1862 **Cresson, E. T.** Ent. Soc. Phila. Proc. p.206 (Listed)

1865 —— —— 4:284 (From Colorado)

1873 —— —— Trans. 4:169 (From Texas)

1863 **Norton, Edward.** Ent. Soc. Phila. Proc. 1:358 (Specific characters)

1874 **Provancher,** *L'Abbé* **A.** Nat. Can. 6:103 (Table of species)

1879 —— —— 11:117 (Table of species), p.118 (Description)

1890 **Ashmead, W. H.** Col. Biol. Ass'n Bul. 1, p.43 (Listed)

1890 **Smith, J. B.** Cat. Ins. N. J. p.25 (Listed)

1892 **Osborn, Herbert.** Part. Cat. Animals Ia. p.15 (Listed)

1892 **Riley, C. V.** Ent. Soc. Wash. Proc. 2:134 (Parasite of Lachnosterna fusca)

1891-92 **Forbes, S. A.** Ins. Ill. 18th Rep't 1894, p.125 (Parasite of white grub)

1896 —— Ill. Agric. Exp. Sta. Bul. 44, p.272 (Same as preceding)

1894 **Slosson, A. T.** Ent. News, 5:4 (In alpine regions of Mt Washington)

Ophion nigrovarium Prov.

This species is undoubtedly closely related to the preceding form, though we have been unable to examine the original type. A few specimens from Colorado which we provisionally assigned to O. bifoveolatum, are exceptionally highly colored, and they probably belong to this species; in which event we are inclined to believe that it is but a variety of the preceding. A translation of the original description is as follows:

♂ Length .6 inch (pouce). Yellowish red varied with black. Head yellow; base and tip of the mandibles, two punctures on the top of the clypeus, the fossa at the insertion of the antennae, with the eyes are of a more or less deep brown. Eyes short, with almost no slope above. Posterior ocelli distant from each other, but close to the eyes. Antennae stout and short, brown. A puncture before the tegulae; the scutellum pale yellow. Thorax yellow; superior border of the prothorax, base of the scutellum, base of the metathorax, its sutures, upper sides of mesothorax, base of the four posterior coxae, black. Metathorax without distinct carinae. Wings slightly smoky; costal nervures brown, stigma yellow. Feet yellow, the anterior coxae in front and the posterior coxae behind more or less spotted with brown. First and second segments of abdomen brown; the posterior segment also brown on the inferior border.

♀ Of a clearer yellow than the ♂. Coxae entirely yellow, except in their articulation with the body. Base and extremity of abdomen of a deep shade of brown. Otherwise like the male. Described from two specimens. Inhabits Canada. [*Nat. Can.* 6:104]

Ophion abnormum n.sp.

A single specimen of this form was received from Colorado through the kindness of Prof. C. P. Gillette, who labeled it no. 2103. This species is very closely allied to what we have considered a light form of O. bifoveolatum Brullé.

Description. Fulvous, with indistinct ferruginous markings on the thorax and abdomen, except that the dorsum of the thorax has two distinct submedian fulvous lines and its lateral margins are also bordered by stripes of the same color. Wing spread 18 mm, length of body about 15 mm.

Head medium, face short, mandibles bidentate, tipped with dark brown or black; clypeal fossae deep, dark brown; antennae slightly shorter than the body; eyes black, small, somewhat distant from the mandibles. Ocelli glassy or black, well separated and the posterior ones distant from the eyes; thorax glassy; mesothorax convex; scutellum and postscutellum conspicuous; metathorax evenly rounded with no carinae. Wings hyaline; nervures and stigma brown, the latter with fulvous markings; cubitodiscoidal nervure plainly appendiculate, the appendix extending into the second discoidal cell; bulla of second recurrent nervure close to the cubitodiscoidal nervure, and that of the latter nearly equally distant between the appendix and the second recurrent nervure [pl. 2, fig. 5]. Legs ferruginous; claws pectinate; abdomen stout, not strongly compressed.

Described from one female from Colorado.

Ophion ferruginipennis n. sp.

One example of this unique form was in the collection of the United States National Museum and through the kind forbearance of Dr Ashmead its characterization has fallen on the writer. Another specimen was taken by Mr L. H. Joutel in the vicinity of New York city.

Description. Ferruginous; wings ferruginous and with a spread of about 40 mm; metathorax strongly areolated in much the same way as in O. tityri Pack.

Head medium; mandibles bidentate; black apically; clypeal fossae deep; antennae nearly as long as the body. The fossae at their bases are well marked. Eyes large, extending nearly to the mandibles; ocelli black and the posterior pair almost contiguous to the eyes; thorax sericeous; mesothorax convex; scutellum and postscutellum prominent. Metathorax with two well developed transverse carinae and a number of longitudinal ones radiating from the insertion of the first abdominal segment. Wings subhyaline with a distinct ferruginous and, in places, fuscous tinge, specially at their base and along the anterior margins. Cubitodiscoidal vein with its appended vein stub extending one third across the cell from the well marked angle; bulla of second recurrent nervure a little distance from the cubitodiscoidal vein [pl.2, fig.1]. Legs light ferruginous, concolorous; claws pectinate; abdomen strongly compressed and somewhat darker at the tip. Length about 25mm, wing spread about 40 mm.

Described from two females. One is in the collection of the United States National Museum and the other in the New York State Museum.

Ophion costale Cresson[1]

This rare species is represented by only one individual, the type being in Mr Cresson's collection. It may be that this form is but a sport, though at present we can do no better than to allow it to stand as a distinct species.

Description. Female. "Fulvo-ferruginous, shining, face broad, the middle closely punctured, subtuberculate immediately beneath base of antennae; clypeus strongly punctured, tips truncate, lateral sutures and tips of mandibles black; cheeks swollen; antennae shorter than usual, reaching about to tip of second abdominal segment; mesothorax convex, polished; scutellum very convex; metathorax confluently punctured, without transverse carina, sutures of thorax narrowly black; wings subhyaline, stained with yellowish at base and with fuscous along apical costal margin, darkest at tip of marginal cell; basal margin of third and fourth abdominal and an oblique mark on sides of second segment, black." Length 13 mm. Habitat: Klamath county, Cal.

"Readily distinguished from all other species known to me by the ornamentation of the wings." [Cresson]

Genophion n. gen.

This genus is proposed to include certain forms remarkable for the development of the lower portions of the head, resulting in a very elongate face and considerable distance between the normal sized eye and the base of the mandible. This is specially marked in Genophion gilletti Felt, the generic type.

Table of species

a Wings fulvo-fuliginous .... gilletti Felt
aa Wings with a distinct fulvous tinge .... coloradensis Felt

Genophion gilletti n. sp.

This small form resembles O. coloradensis Felt, but may be easily separated from it by its shorter antennae, longer face and the dark fuscous coloration of the wings. It is described from one female from Colorado, no. 2565, kindly sent me by Prof. C. P. Gillette, in whose honor it is named.

Description. Dark ferruginous, with the head and thoracic sutures black and the wings tinged with dark fuscous. Wing spread about 18 mm, length of body 9 mm.

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[1]1878 Cresson, E. T. Acad. Nat. Sci. Phila. Proc. p.366.

Head large, face very long with a large, evenly rounded labrum; mandibles stout, bidentate, tipped with dark brown or black, and with black at the extreme base; clypeal fossae black and almost connected with the base of the mandibles by black impressed lines; antennae shorter than the body, stout and with the first joint of the flagellum much longer and more slender than the second; antennal fossae ringed with black and with a conspicuous, impressed, black area above; eyes rather small, distant from the base of the mandibles; ocelli glassy or black, the two lateral distant from the eyes and each connected therewith by a deep, impressed, black line. Thorax glassy with deeply impressed, jet-black sutures; mesothorax highly convex; scutellum and postscutellum prominent; metathorax smoothly rounded and with no well developed carinae. Wings distinctly fulvo-ferruginous; cubitodiscoidal nervure uniformly arching, not appendiculate; first recurrent nervure less than one fourth the length of the second; bulla of the second recurrent nervure close to the cubitodiscoidal nervure, and that of the latter distant from the second discoidal nervure by one half its length. Legs uniformly ferruginous, except the trochanter segments which are black at their base; claws pectinate; abdomen strongly compressed, first segment slender and gradually enlarging at its apical fourth.

Genophion coloradensis n. sp.

This is a small form having somewhat the general appearance of O. tityri Pack., but differing from it in a number of particulars. It is described from two female specimens in the collection of the United States National Museum.

Description. Ferruginous with the thoracic sutures black, wings tinged with fulvous, wing spread 20 mm, length 9 mm.

Head medium; face long; mandibles bidentate, tipped with dark brown or black; clypeal fossae deep, dark brown; antennae about as long as the body, the fossae at their bases well marked and ringed with dark brown. Eyes medium, distant from the mandibles. Ocelli glassy or black, nearly contiguous, distant from the eyes; thorax sericeous, with black sutures; mesothorax convex; scutellum and postscutellum prominent. Metathorax with three well developed carinae, one dorsal, two lateral, radiating from the insertion of the first abdominal segment. Wings subhyaline, with a distinct fulvous tinge, specially on the hind wings. Cubitodiscoidal vein variably appendiculate (in one only a notch and in the other well marked); first recurrent nervure less than one half the length of the second; bulla of second recurrent nervure near cubitodiscoidal nervure, that of the latter at proximal third of distance from the appendix to the second recurrent nervure. Legs light ferruginous, basal articulations variably marked with dark brown, claws pectinate. Abdomen strongly compressed, first segment slender, gradually enlarging at apical third.

Described from two females from Colorado.

INJURIOUS INSECTS

Chrysanthemum lace bug

Corythuca marmorata Uhler

Ord. Hemiptera *Family* Tingitidae

Members of this family have been characterized by Professor Comstock, in the following terms: "Dainty as fairy brides are these tiny, lace-draped insects. One glance at the fine, white meshes that cover the wings and spined thorax is sufficient to distinguish them from all other insects, for these are the only ones that are clothed from head to foot in a fine white Brussels net." This very fitting description applies to all members of the family, and where such insects are found on chrysanthemums, they are very likely to be this species. This group is not only unusual in appearance, but is also one rarely brought to the attention of the economic entomologist. This is particularly true of the species under consideration, concerning which comparatively little is known. It was described in 1878 from North Carolina but with no indication of its food habits. The next record appears in 1898 and relates to an attack the preceding year on chrysanthemums in Alabama.

This insect was brought to our notice last July by Mr Harry Blauvelt of Coeyman, who stated that it had caused considerable injury the past two or three years, and that he feared a repetition of the attack this season. His brother, Mr Egbert Blauvelt, observed that it bred abundantly on ragweed and also on some other which he was unable to identify. Specimens of the insect were colonized on potted plants and the accuracy of the complaint established beyond question. The little pests fed vigorously on the foliage, laid numerous eggs, many young developed and soon one plant after another assumed an unhealthy appearance and died. The attack was characterized in particular by a discoloration of the leaves accompanied by a dark spotting, due to excrement, and the cast skins of the young were also abundant. The general appearance of a badly infested leaf is shown on plate 3.

Life history. The breeding of this insect was placed in Mr C. M. Walker's charge, but owing to pressure of other work he was unable to give it all the attention desirable. He learned, however, that the eggs were laid on the underside of the leaf, being thrust under the epidermis along the larger leaves and veins, leaving only the small, yellowish, conical cap in sight. The eggs soon hatch and the young develop rapidly, since between June 11 and 23 a life cycle was nearly completed. The feeding of the insect causes white, irregular blotches to appear, and if the attack is at all severe, withering of the leaves. The various molts follow each other quickly and the cast skins soon become so abundant as to give the impression of a bad infestation, whereas only a few bugs may be present. The insects are very active and pass readily from one plant to another, though none of the adults were observed to fly.

Description. This species has been the object of considerable study, and the following descriptions and the original illustrations were made under our direction by Mr C. M. Walker. It is believed that all stages are described below though they were not obtained by close breeding.

Egg [pl.4, fig.1]. Length about .5 mm, width .25 mm. Ovate, somewhat fusiform; visible tip truncate, collared, within which is a small, yellowish, ridged conical cap which is displaced by the young when it emerges.

Stage 1. Length .5 mm, breadth one third of length; antennae stout, with numerous long spines; three segmented, the terminal segment being about twice the combined length of the first and second. Legs stout, and about as long as the insect. There are simple spines arising directly from the body [pl.4, fig.2*b*], and also much shorter, compound ones originating from cone-shaped bases [pl.4, fig.2*a*]. Each abdominal segment bears on its lateral margin a single somewhat trumpet-shaped, compound spine on a conical base [pl.4, fig.3]. Two oval openings occur on the dorsal line of the posterior margin of the third and fourth abdominal segments. These may possibly be analogous to the odoriferous glands which occur in certain other species of Heteroptera.

Stage 2 [pl.4, fig.4]. Length 1 mm, width .4 mm. Form broader in proportion to length than in the first stage, and the legs are much shorter. The chief difference between this and the preceding stage, is in the size and number of spines. The dorsal, compound spines, which in stage 1 arose from conical bases, have become much thickened, taper to a point and are about one fourth the length of their bases, which latter are enormously developed and thickly studded with chitinous projections [pl.4, fig.5*a*]. The long simple spines arising directly from the body, are shorter and their bases narrow [pl.4, fig.5*b*]. The marginal, compound spines of each abdominal segment have lost all resemblance to their previous form. Their rugose, spined bases have become thickened and are about twice the length of the spine, which latter is narrowed to a sharp point.

Stage 3. Length 1 mm, width .5 mm. The terminal segment of the antenna is about two and one half times the combined length of segments 1 and 2. In this stage the compound dorsal spines mentioned in the preceding have apparently suffered little change, but their bases have increased five times the length of the spines, and are correspondingly stouter and rougher [pl.4, fig.7*a*]. The simple spines situated near these latter have not changed much, though they are somewhat longer than in stage 2 [pl.4, fig.7*b*]. The bases of the lateral abdominal, compound spines are four times the length of the spines [pl.4, fig.8*a*], which latter have not changed in appearance. Contiguous to these, singly or in pairs, are other shorter compound spines on conical projections about twice their own length [pl.4, fig.8*b*].

Stage 4 [pl.4, fig.9]. Length 1.5 mm, width .75 mm. Form ovate, tapering anteriorly. Head nearly as wide as long, obtusely rounded with the lateral margins behind the eyes arcuate, hind angles rounded. Antennae four segmented, segment 3 a little longer than the fourth, which is about equal to the combined length of 1 and 2, the last being about one half the length of the first. Rostrum stout, dark at tip and extending to about the base of the first abdominal segment. Head, bearing four groups of compound spines on tubercles or bases of varying size and length arranged as follows: a median pair at the anterior margin; three directly back of these, the central one being smaller; two groups of five of various lengths, each a little behind the eye and halfway between the median line and the lateral margin. A long simple spine is also found at the base of each of these groups.

Prothorax tapering anteriorly, three times as broad as long; with two median pairs of grouped compound spines at about equal distance from the anterior and posterior margins, the anterior pair with two smaller spines at their bases. Laterally there is a group of three compound spines at the apical angle of the prothorax, the central one largest, and another of five at the posterior angle, three being much larger than the others. The wing pads are seen for the first time and extend to the anterior margin of the second abdominal segment. There are two sublateral groups, each consisting of two compound spines, one larger, one smaller and a simple one, near the posterior margin of the mesothorax. The anterior lateral margin is armed with a stout spine similar to that on the preceding segment, and on the posterior angle there is a group of five compound spines similar to those on the prothorax.

The abdomen consists of 10 segments, numbers 2 and 3 having a single lateral spine, while segments 4 to 8 are each ornamented with lateral groups of three compound spines [pl.4, fig.10], one being nearly twice the length of the other two. Segment 9 bears only one on each side. There is also a slender, hairlike spine of considerable length at the base of each group of spines on segments 2 to 8. Segments 2, 5, 6, 8 and 9 each bear a median pair of long, stout, compound spines [pl.4, fig.11*a*], each of which, with the exception of those on segments 2 and 9, has a simple spine at its base [pl.4, fig.11*b*]. The so called odoriferous glands appear as in the younger stages on the dorsum of the third and fourth segments. Certain extremely minute projections, with enlarged extremities are scattered over the body, arising directly from its surface. There are also more numerous chitinous points generally distributed and which give the body a brownish appearance.

Stage 5. Length about 2 mm, width nearly 1 mm. The first two segments of the antennae are about equal in length. The third is longest and not quite twice the length of the fourth [pl.4, fig.13]. The wing pads extend to the fifth segment of the abdomen, which latter is nearly fusiform, tapering anteriorly from the extremity of the wing cases. The dorsal spines are relatively much larger and more specialized and the lateral groups on the thorax and abdomen, excepting the last segment of the latter, are distinctly pediceled [pl.4, fig.12]. This is also true of the anterior median pair of the prothorax, which almost coalesce, and of the median pair of the mesothorax.

The original description of the adult is as follows: "Form smilar to that of T. a r c u a t a Say. Body black, the humeral region and pleural margins sometimes paler, or piceous; the venter polished, minutely, transversely wrinkled. Bucculae highly elevated, white; antennae slender, the apical joint sometimes dusky. Pronotal vesicle high, extending far forward, regularly arching over the head, abruptly compressed anteriorly for more than half its length; the meshes large, two larger ones occupying the basal breadth; the nervures more or less embrowned, that of the middle carinate, much elevated, entire.

Most of the nervures with short spines, which in some specimens are obsolete. Lateral lobes of pronotum short, prominent, semi-circular, having the same curve anteriorly as posteriorly; narrower than the base of the hemelytra, with large, rather regular cells; the nervures of the middle tinged with brown; a brown spot exteriorly and sometimes a second spot at the posterior margin; the marginal spines long and slender. Processus divided into cells as far as the tip; only the base of the lateral margin elevated, the middle carina high, not so high as the pronotal vesicle, gradually declining to the tip, the base arched, bearing two large areoles surmounted by a series of smaller ones, the upper edge spinous. Raised margin of the sternum whitish, the metasternum circular, auriculate each side. Legs pale honey yellow, embrowned at tip and on the tarsi. Hemelytra rather quadrangular, with the basal angles very acute, very widely removed from the pronotal lateral lobes, the basal margin distinctly concave; lateral margins spinous until a little beyond the middle, the tips widened, bluntly, broadly rounded; areoles large, next to the apical series is a transverse row of three or four very large ones, usually connected with another large one in front exteriorly; vesicular elevations small, with a high carina, spinous, bearing posteriorly a brown spot; a brown spot exteriorly near the basal angle, another submarginal near the middle, and a broad brown band at tip which omits the subapical series of large areoles.

Length, 3 mm. Breadth at base of hemelytra, 1½ mm."

Remedies. This little pest being a sucking insect, can be controlled only in two ways. Clean culture will probably prove the most effective method of checking its depredations, since it would mean the destruction of weeds and various plants on which the insect could breed. There is little probability of the pest developing in large numbers if the vicinity of a chrysanthemum field is kept clear of weeds. The pest may be severely checked, if not nearly destroyed by thorough spraying with a whale oil soap solution, using 1 pound to 9 gallons of water, according to Mr Egbert Blauvelt. It is very probable that pyrethrum powder, or better still, hellebore could be used wherever a limited number of plants require treatment.

Bibliography

1878 **Uhler, P. H.** Bost. Soc. Nat. Hist. Proc. 19:415-16 (Original description)

1898 **Howard, L. O.** U. S. Dep't Agric. Div. Ent. Bul. 10, n. s. p.99 (Injuries in Alabama)

NOTES FOR THE YEAR

The season of 1903 has been marked in particular by an unusually severe outbreak of plant lice of various species, some of which continued their depredations over an abnormally extended period. These insects were so destructive and generally present on various plants in different sections, that observations relating thereto have been grouped under a separate head. Species depredating on other plants and products of value, have been grouped under convenient headings for the purpose of facilitating ready reference to the various accounts.

Plant lice

The season of 1903 may well be remembered on account of the exceeding abundance of these little insects, particularly of species of economic importance. This is an exceedingly interesting group, and their almost absolute helplessness and enormous prolificacy illustrate one of nature's provisions against the extermination of a species. Despite their apparent weakness, these little creatures are well able to hold their own, as many farmers know to their cost. This group is at present represented in America by the relatively large number of 325 species, as given by Professor Hunter in a recently issued list.

The conditions which control the abundance of these forms are not well understood, though in all probability they are largely climatic, supplemented by the beneficial work of various natural enemies. Some believe that dry weather is favorable to the increase of these little insects, and others attribute their abnormal development to a certain amount of moisture. It is very probable that a protracted dry spell, if not accompanied by excessive dust, is favorable to the development of a large number of species, and that violent rains at intervals, specially if they occur before the foliage is curled by the work of the pests, is very destructive to these little creatures. On the other hand, it is quite possible that a certain amount of moisture is desirable, and that the reports of certain persons, who have noted a coincidence between the appearance of rains and the development of these forms, may be correct.

It is undoubtedly true that natural enemies, prominent among which are ladybugs, syrphus flies and lacewing flies, serve as very useful checks on this interesting group of insects. Repeated observations in different countries, and extending over a series of years, have demonstrated that these insects multiply enormously during periods when plant lice are unusually abundant, and though it may require some time for the natural enemies to overtake their hosts, this is bound to occur in course of time.

The attack of 1903 was not only characterized by excessive severity but also by an undue prolongation; and this latter may have been in part due to unusual rains, which were not favorable to the comparatively unsheltered natural enemies and hindered their gaining an ascendancy over their hosts. The explanation for this is that the plant lice, before the appearance of the rains, had ample opportunity to curl the leaves and therefore provide themselves with shelter from almost any inclement weather. These retreats afforded admirable breeding places from which the insects could emerge and attack adjacent foliage, so that the usual destructive influence of showers would be modified to a considerable extent; on the other hand, the larger predaceous enemies would hardly reap an equal benefit from this protection, and consequently would be delayed in gaining the ascendancy.

Appletree plant lice (Aphis mali Linn. and others). These species commonly occur in greater or less numbers throughout the orchards of the State, and their abnormal increase depends on favorable climatic or other conditions. Such was characteristic of the spring and early summer of 1903, and as a result injuries by these species were not only much more marked than usual but also prolonged to a much later date. The worst affected trees, which were usually young, presented a very characteristic appearance, and the injury was so severe that very little growth was possible. Such a large amount of honeydew was excreted that the foliage was almost entirely blackened, and an examination of many trees showed that the growing tips were literally covered by hungry plant lice anxious to reach a tender spot. The severity of the attack began to be evident about the last of May, and was more so in June, continuing in July, and in some cases at least the plant lice were extremely abundant even to the middle of August. The worse infested trees lost a considerable portion of their foliage; the development of the fruit was severely checked in some instances and many trees were seriously injured. Complaints were received from a number of correspondents in different sections of the State, and almost every observer agreed in holding plant lice responsible for severe damage. Some quince bushes in Genesee county were reported by Mr J. F. Rose as bearing a mass of black, rolled leaves the latter part of June, and the observer in Dutchess county characterized the attack as being more severe than had been known for 10 years. The conditions in the nursery were no better than in the orchard, and a correspondent reports that plant lice obliged him to keep a gang of 15 or 20 men and boys at work continuously in the nursery with a whale oil soap solution, and some other nurserymen found themselves almost unable to cope with the insects, so severe and general was the injury.

Plant lice, as is well known, must be controlled by the use of contact insecticides, the most valuable of which for present purposes are a whale oil soap solution, tobacco water and kerosene emulsion. Some growers prefer the tobacco solution to any other and attribute greater effectiveness to it, while others have obtained excellent results with a whale oil soap solution. The latter, in the case of the appletree plant louse, should be used at a strength of 1 pound to 6 gallons of water, or even 1 to 4, and in any case great care should be exercised to secure thorough treatment. The kerosene emulsion may be used in the same way as the whale oil soap solution, and in case of severe attacks the standard emulsion may be diluted with but 6 or 7 parts of water, since it is better to scorch the foliage a little than to allow many of the insects to escape.

The severe and protracted injuries by plant lice led us to experiment with whale oil soap solution, 1 pound to 4 gallons, for the purpose of testing its effectiveness on the pest and also the liability of injuring the foliage. Apple twigs covered with the insects were dipped into the solution July 28, and on the 30th it was found that all were killed, while repeated observations up to Sep. 8 failed to reveal any injury to the leaves. We are, however, inclined to believe that it is more important to make a very thorough application than to use a strong insecticide, and would therefore emphasize the former most strongly.

Cherry plant louse (Myzus cerasi Fabr.). This common species is likewise generally distributed throughout the State, and always occurs in greater or less numbers on cherrytrees. The past season has been marked by an excessive abundance of this insect, and in some cases sweet cherrytrees have been very seriously injured. We recall, for example, certain trees in Chautauqua county, which were so badly infested, that nearly one third of the leaf-bearing portion of twigs had the foliage so badly affected that it curled, died and dropped, and after a time new leaves were developed in their place. This injury was so great that one or two trees died, probably as an indirect result of the severe drain made on their vitality. The presence of these plant lice in large numbers began to be apparent the middle of May and continued through June and even into early July. Reports of injuries were received from a number of counties in widely separated sections of the State, and were also observed by us in various localities.

Thorough spraying, as in the case of other species, is the only method of controlling this insect, and when applications are necessary they should be timely so that the insects can not curl leaves and thus obtain shelter from the spray.

Cabbage aphis (Aphis brassicae Linn.). This species is usually present in small numbers on various cruciferous plants, and only occasionally does it attract much attention on account of its abnormal abundance and consequent injury. Mr J. F. Rose of South Byron states that about the middle of August it was so abundant on early cabbages as to give them a white appearance, and Mr George S. Graves of Newport, Herkimer co., reports it as being numerous on turnips in early August. This species was observed by us in very large numbers on rape at Kinderhook the early part of the season. The insects were so abundant as to give a whitish color to portions of the plant and rendered walking through the field extremely disagreeable.

Chaitophorus aceris. The Norway maple has enjoyed up to recent years comparative immunity from insect pests, and it was therefore a serious disappointment to its admirers when this species of plant louse injured it so seriously in the last two or three years. The damage by this species has gradually increased, and whereas in 1900 or thereabouts many of the trees had their foliage somewhat disfigured by the sooty fungus growing in the honeydew and drops of this sticky substance occasionally fell on passersby or moistened the sidewalk beneath, in 1903 some of these unfortunate trees had their foliage almost ruined by this pest. Many of the leaves were so badly curled that they presented only about one fourth of the usual surface, and this maple instead of being an object of beauty, was a monument of misery and an eyesore on the landscape. This was true not only about Albany but in various sections of the State. This plant louse can be controlled by thoroughly spraying with a contact insecticide, such as whale oil soap, taking special pains to hit the insects on the undersurface of the leaves, and it looks as though some such treatment would have to be adopted in coming years if we are to keep this shade tree in good condition. This species was the cause of more complaint and incidentally gave more employment to parties operating a spraying outfit in Troy, than even the notorious elm leaf beetle (Galerucella luteola Müll.).

Elm aphis (Callipterus ulmifolii Mon.). This delicate species occurs somewhat generally on our American elms, and occasionally becomes exceedingly injurious, as was demonstrated in 1897 and again in 1903. This little plant louse was so abundant on many trees during the past summer that the foliage became badly smeared by the honeydew, lost its color and all but failed to perform its proper functions. This condition was somewhat general in the vicinity of Albany, at Palatine Bridge in the Mohawk valley, and a similar state of affairs was reported from Ogdensburg, St Lawrence co. The most of the damage appears to be inflicted in the latter part of June and during July.

Drepanosiphum acerifolii Thos. This delicate and really beautiful species when examined under a magnifying glass, is capable of causing considerable injury to various species of maple. Its work on hard maple was observed by us last July at Nassau, where it evidently caused considerable dropping of the foliage, and the young were to be found here and there along the veins on the underside of the leaves. Nearly full grown specimens are remarkable for being incrusted with a whitish secretion which nearly covers them. This species was met with by us in considerable numbers on maples at Saratoga, where it has likewise caused some dropping of the leaves and injured the foliage to a considerable extent. It was also reported by Mr George S. Graves, as being on several varieties of maple at Newport, Herkimer co., where it caused much dropping of foliage, and it was observed by Mr Young in small numbers at Poughkeepsie.

Box elder plant louse (Chaitophorus negundinis Thos.). A number of specimens of what we believe to be this species, was submitted for examination by Mr George S. Graves of Newport, Herkimer co., who stated that it was exceedingly abundant and destructive to box elder or ash-leafed maples in that vicinity. The attack was first observed in early June and continued till September, possibly later. It is probably the same species which we observed at work in large numbers the latter part of September on some box eldertrees at Nassau.

Beechtree blight (Pemphigus imbricator Fitch). This plant louse was exceedingly abundant on some beechtrees at Newport N. Y. Our correspondent, Mr George S. Graves, sent examples under date of Oct. 29, and from the appearance of the twigs we judge that the insect was present in enormous numbers, and had the attack been earlier in the season, it would undoubtedly have caused considerable injury. Mr Graves observed the habit of this species of clustering on the underside of the twigs, and adds that moderately cold weather does not seem to affect them, since an inch of snow was seen on the hillside only a short distance away, and the temperature during the preceding two days had been quite cold.

Wooly beech aphis (Phyllaphis fagi Linn.). This insect has been unusually numerous on purple beech foliage in Washington park, where it was found in very large numbers, July 4. Its depredations on the same tree in Westchester county have also been brought to our attention.

Birch aphis (Callipterus betulaecolens Mon.). This little species is particularly injurious to the cut-leaved birch, and is occasionally very abundant. It was reported as being quite destructive at Newport, Herkimer co., by Mr George S. Graves, and evidences of its work were found by Mr Young at Poughkeepsie in the middle of July. The latter trees showed very plainly that the insect had been exceedingly abundant, since the foliage was badly discolored and well smeared with honeydew. We also observed the work of this insect in the vicinity of Albany, and specimens of very badly infested twigs were submitted for examination by Mr E. P. Van Ness of East Greenbush. In this instance, as in the preceding, the attack was a very severe one and the tree had undoubtedly suffered greatly throughout July, if not earlier in the season. Some of the leaves bore a number of pupae of the two spotted ladybug, Adalia bipunctata Linn., which had evidently fed on the plant lice, and reduced their numbers very largely.

Pemphigus popularius Fitch. This species is rarely brought to notice, though a few infested leaves of the balm of Gilead, Populus balsamiferus, were received from Lake Clear Junction through Mr C. R. Pettis. The leaves were drawn together and had much waxy matter on their surfaces, giving them the appearance of having been coated with a whitish powder. In some instances the insects formed a series of pseudogalls on the upper side of the leaves. The cavity produced by drawing the leaf together contained numerous winged plant lice, a few nymphs and many cast skins. Mr Pettis states that all the trees in the vicinity were affected by this species. Another poplar-infesting species, Chaitophorus populicola Thos., was met with in considerable numbers on the common aspen at Karner, July 24.

Fruit tree insects

Plum curculio (Conotrachelus nenuphar Herbst). This little enemy of stone fruits is prevalent to a greater or less extent in most orchards of this State, and occasionally causes considerable injury. It is remarkable for existing in some localities in such small numbers as to cause practically no damage, while in others a large proportion of the crop would be ruined unless collecting or other repressive measures were employed. Recent experiences by several growers in the State, go far toward showing that thorough and early spraying of the foliage with an arsenical poison affords considerable protection from this pest. This method is preferred by many to the more laborious one of collecting the beetles and is certainly worthy of further trial.

Diplotaxis liberta Germ. This species is rarely brought to notice on account of its depredations and the same is true of its allies. A complaint was received Sep. 24 through the commissioner of agriculture from Mr John R. Crandall of Hauppauge, who stated that this beetle had stripped all the foliage from many young peachtrees in an orchard of about 30 acres. He added that they worked at night, burying themselves in the dirt under the trees during the day, and that anywhere from 10 to 50 were found under each tree, apparently preferring Elbertas. The beetles occurred nowhere except in the peach orchard. This insect is closely related to our common May or June beetles and presumably has similar habits, the larvae probably living on grass roots and undoubtedly thriving best in light, sandy soils. Reference to literature shows that another species, D. frondicola Blanch., was recorded in 1871[1] as being very injurious in June to leaves of rose, mountain ash and wild plum in an Iowa nursery. They were about nearly a month, feeding only at night, and were considered one of the worst pests of that year. An attack similar to the one we have recorded occurred in the spring of 1888,[2] at Herndon Va. in a young orchard which had been mostly planted the preceding year. The 12-spotted Diabrotica, Diabrotica 12-punctata, was the principal depredator, though a species

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[1]Kridelbaugh. Ia. State Hort. Soc. Rep't 1871. 1872. p.161.
[2]Riley-Howard. Insect Life, 1:59.

of Diplotaxis was also present in small numbers. The plums and apricots near an old melon patch where the Diabrotica had bred were soon stripped of foliage and the insects spread over nearly the entire orchard. Another species of the same genus, D. harperi Blanch., was reported May 24, 1894,[1] as injuring strawberry plants at Campbellsburg Ind. The account states that they attacked the smaller and weaker plants on a 2½ acre field and very quickly destroyed them. As many as 20 beetles or over were found at a time on a single plant. The insects appeared first in some wheat and when that became too tough migrated to the recently set strawberry field. The soil was a light, clayey loam and paris green was applied but without benefit.

These little scarabaeids are difficult insects to control and in a general way may be classed in this respect with the closely related and well known May or June beetles, Lachnosterna, and rose beetles, Macrodactylus subspinosus Fabr. Anything that tends to make the foliage distasteful to the insects, such as dusting with air-slacked lime, wood ashes, etc. has some protective value, but comparatively little benefit results from spraying with an arsenical poison. It is possible that collecting the insects by jarring into a curculio catcher might prove of some value. This would have to be done in the evening when the beetles are on the trees, and in all probability it would require considerable shaking to dislodge them. The injury to the foliage late in the fall is of comparatively little importance compared with depredations in the spring, and apparently there is a prospect of this species causing some injury at that time, in which event it would pay to go to considerable expense in collecting the beetles or employing some other means to destroy them, so as to prevent severe injury to the trees by the destruction of fruit and leaf buds early in the season.

Appletree tent caterpillar (Malacosoma americana Fabr.). This insect is more or less injurious each year, and during the present season has not been very destructive, though somewhat abundant in various localities, specially where no effort has been made to control it. The injury, as a rule, has been less than

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[1] Davis. Insect Life, 7:199

in the last two or three years, except in Cattaraugus county, where this species is reported as having increased very largely in the last two or three years.

Codling moth (Carpocapsa pomonella Linn.). It is well known that the larvae of this insect pass the winter in considerable numbers under the sheltering bark of trees, and that they gnaw pupal cavities in the outer dead bark. Our attention was recently called to a somewhat anomalous situation and an examination showed that a small tree had been badly injured by borers in preceding years and that codling moth larvae, descending the tree in the fall, had entered the galleries made by the borers and in excavating pupal cavities had not refrained from eating into living tissue where they caused considerable bleeding and at first sight lead one to suspect that the injury was due to the round-headed borer. The tree in question has a trunk about 6 inches in diameter and some 12 or 15 larvae were taken from several of the cavities. Three or four of the caterpillars were found contiguous to living tissue which had been recently eaten and from which considerable sap was flowing. The borings were conspicuous and many of the pellets were saturated with exuding sap.

Pear Psylla (Psylla pyricola Forst.). The season of 1903 has been remarkable for the unusual development of plant lice, and this little jumping species is no exception to the general rule. It has been exceedingly abundant and destructive over a considerable portion of the State, and peartrees with blackened, scanty foliage or almost none at all, were common sights during the summer not only in the Hudson river valley but also in central and western New York. The injury was much more general and severe than has been observed before, and the explanation therefor is probably found in the unusually favorable climatic conditions. Evidences of great damage began to appear in June, and during July and August the affected trees presented a truly wretched sight. In some cases the injury was so severe that most of the fruit dropped. Mr H. D. Lewis of Annandale reports the crop of that section a failure, due to the work of this pest.

Early and thorough spraying with a whale oil soap solution, 1 pound to 4 gallons, has been found thoroughly effective in the hands of Mr Albert Wood of Carleton Station, who states that he has succeeded in keeping the insect well in subjection by this means. Thorough work in the early part of the season will do much toward preventing subsequent injuries, and if the necessity arises of repeating applications, much better results will be obtained if the work is done just after a rain, which serves the useful purpose of washing away the honeydew and therefore exposing the growing insects to the deleterious action of the insecticide.

San José scale (*Aspidiotus perniciosus* Comst.). This pernicious insect has become so abundant in some orchards in the State that its control is a serious problem, and anything bearing on its habits and disseminative powers is of interest. The latter part of the summer was marked by the development of very large numbers of insects, the breeding being so rapid that in some places the bark of entire trees was covered.

The rapidity of its spread in a locality is of great importance, and is undoubtedly influenced by a number of factors. In the first place, there is no doubt that the spread is much more rapid where the pest is allowed to breed unrestricted than in localities where such is not the case; for example, the scale has been in the large orchard of Mr W. H. Hart of Poughkeepsie for 13 years, and yet it has failed to spread to any great extent, portions being practically free from it even after the lapse of years. A close examination of the center of infestation existing at Clinton Heights shows that while the insect has been present there for about the same time there has been no extensive spread. The primary point of infestation is a little to one side of the center of an isosceles triangle, which has an altitude of ¾ mile. This is bordered on one side by a public highway and on the other by a trolly line. Several contiguous orchards lie within this area, and the pest has gradually made its way from one to the other, though the spread has by no means been rapid. Aside from the point of original infestation, the injury to the trees has not been very marked, in fact, the spread through these small orchards has been so slow that those in the point of the triangle, less than half a mile from the original infestation, are still free from the pest. An examination of orchards just across the highway from near this center, failed to reveal any scale. It should be stated in explanation, that while the insect was allowed to breed in considerable numbers from about 1897 to 1899, since then earnest efforts have been made to keep it in check, and as a general thing, it has been controlled in a fairly satisfactory manner. It is true that there is one point of infestation a half mile southwest of the source of trouble, but investigation shows that in all probability the scale became established there by being carried on infested trees which were set in that vicinity.

Investigations and inquiries in a peach-growing section, where the scale had become established in a few places 3 or 4 years ago, reveals the fact that the pest has already obtained a foothold in some orchards from ½ mile to 2 miles or thereabouts from others, and in this instance we are inclined to believe that these colonies established at a distance are due to the fact that no very adequate control of the insect has been maintained. It may also possibly be explained in part by the fact that young scales are fully as likely to crawl on peach foliage as on that of other fruit trees, and it would therefore stand a better chance of being conveyed by insects or birds.

New York plum scale (E u l e c a n i u m j u g l a n d i s Bouché). This species is well known as a very destructive form to plumtrees in western New York, where it has at times been exceedingly injurious. Our attention was called in August to a plumtree at Kinderhook N. Y., which had the undersides of its branches literally covered with full grown scale insects and a great many young were found beside the parents. The tree itself had suffered serious injury though there were no signs of any numbers of the pest on those adjacent. This insect, as is well known, can be readily controlled by spraying in the fall or early spring with a contact insecticide, such as kerosene emulsion or whale oil soap solution, and we see no reason why the lime-sulfur wash, if it is to be employed in the orchard, would not be as efficacious in killing this species as it is in the destruction of the San José scale.

Plum mite (Phytoptus phlaeocoptes Nal.). The presence of this little mite on plumtrees at Marlborough, was brought to our attention some years ago, and an examination the present season shows that it exists in the locality only in very small numbers, and as a consequence is hardly likely to become a pest of any importance. The owner has cut down the original tree and anticipates very little trouble in the future.

Grapevine pests

Grapevine sawfly (Blennocampa pygmaea Harr.). The larvae of this species were met with rather plentifully July 28 in the vineyard of Mr W. H. Van Benschoten, West Park N. Y. Tips of shoots, here and there, were partially defoliated, but in no instance was material injury caused. The larvae are usually rare in New York State vineyards, so far as our observations go, and in case of their appearing in very large numbers, they should be controlled by thorough spraying with an arsenical poison.

Steely flea beetle (Haltica chalybea Ill.). This pernicious Chrysomelid is well known to grape growers, and in some vineyards in the Chautauqua region it has caused considerable injury year after year; particularly is this the case with certain vineyards located well up on the hill and back from the lake. The greatest damage is done by the beetles feeding on the unfolding buds, and the best method of checking the injury is undoubtedly by very thorough spraying or even painting the unfolding foliage with a strong arsenical mixture, particularly paris green or london purple, because these substances act more quickly than does arsenate of lead.

Grapeberry moth (Polychrosis botrana Schiff.). This insect was not only destructive in Chautauqua county but developed in such large numbers in some Ohio vineyards as to destroy one third of the crop as reported by Mr T. S. Clymonts. Our experiments have shown that one thorough spraying with an arsenical poison, preferably arsenate of lead, just after blossoming, will result in severely checking this pest [*see* New York State Museum Bulletin 72].

Garden insects

Asparagus beetle (Crioceris asparagi Linn.). The common asparagus beetle as recorded in our 15th report, page 540, has attained a wide distribution over the State, though our records limit it almost entirely to the lower Hudson and Mohawk river valleys and the western portion of the State in the vicinity of the lakes. We were therefore somewhat surprised to receive a communication from Mr C. L. Williams of Glens Falls, Warren co., accompanied by specimens, stating that this species had become well established in that vicinity and was known to occur in some numbers over an area several miles in extent. This is the northernmost locality known to us, for the species in New York.

Cabbage maggot (Phorbia brassicae Bouché). This little pest of the market gardener was unusually abundant and destructive this season. Its depredations on early cabbages attracted considerable attention in Genesee county, it was credited with having destroyed one fourth of the crop in St Lawrence county, and with working to some extent in Cattaraugus county and other sections of the State. The life history of this little pest may be summarized briefly as follows: the adult insects appear in the early spring, the precise time depending somewhat on climatic and other conditions. They are, however, usually abroad in time to deposit eggs around early set plants, finding some crevice in which they may creep and place their eggs close to the stem. These remain unhatched for a period variously stated as from 4 to 10 days when the young grubs issue, attack the surface of the root and rasp a burrow into its tissues. They destroy first the smaller rootlets and then begin operations on the main root. They are frequently found in slimy burrows just beneath the surface of the stem. There are usually so many maggots that all are unable to find retreats within the tissues, and consequently many of them lie near the surface, which is kept moist by the juices from the injured parts. The wilting of the plant is the most characteristic indication of injury and on pulling it up, the remains of the roots and the whitish, slimy maggots are easily observed.

One of the best methods for protecting cabbage plants from this insect is to surround them with a tarred paper collar about $2\frac{1}{2}$ inches in diameter, which is so cut as to practically encircle the stem. These are readily adjusted about the plant, easily cut and form one of the most efficient methods of preventing the parent fly from depositing its eggs.

A carbolic soap emulsion composed of 1 pound of hard soap dissolved in a gallon of water, in which 1 pint of crude carbolic acid is then poured, emulsified and diluted with 30 parts of water, is very efficient in killing the maggots about infested plants. An application should be made shortly after the plants are set out, and repeated once a week or 10 days till after the middle of May. The standard kerosene emulsion diluted with 12 to 15 parts of water has also proved very successful. Either may be readily applied with a knapsack pump. It is possible to check the attack, where labor is cheap by removing the earth from the affected parts in the morning of a bright day and replacing it at night. The drying kills the maggots without injury to the plants. This is practised to some extent on Long Island, as stated by Mr F. A. Sirrine.

Onion maggot (Phorbia ceparum Meigen). This serious pest of market gardeners has, like its close ally, the cabbage maggot, been very injurious in portions of the State, particularly in St Lawrence county where it is credited with having destroyed one fourth of the onion crop. It has also caused considerable complaint in the vicinity of Albany.

This insect, so far as known, has a life history very similar to that of the cabbage maggot, and may be controlled in like manner, except that it is impracticable to use the tarred paper collars though the carbolic soap wash can be employed to very good advantage.

Tarnished plant bug (Lygus pratensis Linn.). This notorious and almost ubiquitous pest occurs on a great many plants and causes more or less injury from year to year. Last July our attention was again called to it on account of its sucking the juices from tender aster shoots and thereby killing them. Mr Egbert Blauvelt of Coeyman, who made the complaint, states that the insects can be killed by thoroughly spraying with a whale oil soap solution, using 1 pound to 9 gallons of water. Clean culture, not only in the garden but in adjacent fields, will do considerable toward reducing the numbers of this pest.

Grain and house pests

Saw-toothed grain beetle (Silvanus surinamensis Linn.). This little grain beetle is a common species in prepared foods and various grains and though occasionally very abundant, it does not as a rule cause much annoyance in this country. This species was found last August literally overrunning a dwelling house in Albany. The beetles were so numerous that they made their way into everything and the housekeeper could sweep up nearly a pint almost every warm day. They were found in all parts of the dwelling, resting on ceilings, crawling on walls, under mats, tablecloths etc. and even invaded wearing apparel, articles of food, etc. Investigation showed that the source of the trouble was several thousand bushels of oats in the bin of a near-by brewery. The insects were breeding there very rapidly and on warm days appeared in large numbers and invaded near-by dwellings. The best remedy for such an outbreak is fumigation of the grain with carbon bisulfid and similar treatment of the dwelling houses or better still fumigating them with hydrocyanic acid gas. This latter, however, is a very dangerous poison and must be handed with extreme care.

Fleas. The cat and dog flea (Ceratopsyllus serraticeps Gerv.) is a well known pest of domestic animals, and in the public mind is associated only with these animals. There are a number of records of this species propagating to a marvelous extent in houses closed for the summer, and the occupants on opening them in the fall would find their premises literally overrun by these annoying, active and most hardy pests. This has been the experience of several Albanians in the past summer, and the most practical way of ridding the house of these vermin is by thorough fumigation with hydrocyanic acid gas, using 1 fluid ounce of sulfuric acid diluted with 2 fluid ounces of water and 1 ounce of high grade (98%) cyanid of potassium for every 100 cubic feet of space. A preliminary fumigation using half the above amounts and continuing the treatment two hours killed practically all the Psocids in the house and many fleas, while the usual amounts with a six hour fumigation destroyed all the fleas. The acid and cyanid are among our most deadly and virulent poisons and the same is true of the generated gas. Before treating, the house should be first carefully examined and every orifice or crack which would allow the egress of air should be carefully stopped. All fluids and liquid foods should be removed from the house and arrangements made so that the building can be opened from the outside after fumigation. The gas is generated by dropping the cyanid in large earthenware vessels containing the proper amount of diluted acid. It will be found advisable to have one or two of these jars in each room or hallway, and so arrange matters that the cyanid while still in the bag, can be dropped into one vessel after the other very rapidly, or else with a series of strings, dropped into all of the vessels at once. After the charge is set off the house should be carefully guarded so that no person can enter, and if it be in contact with others in a row, those in adjacent dwellings should also be warned so that the rooms next the treated building may be well aired during the fumigation, which should last from one to several hours. The building should then be thoroughly aired by opening doors and windows from the outside, and utmost pains taken to free the house of gas before any one be allowed to enter. The airing should last at least 30 minutes, and it will be preferable to extend this time to one, two or even three hours, dependent somewhat on the size of the building and the facilities for ventilation. One treatment should be sufficient but in the case of poorly constructed houses a second fumigation may be necessary a week or 10 days later. This dangerous operation should be attempted only by those fully conversant with the nature of the materials with which they are dealing.

Shade tree and forest insects

Elm leaf beetle (Galerucella luteola Müll.). This species has won for itself a very bad reputation in the Hudson river valley on account of its extensive injuries to elms, particularly the European species. It is still extending the area of its operation. Last year it was detected in a limited portion of Saratoga Springs, and this season we were sorry to observe that it had spread over practically the entire village and would have caused material injury to the shade trees had it not been for the systematic and continued spraying conducted by the village authorities. An examination July 16 showed that the grubs were full grown in that locality and that many had pupated. We are inclined to believe that the second brood, if any, would be very limited in that section. This species has also been reported as present in very large numbers at Schuylerville, only a short distance from Saratoga Springs. It has become established over a considerable portion of Schenectady, where it is causing considerable injury and is likely to inflict more in the next year or two unless adequate measures are taken for its suppression. This insect as noted in Museum bulletin 64, has obtained a foothold at Ithaca N. Y. and we are in hopes that it will not be allowed to inflict serious injury on the beautiful trees of that city as it has on those of some others in the State. A detailed account of this species appears in Museum bulletin 57.

White marked tussock moth (Notolophus leucostigma Abb. & Sm.). This common enemy of shade trees annually attracts more or less attention on account of its ravages in different cities of the State, in spite of the fact that it is a comparatively easy one to control, not only on account of its eggs being deposited in conspicuous masses which may readily be removed from trees, but also because it is easily destroyed with arsenical poisons. In our preceding report we chronicled the abundance of this insect in Buffalo, and the present season has been marked by a repetition of the injury, though the attack was not so severe as that of the preceding summer. The causes for this latter condition may be in part due to repressive measures adopted by citizens of that city, but on the whole we are inclined to believe that natural enemies or unfavorable climatic conditions were the most potent factors in reducing the numbers of this pest. The condition of the trees in that city is a most effective argument in favor of establishing a paid forester or other official whose duty it shall be to look after the street trees as well as those in the parks and see that they are adequately protected from insect ravages. This matter is one of increasing importance, as our cities are growing rapidly in size, and as a consequence there is a greater massing of foliage and therefore more favorable conditions for the development of large numbers of a species. It requires but a few years for insects to destroy a tree which may have been from 10 to 50 or more years in growing, and in cities where this is allowed a deterioration of real estate values must follow, accompanied by an increase of various diseases and a higher mortality, because of the rapid and extreme temperature changes due to the absence of trees.

This pest can be easily controlled in either one of two ways. Many of the caterpillars can be jarred or brushed from the infested trees, and their ascent prevented by the use of a band of loose cotton tied around the tree or a band of tar on a piece of stout paper, the latter to prevent injury to the tree. Both of these materials are very effective, and in our judgment vastly superior to the brass bands seen on the trunks of so many shade trees in Buffalo. Bands, however, are of value only in keeping the caterpillars off the trees. The jarring of the pests is somewhat laborious, and as the insects are readily detroyed by spraying with an arsenical poison a prompt application of some such material to the foliage is advisable. Arsenate of lead is one of the best poisons. It may be applied at the rate of 4 pounds to 50 gallons of water. Use this insecticide only in the prepared paste form, diluting to the proper extent, and under no conditions purchase the crystalline article. The older standard poisons, paris green, london purple and similar preparations are very effective, though subject to washing by rains. These latter substances should be used at the rate of 1 pound to 100 gallons of water, with 1 pound of recently slaked lime to protect the foliage from burning. Spray thoroughly in any event and aim to cover so far as possible every leaf with the poison. Protective measures should be adopted early or the injury will be beyond repair. It is hardly necessary to add that it is impossible to grow magnificent trees if they are defoliated year after year, as unhappily seems to be the case in some cities in recent years.

Fall webworm (Hyphantria textor Harr.). This species appeared rather early in the season on various forest and fruit trees in different sections of the State, and in certain localities was somewhat abundant and destructive. Generally speaking it has not caused serious injury except in a few localities where no effort was made to check it. This species, like the two tent caterpillars, is readily controlled by spraying with an arsenical poison, and its conspicuous web nests, which serve as a retreat for the caterpillars, are easily removed from the tree and the inmates destroyed by crushing or burning.

Forest tent caterpillar (Malacosoma disstria Hübn.). As noted in our preceding report, Museum bulletin 64, page 104, the ravages of this pest are on the decrease, and the present season has witnessed practically no injury by this insect. A few caterpillars were observed in Rensselaer and Columbia counties but in no instance coming to our notice was a tree even partially defoliated. A lack of reports from other sections of the State indicates a like gratifying condition, and we are in hopes that this outbreak is practically ended and that the species will be comparatively innocuous for a number of years.

Walnut worm (Datana integerrima Grote & Rob.). The work of this insect is more or less evident each year, particularly in the western part of the State, and during the past summer our attention has been called to its ravages in Herkimer county, and we have observed a number of black walnut trees in Chautauqua county which have been from one half to two thirds or entirely defoliated by this caterpillar.

Beneficial insects

Chinese lady beetles (Chilocorus similis Rossi). The specimens obtained from the United States Department of Agriculture through the kindness of Dr L. O. Howard, and liberated in East Greenbush in August 1902 failed to survive the winter. A second shipment of 25 was received Aug. 13, 1903, again through the generosity of Dr Howard. These specimens were set at liberty at Kinderhook N. Y. on the estate of Mr L. L. Morrell, who is a large fruit grower. The tree selected was a large appletree badly infested with San José scale, near the barn and on the edge of the old orchard, close to his young pear orchard. There is an abundance of scale on the old trees, as well as on the young, and Mr Morrell has consented to refrain from treating these, in order to give the imported beetles an opportunity to demonstrate their value.

An examination Sep. 23, 1903, of the appletree where these insects were placed last August showed that eggs had been laid and a number of young were easily found. Four adult beetles, probably descendants of those originally established and nearly 20 larvae of varying size, from very young to nearly full grown, were found in the center of the tree. This is a quite large one and is very badly infested with the scale and there is every probability that there are many more ladybugs on it and near-by trees than were discovered, though a brief search failed to reveal any on the latter. The examination was purposely limited because of the difficulty of detecting the insects and the danger of crushing them in crawling about on the limbs. It certainly looks as though this introduction had been fully as successful as that of the preceding year and it is most earnestly hoped that some will survive the winter, in which event we may be able to demonstrate the utility of this insect in our climate.

Little black lady beetle (Pentilia misella Lec.). This little lady beetle is usually found toward the end of the season in orchards infested with San José scale, and we have on several occasions recorded its presence in some numbers. Anything relating to the abundance and effectiveness of predaceous insects is of interest, and it is gratifying to state that in October we found this little species, far more abundant than we had observed it before, in a badly infested peach orchard in Orange county. The little beetles were so numerous that 20 or 25 could easily be counted on a small portion of the trunk of a peachtree, and undoubtedly some of them bore from one to several hundred of these little lady beetles. They were crawling actively over the infested tree and evidently looking here and there for insects suitable for their needs. It is a source of regret to state that in spite of the great abundance of these little lady beetles, there appears to be no very material diminution in the numbers of the scale insects, which literally swarmed on many of the trees. The worse infested ones were more attractive to the lady beetles than the others. We have yet to meet evidence showing that this species is very efficient in reducing the numbers of this scale insect.

EXPERIMENTAL WORK AGAINST SAN JOSÉ SCALE INSECT

The control of this pernicious insect is a problem of considerable importance in localities where it has become established. This work was begun by us in 1900, primarily for the purpose of testing the effectiveness and possibilities of crude oil applications. Our results show that a mechanical emulsion of this material can be used, and if great caution is exercised in its application, comparatively little or no injury follows. So many, however, have met with such ill success that we have also experimented to a considerable extent with other materials, specially since in the last year or two we have observed some evidences of injury to the bark after the application of oil. This first appears as an enlargement of the lenticels, which is evidently followed by a great increase in thickness and a very rough, unsatisfactory condition of the bark, and this has led us to question the advisability of continuing such applications year after year, and also to make further tests of materials which were free from this objection.

Early spring or winter applications

20% mechanical crude petroleum emulsion. The work with this insecticide was continued the present season in the experimental orchard, the application being made Mar. 3, to about 70 trees representing a number of the more common varieties. It will be observed that the spraying was earlier than usual, and the weather conditions favorable, the day being dry with only a moderate amount of wind. This insecticide was applied as in the spring of 1902, to the following trees: numbers 15-28, 34-47, 60-74, 79-91 and 101-14; or in other words, to the western end of the experimental orchard, a map of which was published in our report for 1900. The general character of the trees and their varieties have been previously published, and may be ascertained by referring to the above publication. Tests of the mechanical dilution were made while the work was in progress with the following results: at tree 18 slightly less than 20%; at tree 39, 26%; at trees 45 and 46, 31%; at tree 84 slightly less than 20%, and at tree 101, 33% of oil. The above figures represent more variation than is desirable, and yet, so far as we were able to see, the trees suffered very little from the treatment. Inspection a few days after showed that all were well covered with oil, though in some cases where the bark was quite rough, it is probable that there were scales which escaped.

Examination of these trees the latter part of July showed that while a number of them were rather badly infested by living young, a great many were relatively free. The following were rather badly infested: trees 15, 16, 22, 38, 41-44, 73, 79, 82 and 86. The foliage on tree 101 was light in color, small in size and the growth only fair. It looked as though it had suffered some injury, and undoubtedly the petroleum had hurt the bark to some extent. This injury was also noticeable to a lesser extent on some other trees, the most common indication being much enlarged lenticels, which seemed to be followed by an excessive development of outer bark and a corresponding roughness, so that trees in this condition presented a somewhat bad appearance.

A general examination of the experimental orchard Sep. 25, showed that the section sprayed with petroleum emulsion was generally in much better condition than that treated with the lime-sulfur wash. A few of the trees in the petroleum section, notably 23, 41 and 75, were badly infested by numerous living young which had evidently developed within the last two or three weeks.

The ultimate effect of successive applications of crude petroleum to various fruit trees is of some interest, and on this account we purposely made annual applications to certain trees, and an examination of them is not without interest, since while it shows some injury, the damage is not so serious as it first appeared. For example, tree 101, a seckel pear, was very badly infested in 1900, when it was sprayed with undiluted petroleum and seriously injured. The following year it was treated with a mechanical mixture consisting of 15% oil and a whale oil soap solution, 1 pound to 4 gallons, and in the spring of 1902 and of 1903, with 20% mechanical emulsion. The tree at the outset, as above noted, was in poor condition. It has been steadily improving, and last December had developed a large amount of new wood, and during the present season has made a fair growth, though the foliage is rather light in color and less than normal size. Tree 114, a pear of the same variety, received undiluted crude petroleum in 1900, but was not injured so seriously as 101. Each subsequent year it has been sprayed with a mechanical crude petroleum emulsion and is now in a vigorous condition and in much better state than three years ago, though the roughness of the bark on the trunk is becoming more pronounced. Tree 69, a Howell pear, was sprayed in 1900 with the whale oil soap and petroleum combination, and with mechanical petroleum emulsions the three succeeding springs, and is now in as good condition as others which have not been subjected to annual applications of oil. The same is practically true of tree 66, a Bartlett pear. Other instances might be cited, but enough has been given to show that ordinary fruit trees can stand at least four applications in successive years without much injury. The benefits resulting from this treatment in the vicinity of Albany, as compared with those accruing from the lime-sulfur combinations, were so marked that the owner has repeatedly urged us to apply the oil to the entire orchard, because the lime-sulfur wash had not proved satisfactory in controlling the scale. It is only fair to add that much better results have been obtained with this latter insectide in some other portions of the State.

Lime-sulfur washes. Early experiments with this material were so unfavorable, that it was supposed to have no value in our eastern climate, though it had been used with great success in California. The matter was revived in later years, and recent tests have shown that under certain conditions, at least, very large proportions of the scale have been killed by the use of this insecticide. Our applications last year were somewhat unfortunate, in view of the fact that we failed to kill a satisfactory proportion of the insects, and in this respect our results were somewhat different from those obtained by other experimenters. The treatment was followed by continued heavy rains, and this, with oil from applications the preceding year may account for the noneffectiveness of the wash. Further experiments were conducted the present season for the purpose of testing the value of the preparation more thoroughly, and also for determining, if possible, the best wash to be employed. The early spring experiments were at Clinton Heights, and at Warwick. Two formulas, in particular, were tested: one which may be known as the 30-30-30 combination to 100 gallons, and the other the 40-15-20 to 60 gallons. Both gave excellent results at Warwick, where conditions were almost ideal for careful experimentation, and a modification possessing some advantages was also employed. This latter consists of 25 pounds of lime, 20 pounds of sulfur to 60 gallons of water. Unfortunately the experiments at Clinton Heights though carefully performed failed to yield the results we desired, partly on account of unfavorable conditions due to very large trees with rough bark being the only ones available. In our experimental orchard at Clinton Heights an application of lime-sulfur, using a 30-30-30 formula, was made to the same trees treated in this way the preceding year, and we regret to state that the results were not very satisfactory, though the application was more successful than that of 1902. The spraying was followed immediately by some snow and rain, and while this may have had a detrimental effect, it does not account entirely for the failure. It is possible that the extremely rough bark on certain trees sheltered some of the scale insects from the application, and consequently it was only a short time before the trees were restocked by breeding. An interesting series of experiments was conducted at Warwick, the essential details of which are given in the table on page 156. Owing to difficulties in application etc., it was not always possible to regulate closely the period of boiling, and while our intention was to rigidly test the long and the short boil in each formula, as a matter of fact there was some variation as will be seen on consulting the table. The destruction of the scale, however, was all that could be expected, and it is very gratifying to state that Mr W. H. Hart of Poughkeepsie, whose large orchard is infested with this pest, was able by the use of a wash composed of 30 pounds of lime, 20 pounds of sulfur and 15 pounds of salt to 60 gallons of water to keep the insects in subjection in a very satisfactory manner indeed, though some of his trees were of considerable size, being 18 to 20 or more feet high. Mr Hart was careful to have the application made in the most thorough manner and he took pains to always work with the wind when spraying, and in this manner was able to obtain a maximum efficiency with a minimum amount of labor. Comparisons on trees which were sprayed on only one side gave most gratifying testimony to the efficacy of the wash, the treated portions being practically free, while the untreated were almost covered with the pest. Ben Davis seems to be much more susceptible to the scale than the Thompkins County King. Mr Hart is of the opinon that a small amount of rain, particularly a mist for a day or two immediately after spraying, is of value because it brings the caustic wash into more intimate contact with the scale. Mr L. L. Morrell of Kinderhook has also had excellent results from use of a lime-sulfur wash and the same is true of Edward Van Alstyne of the same place.

It is undoubtedly true that considerable variation is allowable without materially influencing the value of the application. A large amount of lime probably has some value because it forms a thicker coat over the branches and is therefore a more efficient mechanical barrier in preventing the establishment of young scale

Warwick experiment, applied March 25-27

Wash	COMPOSITION AND PREPARATION							PROPERTIES				Weather
	Lime	Salt	Sulfur	Resin	Copper sulfate	Water	Boil	Color	Sediment	Adhesiveness	Results	
1	30 lb	30 lb	30 lb	0	0	100 gal.	1½ hr	Dark amber	Very little	Good	Very effective, checking breeding almost entirely and probably killing most of the females	Cloudy with strong wind Fair, few days following
2	30 lb	0	30 lb	0	3	100 gal.	1 hr	Dark amber, bluish tinge	Very little	Good		
3	30 lb	0	30 lb	0	0	100 gal.	1½ hr	Dark amber	Very little	Good		
4	30 lb	0	30 lb	0	0	100 gal.	½ hr	Light orange	Little	Fair		
5	30 lb	0	30 lb	12 lb	0	100 gal.	45 min.	Dark amber	Some	Very good		
6	40 lb	15 lb	20 lb	0	0	60 gal.	1 hr	Amber	Little	Good		
7	40 lb	15 lb	20 lb	0	0	60 gal.	35 min.	Amber	Little	Good		
8	40 lb	0	20 lb	0	0	60 gal.	1 hr	Amber	Little	Good		
9	40 lb	0	20 lb	0	0	60 gal.	½ hr	Amber	Little	Good		
10	40 lb	0	20 lb	8 lb	0	60 gal.	40 min.	Amber	Much	Good		
11	25 lb	0	20 lb	0	0	60 gal.	2 hr	Amber, greenish tinge	Some	Good		
12	25 lb	0	20 lb.	8 lb	0	60 gal.	1 hr	Amber	Much	Fair		

insects. If too much lime is used it is liable to scale off; consequently there is a limit to the amount which can be employed, and for various practical reasons we are inclined to believe that 25 pounds of lime, 20 pounds of sulfur to 60 gallons of water is a very good proportion. The lime probably aids materially in holding the sulfur and its sulfids (which latter are undoubtedly among the most valuable constituents of the wash), and thus adds to the efficiency of the insecticide by preventing to some extent leaching of its active ingredients. Our experiments fail to indicate the necessity of prolonged boiling insisted on in so many formulas. In fact, it seems as though active boiling for 30 minutes meets every requirement. A wash prepared in this manner appears to be just as effective as one which has been boiled for a much longer time. Salt increases the specific gravity of the liquid and thus undoubtedly aids in keeping the solids in suspension, but so far as chemical action and insecticidal properties are concerned, it appears to have no value, and the same is true of its effect on the adhesive qualities of the wash. So marked is this that we have omitted it from the composition of the wash because of its very problematic value. We are still of the opinion that climatic conditions have considerable influence on the effectiveness of this insecticide, and believe that it should be applied when the trees are dry or nearly so, and that, in order to obtain satisfactory results, no large amount of rain should fall within three or four days after the spraying. This insecticide gives very good results wherever it can be applied thoroughly and has the advantage of being cheaper than any other winter wash, though it is decidedly more injurious to apparatus and exceedingly disagreeable to apply.

The resin solution [*see* p. 160 for preparation] was added to several of the washes in hopes that it would materially increase their adhesiveness and likewise their insecticidal properties, because such seemed to be the case in some preliminary indoor experiments. Field tests, however, failed to indicate any great advantage resulting from the addition of this material, except perhaps in the case of rains immediately following the application. It affected the washes by making them more or less flaky, increasing the amount of sediment, and if much more had been added it would probably have seriously affected the operation of the pump. This material, if used, must be thoroughly diluted with warm water before being added to a cooler lime-sulfur wash, or it is likely to give trouble by gumming up the apparatus.

Summary. Our experience and experimental work may be summarized briefly, as follows:

A mechanical 20% crude petroleum emulsion is a very effective insecticide, and if the pump can be relied on to deliver a constant proportion, there is very little danger of much injury from several annual early spring applications. There is, however, some doubt as to the ultimate result, and the continued use of this material causes increased thickness and roughness of the bark, if no other injury.

Early spring applications of whale oil soap solution, even if only 1¼ pounds be used to a gallon, will control the insect in a very satisfactory manner, provided the spraying is thorough. We are by no means certain that this can be done on large trees, particularly those with rough bark.

The lime-sulfur combination is steadily gaining favor in the eastern states, and under certain conditions, at least, is fully as effective in checking the scale as either crude petroleum or a whale oil soap solution. Our experiments lead us to believe that 25 pounds of lime and 20 pounds of sulfur to 60 gallons of water, are equally as effective as larger amounts, and we believe it to be an advantage to have a little more lime than sulfur. We fail to see any beneficial results from the use of salt in this combination, and therefore have omitted it; and in our experience, active boiling for 30 minutes, if the lime is slaked in hot water and the sulfur added at once, gives just as effective a wash as one which has been boiled for one and one half or two hours.

In conclusion, the experience of Mr Hart and other up to date fruit growers, has demonstrated not only the possibility but the practicability of keeping this insect in control in an ordinary commercial orchard. Our observations show beyond doubt, that this scale insect is a very serious enemy, and unless efficient measures are promptly adopted for its suppression, very great injuries may be caused.

Summer washes

This pernicious insect breeds with such extraordinary rapidity during the summer, that ordinary applications of whale oil soap or kerosene emulsion are not entirely satisfactory, since at the strengths usually employed only the crawling young and smaller scale insects are killed. It frequently occurs that an infestation is discovered in midsummer and the owner wishes to do something at once. The unsatisfactory results with the above named washes led Mr P. L. Huested, nursery inspector of the Department of Agriculture, to experiment with a mechanical 20% crude petroleum emulsion, which was applied in July with a kerowater sprayer to peachtrees. A test of this material was made in a very badly infested orchard in the summer of 1902, and beyond causing some of the foliage to drop where it was the thickest, particularly in places where a 25% emulsion was used, as was the case in certain areas, no serious injury to the trees followed the treatment. The results were so satisfactory that the same course was pursued last summer with equally gratifying effect so far as injuring the trees was concerned, though at the time it did not appear as if the application was effective enough in killing the scale. Subsequent observations, however, have shown that it was more beneficial than at first supposed. In spite of this, we still feel some hesitancy in recommending this treatment in summer, except, perhaps, where the pest is breeding in very large numbers.

This condition of affairs led us to undertake a series of experiments for the purpose of ascertaining if it were possible to make some combination which, while not injuring the foliage, would remain on the trees and be effective for some weeks after application, and at least kill the crawling young as they came from under the protecting scales of the females. The late Professor Lowe conducted some experiments along this line, and our work has been a continuation of that with modifications. It appeared to us as though a lime-sulfur combination, possibly without boiling, could be made of a proper strength so that it would kill a large proportion of the younger scales, and we were in hopes that it would be powerful enough to destroy individuals emerging from females several weeks after application. The basis of these experiments was a standard wash which we had used the preceding spring with very gratifying results on dormant fruit trees. This wash contained 25 pounds of lime, 20 pounds of sulfur to 60 gallons of water. It was diluted to various strengths, and an effort made to ascertain whether boiling for 15 or 30 minutes had any material effect on the efficiency of the wash. In addition, a resin solution was used, which is prepared as follows: dissolve 3 pounds of sal soda in 3 quarts of water and add thereto 4 pounds of resin and boil till dissolved. While hot, make up to 5 gallons and keep boiling till the resin is well in solution. The resin was added simply to increase the adhesiveness of the wash, in hopes that if this were done the efficiency of the combination would be materially increased. In a few instances the lime-sulfur combination was used with the bordeaux mixture for the purpose of testing the value of this combined wash. The preparation and application of the washes was the work of Assistant C. M. Walker, who is also responsible for many of the field observations. The following table gives in a summarized form the various ingredients of the different washes and their effects on trees and scale and also the conditions under which they are applied. These experiments were conducted in our experimental orchard at Clinton Heights near the western boundary of East Greenbush.

Table of summer washes

		COMPOSITION AND PREPARATION								PROPERTIES				
Series	Wash	Lime	Sulfur	Resin	Salt	Water	Boil	Bordeaux	Application	Tree	Adhesiveness	Effect on foliage	Effect on scale	Weather
1	1	25 lb	20 lb	4 lb	0	240 gal.	0	0	After 2 hr stand	Young apple	Very poor	Uninjured	Kills crawling young only	Applied June 22, fair, with heavy showers on few following days
	2	"	"	0	15 lb	"	0	0	"	"	"	"	"	
	3	"	"	4 lb	0	960 gal.	15 min.	0	"	"	"	"	"	
	4	"	"	0	0	"	"	0	"	"	"	"	"	
	5	"	"	0	0	"	30 min.	0	"	"	"	"	"	
	6	0	0	0	0	0	0	50 gal.	"	"	Fair	"	"	
	7	0	5	1	0	0	0	"	"	"	"	"	"	
	8	5 lb	5 lb	0	0	0	15 min.	"	"	"	Good	"	"	
	9	"	"	1	0	0	0	"	"	"	Fair	"	"	
2	1	25 lb	20 lb	4 lb	0	60 gal.	0	0	After 2 hr stand	Young apple	Very poor	Uninjured	Kills crawling young only	Applied July 28, fair, with continuous rains for a number of days following
	2	"	"	"	0	120 gal.	0	0	"	"	"	"	"	
	3	"	"	"	0	60 gal.	15 min.	0	"	"	Very good	"	"	
	4	"	"	"	0	120 gal.	"	0	"	"	"	"	"	
	5	"	"	"	0	240 gal.	"	0	"	"	Very poor	"	"	
	6	"	"	"	0	480 gal.	"	0	"	"	"	"	"	
										Peach		Slightly burned		

Table of summer washes (*continued*)

		COMPOSITION AND PREPARATION								PROPERTIES				
Series	Wash	Lime	Sulfur	Resin	Salt	Water	Boil	Bordeaux	Application	Tree	Adhesiveness	Effect on foliage	Effect on scale	Weather
3	1	25 lb	20 lb	4 lb	0	60 gal.	0	0	After 2 hr stand	Old apple	Very poor	Slightly burned	No scale present	Applied August 14, fair, and days immediately following. Rain Aug. 16–20
	2	"	"	"	0	120 gal.	0	0	"	"	"	"	"	
	3	"	"	"	0	60 gal.	15 min.	0	"	"	Very good	Badly burned, leaves off	"	
	4	"	"	"	0	120 gal.	"	0	"	"	"	Burned, leaves retained	"	
	5	"	"	"	0	240 gal.	"	0	"	Old apple	Very poor	Uninjured	"	
										Peach		Tips slightly burned		
	6	"	"	"	0	480 gal.	"	0	"	Old apple	"	Uninjured	"	
										Peach		Tips slightly burned		
4	1	25 lb	20 lb	4 lb	0	240 gal.	15 min.	0	Immediately	Pear	Very good	Slightly burned	75 % killed	Applied August 21, fair and immediate days
										Peach		Slightly burned	15 % killed	
	2	"	"	"	0	"	30 min.	0	"	Pear	"	Slightly burned	85 % killed	
										Peach		Slightly burned	40 % killed	

5	1	25 lb	20 lb	4 lb	0	240 gal.	15 min.	0	Imme-diately	Old apple	Good	Slightly burned	85% killed	Applied Sep. 4, fair, warm and 3 following days. Heavy rains in October
	2	"	"	"	0	"	"	0	After 2 hr stand	"	"	"	Kills crawling young only	
	3	"	"	"	0	"	30 min.	0	Imme-diately	"	"	"	No scale present	
	4	"	"	"	0	"	"	0	After 2 hr stand	Pear	"	"	30% killed	
	5	"	"	"	0	480 gal.	15 min.	0	Imme-diately	Plum	Fair	Very slightly burned	Kills crawling young only	
	6	"	"	"	0	"	30 min.	0	"	Pear	Very good	Uninjured	"	
										Peach		Tips slightly burned		

Series 1. Nine different washes were applied June 22 in this series, and observations made at intervals from June 26 to Sep. 28. Very small amounts were used and the solutions allowed to stand two hours. Different results might have been secured if larger quantities had been employed and applications made at once. The spraying was done with a fine hand atomizer and treatment limited to young, badly infested appletrees which bore all stages of the scale. These trees had been set out only a few weeks and consequently made little growth, though the foliage was in fair condition. The various washes did not injure the leaves, and it will be noted that washes 1 to 5, which were either unboiled or very dilute, adhered poorly, while 6, 7 and 9 containing bordeaux were better in this respect, and 8, which was boiled and also contained bordeaux, was much better. None could be distinguished on the tree 10 days after application. All washes killed the majority of the crawling young but did not prevent the development of established scales or the growth of young appearing after treatment. There was very little appreciable difference in the various washes, and on Sep. 8 all the trees were badly infested by all stages, crawling young being specially abundant.

Series 2. Six washes were applied July 28 in this series, and observations made from July 30 to Sep. 8. The washes were prepared in substantially the same manner as indicated above, and applied to the same lot of trees with the exception of a branch of a peachtree which was sprayed with 6. The condition of the foliage and scale infestation was identical with that in series 1, and the weather conditions were similar. Apple foliage was uninjured by any of the washes, but peach leaves were slightly burned at the tips by wash 6. Washes 3 and 4 were boiled 15 minutes, were more adhesive than the others, and Aug. 10 showed good color but on Sep. 8 no trace remained. The crawling young only were killed.

Series 3. Washes in this series were applied Aug. 14 and were similar to those of series 2. Observations were made from Aug. 17 to Sep. 8, and the conditions, preparation, etc., were practically the same as in series 1. The applications were confined to portions of old appletrees except in cases of washes 5 and 6, which were also applied to peachtrees. The scale infestation was slight and the weather fair immediately following the treatment. Appletree foliage was injured by wash 3, which caused the leaves to shrivel and fall off, and 4 burned them slightly. Wash 5 burned tips of peach leaves, and 6 had the same effect. Numbers 3 and 4 adhered very well for three weeks.

Series 4. The two washes used in this experiment were applied Aug. 21 and observations made from Aug. 27 to Oct. 20. Relatively large amounts were used and the applications made immediately after preparation. The cyclone nozzle used gave a somewhat coarser spray than the atomizer employed in the first three series. Pear, plum, peach and mulberry trees were used in this experiment and most of them were badly infested. The foliage was in good condition, the weather fair and remained so for a few days following the spraying. Plum and pear leaves were injured by wash 1, particularly in the case of a pear where the treatment was specially thorough. This latter dropped its leaves, while another, which received less of the mixture, did not, though the foliage was evidently injured. Wash 2 seriously injured peach leaves and caused slight burning of plum and mulberry foliage. Wash 1 adhered very well and was present in thick layers Sep. 8 and traces of color could be detected Oct. 20. The same was true to a lesser extent of wash 2. Oct. 20, number 1 had destroyed 75% of the scale on a peartree, and the foliage was slightly burned. A number of limbs were dying on the tree, which had dropped its lower foliage and on which the scale was entirely dead. Only about 15% of the scale had been killed on the living branches. Wash 2 killed 40% of the scale on one tree and about 85% on the other, which latter was in very bad condition.

Series 5. Six washes were applied Sep. 4, and observations made at intervals from Sep. 6 to Oct. 20. Small amounts of the washes were used and the same nozzle was employed as in series 4. Apple foliage was slightly burned by washes 1, 2 and 3, and pear leaves with wash 4. Plum foliage was injured very slightly by wash 5, and number 6 burned tips of peach leaves to a slight extent but did not injure pear foliage. Washes 1, 2, 3 and 4 adhered well, 5 and 6 more so, 6 in particular being thickly incrusted on limbs and foliage. Wash 1 killed 85% of the scale, and there was a marked contrast between sprayed and unsprayed branches. Wash 2 had no effect on the scale, while 4 killed 30%. The latter was boiled longer and this may account for its greater effectiveness. Variation in intervals between preparation and application appeared to have no effect on the adhesive or insecticidal qualities of these washes.

Summary. A mechanical 20% crude petroleum emulsion was applied in early July, two seasons in succession, to peachtrees without causing much injury beyond dropping some of the foliage where it was the thickest. It undoubtedly destroys a large amount of scale and seriously checks breeding, yet we hesitate to do more than state what it has accomplished. It is perhaps the best thing that can be used where a very bad infestation is discovered in midsummer.

A whale oil soap solution, 1 pound to 8 or 10 gallons; a kerosene emulsion (standard formula diluted with 6 to 10 parts of water), or a 15 or 20% mechanical kerosene emulsion can be used in midsummer for checking the San José scale, but none of these materials can be relied on to kill much more than the crawling young, and breeding is soon almost as bad as before the application unless treatments are frequent.

Our experiments with lime-sulfur combinations for a summer wash have not been as successful as was hoped, though 25 pounds of lime, 20 pounds of sulfur to 240 gallons of water with a 15 minute boil killed a large percentage of the scales on an old appletree in early September without materially injuring the foliage. It is barely possible that a combination of about this strength can be used with beneficial results, but nothing of the kind can be recommended till further experiments have tested its practicability.

DISEASED AND DYING TREES AND INSECT ATTACK

The connection existing between diseased and dying trees and insect depredations is not only one of interest, but also of considerable importance, since in some instances at least serious depredations have origin in a group of diseased or dying trees. It is well known for example that certain species exhibit a decided preference for trees in this condition, and when breeding therefrom in very large numbers are liable to attack healthy trees, if nothing more suitable is within reach. It is very likely for example that the more serious injuries by the elm borer, Saperda tridentata Oliv., and the elm snout beetles, Magdalis armicollis Say and M. barbita Say, begin in this manner. These three insects can at least complete their transformations in dead tissues and are known to work in those which are living, and it seems very likely that in some cases they first attack a sickly limb or tree, and then after becoming abundant are able to kill others which show no signs of lowered vitality. The same is true of certain bark borers belonging to the genus Tomicus which operate exclusively in coniferous trees. Our largest species known as the coarse-writing bark beetle, Tomicus calligraphus Germ., usually breeds abundantly in diseased bark and instances have come under our observation where this species not only ran a few galleries in living tissues, but evidently took part in a primary attack on a tree in apparently normal condition. It was assisted in this work by a smaller pine bark beetle, Tomicus pini Say, which operates in the thinner bark, about the middle portion of the trunk and on the larger limbs. This latter species very likely has more to do in killing trees than the form previously mentioned, but evidence at hand indicates that the larger as well as the smaller may have an important part in this destructive work when conditions are favorable. The destruction of trees by insects breeding from a few dying ones was well illustrated in the summers of 1900 and 1901, at which time a number of pines in the vicinity of Albany began to look unhealthy. Investigation showed that they were infested with bark borers, and later in the season of 1900 and the following many of the borers emerged from these dying trees and entered others, in which latter they were presumably the prime cause of death. The evidence at hand leads us to believe that in this case the bark beetles were primarily attracted to certain trees because of reduced vitality, possibly as a result of the excessive drouth of the preceding year, and that all subsequent injuries were due to their abnormal abundance; since they issued from the infested trees in swarms and attacked those adjacent, and the insects breeding from the latter in turn invaded others more remote from the center of infestation. The obtaining of data along these lines is somewhat difficult, since it is dependent on favorable conditions, and the following account of observations made during the past season has an important bearing on one aspect of this subject.

Forest fires and insect attack. The annals of entomology contain very little regarding the relationship existing between forest fires and insect attack, and the extended burnings last spring in the Adirondacks, presented a most favorable opportunity for studying this question, so far as fires occurring at that time of year are concerned. The principal object was first to secure data on the rapidity with which insect injury followed fire, and second to learn if there was a connection between extended fires and serious damage by insects in adjacent forests. It is very probable that the time of year when the fire occurs, has considerable bearing on the liability of insects entering the trees and breeding in large numbers, and the same is true of the character of the fire. A forest fire which not only kills but burns trees so badly that there is a rapid drying of those standing is much less likely to be followed by insect attack than one where there is only sufficient burning at the base to kill, specially if death is not rapid. Ap. 30, May 15 and June 3 there were somewhat extensive fires in the vicinity of Big Moose, and investigations by assistant D. B. Young, July 2, showed that insect attacks had become nicely started in the burning of May 15, more advanced in that of April 30, while practically no signs of insect presence were observed in that of June 3. This would seem to indicate that the trees are not attacked till from four to six weeks after the initial injury. Mr Young's investigations showed that trees entirely killed by the fire were less subject to attack than those which had been so severely scorched as to be nearly dead or in a dying condition. An examination July 3 of a large tract at Big Moose, which was burned over June 3 and was extinguished on the 18th, failed to show any insects working on these trees; in fact, within the fire zone they were scarce, only a few common moths and a lady beetle being observed; just outside this fire zone, where trees had been felled to keep the fire from spreading, a few spruce bark beetles, Polygraphus rufipennis Kirby had begun to attack the spruce. The trees were attacked in the following order: pine, spruce, tamarack, birch, hemlock, balsam, beech and maple.

Investigations by Mr Young on Aug. 12 of the area burned June 3 showed a remarkable scarcity of bark borers (scolytids) in the fire zone at Big Moose. This may possibly be explained by the fire occurring at a time when no brood of adults was able to take advantage of the favorable conditions, and it may also be that the injured trees were not attractive enough to the insects for some reason or other. In our own experience, we have come across several burnings where it would appear as though bark borers should be abundant, and yet examination has shown them to be present in very small numbers. The timber on the above mentioned area has been injured entirely by large buprestids mentioned in succeeding paragraphs, which cause comparatively little injury to the lumber. The section burned Ap. 30 was also examined, and the principal damage here had evidently been caused by the ambrosia beetles (mentioned in following paragraphs), since they operate in sapwood and produce the black pin holes which seriously affect the commercial value of lumber.

Pine. Investigations July 9 at Lake Clear Junction, where a fire occurred May 18, showed that the pine bark borer, Tomicus pini Say, was working in the living tissues of a tree which had been injured by the fire.

The work of this species should be followed soon by that of the sawyer, Monohammus confusor Kirby, or M. scutellatus Say, which begins its operations by depositing eggs in large slits in the bark. The grubs tunnel the inner tissues of the bark and in the course of a short time enter the sapwood and by winter probably pierce the trunk to a considerable depth, materially injuring the lumber for other purposes than firewood. Mr Young's investigations in both July and August disclosed no signs of injury by this species. Two specimens of Rhyncolus brunneus Mann. were taken by him July 9 at Lake Clear Junction from a pine injured by fire the previous year.

Spruce. This tree was first attacked by the spruce bark beetle, Polygraphus rufipennis Kirby, and the lined ambrosia beetle, Xyloterus lineatus Kirby. The former is a very common insect in the Adirondacks and undoubtedly causes a large amount of injury by killing trees, while the latter, working as it does in the sapwood and producing conspicuous black holes, seriously affects the merchantable value of considerable lumber. July 3 almost every spruce in the area burned Ap. 30 at Big Moose was attacked by these two insects, the first working near the top of the tree, while the latter operated in the lower portions of the trunk. Another ambrosia beetle, Gnathotricus materiarius Fitch, was also observed in small numbers in the base of one or two trees. On another section, where the fire occurred May 14, it was found that the spruce bark beetle, Polygraphus rufipennis Kirby, and the lined ambrosia beetle, Xyloterus lineatus Kirby, had just begun work, and a species of Chrysobothris was also met with on spruce. Burned areas in the neighborhood of Lake Placid were also visited, and it was found that on the section where a very severe fire occurred April 30, the insects began operations later than on the area burned over about the same time at Big Moose, where the fire was not so injurious to the trees. The fire at Lake Placid, occurring June 3, was less injurious than the one at Big Moose on the same date, and on July 9 the scolytids were just beginning to attack the spruce, indicating that trees which were merely scorched, but not so much as to kill them at once, are sooner attacked by insects.

Investigations of spruce Aug. 12 on the tract at Big Moose which was burned June 3 showed that trees giving no evidence of insect attack on July 3 were infested with the larvae of a buprestid, probably Chrysobothris scabripennis Lap. & Gory. This record is of interest as showing when the trees are likely to be infested by this class of borers, which operate largely in the sapwood and do not seriously affect the value of the lumber. This beetle was fairly common on standing but badly burned spruce. The buprestid showed a decided preference for larger trees, though those which were badly scorched so that the inner bark had dried were not infested. Two or three specimens of Xylotrechus undulatus Say were taken on spruce, and Phymatodes dimidiatus Kirby was also met with in sparing numbers. The bark borers noticed above had made considerable progress.

Tamarack. Investigations July 9 of a section burned May 14 at Lake Clear Junction resulted in finding a tamarack infested by a scolytid, possibly Tomicus pini Say. A specimen of Leptura, L. subhamata Rand., was also taken from a burned trunk.

Birch. The yellow birches at Big Moose on the tract burned over Ap. 30 were in early July, in many cases, slightly green at the top and were being mined by Dryocoetes eichhoffi Hopk.; specially was this the case where the trunks were scorched seriously enough to interfere with the circulation of sap. The common flat-headed borer, Chrysobothris femorata Fabr., was taken on a fallen birch. The pigeon tremex, T. columba Linn., was observed in small numbers on birch, but investigations showed that its attack was confined to more or less decayed trees. This insect was also met with under the same conditions on maple and beech trees. Birch trees were relatively free from insect attack in August, probably because the thin bark permitted rapid evaporation and the consequent drying was unfavorable for borers, through Dryocoetes had made considerable progress in the large trees.

Hemlock. The 6-spotted buprestid, Melanophila fulvoguttata Harr., was numerous at Big Moose July 3 in the burning of Ap. 30, on large hemlocks. Though they were somewhat green, none were observed on very small dead trees. A cerambicid, Xylotrechus undulatus Say, was observed in some numbers. Examination of these trees Aug. 10 resulted in finding some infested which showed no evidence of insect attack July 3, the larvae of Melanophila fulvoguttata Harr. probably being the principal offender. This is perhaps to be explained by this buprestid being on the wing mostly during July, and consequently there would not be a serious infestation till after the adults had flown for a period.

Balsam. Investigations July 2 on an area near Big Moose, burned over Ap. 30 resulted in finding several specimens of Chrysobothris pusilla Lap. & Gory on this tree, while C. scabripennis Lap. & Gory, were fairly common on the standing but badly burned balsams. Investigations Aug. 12 showed that the balsam compared with spruce was quite exempt from attack, probably due to the thinness of the bark and consequently quick drying of the sapwood. The lined ambrosia beetle, Xyloterus lineatus Kirby, was found in small numbers in July and its operations had progressed but little in August.

Poplar. Examinations July 7 of an area near Big Moose burned over May 14 resulted in finding a large species of Xyleborus in poplar.

Conclusions. Investigations the present season have shown that, while a number of insects are liable to attack burned trees within four to six weeks after injury, no very material injury is likely to result during the summer, except possibly from the work of ambrosia beetles. The other species either confine their operations so largely to the bark or else occur in such small numbers that for the present they may be neglected. The ambrosia beetles rarely extend their operations to a greater depth than 2 or 3 inches and as a consequence a considerable proportion of the lumber will be free of injury. This would hardly prove to be the case if the trees are allowed to remain standing a second season, at which time they will undoubtedly offer attractive shelters for a number of other borers, some of which may penetrate the wood to a considerable depth and damage it very materially for other than firewood purposes. While prompt cutting of burned timber is advised wherever practical, the evidence at hand is not sufficient to indicate any very urgent necessity of its being removed prior to the winter following the attack. The insects now in the burned trees (if the latter are allowed to remain) will probably appear another spring and be numerous enough to cause considerable damage at least to weaker trees in the vicinity of the burned areas, and their multiplication in such places may eventually lead to a considerable extension of the damage. This is particularly liable to be the case with evergreen trees, and in the vicinity of Albany we have observed several localities where bark borer attack appeared to start with one or more infested trees, and the affected area was gradually increased till a considerable number of pines were destroyed.

It is not only advisable to cut the burned trees so far as possible during the winter, but they should also be removed from the land or at least gotten into water, so that the insects now under the dead bark will be unable to emerge and continue the attack. The same end may be attained in the case of bark borers, and they are the ones most likely to injure standing trees, by peeling the bark from the logs. This will hardly be practised in this county, even if it were profitable—something requiring demonstration.

VOLUNTARY ENTOMOLOGIC SERVICE OF NEW YORK STATE

The work of the last four years has been continued and a number of valuable observations added to our previous reports. The season of 1902 was unfavorable for the development of certain forms of insect life, and the same has been true to even a more marked extent in 1903. The latter, however, will probably go down in history as a season when plant lice or aphids were abnormally abundant and injurious to a great many plants throughout the entire State. 36 voluntary observers were appointed during the season and but 21 of them rendered reports. This is largely due to the general scarcity of forms which lend themselves readily to observation, and the depredations of plant lice are so similar that most observers were unable to report on the outbreak in a satisfactory manner. It will be noted that the following reports contain some negative statements, which are of value because they emphasize the abnormal scarcity of various species. Too much dependence can not be placed on these reports, because with some exceptions they may be called local and not representative even of the county. It will also be observed that there are a number of conflicting statements, due to the belief by some parties that dry weather is favorable to the development of plant lice, while others state most clearly that the great increase in numbers of these pests was subsequent to the rains. It may be stated that we have not enough data to explain this difference and we are content at present to give opinions as they are transmitted. The observers all agree in reporting very cold, inclement weather in the early part of the season, and this undoubtedly had considerable effect in checking the appearance or in reducing the destructiveness of some of our more common injurious species.

Albany county [E. T. Schoonmaker, Cedar Hill]—Forest tent caterpillars (Malacosoma disstria Hübn.) hatched in limited numbers Ap. 23 and apparently have not suffered by the freeze. These insects caused practically no injury later in the season and consequently no report was made regarding the same. Elm leaf beetles (Galerucella luteola Müll.) occurred in limited numbers but were not abundant enough in the country to cause material damage.

Cattaraugus county [C. E. Eldredge, Leon]—Complaint of a looper caterpillar, probably a species of canker worm, was received June 10 with the statement that they had been observed on forest trees in that vicinity for several years, and that previously they had not appeared on appletrees. These insects were so near maturity that on June 17 no specimens were to be found. A soft scale (Lecanium ?pruinosum Coq.) was taken in some numbers from a trumpet vine. The unusually cold, inclement weather kept insects well in control, and as a consequence there was comparatively little to report from this section.—*June 10*

Cattaraugus county [F. A. Fitch, Randolph]—Appletree tent caterpillars (Malacosoma americana Fabr.) appeared the latter part of April and were very abundant in neglected orchards, increasing immensely in numbers during the last two or three years. Squash bugs (Anasa tristis DeGeer) ruined a crop of squashes in this section last year. Cabbage butterflies (Pieris rapae Linn.) appeared about the middle of May, and the same was true of May bugs, species unknown, and various mosquitos. The white grub of the May beetle has not been as destructive as in former years.—*May 18.* Potato beetles (Doryphora 10-lineata Say), grasshoppers and the plum curculio (Conotrachelus nenuphar Herbst.) made their appearance May 26. Early in June curculios were reported as being at work, potato beetles as laying eggs, and plant lice as being present on cherrytrees. The latter are the ordinary black species (Myzus cerasi Fabr.) which has been unusually destructive and injurious in various sections of the State. Squash bugs appeared June 18, horn flies (Haemotobia serrata Rob. Desv.) the second week in June, and rose beetles (Macrodactylus subspinosus Fabr.) were very abundant on some rose bushes. Potato beetles are somewhat abundant and are laying eggs on potatoes. So far this season insects appeared to be less injurious than usual, probably on account of cold rains. —*June 22.* Large, green horseflies are quite troublesome and young grasshoppers are numerous on lowlands. Insect depredations are less than usual.—*July 8.* There are few mosquitos in the village and on the farm we saw none where commonly there have been millions. Ditching the land has undoubtedly aided very much in reducing their number. Flies are also less abundant than usual.—*July 22.* The first cabbage butterfly was observed in the field Aug. 11. A single mosquito was observed recently, though none had been seen for weeks before. Cabbage maggots (Phorbia brassicae Bouché) are working to some extent on cabbage, and the same is true of the cabbage louse

(Aphis brassicae Linn.) Grasshoppers are scarce as well as most other injurious insects.—*Aug. 17*

Cayuga county [Purley Minturn, Locke]—Appletree tent caterpillars (Malacosoma americana Fabr.) were observed for the first time May 5. Farmers have begun spraying. Very few injurious insects appeared owing probably to the extremely cold and frosty nights.—*May 5.* Colorado potato beetles (Doryphora 10-lineata Say) are very plenty, and the small, black flea beetle (Crepidodera cucumeris Harr.) is at work on potatoes and also feeding on various weeds in the potato field.—*June 11*

Chemung county [M. H. Beckwith, Elmira]—Cabbage butterflies (Pieris rapae Linn.) appeared Ap. 23. The Indian Cetonia (Euphoria inda Linn.) was observed May 1, and appletree tent caterpillars (Malacosoma americana Fabr.) the 2d. The latter do not appear to be as numerous as usual at this season of the year.—*May 8.* Currant worms (Pteronus ribesii Scop.) appeared on gooseberries May 8, asparagus beetles (Crioceris asparagi Linn.) May 11 and potato beetles (Doryphora 10-lineata Say) were first observed May 16. There were at this time no depredations of special importance.—*May 25.* Plant lice have been very abundant on plum and cherry trees but since the rains they are less numerous. Potato beetles are not very abundant and their eggs are developing slowly.—*June 30.* This has been a most remarkable season for insect depredations, as there have been very few species observed during the protracted dry weather. Early in the summer plant lice were quite abundant on cherry and plum trees and threatened for a time to cause considerable injury, but the wet weather came soon enough to prevent any great damage. Currant worms were less numerous than last year and the second brood was very small. Potato beetles were less destructive than usual and occurred in very small numbers. Cutworms were quite numerous, yet they caused less damage to plants than usual. Tobacco worms (Phlegethontius 5-maculatus Hübn.) were very scarce, in fact, only two were met with this season, though much time was spent in tobacco fields. The striped cucumber beetle (Diabrotica vittata Fabr.) and the squash bug (Anasa tristis DeGeer) have been so few in number that their attacks were not noticed. The fall webworm (Hyphantria textor Harr.) was rather more abundant than last season.—*Oct. 8*

Dutchess county [H. D. Lewis, Annandale]—Appletree tent caterpillars (Malacosoma americana Fabr.) were first observed Ap. 20, and forest tent caterpillars (Malacosoma disstria Hübn.) on the 30th. A very few bud moth larvae (Tmetocera ocellana Schiff.) were observed May 1. Cold weather has kept insects in check and no species is remarkably abundant.—*May 4.* Tent caterpillars are, so far, much less abundant than for the past five years. The weather continues cold and dry and insects and fungi are developing slowly.—*May 12.* Tent caterpillars of both species are reported as causing some injury. Plant lice (Aphis mali Fabr. and Myzus cerasi Fabr.) are exceedingly abundant on apple and cherry trees respectively.—*May 27.* The latter have appeared recently and they are the only insects which are at all abundant. The weather continues cold and dry.—*June 1.* There is a great decrease in the number of caterpillars from last year and plant lice are exceedingly abundant.—*June 15.* Plant lice are still increasing and are the only insects which are of much importance. Tent caterpillars, both species, are not nearly so abundant as in former years. The weather is very wet at present.—*June 22.* Apple plant lice are present in enormous numbers and more abundant than they have been for 10 years. There are a few cutworms but other insects are scarce. The weather continues cold and very wet.—*June 25.* A very serious attack of pear psylla (Psylla pyricola Forst.) has developed within the last 10 days, and the crop will be seriously hurt. Apple aphis is still present in very large numbers, and potato beetles (Doryphora 10-lineata Say) are remarkable for their scarcity.—*July 10.* The apple aphis and the pear psylla continued in great abundance and have inflicted very serious damage, specially the latter. The weather has been very wet and cold since June 1, and apparently favorable for the development of the above insects. The peartrees have suffered extremely, all the young growth being killed, and they are now starting a new growth from next year's buds. This wood can not ripen and the results must be very injurious. We visited one pear orchard of 600 trees where Psyllas were still very active and attacking the new growth as fast as it appeared. The pear crop in this section is ruined.—*Aug. 10*

Erie county [J. U. Metz, Swormville]—Striped asparagus beetle (Crioceris asparagi Linn.) was observed today for the first time. We have not been able to find any of the spotted species (C. 12-punctata Linn.). Quite a little wheat is down but we have not been able to detect any work of the Hessian fly (Cecidomyia destructor Say).—*May 28.* Currant worms (Pteronus ribesii Scop.) were observed yesterday in numbers for the first time. Rose beetles (Macrodactylus subspinosus Fabr.) are exceedingly numerous and causing considerable damage. Both moth larvae (Tmetocera ocellana Schiff.) are quite numerous and causing some injury. Not a trace of Hessian fly has been observed. Many young shoots of blackberries are affected by the gouty gall beetle (Oberea bimaculata Oliv.). Potato beetles (Doryphora 10-lineata Say) are numerous on early potatoes.—*June 11.* Rose beetles are very numerous and in one instance were so abundant that some cherrytrees were literally covered with them and looked as though they had been scorched by fire; not only the foliage but also the fruit was affected, and the insects were not above eating the grass beneath the trees. Grapevines are also being injured to some extent by these pests.—*July 6*

Genesee county [J. F. Rose, South Byron]—Cabbage butterflies (Pieris rapae Linn.) were first observed May 6, and potato beetles (Doryphora 10-lineata Say) were first noticed May 7. Tent caterpillars (Malacosoma americana Fabr.) are scarce as yet. The extremely cold, inclement weather of early May has kept many insects in check.—*May 11.* Cabbage worms were first observed on plants the 22d. Asparagus beetles (Crioceris asparagi Linn.) are plenty. There are not many potato beetles as yet. Cigar case-bearers (Coleophora fletcherella Fern.) are very numerous in some orchards. Something has happened to tent caterpillars, as they are extremely scarce; so evident is this that it is a source of common remark. There are no evidences of injury by cankerworm.—*May 25.* The cabbage root maggot (Phorbia brassicae Bouché) is unusually numerous and very destructive to early cabbages. The four-lined leaf bug (Poecilocapsus lineatus Fabr.) is quite abundant and, as usual, is indifferent as to what kind of plant it attacks, occurring with great impartiality on burdock, peppermint, sage, currant etc. Cankerworms are very scarce in this immediate vicinity, but are reported as having done considerable damage in orchards between here and Rochester. In a trip to Niagara Falls I observed several orchards between LaSalle and that place, which were brown from the work of this pest.—*June 3.* There is practically no Hessian fly (Cecidomyia destructor Say) as after inquiry at a grange meeting, only one farmer reported any, and that was in a field of late sown no. 6 white wheat. A similar inquiry regarding cankerworms and tent caterpillars resulted in statements that very few or none had been seen. There is some complaint of plant lice on plum and cherry trees.—*June 15.* The black or cucumber flea beetle (Crepidodera cucumeris Harr.) is much complained of and has not only perforated potato leaves but is said to be at work on corn and beans as well as tomatoes. The striped cucumber beetle (Diabrotica vittata Fabr.) is very numerous on squash, melon and cucumber vines, nearly destroying them in some gardens. Following our severe drouth we have had three weeks of drizzling rain, and plant lice are very bad on fruit and other trees. We have never seen them on so many varieties of trees till this year. The young growth of quinces for 6 or 8 inches on each shoot is a mass of lice, and the leaves are blackened and rolled up. This plant louse outbreak has been exceedingly severe and injurious to a great many plants. There is a very general complaint among cabbage growers about the root maggot. The cabbage plant louse (Aphis brassicae Fabr.) is also abundant, curling the leaves and turning them blue.—*June 29.* Fall webworms (Hyphantria textor Harr.) appeared July 2 and are now quite numerous. The squash bug (Anasa tristis DeGeer) has not appeared. There was a fair crop of striped cucumber beetles and they have now disappeared. Cabbages are white with cabbage aphis. This is the first time this insect has been a serious pest in this locality. Plant lice are also exceedingly abundant on fruit trees. Pear psylla (Psylla pyricola Forst.) is very abundant and seriously injuring the crop.—*July 2.* Fall webworms are unusually numerous, and potato growers have had little difficulty in controlling the potato beetle. Cabbages are very seriously affected by the aphis. Not a squash bug has been seen.—*Aug. 17*

Greene county [O. Q. Flint, Athens]—No injurious insects have been observed except tent caterpillars (Malacosoma americana Fabr.), which appeared later than usual and are much scarcer at this date than has ever been known before. The weather was extremely dry and growers are spraying pear and plum trees.—*May 20*

Herkimer county [George S. Graves, Newport]—Black butterflies (probably Euvanessa antiopa Linn.), were observed for the first time Ap. 25, and the same is true of the cabbage butterfly (Pieris rapae Linn.). Cold winds and cloudy weather seem to have delayed the appearance of insects.—*Ap. 28.* Webs of the appletree tent caterpillar (Malacosoma americana Fabr.) began to appear Ap. 30 and were by no means abundant May 6. The weather has been too cold for any rapid increase in insect life.—*May 7.* Plant lice have appeared on wild cherrytrees, and the currant worm (Pteronus ribesii Scop.) is at work, both eggs and larvae being found. No nests of tent caterpillars have been observed this week. The weather is warm and dry.—*May 14.* Potato beetles (Doryphora 10-lineata Say) were observed May 16, and currant lice (Myzus ribis Fabr.) were just appearing on the leaves on the same date.—*May 21.* Black flea beetles (Crepidodera cucumeris Harr.) are appearing on potato leaves, and some insect is feeding quite generally on plantains, (very probably Dibolia borealis Chev.). Horn flies (Haematobia serrata Rob.-Desv.) are quite numerous on cattle. An examination shows that eggs of the currant worm are abundant. Elm foliage is full of holes, probably the work of larvae of the elm flea beetle (Disonycha triangularis Say).—*May 27.* Terminal leaves of elms are badly twisted and wrinkled by aphis attack, very probably Schizoneura americana Riley. Potato beetles are very rarely seen, though many eggs have been observed. The foliage of the few potatoes above ground is badly eaten by the black flea beetle. Nests of the appletree tent caterpillar are very scarce and with but few tenants. Currant aphis continues abundant.—*June 3.* Rose beetles (Macrodactylus subspinosus Fabr.) were observed for the first time on rosebushes June 4, and considerable damage has been inflicted. A species of plant louse (Chaitophorus negundinis Thos.) has appeared somewhat abundantly on the ash-leaf maple. Grasshoppers are becoming quite abundant in old pastures. The scarcity of potato beetles is cause for general comment, and the black flea beetles are exceedingly numerous on potato and tomato vines.—*June 10.* A few full-grown forest tent caterpillar larvae (Malacosoma disstria Hübn.) were observed. Spittle insects are uncommonly abundant on grass under a spreading shade tree. Rose beetles (Macrodactylus subspinosus Fabr.) are abundant on appletrees, on thorn apple, and very numerous on white daisy and dock. The daisy flowers are eaten off in many instances.—*June 17.* Potato beetle larvae were observed on one plant June 22, and a few striped cucumber beetles (Diabrotica vittata Harr.) were noticed on lima beans. The currant aphis (Myzus ribis Fabr.) is causing very little damage, while tomato and potato vines are considerably injured by the black flea beetle.—*June 24.* Currant leaves appear as though they had been eaten by the sawfly, though no larvae have been observed. The little plant louse (Drepanosiphum acerifolii Thos.) appears to be quite common on a number of varieties of maple and is causing some injury.—*July 1.* Black-headed cabbage worms (Evergestis stramenalis Hübn.) are causing some injury to turnips. Some caterpillars, probably fall webworms (Hyphantria textor Harr.) have appeared in small numbers on an appletree. Plant lice are abundant on many plants, such as apple, elm, box-elder, birch, wild cherry, burdock, pigweed and dock. Though potato beetles were never so inconspicuous, there are plenty of grubs.—*July 22.* The maple aphis (Drepanosiphum acerifolii Thos.) appears to be the cause of much premature falling of leaves, the pests being generally distributed, occurring even in the tops of trees 60 feet high. Plant lice have appeared in some numbers on red rose bushes.—*July 29.* There is apparently another brood of black-headed cabbage worms at work, if size is any indication. Plant lice (probably Aphis brassicae Linn.), are numerous on turnips. The appletree plant louse (Aphis mali Fabr.) is abundant and seriously injuring appletrees. The pests are specially abundant on new, tender shoots. Cherrytrees are very little affected, and plumtrees more so, but in the latter case black knot is also prevalent. Grasshoppers are generally scarce, though in a few localities they are abundant. Cabbage butterfly (Pieris rapae Linn.) has not been very abundant so far this season.—*Aug. 4.* A psocid (Psocus ? venosus Burm.) was found in clusters of 200 or more on the trunks of maple, and a few were also observed on appletrees. In some cases the bark of the tree seemed to be whitened as though it were partially eaten, probably by the insects gnawing away the lichens and outer portions of the bark. Larvae of the elm flea beetle (Disonycha triangularis Say) are very plentiful on elmtrees near by and have severely injured the foliage.—*Aug. 12.* A small, yellowish leaf hopper (? jassid) is abundant on beans and has apparently caused considerable yellowing of the foliage. Yellow-necked appletree worm (Datana ministra Drury) is present in small numbers, and the same is also true of the fall webworm. The brown and black woolly bears (Pyrrharctia isabella

Abb. & Sm.) were unusually numerous in a timothy field.—*Aug. 12.* Plant lice are numerous on beans, and on sunflowers there is a similar species. Codling moth larvae (Carpocapsa pomonella Schiff.) have begun operations, and wormy apples are not uncommon. Plant lice continue abundant on pigweed.—*Aug. 19.* Horn flies (Haematobia serrata Rob.-Desv.) and horseflies have been very troublesome for the past two weeks. A few caterpillars of Apatela americana Harr. were observed on soft maple today. Fall webworms (Hyphantria textor Harr.) are apparently more abundant than last year, occurring in some numbers on appletrees. Hornet nests are more numerous than usual.—*Aug. 25.* Butternut trees are very badly eaten in some places by Datana integerrima Gr. & Rob. Fall webworms continue to be unusually abundant.—*Sep. 1.* Plant lice (Chaitophorus negundinis Thos.) still continues abundant on box-elder. Apples are comparatively scarce this year and appear to be wormier than ever. A few webworm nests were observed on lilac and alder today.—*Sep. 16.* Pieris larvae are injuring foliage of cultivated nasturtiums to a considerable extent.—*Oct. 1*

Onondaga county [Mrs A. M. A. Jackson, Camillus]—First nest of an appletree tent caterpillar (Malacosoma americana Fabr.) was observed Ap. 26, and the present indications are that this insect will not be as abundant as usual. There is a report that Hessian fly (Cecidomyia destructor Say) is working in some fields.—*Ap. 28.* The blue or meat fly is quite abundant about houses. Cabbage butterflies (Pieris rapae Linn.) are about, though not numerous. Spotted lady beetles occur on many weeds and plants, and though abundant do not appear to be destructive. Tent caterpillars are not numerous and are causing very little injury. Cold, inclement weather has kept caterpillars and other insects in check. Examination of one wheat field showed no Hessian fly, and growers state that thus far none has been met with.—*May 6.* Cankerworms appeared May 12 and are quite abundant and destructive. The bud moth (Tmetocera ocellana Schiff.) is at work on appletrees, though not causing very much injury. The forest tent caterpillar (Malacosoma? disstria Hübn.) has appeared in very small numbers on chokecherry trees. The weather is dry and warm and consequently favorable to the development of insect life. Many clover leaves have small, round holes eaten in them, possibly the work of the clover leaf weevil (Phytonomus punctatus Fabr.).—*May 13.* Cankerworms are developing rapidly and have caused a great deal of injury. Ants of several species are quite abundant.—*May 20.* Red admiral butterflies (Vanessa atalanta Linn.) have appeared but are not as abundant as usual. The appletree tent caterpillar is quite scarce, only five webs or nests being observed in a 5 mile drive. Cankerworms are abundant, and while many trees have been injured to a considerable extent, none have been entirely defoliated. Potato beetles (Doryphora 10-lineata Say) have appeared and deposited some eggs. Cold weather is keeping insects in control. Green plant lice are somewhat abundant on rosebushes. Currant worms (Pteronus ribesii Scop.) are present in small numbers, though not causing much damage. Red admiral butterflies continue scarce and others are not so numerous as usual. Potato beetles and their eggs are very abundant on early potatoes. A white frost occurred May 31 and June 1, but did not seriously affect insects.—*June 1.* Plum curculios (Conotrachelus nenuphar Herbst.) have stung much fruit and considerable is dropping. Cankerworms have about all disappeared and have not caused as much injury as in former years. Many farmers think that tent caterpillars hatched during the warm days of March and were killed by the cold weather which followed, or else perished from lack of food. This hardly seems probable, as instances have been recorded where eggs of this species hatched in the fall and the caterpillars successfully survived the winter in the latitude of Missouri.—*June 10.* There are but few cocoons of the tent caterpillars, and this appears to be due in part to the continuous wet weather of 1902, when the caterpillars ate but little, were not healthy and appeared to be only partly grown at the time they spun up. A very few Hessian flies are to be found in the "flaxseed" stage, though no complaints of their work have been received. A leaf miner, probably Pegomyia vicina Lintn., is very abundant in a large field of beets. Spittle insects are quite common in certain fields of grass. Potato beetle eggs are hatching, but the grubs do not appear to be as numerous as the old ones and are causing comparatively little damage. Black flea beetles (Crepidodera cucumeris Harr.) have caused some injury to both tomato and potato vines. Striped cucumber beetles (Diabrotica vittata Fabr.) are present on pumpkin vines but are not causing much injury. No squash bugs (Anasa tristis DeGeer) have been observed this year, though they are usually very abundant and destructive in this section. Rose beetles (Macrodactylus subspinosus Fabr.) are quite destructive to rose bushes, though late in appearing, and leaf hoppers have also caused some injury to rose bushes. Peas are more free from weevils (Bruchus pisorum Linn.) than usual, but the vines are being eaten by a green worm similar to the cabbage worm. House flies are not as abundant as usual.—*June 29*

Orange county [J. M. Dolph, Port Jervis]—A few mourning cloaks (Euvanessa antiopa Linn.) and some Colias butterflies have appeared. Many small bees are frequenting plum blossoms.—*April 23.* Plant lice (Aphis mali Fabr. and Myzus cerasi Fabr.) are very numerous, specially on apple and cherry trees and rose bushes. Tomato plants are also affected by a species of plantlouse which may be Rhopalosiphum solani Thos. In general there are fewer insects than usual, due probably to the exceedingly dry weather.—*June 2.* Potato beetles (Doryphora 10-lineata Say) have made their appearance in considerable numbers, the first abroad on May 20, and the first larvae being observed June 9. Hundreds of lady-beetles were found on a crimson rambler rose, three or four on a leaf. We have never seen them in such great numbers before. This bush had been badly infested by plant lice, and the lady beetles were undoubtedly attracted by their prey. The currant worm (Pteronus ribesii Scop.) has caused some injury though it has not been abundant as in former years. The spiny elm caterpillars (Euvanessa antiopa Linn.) have stripped the leaves from a number of North Carolina poplars planted for shade tree purposes.—*June 11.* Striped cucumber beetles (Diabrotica vittata Fabr.) have appeared in considerable numbers. Pear and cherry slug (Eriocampoides limacina Retz.) is inflicting much injury on the foliage of peartrees. Rose beetles (Macrodactylus subspinosus Fabr.) have been specially numerous and abundant this year. The foliage of very few bushes has escaped being eaten or seriously disfigured.—*June 30*

Rockland county [S. B. Huested, Blauvelt]—Appletree tent caterpillars (Malacosoma americana Fabr.) appeared as usual but have not done as much injury as in former years. No potato beetles have appeared, while plant lice (Myzus cerasi Fabr. and M. ribis Fabr.) are unusually abundant on cherry and currant bushes. Cutworms are reported rather plenty and cedar birds have been unusually numerous on cherrytrees, probably being more noticeable on account of the scarcity of fruit.—*June 7*

St Lawrence county [C. J. Locke, Ogdensburg]—June bugs and grubs were abundant May 1. 90% of the birch trees in this section are affected by a borer, possibly the bronze birch borer (Agrilus anxius Lec.), and an equal proportion of poplar trees are also injured. These latter may possibly be affected by a buprestid, though it is not improbable that considerable damage is caused by the poplar borer (Saperda calcarata Say). The gouty gall beetle (Oberea bimaculata Oliv.) is causing considerable injury in blackberry patches. Appletree borers (Saperda candida Fabr.) are abundant and infest many appletrees. Woodpeckers are at work on infested trees, and have undoubtedly destroyed many grubs.—*May 16.* Mourning cloak butterflies (Euvanessa antiopa Linn.) were first observed May 18, and cabbage butterflies (Pieris rapae Linn.) on the 22d. Currant worms (Pteronus ribesii

Scop.) put in appearance May 18, and the same is true of the appletree aphis (Aphis mali Fabr.).—*May 22.* Eggs of the potato beetle (Doryphora 10-lineata Say) were observed May 21, and shad flies or May flies, the 22d. Mosquitos were abundant on the 25th. Generally speaking, no insects are specially injurious.—*May 28.* Cucumber beetles (Diabrotica vittata Fabr.) were very numerous June 4; same was true on the 10th of strawberry weevil (? Anthonomus signatus Say) and potato beetles. White grubs are abundant and totally destroying oats.—*June 11.* Cabbage worms appeared on the 20th, and onion maggots (Phorbia ceparum Meigen) were at work the 22d. This latter insect has destroyed one fourth of the onion crop. Cabbages have likewise suffered from the maggot (Phorbia brassicae Bouché). Rose slugs were observed at work on the 23d.—*June 25.* A second brood of currant worms appeared July 1. Cabbage worms, cucumber beetles, plant lice and onion maggots are very numerous and destructive. The wet weather continues, accompanied by an increase of leaf-eating insects. The foliage of appletrees, plumtrees, maples and elms are all attacked by plant lice. Some apples are dropping and show no sign of injury except at the end of the stem, probably the work of the codling moth (Carpocapsa pomonella Schiff.).—*July 9.* Crane flies and dragon flies were numerous July 10, and a single specimen of the tomato worm (Phlegethontius 5-maculatus Haw.) was observed on the 15th. Cabbage worms, potato beetles and plant lice continue abundant and destructive. Mosquitos are abundant and rains continue. Striped cucumber beetles and plant lice are attacking vines, egg plants and wild tansy.—*July 16.* White marked tussock moths (Notolophus leucostigma Abb. & Sm.) were observed July 20, and dragon flies on the 15th. Potato beetles are abundant and plant lice very numerous, mosquitos are rare. Cool and wet weather has interfered with the successful application and efficiency of insecticides, and as a consequence caterpillars are abundant. Apples are dropping from the tree, and only about one quarter of the crop will be saved. Most of the trouble is probably caused by the codling moth larvae.—*July 30.* Fall webworms (Hyphantria textor Harr.) appeared July 15 on plum, apple and elm trees, and a species of sawfly on asters.—*Aug. 8.* Potato beetles continue numerous and destructive. Cool, wet weather has not affected the leaf-eating caterpillars or plant lice, both of which continue abundant.—*Aug. 14*

Saratoga county [C. W. Ferris, Schuyler]—Appletree tent caterpillars (Malacosma americana Fabr.) are present in some numbers and were not injured by a frost, the mercury dropping to 24 F. on May 2.—*May 5.* Cherry aphis (Myzus cerasi Fabr.) are abundant on sweet cherries, and a green plant louse is affecting Bosc peartrees very seriously.—*July 15*

Schenectady county [Paul Roach, Quaker Street, Schenectady co.]—Appletree tent caterpillars (Malacosoma americana Fabr.) are just hatching on trees in warm situations. Their numbers are small, and but few egg clusters have been observed.—*May 1*

Schuyler county [Mrs Harriet S. Updyke, Logan]—Appletree tent caterpillars (Malacosoma americana Fabr.) appeared for the first time May 8. They have not caused as much damage as usual.—*May 20*

Ulster county [George S. Clark, Milton]—Appletree tent caterpillars (Malacosoma americana Fabr.) have been at work for two weeks and were not affected by the frost of April 12, even though they were not protected by a web.—*Ap. 23.* Tent caterpillar nests are present in large numbers except in localities where they were carefully destroyed the preceding year.—*Ap. 30.* Tent caterpillars continue to increase in size, and their nests are becoming more conspicuous. Aphis (Myzus cerasi Fabr.) are beginning to appear on cherrytrees. Currant worms (Pteronus ribesii Scop.) are abundant on bushes that were not sprayed last year, and a few occur on those that were treated.—*May 14.* There has been no increase in appletree tent caterpillars, and currant worms are few, specially on bushes that were sprayed last year. Plant lice (Myzus cerasi Fabr.) are increasing on cherrytrees, and it is now too late to reach them because the leaves are so badly curled. Some plant lice (Aphis mali Fabr.) have developed on appletrees. The black flea beetle (Crepidodera cucumeris Harr.) is working on potato, tomato vines and eggplants. Some caterpillars, probably those of the gartered plume moth (Oxyptilus periscelidactylus Fitch) are not doing much damage.—*May 21.* Tent caterpillars are beginning to crawl, evidently preparatory to pupation, and are not more than one quarter as abundant as last year. Plant lice are numerous on cherrytrees, specially young ones. The red spider (Tetranychus telarius Linn.) is abundant on roses.—*May 28.* A few potato bugs have just appeared, and plant lice are more abundant on cherrytrees than usual. Tent caterpillars do not appear to be as energetic as usual, possibly they were weakened by the early frost. Elm leaf beetles (Galerucella luteola Müll.) are very scarce, not a sign of one could be found on a large tree which had its foliage entirely destroyed two years ago.—*June 4.* Heavy rains have washed many of the aphids from the trees. Many plant lice continue on rosebushes that have not been sprayed.—*June 12.* The recent continued rains have prevented much damage from insect pests. Squash bugs (Anasa tristis DeGeer) are abundant enough to destroy the vines unless controlled. Some pear psylla (Psylla pyricola Forst.) has appeared on the trees in various pear orchards in this vicinity.—*June 18.* Pear psylla is injuring many trees and causing much of the fruit to drop. Plant lice are abundant on both young pear and apple trees.—*July 2*

Warren county [C. L. Williams, Glens Falls]—May beetles appeared in large numbers May 9. The asparagus beetle (Crioceris asparagi Linn.) was observed in considerable numbers May 16. It has become distributed over a tract at least 8 miles long and is abundant.—*May 25.* Rose beetles (Macrodactylus subspinosus Fabr.) appeared about June 22, and the depredations of a gray cutworm attracted attention about the same time. The former are very abundant and feed on all kinds of vegetation. The zebra caterpillar (Mamestra picta Harr.) was found at work on strawberry plants.—*June 9.* June beetles are exceedingly abundant; more so than we have known for years.—*July 3.* The stalk borer (Papaipema nitela Guen.) is at work in small numbers on various plants, and we have succeeded in detecting a parasite on the same, which proves to be a tachinid.

Wayne county [C. H. Stuart, Newark]—The first aphids were observed on roses May 5, and comparatively few plants were infested. No tent caterpillars or cankerworms have been observed, and the spotted asparagus beetle (Crioceris 12-punctata Linn.) has disappeared, though the common species (C. asparagi Linn.) is present in force. House flies are scarce and occur only on the sunny side of buildings.—*May 19.* Plant lice began to appear the latter part of May, and have been more abundant than we have ever known them to be before. They oblige us to keep a gang of 15 or 20 men and boys at work continuously in the nursery with a whale oil soap solution to keep them in check. Larvae of lady beetles are more than usually abundant and are undoubtedly doing good service. On our lawn the only trees or plants that have escaped plant lice are poppies and evergreens; everything else is literally covered with them, or at least was so a week ago. Now the lady beetles are beginning to get the upper hand of the pests.—*July 2*

Westchester county [F. R. Calkins, Ossining]—Elm leaf beetles (Galerucella luteola Müll.) appeared May 3 and have been increasing rapidly but have caused no serious damage.—*May 4.* Bumble flower beetles (Euphoria inda Fabr.) were flying about in considerable numbers. Hundreds of them were observed, though there was no evidence of material injury. Grasshoppers were first seen May 6 and have become very numerous. Striped cucumber beetles (Diabrotica vittata Fabr.) appeared in large numbers on the 8th. The first Colorado potato beetles (Doryphora 10-lineata Say) were observed on the 15th. Appletree tent caterpillars (Malacosoma americana Fabr.) are causing a great deal of injury in this section, and species of plant lice are curling the leaves of various shrubs in this vicinity.—*May 18.* The majority of elms in this section are in very bad condition owing to the work of the elm leaf beetle. Striped cucumber beetles continue very numerous, and potato beetles have appeared in the past week in increasing numbers. It looks as though the appletree tent caterpillars had been destroyed by some climatic condition; possibly the severe rains in May and June. Since we had 31 days of rain with hardly a ray of sunshine, the webs are empty and there are no signs of cocoons. Mosquitos are somewhat scarce. The work of the pear midge (Diplosis pyrivora Riley) is very evident, and cherry borers (probably the fruit tree bark beetles Scolytus rugulosus Ratz.), have ruined some trees.—*July 13*

Westchester county [Mrs Edwin H. Mairs, Irvington-on-Hudson]—White marked tussock moth caterpillars (Notolophus leucostigma Abb. & Sm.) are injuring the foliage of a fine purple beech, which is also suffering severely from plant lice, probably the woolly beech aphis (Phyllaphis fagi Linn.). Mapletrees have dropped many leaves, probably because of plant lice injury. Very likely this is the work of Chaitophorus aceris Thos.—*June 29.* A curious worm (Seirodonta bilineata Pack.) was found feeding on foliage of purple beech. Mosquitos are more abundant than ever. Elm leaf beetle larvae (Galerucella luteola Müll.) are crawling along the trunks of infested trees, the foliage of which is turning brown. American, English, weeping and slippery elms are all attacked. Maple and beech trees are still suffering from plant lice injury. Some red bugs are present on the infested trees.—*July 12*

Wyoming county [W. H. Roeper, Wyoming]—Appletree tent caterpillars (Malacosoma americana Fabr.) were first observed May 2. They are present in small numbers, and some think this is due to the excessively cold weather.—*May 9.* Insects of various kinds are much scarcer than usual.—*May 18.* Tent caterpillars are not causing much injury though cankerworms are working to some extent. The weather continues very cold at night, and it is exceedingly dry.—*May 25.* Codling moth larvae (Carpocapsa pomonella Schiff.) are unusually abundant in this locality, and apple aphis (Aphis mali Fabr.) is very numerous and rolling the leaves to a considerable extent. The injury is so severe that it would not be surprising if a considerable proportion of the foliage dropped. Potato beetles (Doryphora 10-lineata Say) are present in large numbers. Plant lice are also working on forest trees in about the same way as on fruit trees. The weather continues very dry and appears to be favorable to plant lice. The apple crop will be only about one quarter its normal size, and pears are almost a failure. Plant lice continue to be the most destructive form in this section, and the injury is so severe that some trees have half their leaves badly curled by the pests. A good rain has benefited crops very much.—*June 15.* Maple foliage is dropping to a considerable extent, probably as a result of injury by plant lice (Drepanosiphum acerifolii Thos.)—*July 3*

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1903. 70 are given with the title,[1] place, time of publication and a summary of the contents of each. Volume and page number are separated by a colon, the first superior figure tells the column, and the second the exact place in the column in ninths; e.g. 67:974[16] means volume 67, page 974, column 1, beginning in the sixth ninth, i.e. about two thirds of the way down.

Turnips. Country Gentleman, Nov. 27, 1902, 67:974[16]

The work of the cabbage root maggot, Phorbia brassicae Bouché, in turnips is identified and remedial measures discussed.

Experimental Work in New York State against the San José Scale [Aspidiotus perniciosus Comst.] U. S. Dep't Agric. Div. Ent. Bul. 37, n.s. 1902. p.35-36

Discussion of results obtained with 20% mechanical crude petroleum emulsion and whale oil soap.

Notes for the Year in New York. U. S. Dep't Agric. Div. Ent. Bul. 37, n.s. 1902. p.102-3

Brief records of injury by grapevine root worm, Fidia viticida Walsh; grapevine leaf hopper, Typhlocyba comes var. vitis Harr.;

[1] Titles are given as published, and in some instances they have been changed or supplied by the editors of the various papers.

appletree tent caterpillar, Clisiocampa [Malacosoma] americana Fabr.; forest tent caterpillar, Clisiocampa [Malacosoma] disstria Hübn. and fall webworm, Hyphantria cunea Drury [textor Harr.].

Observations on Certain Insects Attacking Pine Trees. U. S. Dep't Agric. Div. Ent. Bul. 37, n.s. 1902. p.103-4

Records of injuries by Tomicus calligraphus Germ., T. pini Say and also of Monohammus confusor Kirby and Dendroctonus terebrans Oliv.

Potato Wireworms. Country Gentleman, Dec. 4, 1902, 57:992[13]

General remedial measures for wireworms are briefly discussed.

Crude Petroleum as an Insecticide. Soc. Promotion Agric. Sci. Proc. 23d An. Meeting 1902, p.86-95; separate p.1-10 received Dec. 24, 1902

A review of experiments with crude petroleum and summary of results in controlling San José scale, Aspidiotus perniciosus Comst.

Maggots in Mushrooms. Country Gentleman, Jan. 1, 1903, 68:6[15]

Brief account of species injuring mushrooms and remedies therefor, Phora agarici Lint. and species of Sciara being mentioned in particular.

Entomology. U. S. N. Y. Handbook 16, revised Dec. 1902, p.1-12, issued Jan. 3, 1903

Contents

Grapevine Root Worm [Fidia viticida Walsh]. N. Y. State Mus. Bul. 59. 1902. p.49-84, 1 col.pl. 4 halftones

Issued Jan. 5, 1903. Republished in great part in issues of *Grape Belt* [Dunkirk N. Y.] for Jan. 9, 13, 20, 27, Feb. 3, 10.

Contents

Cucumber Beetle. Country Gentleman, Jan. 15, 1903, 68:43[24]

Remedial measures for the striped cucumber beetle, Diabrotica vittata Fabr.

Insecticides and Notes. Country Gentleman, Jan. 15, 1903, 68:47[35]

Summary of results obtained with insecticides against San José scale, Aspidiotus perniciosus Comst., and notes on the Chinese ladybug, Chilocorus similis Rossi, and the grapevine root worm, Fidia viticida Walsh.

Beware the Pea Weevil. Country Gentleman, Jan. 22, 1903, 68:63[42]

Injuries by Bruchus pisorum Linn. in Canada and means of controlling.

Legislation against Pests. Country Gentleman, Jan. 29, 1903, 68:89[25]

General discussion of the efficacy of nursery inspection work with comments on present conditions.

The San José Scale. Country Gentleman, Feb. 19, 1903, 68:158[11]

Comparative value of crude petroleum emulsion, lime, salt and sulfur mixture and whale oil soap for Aspidiotus perniciosus Comst.

Beneficial Insects. Country Gentleman, Mar. 5, 1903, 68:206[33]

General observations on the establishment of Scutellista cyanea Motsch, Novius cardinalis Mask. and Chilocorus similis Rossi in the United States.

Scale Insects. Worcester [Mass.] Evening Gazette, Mar. 12, 1903, p.1

Summary notice of scale insects with special reference to remedies for the San José scale, Aspidiotus perniciosus Comst.

Arsenate of Lead. Country Gentleman, Mar. 19, 1903, 68:252[17]

Formula and method of preparation.

Looper Caterpillar. Country Gentleman, Mar. 19, 1903, 68:252[23]

Description too brief to permit identification of the geometrid.

Grapevine Root Worm. Country Gentleman, Mar. 19, 1903, 68:255[34]

Corrects reported error and gives estimates of damage by Fidia viticida Walsh.

Recent Work with Insecticides in the East. Col. State Bd Hort. Rep't 1902. 1903. p.121-27

Brief discussion of the value of arsenate of lead, crude petroleum, the lime, salt and sulfur mixture and whale oil soap as insecticides.

Fleas. Country Gentleman, Mar. 26, 1903, 68:276[16]

Brief account of life history with various repressive measures.

Appletree Bark Louse. Country Gentleman, Mar. 26, 1903, 68:276[24]

Remedial measures for Mytilaspis pomorum Bouché [Lepidosaphes ulmi Linn.].

Insecticides and Fungicides. U. S. N. Y. Handbook 18, p.16

More important formulas recommended with general directions for use.

Pea Weevil. Country Gentleman, Ap. 2, 1903, 68:293[24]

Discussion of rise in temperature in peas infested with Bruchus pisorum Linn. and methods of controlling the pest.

San José Scale. Country Gentleman, Ap. 2, 1903, 68:300[12]

No danger of Aspidiotus perniciosus Comst. spreading from infested wood cut in early spring.

Elm Leaf Beetle. Schenectady Daily Union, Ap. 3, 1903, p.7

Nearly the same in Evening Star [Schenectady] Ap. 3, p.12.

Extracts from Museum Bulletin 57 on Galerucella luteola Müll., with special reference to local conditions.

Shade Tree Ratings. Street forestry report on the selection, planting, cultivation and care of street shade trees by Frederic Shonnard, Dep't Public Works, Yonkers, 1903

Ratings of comparative immunity from insect enemies of various shade trees.

Dust and Other Sprays. Country Gentleman, Ap. 16, 1903, 68:350[23]

Brief discussion of various insecticides with special reference to scale insects and dry or dust sprays.

Advice about Spraying. Country Gentleman, Ap. 30, 1903, 68:392[23]

General directions for spraying with references to convenient literature.

Arsenate of Lead. Country Gentleman, May 7, 1903, 68:410[35]

Its preparation from arsenic, soda and sugar of lead not advisable. Directions are given for making it.

Literature of American Economic Entomology. Am. Ass'n Eco. Ent. 15th An. Meeting, Presidential address, Washington D. C. Dec. 26, 1902. U. S. Dep't Agric. Div. Ent. Bul. 40, n.s. 1903. p.7-22

Also published separately.

After a general review with a few statistics regarding the amount of literature relating to some of the more notorious insects, the following topics were discussed: Newspaper and Minor Articles; Reports; Bulletins; Journals; General Works and Indexes.

Work and Observations in 1902. N. Y. State Fruit Growers Ass'n Rep't 1903, p.92-94. Rec'd May 15

Results obtained with crude petroleum, whale oil soap and lime, salt and sulfur against San José scale, Aspidiotus perniciosus Comst. Notes on the establishment of Chilocorus similis Rossi and work of grapevine root worm, Fidia viticida Walsh.

Elm Leaf Beetle Ravages. Argus [Albany] May 16, 1903; New York Times, May 17; Rensselaer County Standard [Hoosick Falls] May 22, 1903, p.4

Summary of injuries by Galerucella luteola Müll. in Hudson river valley.

New York Entomologic Service. Country Gentleman, May 21, 1903, 68:451[36]

Summary of reports from voluntary observers.

Diseases and Pests. N. Y. State Lib. Bul. 80. Review of Legislation 1902, p.837-38

Summary of recent laws relating to plant diseases and insect enemies.

Importance of Injurious Insects Introduced from Abroad. Soc. Promotion Agric. Sci. Proc. 24th An. Meeting 1903, p.39-48; separate, p.1-10

Summarized account of injuries with classified lists of introduced species and notes on the relative importance of various species.

New York Entomologic Service. Country Gentleman, May 28, 1903, 68:471[33]

Summaries of reports from voluntary observers.

18th Report of the State Entomologist on Injurious and Other Insects of the State of New York 1902. N. Y. State Mus. Bul. 64. 1903. p.89-193, 1 lith. 5 halftones

Issued June 2.

Contents

New York Entomologic Service. Country Gentleman, June 4, 1903, 68:498[14]

Summary of reports from voluntary observers.

Remedies for Grapevine Root Worms. Grape Belt, June 16, 1903, p.2

Brief statement of remedial measures for Fidia viticida Walsh.

New York Entomologic Service. Country Gentleman, June 18, 1903, 68:530[38]

Summary of reports from voluntary observers.

Hints to Fruit Growers and Truckers. Am. Agric. June 20, 1903, 71:648[24]

Briefly discusses the grapevine root worm, Fidia viticida Walsh, injuries in Chautauqua grape belt and remedies for same, and also the plum curculio, asparagus beetles, and insect enemies of squash.

New York Entomologic Service. Country Gentleman, June 25, 1903, 68:551[12]

Summary of reports from voluntary observers.

Destroying Flies. Country Gentleman, June 25, 1903, 68:561[21]

Destructive and preventive measures for the house fly, *Musca domestica* Linn.

Grapevine Root Worm. Grape Belt, June 26, 1903, p.1, 6

Beetles attack best vineyards, no decided migration, figures on efficacy of destroying pupae and remarks on value of beetle catchers and arsenical poisons for *Fidia viticida* Walsh.

Mosquitos. N. Y. State Mus. folder. 8p.

Issued June 29, 1903.

Brief description with discussion of habits, life history, genera and species, methods of controlling and collecting.

Grapevine Root Worm. Grape Belt, June 30, 1903, p.4

Results of breeding from entire vines and efficiency of beetle catchers for *Fidia viticida* Walsh.

New York Entomologic Service. Country Gentleman, July 2, 1903, 68:578[33]

Summary of reports from voluntary observers.

Plant Lice. Country Gentleman, July 9, 1903, 68:590[27]

Remedial measures for plant lice on fruit trees.

Killing Ants. Country Gentleman, July 9, 1903, 68:590[32]

Method of destroying ants in nests.

Rose Beetles. Country Gentleman, July 9, 1903, 68:590[34]

Methods of destroying the beetles, *Macrodactylus subspinosus* Fabr.

New York Entomologic Service. Country Gentleman, July 9, 1903, 68:590[45]

Summary of reports from voluntary observers.

About Maple Tree Borers. Rome Daily Sentinel, July 10, 1903

Methods of controlling the sugar maple borer, *Plagionotus speciosus* Say.

Plant Lice. Country Gentleman, July 16, 1903, 68:610[27]

Comments on unusual abundance of plant lice and remedies for the same.

New York Entomologic Service. Country Gentleman, July 16, 1903, 68:610[47]

Summary of reports from voluntary observers.

Mosquitos. Sunday [Albany] Press, July 19, 1903, p.6

Reprint of portions of mosquito folder.

Spray for Potatoes. Country Gentleman, July 23, 1903, 68:630[17]

Advises arsenate of lead for potato beetles and bordeaux mixture for fungus.

New York Entomologic Service. Country Gentleman, July 23, 1903, 68:630[43]

Summary of reports from voluntary observers.

Plant Lice. Country Gentleman, July 30, 1903, 68:650[34]

Remedies for the pests.

New York Entomologic Service. Country Gentleman, July 30, 1903, 60:650[45]

Summary of reports from voluntary observers.

Forest Fires and Insect Attack. Am. Lumberman, Aug. 8, 1903, p.15

Preliminary report on investigations in burned areas in the Adirondacks.

Aquatic Nematocerous Diptera by Oskar Augustus Johannsen. Reprint from N. Y. State Mus. Bul. 68. 1903. p.328-441

Issued Aug. 11, 1903.

This paper includes a key to families of nematocerous diptera with accounts of the net-winged midges (Blepharoceridae), black flies (Simuliidae) and mosquitos (Culicidae).

Tulip Tree Scale. Country Gentleman, Aug. 20, 1903, 68:712[25]

Brief notice with remedies for Lecanium [Eulecanium] tulipiferae Cook.

Summary of Root Worm Situation and Experiments. Grape Belt, Sep. 4, 1903, p.1; Jamestown Journal, Sep. 4, 1903, p.1; Country Gentleman, Sep. 24, 1903, 68:828[27]

Brief summary of observations and experimental work on Fidia viticida Walsh in 1903.

Mosquitos on High Ground. Country Gentleman, Sep. 10, 1903, 68:781[24]

Brief comments on the breeding habits and methods of controlling these insects.

Aquatic Chrysomelidae and a Table of the Families of Coleopterous Larvae by Alex. D. MacGillivray. Reprint from N. Y. State Mus. Bul. 68. 1903. p.288-331

Issued Sep. 12, 1903.

This paper includes a key to families of coleopterous larvae and a monograph of the subfamily Donaciinae, family Chrysomelidae.

Aquatic Insects of New York State. N. Y. State Mus. Bul. 68. 1903. p.199-517, 52 pl. (3 col.) by James G. Needham Ph.D., professor of biology, Lake Forest Univ.; A. D. MacGillivray Ph.D., instructor in entomology, O. A. Johannsen M.S., instructor in civil engineering, both of Cornell Univ.; and K. C. Davis Ph.D., professor of horticulture, West Virginia Univ.

Issued Sep. 28, 1903.

Contents

Sialididae of North and South America by K. C. Davis. Reprint from N. Y. State Mus. Bul. 68. 1903. p.441-87

Issued Sep. 30, 1903.

A systematic and biologic account of this group.

Two Tree Pests. Country Gentleman, Oct. 1, 1903, 68:852[43]

Pear psylla, Psylla pyricola Forst. probably weakened the pear trees at Hartley Hall Pa., so that they were attacked by the fruit tree bark beetle, Scolytus rugulosus Ratz. Destruction of the infested trees by fire is advisable. The maple is probably infested by Sesia acerni Clem. Preventive measures are indicated.

Chinese Lady Bugs. Country Gentleman, Oct. 8, 1903, 68:871[18]

Records establishment and breeding of Chilocorus similis Rossi at Kinderhook N. Y.

INSECT EXCHANGE

The state collection of insects contains large numbers of many local, and in some cases somewhat rare forms. This, in connection with the fact that many species are not represented, and specially in view of the economic importance of introduced insects, led us to inaugurate a system of exchanges the past summer. Those offered for exchange are, in every case, only such as can be spared without detriment to the general collections, and in return it has been our desire to obtain, so far as possible, species of economic importance in other sections of this country or any other countries, specially those which might develop into injurious pests. A preliminary exchange list was sent out in the early summer, and the results have been very gratifying, since we have been able by this means, to make a number of extremely valuable additions to the state collections. This is specially true in the case of Coccidae, and was largely possible through the kindness of Prof. V. L. Kellogg of Leland Stanford Jr University, who was able to offer us some extremely desirable Californian and Japanese scale insects in exchange for some of our native forms. Another very desirable exchange was arranged with Prof. F. H. Snow of Kansas University, who sent valuable Diptera and some cotypes, all determined by the noted authority in this group, Dr S. W. Williston. The species, 418 in number, acquired in this manner are listed below.

SPECIES RECEIVED IN EXCHANGE

The source of various species listed below, is indicated by superior figures following the author of the species, as follows:

1, from Prof. C. P. Gillette, Agricultural College, Fort Collins Col.; 2, from Prof. V. L. Kellogg, Leland Stanford Jr University, California; 3, from E. M. Ehrhorn, Mountain View Cal.; 4, from Prof. F. H. Snow, University of Kansas, Lawrence Kan.; 5, from Prof. E. A. Popenoe, state entomologist, Topeka Kan.; 6, from Prof. H. Garman, Agricultural Experiment Station, Lexington Ky.; 7, from J. G. Sanders, 8, from Prof. Herbert Osborn, both of the Ohio State University, Columbus O.

Hymenoptera

Bombus separatus *Cress.*[1]
B. sylvicola *Kirby*[1]
B. putnami *Cress.*[1]
B. proximus *Cress.*[1]
B. nevadensis *Cress.*[1]
B. morrisonii *Cress.*[1]
B. mixtus *Cress.*[1]
B. juxtus *Cress.*[1]
B. flavifrons *Cress.*[1]
B. bifarius *Cress.*[1]
B. appositus *Cress.*[1]
Psithyrus insularis *Cress.*[1]
Anthopora vallorum *Ckll.*[1]
A. urbana *Cress.*[1]
A. smithii *Cress.*[1]
A. occidentalis *Cress.*[1]
Synhalonia frater *Cress.*[1]
Melissodes obliqua *Say*[1]

Diadasia australis *Cress.*[1]
D. diminuta *Cress.*[1]
Megachile montivaga *Cress.*[1]
M. fidelis *Cress.*[1]
Lithurgus apicalis *Cress.*[1]
Anthidium maculifrons *Smith*[1]
A. interruptum *Say*[1]
Coelioxys gilensis *Ckll.*[1]
Augochlora coloradensis *Titus*[1]
Epeolus robustus *Cress.*[1]
E. occidentalis *Cress.*[1]
E. concavus *Cress.*[1]
E. compactus *Cress.*[1]
Nomada ridingsii *Cress.*[1]
Vespa occidentalis *Cress.*[1]
Polybia flavitarsis *Sauss.*[1]
Odynerus taos *Cress.*[1]
O. foraminatus *Sauss.*[1]
Crabro 6-maculatus *Say*[1]
Philanthus flavifrons *Cress.*[1]
Eucerceris fulvipes *Cress.*[1]

Coleoptera

Hylastes longus *Lec.*[4]
Scolytus 4-dentatus *Say*[5]
Pityogenes pondrosae *Hopk.*[1]
Tomicus integer *Eich.*[1]
Calandra oryzae *Linn.*[6]
Baris strenua *Lec.*[5]
Thysanocnemis helvolus *Lec.*[5]
T. fraxini *Lec.*[5]
Anthonomus squamosus *Lec.*[1]
Tachypterus 4-gibbus *Say*[5]
Lixus macer *Lec.*[5]
Rhynchites hirtus *Fabr.*[5]
Epicauta corvina *Lec.*[5]
Crymodes discicollis *Lec.*[1]
C. exiguus[5]
Bruchus fraterculus *Horn*[1]
B. discoideus *Say*[5]
B. 4-maculatus *Fabr.*[5]
B. mimus *Say*[1]
Spermophagus robiniae *Sch.*[1]
Chelymorpha phytophagica *Cr.*[5]
Cassida pallidula *Boh.*[5]
C. ellipsis *Lec.*[5]
Diabrotica lemniscata *Lec.*[4]
Monocesta coryli *Say*[4]
Lina lapponica *Linn.*[6]
Colaspis favosa *Say*[4]
Paria viridicyanea *Cr.*[4]
Myochrous denticollis *Say*[4]
Fidia longipes *Melsh*[4]
Exema conspersa *Mann.*[4]
E. dispar *Lec.*[5]
Saxinis omogera *Lac.*[4]
Babia 4-guttata *Oliv.*[4]
Coscinoptera dominicana *Fabr.*[4]
C. axillaris *Lec.*[4]
Tetraopes canescens *Lec.*[1]
T. femoratus *Lec.*[1]
Dectes spinosus *Say*[4]
Plectrodera scalator *Fabr.*[1]
Dorcaschema alternatum *Say*[5]
D. wildii *Uhler*[5]
Monohammus oregonensis *Lec.*[1]
Monilema annulatum *Say*[5]
Leptura chrysocoma *Kirby*[1]
Typocerus sinuatus *Newm.*[5]
Neoclytus muricatulus *Kirby*[4]
Cyllene decorus *Oliv.*[4]
Tragidion fulvipenne *Say*[4]
Rhopalophora longipes *Say*[4]
Eburia 4-geminata *Say*[6]
Callidium janthinum *Lec.*[1]
Prionus imbricornis *Linn.*[5]
Euphoria kernii *Hald.*[5]
E. kernii *var.*[5]
E. kernii *black var.*[5]
E. areata *Fabr.*[5]
Dynastes tityus *Linn.*[6]
Strigoderma arboricola *Fabr.*[5]
Polyphylla decemlineata *Say*[1]
Bolboceras farctus *Fabr.*[6]
Phanaeus palliatus[1]
Canthon praticola *Lec.*[5]
Hydnocera tabida *Lec.*[4]
H. subfasciata *Lec.*[1]
Clerus sphegeus *Fabr.*[4]
C. nigriventris *Lec.*[4]
C. ichneumoneus *Fabr.*[5]
C. spinolae *Lec.*[5]
Acmaeodera pulchella *Herbst.*[1]
Psiloptera drummondi *Lap. & Gory.*[5]
Gyascutus obliteratus *Lec.*[1]
Limonius canus *Lec.*[1]
Elater apicatus *Say*[1]
Crytohypnus pectoralis *Say*
Plegaderus nitidus *Horn*[1]
Hister instratus *Lec.*[1]
Orphilus niger *Rossi*[1]

Dermestes fasciatus *Lec.*[1]
Silvanus planatus *Germ.*[1]
Languria laeta *Lec.*[1]
Hyperaspis lateralis *Muls.*[1]
Brachyacantha dentipes *Fabr.*[4]
Exochomus contristatus *Muls.*[4]
E. aethiops *Bland.*[1]
Coccinella abdominalis *Say*[4]
C. annectans *Cr.*[1]
C. monticola *Muls.*[4]
C. transversoguttata *Fabr.*[1]
Hippodamia sinuata *Muls.*[1]
Olibrus vittatus *Lec.*[1]
Homalium humerosum *Fauv.*[1]
Homalota lividipennis *Mann.*[1]
Dineutes assimilis *Aube.*[5]
Nothopus zabroides *Lec.*[1]
Cymindis planipennis *Lec.*[1]
Lebia atriceps *Lec.*[1]
Anophthalmus horni *Garman*[6]
Tetracha virginica *Linn.*[6]

Diptera

Cistogaster immaculata *Macq.*[4]
Gymnosoma fuliginosa *Desv.*[4]
Xanthomelana arcuata *Say*[4]
Hemyda aurata *Desv.*[4]
Epigrimyia lucens *Town.*[4]
Belvoisia bifasciata *Fabr.*[4]
B. unifasciata *Desv.*[4]
Ocyptera carolinae *Desv.*[4]
O. dosiades *Walk.*[4]
Linnaemyia comta *Fall.*[4]
Blepharipeza adusta *Loew.*[4]
Hilarella polita *Town.*[4]
Gonia capitata *DeG.*[4]
Spallanzania hebes *Fall.*[4]
S. hesperidarum *Will.*[4]
Tricophora ruficauda *v.d. W.*[4]
Peleteria robusta *Wied.*[4]
Archytas analis *Fabr.*[4]
A. aterrima *Desv.*[4]
A. hystrix *Wied.*[4]
A. lateralis *Macq.*[4]
Echinomyia algens *Wied.*[4]
E. decisa *Walk.*[4]
E. hystricosa *Will.*[4]
Epalpus bicolor *Will.*[4]
E. signifera *Will.*[4]
Bombyliomyia abrupta *Wied.*[4]
Dejeania vexatrix *O. S.*[4]
Paradejeania rutilioides *Jaen.*[4]
Jurinella ambigua *Macq.*[4]
Syrphus arcutatus *Fall.*[8]
S. umbellatarum *Schiner*[8]
Mesograpta marginata *Say*[8]
M. polita *Say*[8]
Rhingia nasica *Say*[8]
Heliophilus laetus *Loew.*[8]
Tropidia quadrata *Say*[8]
Spilomyia longicornis *Loew.*[8]
Chrysops callidus *O. S.*[4]
C. plangens *Wied.*[4]
Tabanus rhombicus *O. S.*[4]

LIST OF CULICIDAE FROM PROF. F. V. THEOBALD, ENGLAND

Myzomyia rossi *Giles;* India
Pyretophorus costalis *Loew;* West Africa
Myzorhynchus barbirostris *v. d. Wulp.;* Malay states
M. nigerrimus *Giles;* India
M. sinensis *Wied.;* Malay states
Nyssorhynchus fuliginosus *Giles;* India
N. jamesii *Theob.;* India
N. maculata *Theob.;* India
N. masteri *Skuse;* Australia
Cellia argyrotarsis *Desv.;* South Lucia
C. albipes *Theob.;* New Amsterdam
Janthinosoma lutzii *Theob.;* Rio de Janeiro
J. musica *Say;* Rio and New Amsterdam
Mucidus alternans *Westw.;* Australia
Eretmapodites quinquevittata *Theob.;* Uganda
Desvoidea obturbans *Walk.;* India
D. panalectros *Giles;* India
Stegomyia fasciata *Fabr.*
S. scutellaris *Walk.;* Malay states
Scutomyia (Stegomyia) notoscripta *Skuse;* Australia and India
Theobaldia annulata *Meig.;* England

T. incidens *Thomson;* North America
T. spathipalpis *Rondani;* Madeira
Culex alboannulatus *Macq.;* Australia
C. annulioris *Theob.;* Transvaal
C. annulirostris *Skuse;* Australia and New Guinea
C. canadensis *Theob.;* Canada
C. cantans *Meig.;* Canada
C. concolor *Desv.;* India
C. confirmatus *Arrib.;* Rio de Janeiro
C. cylindricus *Theob.;* Australia
C. diversus *Theob.;* Europe
C. fatigans *Wied.*
C. gelidus *Theob.;* Malay states
C. luteolateralis *Theob.;* west and central Africa
C. mimeticus *Noè;* India and Malay states
C. occidentalis *Skuse;* Australia
C. ochraceus *Theob.;* central Africa
C. pulcriventer *Giles;* India
C. sylvestris *Theob.;* Canada
C. taeniorhynchus *Wied.;* Rio de Janeiro
C. tigripes *Grandpré;* Mauritus
C. viridiventer *Giles;* India
C. vittiger *Skuse;* Australia
Melaniconion atratus *Theob.;* Jamaica
Grabhamia pygmaeus *Theob.;* West Indies
G. vittata *Theob.;* New Mexico
Taeniorhynchus aurifer *Theob.;* Uganda
T. brevicellulus *Theob.;* Malay states
T. conopas *Frau.;* Malay states
T. fasciolatus *Arrib.;* British Guiana
T. fulvus *Wied.;* Para
Mansonia annulifera *Theob.;* India
M. annulipes *Walk.;* Malay states
M. titillans *Walk.;* British Guiana
M. uniformis *Theob.;* Malay states and Africa
Deinocerites cancer *Theob.;* West Indies and Uganda
Uranotaenia socialis *Theob.;* West Indies
Aedeomyia squammipenna *Arrib.;* Malay states
Phoniomyia longirostris *Theob.;* Trinidad
Sabethes remipes *Wied.;* Brazil
Limatus durhamii *Theob.;* para
Trichoprosopon (Joblotia) nivipes *Theob.;* Trinidad

Lepidoptera

Anaea andria *Scud.*[6]
Ceratomia catalpae *Bdv.*[6]
Eubaphe rubicundaria *Hübn.*[1]
Arachnis picta, *Pack.*[1]
Apantesis incorrupta *Hy. Edw.*[1]
Parasemia plantaginis *Linn.*[1]
Laphygma frugiperda *Sm. & Abb.*[6]
Oncocnemis augustus *Harv.*[1]
Heliothis armiger *Hübn.*[6]
Autographa brassicae *Riley*[6]
Syneda howlandii *Grote*[1]
Homoptera rubi *Hy. Edw.*[1]
Nycteola proteella *Dyar*[1]
Hydriomena *sp.*[1]
Triprocris smithsonianus *Clem.*[1]
Loxostege sticticalis *Linn.*[1]
L. commixtalis *Walk.*[1]
L. coloradensis *Gr. Rob.*[1]
Cornifrons simalis *Grote*[1]
Crambus teterrellus *Zinck.*[1]
Thaumatopsis repanda *Grote*[1]
Hulstea undulatella *Clem.*[1]
Homoeosoma electellum *Hulst.*[1]
Ethmia discostrigella *Chamb.*[1]

Neuroptera

Raphidia oblita *Hag.*[1]
Chrysopa externa *Hag.*[1]
Brachynemurus nigrilabris *Hag.*[1]
Platyphylax designata *Walk.*[1]

Hemiptera

Homaloporus congruus *Uhl.*[1]
Perillus claudus *Say*[1]
Apateticus marginiventris *Stal.*[1]
Cosmopepla conspicillaris *Dallas*[1]
Carpocoris lynx *Fabr.*[1]
Thyanta custator *Fabr.*[1]
T. rugulosa *Say*[1]
Archimerus calcarator *Fabr.*[1]
Catorhintha guttula *Fabr.*[1]
Ficana apicalis *Dallas*[1]
Alydus quinquespinosus *Say*[1]
A. pluto *Uhl.*[1]
Darmistus subvittatus *Stal.*[1]
Scolopocerus secundarius *Uhl.*[1]
Nysius minutus *Uhl.*[1]
Orsillus scolopax *Say*[1]
Ischnodemus falicus *Say*[1]
Geocoris pallens *Stal.*[1]
Heraeus insignis *Uhl.*[1]
Pamera bilobata *Say*[1]
Trapezonotus nebulosus *Fall.*[1]
Emblethis arenarius *Linn.*[1]
Rhyparochromus floralis *Uhl.*[1]
Melanocoryphus bicrucis *Say*[1]
M. facetus *Say*[1]
M. admirabilis *Uhl.*[1]
Lygaeus reclivatus *Say*[1]
Largus cinctus *H. Sch.*[1]
Dysdercus mimus *Say*[1]
D. albidiventris *Stal.*[1]
Trigonotylus pulcher *Reut.*[1]
Callimiris tarsalis *Reut.*[1]
Resthenia insignis *Say*[1]
Lomatopleura caesar *Reut.*[1]
Hadronema militaris *Uhl.*[1]
Poeciloscytus[1]
Systratiotus americanus *Reut.*[1]
Camptobrochis nebulosus *Uhl.*[1]
Capsus brachycorus *Uhl.*[1]
Pycnoderes 4-maculatus *Guer.*[1]
Labops hesperius *Uhl.*[1]
Dicyphus californicus *Stal.*[1]
Orectoderus[1]
Anthocoris melanocerus *Reut.*[1]
Coriscus kalmii *Reut.*[1]
Repipta taurus *Fabr.*[1]
Apiomerus pictipes *H. Sch.*[1]
A. ventralis *Say*[1]
Hygrotrechus remigis *Say*[1]
Limnotrechus marginatus *Say*[1]
Hebrus concinnus *Uhl.*[1]
Cicada *var.* cassinii *Fish.*[6]
Microvelia[1]
M. hornii *Uhl.*[1]
Salda interstitialis *Say*[1]
S. pallipes *Fabr.*[1]
Galgulus oculatus *Fabr.*[1]
Anisops platycnemis *Fieb.*[1]
Corisa abdominalis *Say*[1]

Coccidae

Parlatoria pergandii *Comst.*[2] on Japanese orange; Stanford University Cal.

P. fiorinia[2]; Gifu-Ken, Japan

Lepidosaphes ulmi *Linn.*[2] on apple; Stanford University Cal.

L. newsteadi tokionis *Kuw.*[2] on Codiaeum; Tokyo, Japan

L. gloverii *Pack.*[2] on orange; Kiushiu, Japan

L. crawii *Ckll.*[2] Angio Saitama-Ken, Japan

Odonaspis secreta *Ckll.*[2] on bamboo; Hikosan, Kiushiu, Japan

Chrysomphalus rossi *Mask.*[2] on Araucaria bidwillii; Stanford University Cal.

C. obscurus *Comst.*[7] on Quercus coccinea; Columbus O.

C. kelloggi *Kuw.*[2] Chikujo-gun, Kiushiu, Japan

C. aurantii citrinus *Coq.*[2] Mazatlan, Mexico

C. aonidum *Linn.*[2] on fern; Tokyo, Japan

Pseudaonidia paeoniae *Ckll.*[2] on Aoskia; Hikosan, Kiushiu, Japan

Aspidiotus rapax *Comst.*[2, 3] on laurel; Stanford University Cal.

A. perniciosus *Comst.*[2] on peach; Stanford University Cal.

A. lataniae *Sign.*[2] Tokyo, Japan

A. hederae *Vall.*[2] on Sequoia sempervirens; Stanford University Cal.

A. glanduliferus *Ckll.*[7] on Pinus sylvestris; Columbus O.
A. coniferarum shastae *Cole*[2] on cypress; Lake co. Cal.
A. californicus *Cole*[2] on Pinus ponderosa; Cobb Mt, Lake co. Cal.
A. aesculi *Johns.*[2] on buckeye; San Mateo Cal.
Leucaspis kelloggi *Cole*[2] on Abies concolor; Mt Shasta Cal.
Poliaspis pini *Mask.*[2] on Abies firma; Tokyo, Japan
Aulacaspis rosae *Bouché*[2] on wild rose; Palo Alto Cal.
A. pentagona *Targ.*[2] on cherry, plum; Tokyo, Japan
A. crawii *Ckll.*[2] on Yumi; Tokyo, Japan
Epidiaspis pyricola *Del Guer.*[3] on prune; Miliken, Santa Clara co. Cal.
Diaspis bromeliae *Kern.*[2] on palm; San José Cal.
Chionaspis spartinae *Comst.*[2] on Spartina stricta; Palo Alto Cal.
C. salicis-nigrae *Walsh*[7] on Salix cordata; Columbus O.
C. quercus *Comst.*[3] on Quercus chrysolepis; Stevens creek, Mountain View Cal.
C. pinifoliae *Fitch*[3] on Torreya californica; Stevens creek, Mountain View Cal.
C. ortholobis *Comst.*[3] on dogwood; Mountain View Cal.
C. gleditsiae *Sand.*[7] on Gleditsia tricanthos; Columbus O.
C. americana *Johns.*[7] on Ulmus americana; Columbus O.
Aclerda tokionis *Ckll.*[2]; Tokyo, Japan
A. californica *Ehrh.*[2] on bunch grass; Mountain View Cal.
Physokermes insignicola *Craw.*[2] on Pinus radiata; San Mateo Cal.
Saissetia oleae *Bern.*[2,3] on vine; San Mateo Cal.
Eulecanium quercitronis kermoides *Tyr.*[3] on Quercus agrifolia; Mountain View Cal.
E. armeniacum *Craw.*[2] on prune; Stanford University Cal.
E. adenostomae *Kuw.*[2] on Adenostoma fasciculatum; Black Mt Cal.
Coccus hesperidium *Linn.*[2,3] on rose; Arcada Cal.
Eucalymnatus tessellatus *Sign.*[2] on fern; San Francisco Cal.
Ceroplastes ceriferus *And.*[2] on tea
Pulvinaria rhois *Ehrh.*[3] on Rhus diversiloba; near Mountain View Cal.
P. aurantii *Ckll.*[2] on tea; Kokura, Kiushiu, Japan
Pseudococcus pseudonipae *Ckll.*[2] on palm; San Francisco Cal.
Phenacoccus dubia[2] on Diospyros kaki; Kusatsu, Shiga-Ken, Japan
Dactylopius dudleyi *Cole.*[2] on Cupressus macnabiona; Shasta Cal.
D. sp. *Coq.*[2] on cypress; Del Monte Cal.
Eriococcus graminis *Mask.*[2] on bamboo; Gifu-Ken, Japan.
E. artemisiae *Kuw.*[3] on Artemesia californica; Santa Clara county Cal.
E. araucariae *Mask.*[2] on Araucaria excelsa; Berkley Cal.
E. adenostomae *Ehrh.*[2] on Adnostoma fasciculatum; Black Mt Cal.
Gossyparia spuria *Modeer.*[2] on elm; Stanford University Cal.
Cerococcus quercus *Comst.*[2] on oak; Mountain View Cal.
C. ehrhorni *Ckll.*[2,3] on live oak; Mountain View Cal.
Lecaniodiaspis quercus *Ckll.*[2] on oak
Asterolecanium quercicola *Bouché*[2] on Quercus lobata, Stanford University Cal.
Icerya purchasi *Mask.*[2] on Scotch broom; Stanford University Cal.

Orthoptera

Hypochlora alba *Dodge*[1]
Campylacantha olivacae *Scud.*[1]
Hesperottetix viridis *Thos.*[1]
H. pratensis *Scud.*[1]
H. speciosus *Scud.*[1]
Aeoloplus regalis *Dodge*[1]
Podisma dodgei *Thos.*[1]
Melanoplus lakinus *Scud.*[1]
M. differentialis *Thos.*[6]
M. flabellifer *Scud.*[1]
M. bowditchi *Scud.*[1]
M. flavidus *Scud.*[1]
M. flabellatus *Scud.*[1]
M. packardii *Scud.*[1]
M. minor *Scud.*[1]
M. luridus *Dodge*[1]
M. bivittatus *Say*[1]
Phoetaliotes nebrascensis (nebrascensis) *Thom.*[1]
P. nebrascensis (volucris) *Dodge*[1]
Schistocerca americana *Drury*[6]

Plecoptera

Perla ephyre *Newm.*[4]
P. lurida *Hag.*[4]
P. xanthenes *Say*[4]

EXCHANGE LIST

The following is a partial list of the species of insects in the New York State Museum which are available for exchange purposes. In return we are specially desirous, as above stated, of securing specimens of economic importance in different sections of this country and of foreign countries, and particularly of forms likely to become destructive if established in this State.

Hymenoptera

Bombus fervidus *Fabr.*
B. ternarius *Say*
B. terricola *Kirby*
B. vagans *Smith*
Xylocopa virginica *Drury*
Megachile latimanus *Say*
Andrena vicina *Smith*
Vespa arenaria *Fabr.*
V. consobrinus *Sauss.*
V. diabolica *Sauss.*
V. maculata *L.*
Polistes pallipes *St Farg.*
Odynerus capra *Sauss.*
Philanthus solivagus *Say*
Monedula ventralis *Say*
Bembex fasciata *Fabr.*
Chalybion caeruleum *Linn.*
Pelopoeus cementarius *Drury*
Ammophila communis *Cress.*
Aporus biguttatus *Fabr.*
A. marginatus *Say*
Pelecinus polyturator *Drury*
Apanteles congregatus *Say*
Lampronota americana *Cress.*
Pimpla conquisitor *Say*
P. inquisitor *Say*
Theronia fulvescens *Cress.*
Ephialtes irritator *Fabr.*
Thalessa lunator *Fabr.*
Paniscus geminatus *Say*
Anomalon exile *Prov.*
Ichneumon centrator *Say*
I. cincticornis *Cress.*
I. confirmatus *Cress.*
I. scelestus *Cress.*
I. unifasciatorius *Say*
I. laetus *Brullé*
Tremex columba *Linn.*
Allantus basillaris *Say*
Dolerus arvensis *Say*
D. sericeus *Say*
Lygaeonematus erichsonii *Hartig*
Trichiocampus viminalis *Fallen*
Cimbex americana *Leach*

Coleoptera

Cratoparis lunatus *Fabr.*
Tomicus calligraphus *Germ.*
T. cacographus *Lec.*
T. pini *Say*
T. balsameus *Lec.*
Xyleborus celsus *Eich.*
X. dispar *Fabr.*
Cossonus platalea *Say*
Calandra granaria *Linn.*
Balaninus nasicus *Say*
Mononychus vulpeculus *Fabr.*
Cryptorhynchus lapathi *Linn.*
Conotrachelus nenuphar *Hbst.*
Gymnetron teter *Fabr.*
Tachypterus quadrigibbus *Say*
Magdalis armicollis *Say*
M. barbita *Say*
M. perforata *Horn*
Lixus concavus *Say*
Hylobius pales *Hbst.*
Pissodes strobi *Peck*
Phytonomus nigrirostris *Fabr.*
P. punctatus *Fabr.*
Cyphomimus dorsalis *Horn*
Pandeletejus hilaris *Hbst.*
Otiorhynchus ovatus *Linn.*
Rhynchites bicolor *Fabr.*
Epicauta vittata *Fabr.*
E. cinerea *Forst.*
E. pennsylvanica *DeG.*
Macrobasis unicolor *Kirby*
Henous confertus *Say*
Meloe angusticollis *Say*
Notoxus anchora *Hentz.*
N. bifasciatus *Lec.*
Mordella marginata *Melsh.*
Anaspis flavipennis *Hald.*
Nacerdes melanura *Linn.*
Pytho americanus *Kirby*
Melandrya striata *Say*
Cistela sericea *Say*
Boletotherus bifurcus *Fabr.*
Hoplocephala bicornis *Oliv.*
Diaperis hydni *Fabr.*
Paratenetus punctatus *Sol.*
Tribolium ferrugineum *Fabr.*
Tenebrio tenebriodides *Beauv.*
T. molitor *Linn.*
Xylopinus saperdioides *Oliv.*
Scotobates calcaratus *Fabr.*
Merinus laevis *Oliv.*
Iphthimus opacus *Lec.*
Nyctobates pennsylvanica *DeG.*
Eleodes tricostata *Say*
Bruchus obtectus *Say*
Chelymorpha argus *Licht.*
Coptocycla aurichalcea *Fabr.*
Odontota rubra *Web.*
Microrhopala vittata *Fabr.*
Dibolia borealis *Chev.*
Phyllotreta sinuata *Steph.*
Systena hudsonias *Forst.*
S. frontalis *Fabr.*
S. bitaeniata *Lec.*
Crepidodera rufipes *Linn.*
C. helxines *Linn.*
C. cucumeris *Harr.*
Haltica bimarginata *Say*
Disonycha alternata *Ill.*
D. pennsylvanica *Ill.*
D. collaris *Fabr.*
Galerucella decora *Say*
G. luteola *Müll.*
Trirhabda canadensis *Kirby*
Diabrotica 12-punctata *Oliv.*
D. vittata *Fabr.*
Cerotoma caminea *Fabr.*
Lina scripta *Fabr.*
Gastroidea polygoni *Linn.*
Chrysomela similis *Rog.*
C. elegans *Oliv.*
C. bigsbyana *Kirby*
Doryphora clivicollis *Kirby*
D. 10-lineata *Say*
Prasocuris varipes *Lec.*
Nodonota brunnea *Fabr.*
N. tristis *Oliv.*
Graphops pubescens *Melsh.*
Metachroma marginalis *Cr.*
Typophorus aterrima *Oliv.*
Chrysochus auratus *Fabr.*
Glyptoscelis pubescens *Fabr.*
Fidia viticida *Walsh*
Xanthonia 10-notata *Say*
Monachus saponatus *Fabr.*
Chlamys plicata *Fabr.*
Babia 4-guttata *Oliv.*
Crioceris asparagi *Linn.*

C. 12-punctata *Linn.*
Lema trilineata *Oliv.*
Syneta ferruginea *Germ.*
Orsodachna atra *Ahr.*
Donacia cincticornis *Newm.*
D. rufa *Say*
Tetraopes tetraophthalmus *Forst.*
Saperda tridentata *Oliv.*
Liopus alpha *Say*
Monohammus maculosus *Hald.*
M. scutellatus *Say*
M. confusor *Kirby*
Leptura lineola *Say*
L. exigua *Newm.*
L. cordifera *Oliv.*
L. canadensis *Fabr.*
L. rubrica *Say*
L. vagans *Oliv.*
L. proxima *Say*
L. vittata *Germ.*
Typocerus velutinus *Oliv.*
Strangalia acuminata *Oliv.*
Rhagium lineatum *Oliv.*
Desmocerus palliatus *Forst.*
Euderces picipes *Fabr.*
Clytanthus ruricola *Oliv.*
Neoclytus erythrocephalus *Fabr.*
Xylotrechus colonus *Fabr.*
Cyllene robiniae *Forst.*
Molorchus bimaculatus *Say*
Elaphidion villosum *Fabr.*
Callidium antennatum *Newm.*
Prionus laticollis *Drury*
Orthosoma brunneum *Forst.*
Parandra brunnea *Fabr.*
Trichius affinis *Gory*
Osmoderma scabra *Beauv.*
O. eremicola *Knoch.*
Euphoria inda *Linn.*
Chalepus trachypygus *Burm.*
Pelidnota punctata *Linn.*
Strigoderma arboricola *Fabr.*
Anomala lucicola *Fabr.*
Lachnosterna fusca *Froh.*
L. tristis *Fabr.*
Macrodactylus subspinosus *Fabr.*
Serica trociformis *Burm.*
Dichelonycha elongata *Fabr.*
D. albicollis *Burm.*
Hoplia modesta *Hald.*
Geotrupes splendidus *Fabr.*
Bolboceras farctus *Fabr.*
Aphodius fossor *Linn.*
A. fimetarius *Linn.*
A. granarius *Linn.*
A. inquinatus *Hbst.*
Onthophagus pennsylvanicus *Harold*
O. hecate *Panz.*
Phanaeus carnifex *Linn.*
Copris anaglypticus *Say*
Canthon laevis *Drury*
Passalus cornutus *Fabr.*
Ceruchus piceus *Web.*
Dorcus parallelus *Say*
Ennearthron thoracicornis *Zeigl.*
Lyctus opaculus *Lec.*
Sitodrepa panicea *Linn.*
Ptinus quadrimaculatus *Melsh.*
Clerus quadriguttatus *Oliv.*
C. nigriventris *Lec.*
C. analis *Lec.*
Trichodes nuttali *Kirby*
Telephorus carolinus *Fabr.*
T. scitulus *Say*
T. rotundicollis *Say*
T. bilineatus *Say*
Podabrus rugulosus *Lec.*
Chauliognathus pennsylvanicus *DeG.*
C. marginatus *Fabr.*
Photuris pennsylvanicus *DeG.*
Photinus scintillans *Say*
Pyropyga nigricans *Say*
Ellychnia corrusca *Linn.*
Lucidota atra *Fabr.*
Calopteron reticulatum *Fabr.*
Brachys ovata *Web.*
Agrilus anxius *Gory*
A. ruficollis *Fabr.*
Acmeodera pulchella *Hbst.*
Chrysobothris femorata *Fabr.*
C. floricola *Gory*
C. dentipes *Germ.*
C. scabripennis *Lap. & Gory*
C. pusilla *Lap. & Gory.*
Buprestis maculiventris *Say*
Dicerca divaricata *Say*
Chalcophora virginiensis *Drury*
Asaphes decoloratus *Say*
Oxygonus obesus *Say*
Corymbites inflatus *Say*

C. cylindriformis *Hbst.*
Limonius confusus *Lec.*
Melanotus communis *Gyll.*
Dolopius lateralis *Esch.*
Elater nigricollis *Hbst.*
E. obliquus *Say*
Cryptohypnus planatus *Lec.*
Alaus oculatus *Linn.*
Tharops ruficornis *Say*
Tenebrioides corticalis *Melsh.*
Ips quadriguttatus *Fabr.*
Omosita colon *Linn.*
Nitidula bipustulata *Linn.*
Conotelus obscurus *Er.*
Colastus truncatus *Rand.*
Hister parallelus *Say*
Anthrenus scrophulariae *Linn.*
A. verbasci *Linn.*
Attagenus piceus *Oliv.*
Dermestes lardarius *Linn.*
Byturus unicolor *Say*
Triphyllus humeralis *Kirby*
Mycetophagus punctatus *Say*
M. flexuosus *Say*
Silvanus surinamensis *Linn.*
Tritona thoracica *Say*
T. humeralis *Fabr.*
Lycoperdina ferruginea *Lec.*
Epilachna borealis *Fabr.*
Brachyacantha ursina *Fabr.*
Chilocorus bivulnerus *Muls.*
Psyllobora 20-maculata *Say*
Anatis ocellata *Linn.*
Adalia bipunctata *Linn.*
Coccinella trifasciata *Linn.*
C. 9-notata *Hbst.*
C. transversalis *Muls.*
C. sanguinea *Linn.*
Hippodamia 13-punctata *Linn.*
H. parenthesis *Say*
Megilla maculata *DeG.*
Tachinus fimbriatus *Grav.*
Stenus flavicornis *Er.*
Paederus littorarius *Grav.*
Philonthus aeneus *Rossi*
Staphylinus cinnamopterus *Grav.*
S. maculosus *Grav.*
Creophilus villosus *Grav.*
Listotrophus cingulatus *Grav.*
Silpha surinamensis *Fabr.*
S. lapponica *Hbst.*
S. inaequalis *Fabr.*
S. noveboracensis *Forst.*
S. americana *Linn.*
Necrophorus marginatus *Fabr.*
N. pustulatus *Hersch*
N. tomentosus *Web.*
Sphaeridium scarabaeoides *Linn.*
Hydrobius fuscipes *Linn.*
H. globosus *Say*
Hydrocharis obtusatus *Say*
Hydrophilus triangularis *Say*
H. glaber *Hbst.*
Dineutes assimilis *Aube*
Gyrinus ventralis *Kirby*
G. picipes *Aube*
Acilius semisulcatus *Aube*
Dytiscus fasciventris *Say*
Colymbetes sculptilis *Harr.*
Agabus punctulatus *Aube*
Ilybius biguttatus *Germ.*
Deronectes griseostriatus *DeG.*
Laccophilus maculosus *Germ.*
Cnemidotus 12-punctatus *Say*
Anisodactylus rusticus *Say*
A. discoideus *Dej.*
A. interstitialis *Say*
Bradycellus rupestris *Say*
Harpalus erraticus *Say*
H. viridiaeneus *Beauv.*
H. caliginosus *Fabr.*
H. pennsylvanicus *DeG.*
H. herbivagus *Say*
Agonoderus pallipes *Fabr.*
Chlaenius sericeus *Forst.*
C. tricolor *Dej.*
C. pennsylvanicus *Say*
C. tomentosus *Say*
Lebia grandis *Hentz*
L. viridis *Say*
Galerita janus *Fabr.*
Calathus gregarius *Say*
Dicaelus elongatus *Bon.*
Amara impuncticollis *Say*
Pterostichus stygicus *Say*
P. lucublandus *Say*
P. corvinus *Dej.*
P. patruelis *Dej.*
P. femoralis *Kirby*
Tachys nanus *Gyll.*

Bembidium quadrimaculatum *Linn.*
Scarites subterraneus *Fabr.*
Pasimachus elongatus *Lec.*
Nebria sahlbergi *Fisch.*
Elaphrus ruscarius *Say*
Calosoma calidum *Fabr.*
Carabus vinctus *Web.*
Omophron americanum *Dej.*
Cicindela lecontei *Hald.*
C. sexguttata *Fabr.*
C. generosa *Dej.*
C. vulgaris *Say*
C. repanda *Dej.*
C. purpurea Oliv.
C. 12-guttata *Dej.*
C. punctulata *Fabr.*

Diptera

Physocephala furcillata *Will.*
Drosophila ampelophila *Loew.*
Chloropisca variceps *Loew.*
Piophila casei *Linn.*
Lauxania flaviceps *Loew.*
Trypeta longipennis *Wied.*
Rhagoletis cingulata *Loew.*
Phorbia fusciceps *Rondani*
Pollenia rudis *Fabr.*
Belvoisia unifasciata *Desv.*
Ocyptera carolinae *Desv.*
Tachina mella *Walk.*
Echinomyia algens *Wied.*
Gonia capitata *DeG.*
Archytas analis *Fabr.*
Spilomyia fusca *Loew.*
Syritta pipiens *Linn.*
Helophilus similis *Macq.*
Eristalis dimidiatus *Wied.*
E. tenax *Linn.*
E. transversus *Wied.*
Rhingia nasica *Say*
Sphaerophoria cylindrica *Say*
Mesograpta marginata *Say*
Syrphus lesueurii *Macq.*
S. ribesii *Linn.*
S. americanus *Wied.*
Platycherus quadratus *Say*
Tabanus atrata *Fabr.*
T. reinwardtii *Wied.*
T. lineola *Fabr.*
Therioplectes microcephalus *O. S.*
Chrysops vittatus *Wied.*
C. excitans *Walk.*
C. niger *Macq.*
Pangonia tranquilla *O. S.*
Bibio albipennis *Linn.*

Lepidoptera

Papilio glaucus turnus *Linn.*
Pontia rapae *Linn.*
Eurymus philodice *Godt.*
Argynnis aphrodite *Fabr.*
A. atlantis *Edw.*
Brenthis myrina *Cram.*
B. bellona *Fabr.*
Phyciodes tharos *Dru.*
Eugonia j-album *Boisd.*
Euvanessa antiopa *Linn.*
Vanessa atalanta *Linn.*
Basilarchia arthemis *Dru.*
B. archippus *Cram.*
Anosia plexippus *Linn.*
Feniseca tarquinius *Fabr.*
Heodes hypophleas *Boisd.*
Samia cecropia *Linn.*
Callosamia promethia *Dru.*
Lycomorpha pholus *Dru.*
Ctenucha virginica *Charp.*
Eubaphe aurantiaca *Hub.*
Haploa confusa *Lyman*
Estigmene acraea *Dru.*
Isia isabella *Sm. & Abb.*
Diacrisia virginica *Fabr.*
Apantesis virgo *Linn.*
A. parthenice *Stretch.*
Halisidota tessellaris *Sm. & Abb.*
H. caryae *Harr.*
Alypia octomaculata *Fabr.*
Hadena passer *Guen.*
H. dubitans *Walk.*
H. devastatrix *Brace.*
H. arctica *Boisd.*
Pyrophila pyramidoides *Guen.*
Adelphagrotis prasina *Fabr.*
Peridroma margaritosa *Harr.*
Noctua smithii *Snell.*

N. bicarnea *Guen.*
N. c-nigrum *Linn.*
N. clandestina *Harr.*
Feltia subgothica *Haw.*
F. jaculifera *Guen.*
Paragrotis redimicula *Morr.*
Mamestra purpurissata *Grote*
M. meditata *Grote*
M. renigera *Steph.*
M. olivacea *Morr.*
Nephelodes minians *Guen.*
Heliophila unipuncta *Haw.*
H. luteopallens *Smith*
Tricholita signata *Streck.*
Gortyna nictitans *Bork.*
Orthosia helva *Grote*
Plusia aerea *Hübn.*
P. aeroides *Grote*
Autographa bimaculata *Steph.*
A. precationis *Guen.*
A. brassicae *Riley*
A. rectangula *Kirby*
A. u-aureum *Guen.*
A. falcigera *Kirby*
Eustrotia carneola *Guen.*
Notolophus badia *Hy. Edw.*
Hemerocampa leuçostigma *Abb. & Sm.*
Eudule mendica *Walk.*
Cingilia catenaria *Dru.*
Sabulodes transversata *Dru.*
Sesia tipuliformis *Clerck.*
Desmia funeralis *Hübn.*
Evergestis straminalis *Hübn.*
Tholeria reversalis *Guen.*

Trichoptera

Leptocerus resurgens *Walk.*
Hydropsyche scalaris *Hag.*
Halesus guttifer *Walk.*
Goniotaulius dispectus *Walk.*
Neuronia postica *Walk.*

Mecoptera

Panorpa rufescens *Rambur*
P. maculosa *Hag.*
Bittacus strigosus *Hag.*

Neuroptera

Polystoechotes punctatus *Fabr.*
Corydalis cornuta *Linn.*

Hemiptera

Canthophorus cinctus *Beauv.*
Podisus maculiventris *Say*
P. placidus *Uhler*
Brochymena 4-pustulata *Fabr.*
Cosmopepla carnifex *Fabr.*
Euschistus servus *Say*
E. tristigmus *Say*
E. fissilis *Uhler*
E. variolarius *P. B.*
Coenus delius *Say*
Pentatoma juniperana *Linn.*
Murgantia histrionica *Hahn.*
Nezara hilaris *Say*
Anasa tristis *DeG.*
Alydus eurinus *Say*
Leptocoris trivittatus *Say*
Blissus leucopterus *Say*
Lygaeus turcicus *Fabr.*
Leptopterna dolobrata *Linn.*
Calocoris rapidus *Say*
Lygus pratensis *Linn.*
Poecilocapsus lineatus *Fabr.*
Capsus ater *Linn.*
Piesma cinerea *Say*
Corythuca arcuata *Say*
Phymata wolffii *Her. Sch.*
Nabis rufusculus *Reut.*
Acholla multispinosa *DeG.*
Limnotrechus marginatus *Say*
Belostoma americana *Leid.*
Notonecta undulata *Say*
Cicada tibicen *Linn.*
C. septendecim *Linn.*
Publilia concava *Say*

P. bicinctus *Godg.*
Ceresa bubalus *Fabr.*
C. diceros *Say*
Stictocephala inermis *Fabr.*
Smilia camelus *Fabr.*
Telamona ampeloposidis *Harr.*
Enchenopa binotata *Say*
Ormenis pruinosus *Say*
Aphrophora saratogensis *Fitch*
A. quadrangularis *Say*
Clastoptera proteus *Fitch*
Diedrocephala mollipes *Say*
D. coccinea *Forst.*
D. noveboracensis *Fitch*
Helochara communis *Fitch*
Thamnotettix clitellarius *Say*
Empoasca rosae *Harr.*
Trioza tripunctata *Fitch*

Coccidae

Lepidosaphes ulmi *Linn.*
Aspidiotus perniciosus *Comst.*
A. ostreaeformis *Curt.*
A. ancylus *Putn.*
A. abietis *Schr.*
Aulacaspis rosae *Bouché*
Diaspis boisduvalii *Sign.*
Chionaspis furfura *Fitch*
C. euonymi *Comst.*
C. americana *Johns.*
Eulecanium nigrofasciatum *Perg.*
Pulvinaria innumerabilis *Rathv.*
Gossyparia spuria *Modeer*
Kermes galliformis *Riley*

CONTRIBUTIONS TO COLLECTION OCT. 16, 1902–OCT. 15, 1903

Hymenoptera

Bombus vagans Smith, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Melissodes sphaeralceae Ckll., adult, Sep. 10, **T. D. A. Cockerell**, Pecos N.M.

Megachile cleomi ? Ckll., adult, Sep. 10, **T. D. A. Cockerell**, Pecos N.M.

M. sapelloni ? Ckll., adult, Sep. 10, **T. D. A. Cockerell**, Pecos N.M.

M. monardarum Ckll., adult, Sep. 10, **T. D. A. Cockerell**, Pecos N.M.

Perdita stotteri Ckll., adult, Sep. 10, **T. D. A. Cockerell**, Pecos N.M.

Camponotus herculaneus Linn., adult, May 21, **F. R. Calkins**, Ossining N.Y.

C. var. pennsylvanicus DeG. large black ant, work on balsam, Oct. 31, **Jonas H. Brooks**, Albany N.Y.

Pteromalus puparum Linn., adult, from Euvanessa antiopa Linn., Feb. 8, **J. H. Cook**, Albany N.Y.

Biorhiza forticornis Walsh, oak fig gall on oak, Aug. 24, **C. H. Peck**, Albany N.Y.

Urocerus tricolor Prov., adult, July 18, **James Roy & Co.**, Troy N.Y.

Dolerus arvensis Say, adult, Ap. 30, **F. R. Calkins**, Ossining N.Y.

Emphytus cinctipes Nort., July 11, **C. J. Locke**, Ogdensburg N.Y.

Coleoptera

Phytonomus nigrirostris Fabr., adult, on clover, Mar. 25, **F. R. Calkins**, Ossining N.Y.

Mycetochares binotata Say, adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Spermophagus robinae Sch., adult, June 6, **Reinlein Gasoline Torch Co.**, Mt Vernon Ill.

Chelymorpha argus Licht., argus beetle, adult, June 6, **C. J. Locke**, Ogdensburg N.Y.

Coptocycla bicolor Fabr., golden tortoise beetle, adult on peach leaves, May 30, **Emma S. Thomas**, Schoharie N.Y. Same, adult, June 6, **C. J. Locke**, Ogdensburg N.Y.

Galerucella luteola Müll., elm leaf beetle, adult on elm, May 25, **F. R. Calkins**, Ossining N.Y. Same, eggs and larvae on elm, July 13, **F. R. Calkins**, Ossining N.Y.

Diabrotica vittata Fabr., adult on squash, May 25, **F. R. Calkins**, Ossining N.Y.

Chrysomela bigsbyana Kirby, adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Doryphora clivicollis Kirby, adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Chrysochus auratus Fabr., golden gilt beetle, adults on dogbane, July 16, **J. Jay Barden**, Dansville N.Y. Same, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Diabrotica vittata Fabr., striped cucumber beetle, adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Crioceris 12-punctata Linn., 12-spotted asparagus beetle, adult, June 3, **C. H. Peck**, Menands N.Y.

C. asparagi Linn., asparagus beetle, adult on asparagus, May 25, **C. L. Williams**, Glens Falls N.Y. Same, adult on asparagus Sep. 3, **W. F. Greene**, Mt Vernon N.Y.

Tetraopes tetraophthalmus Forst., adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Oberea bimaculata Oliv., raspberry cane girdler work on raspberry canes, June 24, **John U. Metz**, Swormville N.Y.

Centrodera decolorata Harr., adult on butternut, Jan. 5, **G. S. Graves**, Newport N.Y.

Desmocerus palliatus Forst., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Cyllene robiniae Forst., locust borer, Oct. 18, **W. C. Hitchcock**, Pittstown N.Y. Same, larvae on locust, June 16, **M. T. Richardson**, Brooklyn N.Y.

Prionus laticollis Drury, broad-necked Prionus, adult, July 20, **Miss M. J. Tyers**, Dobbs Ferry N.Y.

Ligyrus gibbosus DeG., adult, June 6, **Reinlein Gasoline Torch Co.**, Mt Vernon Ill.

Pelidnota punctata Linn., spotted grapevine beetle, Oct. 18, **W. C. Hitchcock**, Pittstown N.Y.

Lachnosterna fusca Fröhl., larva, June 25, **C. J. Locke**, Ogdensburg N.Y.

Diplotaxis liberta Germ., adults on peach, Sep. 24, **J. R. Crandall**, Hauppauge N.Y.

Macrodactylus subspinosus Fabr., rose beetle, adult on fruit trees, June 16, **H. A. Jordan**, Coxsackie N.Y.

Dichelonycha elongata Fabr., adult, June 6, **C. J. Locke**, Ogdensburg N.Y.

Lyctus parallelopipedus Melsh., adults in ash, July 10, **Joseph P. McHugh & Co.**, New York.

Collops vittatus Say, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Telephorus carolinus Fabr., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Podabrus rugulosus Lec., adult, June 25, **C. J. Locke**, Ogdensburg N.Y. Same, adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Lampyrid, larva, June 12, **George S. Graves**, Newport N.Y.

Chalcophora virginiensis Drury, adults, Oct. 18, **W. C. Hitchcock**, Pittstown N.Y.

Melanotus communis Gyll., adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Dolopius lateralis Esch., adult, July 11, **C. J. Locke**, Ogdensburg N.Y.

Alaus oculatus Linn., owl beetle, adult, July 9, **C. L. Daggett**, Albany N.Y. Same, adults, July 27, **Fred G. Carnes**, W. Chazy N.Y.

Anthrenus verbasci Linn., adult, May 25, **F. R. Calkins**, Ossining N.Y.

Chilocorus bivulnerus Muls., twice-stabbed ladybeetle, adult (feeding on San José scale) June 13, **Mr Hotchkin**, Binghamton N.Y.

Adalia bipunctata Linn., two-spotted lady beetle, adult, July 31, **George S. Graves**, Newport N.Y. Same on Norway maple, June 12, **M. F. Tiger**, Patchogue N.Y. Same, larvae on rose, June 3, **Mrs A. G. Dana**, Far Rockaway N.Y.

Coccinella transversalis Muls., adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

C. 9-notata Herbst, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Hydrophilus triangularis Say, adult, June 16, **Frances McCarty**, Albany N.Y.

Harpalus erraticus Say, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Agonoderus pallipes Fabr., adult., May 21, **F. R. Calkins**, Ossining N.Y.

Pterostichus lucublandus Say, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Cicindela punctulata Fabr., adult, July 6, **Richard Lohrmann**, Herkimer N.Y.

C. repanda Dej., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

C. vulgaris Say, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

C. generosa Dej., adult, July 6, **Richard Lohrmann**, Herkimer N.Y.

C. 6-guttata Fabr., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Siphonaptera

Ceratopsyllus serraticeps, cat flea, adult, infesting house, Sep. 14, **Otis Arnold**, Albany N.Y.

Diptera

Mosquito, larvae and adults, July 11, **C. J. Locke**, Ogdensburg N.Y.

Psorophora ciliata Fabr., adult, Aug. 6, **H. C. Weeks**, Sheepshead Bay, Brooklyn N.Y.

Chironomids, adult, Ap. 30, **F. R. Calkins**, Ossining N.Y.

Lasioptera vitis? O. S., June 4, **Francesco Landini**, New York.

Therioplete affinis adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Tabanus atratus Fabr., mourning horsefly, adult, July 7, **Abraham Knechtel**, Albany N.Y.

Syrphus ribesii Linn., adult, Ap. 30, **F. R. Calkins**, Ossining N.Y.

Stratiomyid, adult, May 25, **C. L. Williams**, Glens Falls N.Y.

Tachinid sp., puparium infesting stalk borer, July 15, **C. L. Williams**, Glens Falls N.Y.

Pollenia rudis Fabr., cluster fly, adults in house, Sep. 1, **K. B. Christman**, Burtonville N.Y.

Phorbia brassicae Bouché, cabbage root maggot, larvae in turnips, Nov. 18, **J. J. Cormot**, Phoenix R.I.

P. ceparum Meigen, onion maggot, grubs on onions, June 19, **Mr VanDerzee**, Kenwood N.Y. Same, Mar. 25, **F. R. Calkins**, Ossining N.Y.

Trypeta longipennis Weid., adult, on Helianthus, July 31, **George S. Graves**, Newport N.Y.

Lepidoptera

Papilio polyxenes Fabr., adult, Feb. 11, **R. K. Colville**, Kenwood N.Y. Same, larva, June 16, **Mrs Humphrey**, Watervliet N.Y.

Pieris oleracea Harr., cabbage butterfly, adult, July 14, **Carl Heiser**, Malone N.Y.

Basilarchia arthemis Dr. banded purple, adult, June 17, **Mrs A. M. A. Jackson**, Camillus N.Y.

Sphecodina abbotii Swains, Oct. 18, **W. C. Hitchcock**, Pittstown N.Y.

Samia cecropia Linn., cecropia moth, adult eggs, June 12, **A. Saunders**, Ridge road, Irondequoit N.Y.

Telea polyphemus Cramer, egg and cocoon, June 6, **C. J. Locke**, Ogdensburg N.Y.

Ctenucha virginica Charp., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Estigmene acraea Dr. salt marsh caterpillar, adult, June 9, **George S. Graves**, Newport N.Y.

Alypia octomaculata Fabr., 8-spotted forester, larvae on virginia creeper, July 26, **Percy MacG. Allen**, Albany N.Y.

Noctua clandestina Harr., adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Feltia subgothica ? Haworth, larva on cabbage, June 25, **C. J. Locke**, Ogdensburg N.Y.

Mamestra picta Harr., zebra caterpillar, larva on strawberry, June 9, **C. L. Williams**, Glens Falls N.Y.

Heliophila pseudargyria Guenée, adults, May 21, **F. R. Calkins**, Ossining N.Y.

Xylina laticinerea? Grote, larva on peach, May 28, **Henry G. Parsons**, Milton N.Y.

Heliothis Armiger Hübn., corn worm, larva on corn, Aug. 25, **Dr M. W. VanDenburg**, Mt Vernon N.Y.

Heterocampa bilineata Pack., larvae on beech, July 12, **E. H. Mairs**, Irvington N.Y.

Notolophus antiqua Linn., larva, June 25, **C. J. Locke**, Ogdensburg N.Y.

Tolype velleda? Stoll, lappet moth, larva on apple, June 13, **Mr Hotchkin**, Binghamton N.Y.

Hydria undulata Linn., on cherry, Aug. 15, **C. R. Pettis**, Saranac Inn N.Y.

Prionoxystus ? robiniae Peck, larvae on beech. Jan. 5, **George S. Graves**, Newport N.Y.

Sanninoidea exitiesa Say, Oct. 18, **W. C. Hitchcock**, Pittstown N.Y.

Sesia acerni Clem., maple seslan, larva on maple, Sep. 18 **W. C. H.**, Hartley Hall Pa.

Evergestis straminalis Hübn., black headed cabbage worm, larvae on turnip, july 22, **George S. Graves**, Newport N.Y.

Hypsopygia costalis Fabr., clover hay worm, larvae, Mar. 16, **J. Mace Smith**, Ithaca N.Y.

Archips rosaceana Harr., adult, June 6, **Reinlein Gasoline Torch Co.**, Mt Vernon N.Y. Same, July 11, **C. J. Locke, Ogdensburg** N.Y. Same, larva on rose, June 25, **C. J. Locke**, Ogdensburg N.Y.

Gelechia aceriella Clem., larva on maple, Aug. 27, **George S. Graves**, Newport N.Y.

Bucculatrix pomifoliella Clem., apple leaf Bucculatrix, cocoons on apple, Nov. 17, **L. L. Woodford**, Berwyn N.Y.

Tineola biselliella Hummel, clothes moth, larva in a mattress, June 25, **Mrs P. N. Nicholas**, Geneva N.Y.

Neuroptera

Psocus venosus Burm., on maple, Aug. 12, **George S. Graves**, Newport N.Y.

Sialis infumata Newm., alder fly, June 6, **C. J. Locke**, Ogdensburg N.Y.

Trichoptera

Mystacides nigra Linn., July 11, **C. J. Locke**, Ogdensburg N.Y.

Plecoptera

Taeniopteryx fasciata Burm., Mar. 25, **F. R. Calkins**, Ossining N.Y.

Pteronarcys regalis Newm., adult, June 6, **C. J. Locke**, Ogdensburg N.Y.

Hemiptera

Canthophorus cinctus Beauv., adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

?Nezara hilaris DeG., nymphs killing asparagus beetle grubs, Sep. 3, **W. F. Greene**, Mt Vernon N.Y.

Leptopterna dolobrata Linn., on wheat, June 15, **J. Jay Barden**, Stanley N.Y. Same, adult, June 25, **C. J. Locke**, Ogdensburg N.Y. Same, July 11, **C. J. Locke**, Ogdensburg N.Y.

Calocoris rapidus Say, adult, June 25, **C. J. Locke**, Ogdensburg N.Y.

Poecilocapsus lineatus Fabr., July 11, **C. J. Locke**, Ogdensburg N.Y.

Capsus ater Linn., adult, June 25, **C. J. Locke**, Ogdensburg N.Y. Same, July 11, **C. J. Locke**, Ogdensburg N.Y.

Acanthia lectularia Linn., bedbug, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Corythuca marmorata Uhler, adults on chrysanthemum, June 1, **Harry Blauvelt**, Coeyman N.Y.

Coriscus subcoleopterus Kirby, adult, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Acholla multispinosa DeG. nymphs on grape, May 25, **F. R. Calkins**, Ossining N.Y.

Cicada tibicen Linn., harvest fly, adult, Aug. 12, **George S. Graves**, Newport N.Y. Same, Aug. 24, **H. B. Taylor**, Albany N.Y.

Ceresa taurina Fitch, tree hopper scars on apple, Ap. 24, **Mr Niles**, Chatham N.Y.

Telemona reclivata? Fitch, July 11, **C. J. Locke**, Ogdensburg N.Y.

Psylla pyricola Riley, pear psylla, all stages on pear, July 26, **Jacob H. Wagar**, Cropseyville N.Y. Same, nymphs on pear, Aug. 17, **Miss M. L. Williams**, Sherburne N.Y. Same, pupa on pear, May 25, **G. F. White**, Preston Hollow N.Y.

Chermes pinicorticis Fitch, pine bark chermes, eggs on white pine, May 2, **C. R. Pettis**, Saranac Inn N.Y.

Pemphigus tessellatus Fitch, larvae and adult on alder, Aug. 29, **C. R. Pettis**, Saranac Inn N.Y.

P. popularius Fitch, adult on poplar P. balsamifera, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Hormaphis hamamelidis Fitch, galls on witch hazel, Aug. 12, **George S. Graves**, Newport N.Y.

Schizoneura americana Riley, adults on elm, June 15, **C. J. Locke**, Ogdensburg N.Y.

Lachnus viminalis Fonsc., adult, May 25, **F. R. Calkins**, Ossining N.Y.

Drepanosiphum acerifolii Thos., adults on Acer saccharinum June 26, **George S. Graves**, Newport N.Y.

Aphis gossypii Glover, adults and larvae on tomato, Aug. 6, **C. H. Peck**, Menands N.Y.

?Nectarophora tiliae Monell, basswood louse, eggs on basswood, Nov. 24, **L. L. Woodford**, Berwyn N.Y.

Nectarophora rudbeckiae Fitch, adults on Rudbeckia laciniata, June 25, **G. G. Atwood**, Albany N.Y.

Myzus ribis Linn.? on Ribes aureum, July 8, **W. H. Harrison**, Lebanon Springs N.Y.

M. cerasi Fabr., on cherry, May 25, **F. R. Calkins**, Ossining N.Y. Same, larvae and adult on Prunus pennsylvanica, July 24, **C. R. Pettis**, Saranac Inn N.Y.

Rhopalosiphum solani Thos., tomato louse, all stages, on tomato, June 9, **J. M. Dolph**, Port Jervis N.Y.

Callipterus betulaecolens Fitch, birch leaf aphis on cut leaved birch, Aug. 8, **E. P. VanNess**, East Greenbush N.Y.

Lepidosaphes ulmi Linn., appletree bark louse, eggs on lilac, Mar. 17, **T. L. M.**, Staten Island N.Y. Same, adults on willow, May 2, **M. T. Richardson**, New York.

Chrysomphalus tenebricosus Comst., gloomy scale insect, on maple, Dec. 29, **G. W. Herrick**, Vicksburg Miss.

Aspidiotus perniciosus Comst., San José scale, adults and young on apple, Nov. 3, **Edward V. Cox**, New York city. Same, adults and young on peach and plum, Dec. 29, **G. W. Herrick**, Ellisville Miss. Same, adults on Japanese quince, Feb. 23, Albany N.Y. Same, young adults on Japanese quince, May 7, **M. T. Richardson**, New York. Same, adults on apple, May 16, **A. N. Cloud**, Coxsackie N.Y. Same, adults on pear, June 9, **George M. Adams**, Spencerport N.Y.

A. forbesi Johns., cherry scale insect, adults on cherry, Dec. 29, **Glenn W. Herrick**, Meridian Miss.

A. ancylus Putn., Putnam's scale, young on apple (fruit) Nov. 10, **C. H. Darrow**, Geneva N.Y. Same, adult on white birch, Ap. 7, **Prof. C. F. Hodge**, Clark University, Worcester Mass.

Poliaspis carissae Ckll., adults on carissa, Dec. 22, **T. D. A. Cockerell, East Las Vegas N.M.**

Pheuacaspis natalensis Ckll., adults on mango, Dec. 12, **T. D. A. Cockerell, East Las Vegas N.M.**

Aulacaspis rosae Bouché, rose scale insect, on blackberry, Nov. 24, **L. L. Woodford**, Berwyn N.Y.

Chionaspis euonymi Comst., euonymus scale, adults on euonymus, Sep. 19, **T. W. Baldwin**, Nyack N.Y.

C. lintneri Comst., adults on cornus, Ap. 27, **H. C. Peck**, Rochester N.Y.

Eulecanium tulipifereae Cook, tuliptree scale insect, adults and young on tulip, Aug. 2, **Mrs W. H. Whitaker**, Flushing N.Y.

E. prunastri? Fonsc., New York plum scale, adults on pear, June 12, **E. L. Mitchell**, Clarksville N.Y.

E. nigrofasciatum Perg., black banded lecanium on peach, May 1, **G. S. Clarke**, Milton N.Y.

E. armeniacum Craw., adults on crimson rambler rose, May 26, **Myron S. Wheeler**, Berlin Mass.

Coccus hesperidum Linn., on begonia, June 6, **C. J. Locke**, Ogdensburg N.Y.

Lecanium sp., adult on trumpet vine, June 10, **C. E. Eldridge**, Leon N.Y.

Pulvinaria innumerabilis Rathv., maple tree scale insect, adult on maple, June 20, **M. T. Tyers**, Dobbs Ferry N.Y.

Halimococcus lampas Ckll., adults on palm, Dec. 22, **T. D. A. Cockerell**, East Las Vegas N.M.

Orthoptera

Ceuthophilus maculatus Say, spotted wingless grasshopper, adult, May 15, **C. E. Wieting**, Cobleskill N.Y.

Thysanura

Achorutes packardi Folsm., adults on peartree bark Ap. 7, **A. W. K. Lick**, Germantown N.Y.

Arachnida

Micrathena sagittata Walck., adult killing asparagus beetles, Sep. 3, **W. F. Greene**, Mt Vernon N.Y.

Ixodes cruciarius Fitch, tick, Ap. 21, **C. H. North**, Dannemora N.Y.

Dermacentor americanus, the dog or wood tick, adult on dog, July 26, **E. N. Huyck**, Rensselaerville N.Y.

Chernes sanborni Hagen, adult on house fly, Sep. 7, **Dr H. E. Smith**, Norwich N.Y.

Trombidium muscarum Riley, adults on house fly, Sep. 7, **Dr H. E. Smith**, Norwich N.Y.

Phytoptus quadripes Shimer, galls on Acer dasycarpum, July 3, **G. G. Atwood**, Albany N.Y.

Bryobia pratensis Garm., clover mite, eggs on peach, Nov. 17, **L. L. Woodford**, Berwyn N.Y.

Gamasus sp. adult? May 21, **F. R. Calkins**, Ossining N.Y

Myriapoda

Scutigera forceps Raf., house centipede, adults in house, Sep. 22, **Chancey Whitmyre**, Schenectady N.Y.

The following is a small collection, except a few species which have not been determined, of insects kindly contributed by Mr J. R. de la Torre Bueno of New York city, who collected the same in that vicinity.

Cossonus platalea *Say*
Centrinus picumnus *Hbst.*
C. scutellum-album *Say*
Madarus undulatus *Say*
Baris transversa *Say*
Copturus minutus *Lec.*
Conotrachelus seniculus *Lec.*
C. nenuphar *Hbst.*
Gymnetron teter *Fabr.*
Anthonomus signatus *Say*
Otidocephalus chevrolatii *Horn*
Phytonomus nigrirostris *Fabr.*
P. punctatus *Fabr.*
Apion nigrum *Hbst.*
Sitones flavescens *Marsh*
S. hispidulus *Germ.*
Aphrastus taeniatus *Gyll.*
Otiorhynchus ovatus *Linn.*
Phyxelis rigidus *Say*
Attelabus nigripes *Lec.*
Rhynchites bicolor *Fabr.*
Eugnamptus collaris *Fabr.*
Rhipiphorus limbatus *Fabr.*
Mordellistena aspersa *Melsh.*
M. comata *Lec.*
M. trifasciata *Say*
Mordella marginata *Melsh.*
Bruchus musculus *Say*
Cerotoma caminea *Fabr.*
Trichius affinis *Gory.*
Ligyrus gibbosus *DeG.*
Chalepus trachypygus *Burm.*
Anomala lucicola *Fabr.*
Macrodactylus subspinosus *Fabr.*
Chauliognathus pennsylvanicus *DeG.*
Photinus consanguineus *Lec.*
Lucidota atra *Fabr.*
Calopteron reticulatum *Fabr.*
Adalia bipunctata *Linn.*
Coccinella 9-notata *Hbst.*
Hippodamia glacialis *Fabr.*
Silpha surinamensis *Fabr.*
Harpalus caliginosus *Fabr.*
Casnonia pennsylvanica *Linn.*
Cicindela punctulata *Fabr.*

EXPLANATION OF PLATES

PLATE 1

Dorsal view of Eniscopilus arcuatus Felt

PLATE 2

Ophionid wings

1 Ophion ferruginipennis Felt
2 Ophion bifoveolatum Brullé
3 Ophion bilineatum Say
4 Eniscopilus appendiculatus Felt
5 Ophion abnormum Felt
6 Eremotylus macrurus Linn.

PLATE 3

Work of Chrysanthemum lace-bug, Corythuca marmorata Uhler

PLATE 4

Chrysanthemum lace-bug

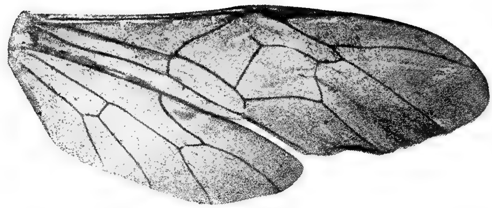
Corythuca marmorata Uhler

1 Section of leaf showing insertion of eggs below the surface
2 Dorsal spines of stage 1: *a*, arising from cone-shaped base, *b*, directly from the body
3 Lateral abdominal spine of stage 1
4 Dorsal view of nymph in stage 2
5 Dorsal spines of stage 2: *a*, arising from cone-shaped base, *b*, directly from the body
6 Lateral abdominal spine of stage 2
7 Dorsal spines of stage 3: *a*, arising from cone-shaped base, *b*, directly from the body
8 Lateral abdominal spines of stage 3
9 Dorsal view of nymph in stage 4
10 Lateral abdominal spines of stage 4
11 Dorsal spines of stage 4: *a*, arising from cone-shaped base, *b*, directly from the body
12 Lateral abdominal spines of stage 5
13 Antennae in stage 5

Plate 1

Eniscopilus arcuatus

Plate 2



1

2

4

3

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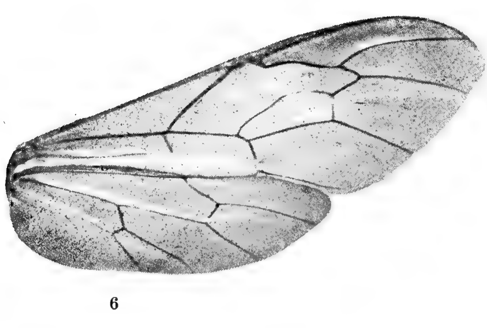
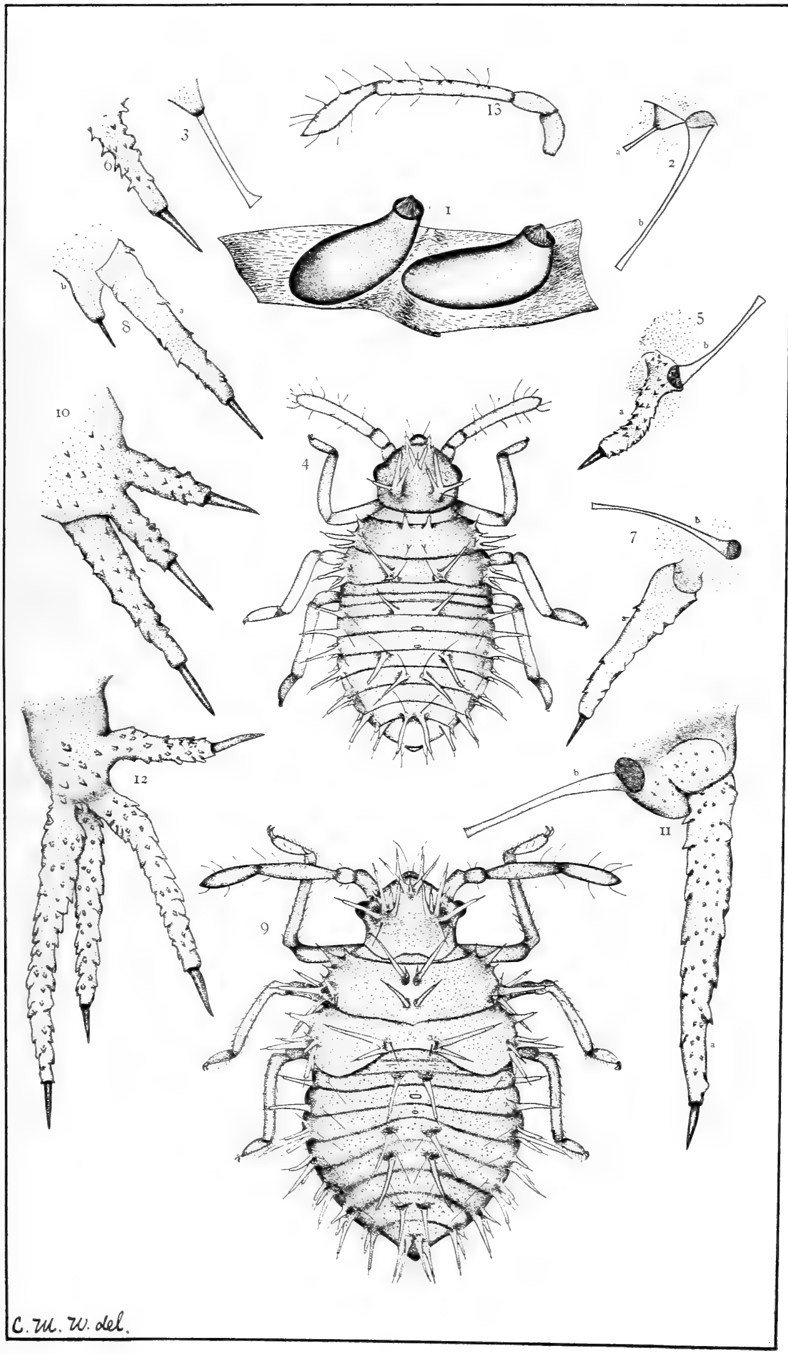


6

Ophionid wings

Plate 3

Work of chrysanthemum lace bug



Chrysanthemum lace bug

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Published monthly by the

University of the State of New York

BULLETIN 324 OCTOBER 1904

New York State Museum

EPHRAIM PORTER FELT State Entomologist

Bulletin 79

ENTOMOLOGY 22

MOSQUITOS OR CULICIDAE

OF

NEW YORK STATE

University of the State of New York

New York State Museum

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ENTOMOLOGY 22

MOSQUITOS OR CULICIDAE

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PREFACE

Large scale operations have demonstrated the practicability of the apparently impossible, and many formerly pest ridden areas are nearly free from mosquitos as a result of well directed exterminative work. This publication calls attention to the more important species, the number of forms which occur in the State, the advisability of studying them closely in order to devise improved methods of controlling the pests, and gives keys and illustrations for their identification. It will be seen by reference to the following pages, that the term mosquito includes a great many forms, and it requires no argument to prove the advisibility not only of knowing the species we are obliged to fight, but also their habits, in order that the work may be carried on most intelligently. Such information should also prove of service to nature teachers, since no group of insects is more easily obtained or lends itself more readily to classroom conditions.

This bulletin summarizes our knowledge to date and places on record the results of such studies as we have been able to make during the past few years. No attempt has been made to revise the generic grouping or to determine the synonymy of the species. Special attention has been given to establishing the identity of larvae and adults by isolated rearings and when in doubt as to specific identity, we prefer to describe and risk creating a synonym rather than confuse two species. We have studied, in the course of this work, specimens of over 40 species, rearing from larvae both sexes of most forms.

The writer acknowledges the earnest cooperation of his assistant, Mr D. B. Young, who has not only done much of the field work, but has determined many of the species and prepared the tables for separating the adults.

Mr C. M. Walker did considerable field work and breeding in 1903. Most of the determinations have been kindly reviewed through the courtesy of Dr L. O. Howard, by Mr D. W. Coquillett, of the United States National Museum. Due acknowledgment should also be made to Dr H. G. Dyar of the same institution, who generously donated a number of larvae and adult mosquitos from which certain illustrations were made.

E. P. Felt

Albany N. Y. March 1904

MOSQUITOS OR CULICIDAE OF NEW YORK

INTRODUCTION

Mosquitos, individually and collectively, have long forced themselves on the attention of mankind, but it is only within recent years that they have received careful scientific study and that the practicability of abating the annoyance and injury caused by them has been demonstrated. The discoveries that certain species conveyed malaria and yellow fever aroused great interest in this group. This is well illustrated by what we knew a few years ago compared with the present time. Our leading dipterist in 1878, published a list containing 33 species, which represented all that were then known to occur in North America; and only three years ago Dr Howard stated that there were about 24 species in the United States. Today over 50 have been found in New York or adjacent states, the latter under conditions which lead us to believe that they also exist within our boundaries. It is very likely that the total number of mosquitos in North America, is treble that known 25 years ago. A monograph of the mosquitos of the world published in 1901, by F. V. Theobald, lists 343 species, and within two years, owing to active collecting and study by scientists all over the world, a third volume has been issued, describing 88 additional species, making a total of over 430. It is very probable that since this volume was published, at least 20 new forms have been characterized. It would not surprise us, if within a year or two this list of species of the entire world, of an heretofore inconspicuous group, closely approached the 500 mark.

The excellent work of the North Shore Improvement Association, and that of such villages as Lawrence, L. I., South Orange and others in New Jersey have demonstrated the practicability of keeping the mosquito pest in subjection. This practical work has concerned itself not only with disease-carrying species, but it has sought to lessen the hordes of those annoying to man, both materially depreciating the value of real estate, particularly in the vicinity of New York city. The magnitude of this evil can be appreciated only by those conversant with the situation. It is surprising, though nevertheless true, that there are practically 200 (199.15) square miles of swamp land within 25 miles of New York City Hall. Nearly 100 (95.55) square miles of this salt marsh are within the boundaries of New York State, and very little (1.75 sq. m.) fresh water. New Jersey has over 100 square miles (101.85), 41.4 being fresh water swamps. The proximity of this entire area to New York city makes it of considerable importance, particularly as portions produce billions of annoying pestiferous insects, which have a detrimental influence on the value of adjacent highlands. Certain of these insects are a serious menace to public health, and swarms of the others are nearly unendurable nuisances.

The extended areas favorable to the production of mosquitos, and the fact that not all marshes lend themselves kindly to political boundaries, make it difficult to devise practical methods of checking the evil. The work so far done about New York has been performed under considerable disadvantages. On account of the lack of funds, it has been impossible for local associations to give proper attention to the scientific aspects of the case and at the same time carry on the extensive field operations necessary. Experience in other lines of applied entomology has demonstrated time and again not only the advisability but the necessity from an economic standpoint of basing practical work on scientific investigations. No one thinks of employing an architect to superintend the construction of a dry-goods box, and yet the man who undertook to erect one of the modern large buildings without such skill at his command would be engaged in a foolish undertaking. In the same way, it requires little scientific knowledge to drain a small swamp or kill a few mosquitos, particularly if they belong to only one or two species. It is entirely different when we undertake to apply this process to large areas, possessing considerable diversity and possibly lying in different sections of the State. This can be done to advantage only after extended studies have demonstrated the advisability of certain courses for the control of various species under different conditions. The time and money expended by a specialist in solving these preliminary problems are exceedingly well invested, and the saving resulting from his services should pay for the cost of his work many times over.

It must not be assumed that we know all about mosquitos. Much valuable work has already been done, but there is great need in this State of a general biologic survey of the more important swamp areas, particularly those about large cities, for the purpose of determining the places most prolific of mosquitos, the species which occur there, and the times when they are most likely to appear. The effect of climate and other conditions on the abundance of these insects should be carefully studied, since there is considerable variation in this respect. The number of kinds of mosquitos occurring in different areas should be determined, and their habits, powers of flight, etc. carefully ascertained. There is great divergence in this respect among the different species, and knowledge of this is of utmost importance in all practical efforts looking to their subjection. These fundamental facts acquired, we are in position to determine by experiment the best method of solving the problem under various conditions. Every effort should be made to find solutions which will result in the increased value of swamp lands, paying very largely or entirely for the improvement; in other words, aim wherever possible to make permanent betterments which will pay for themselves and incidentally solve the mosquito problem. The extensive swamp areas about New York city, if reclaimed, would possess considerable value either for market garden purposes, or, in the course of time, as residential sites.

Mosquitos as carriers of disease. A number of years ago it was demonstrated that filariasis or elephantiasis was conveyed by the bite of certain mosquitos, and more recent investigations have shown that both malaria and yellow fever are disseminated in the same manner. In fact, it is very probable that these diseases of man can be spread in no other way, and there is a possibility that others of a similar character may pass a portion of their life in and depend for transmission on members of this exceedingly interesting and important group.

Malaria. This disease is by far the most important of the above named in New York State. Professor Herrick, in a recent paper, concludes that "malaria is responsible for more sickness among the white population of the South, than any disease to which it is now subject." It is less important in New York, yet this enervating disease is certainly responsible for large annual losses, because all those infected are frequently unfitted for work, though comparatively few deaths are attributed directly to it. It is conveyed, as shown by various investigators, by members of the genus Anopheles, of which we have three species, A. crucians, A. maculipennis and A. punctipennis, the latter two are probably agents in its distribution. These insects act only as intermediary hosts, affording the parasite which produces the fever, favorable conditions for undergoing certain changes prior to its introduction into the human system. It is impossible for these mosquitos to convey malaria before they have become infected by biting a malarious subject, and consequently the spread of this disease is readily checked by either destroying all of the insects capable of carrying it, or by keeping them from sources of infection. Anopheles must exist where malaria occurs, though it does not follow that the distribution of malaria is coincident with that of Anopheles.

Yellow fever. This dread disease of man is well known, and up to within very recent years no adequate knowledge existed as to the way in which it was spread. Dr Josiah C. Nott, of Mobile Ala., published in the *New Orleans Medical and Surgical Journal* for March 1848, a number of reasons why insects probably were agents in carrying this disease. This was again advocated in 1881 to 1886 by Dr Finlay of Havana, and recent investigations in Cuba demonstrated that it may be carried by a mosquito, Stegomyia fasciata, and possibly by some other forms belonging to the same genus. As in the case with malaria, the yellow fever mosquito is simply what is known as an intermediary host and must first become infected with the parasite before it is capable of imparting this dangerous disease. Control of these pests is so important in Cuba that the general government spent about

$100,000 in their destruction the year after it was proved that mosquitos conveyed the fever, eminently satisfactory results being obtained.

Filariasis. This dread disease is limited to the tropics, and while horrible in its effects, is of much less importance in New York State, and consequently is only mentioned.

It has been demonstrated that certain mosquitos convey malarious parasites to birds, and it would not be surprising if future investigations should show that some species were guilty of harboring other diseases than those named above.

Distribution and abundance of mosquitos. These frail insects are ordinarily regarded as inhabitants of temperate or warmer climates, yet it is a fact that certain species exist in hordes even within the arctic circle. Entomologic literature contains many records of enormous swarms of these insects, and in some cases they are carried miles by the wind, and are so bloodthirsty as to drive man and beast before them. These insects are so aggressive in some localities as to give name to a place; for example, there is a town named Mosquito in Illinois, a village bearing the same title in Newfoundland, a Mosquito creek in Indiana, another in Iowa, still another in Ohio, and most of us have heard of the mosquito country of Central America. Dr Riley states that the bravest man on the fleetest horse dares not to cross some of the more rank and dark prairies of Minnesota in June, while the marshlands of New Jersey and the hills of Long Island have become notorious because of the abundance of these little pests, and frequenters of the Adirondacks can speak from experience of the biting powers of these insects.

Adults. Adult mosquitos vary in habit, many, as we know, flying at dusk, some almost all night, and a few may be found abroad in the daytime. The normal food of adult mosquitos is probably plant juices, and the taste for blood possessed by certain species is presumably an acquired habit. Blood-sucking mosquitos not only attack mammals, but also birds, reptiles and fish, even killing the latter in some cases. Members of certain genera, according to Theobald, are not bloodsuckers. Aedes, in the restricted sense, rarely attacks men or animals, while Sayomyia and Corethra feed exclusively on vegetation. These latter two are said to inhabit the open country and do not enter human habitations. Certain species pass the winter as adults, and all as a rule, fly relatively short distances. Notable exceptions to this are Culex sollicitans and C. cantator. Very few mosquitos are met with in the daytime because they are usually hiding in dark crevices about houses and other shelters, or have taken refuge among foliage or near the base of grasses. These insects are very susceptible to climatic changes, though we believe that the frequently noted appearance of large numbers just after rains is due more to the multiplicity of favorable breeding places, than the necessity of moisture for the welfare of the adult. Heat favors rapid transformations, and this may hasten the disclosure of unusually large numbers of the pests.

Migration of flight. The migratory habits of mosquitos have a very important bearing on repressive measures, because if the insects are capable of flying long distances it means that considerable areas must be treated in order to secure immunity from the pests. Extended experience and observation, not only in this but other countries, have shown that the malarial mosquitos, Anopheles, are very restricted in their habits, flying only 200 to 300 yards, and consequently that local work is exceedingly effective in reducing their numbers. The same is probably true of our house mosquito, Culex pipiens, and to a less extent of a number of other species. This is not the case with the salt marsh mosquito, Culex sollicitans and its associate, C. cantator, both of which, as demonstrated by Dr Smith, are capable of flying or drifting with the wind to a distance of 40 miles or thereabouts. His observations were limited to New Jersey, and we have yet to learn of equally prolonged flights in New York State, though data at hand and observations indicate that this species may easily fly or drift several miles. The practical work conducted in the vicinity of New York city indicates that a large amount of freedom, even from these two species, may be secured by work restricted to comparatively limited areas, and as a rule local effort, even in the case of these two species, will afford considerable relief, which is certainly true of others liable to become at all troublesome. A number of instances have been placed on record in recent years, proving the efficacy of operations confined to small areas, and further investigations may show that the migrations observed by Dr Smith were somewhat local and brought about by peculiar conditions. Mr G. C. Davis has recently published data showing that mosquitos in arid portions of California are carried over 20 miles by steady, gentle breezes. Railroad trains have been suggested as an efficient means of disseminating mosquitos, but Dr Smith's observations, showing that while a train might become filled with mosquitos while passing through an infested marsh, it was practically free when the haunts of the mosquitos were left behind, would seem to indicate that this method of transportation is of relatively small importance. Railroad trains might, however, convey small numbers to favorable breeding places, where the insects would be able to survive for a few generations, and in this way centers might become established. Ships are probably very efficient in conveying species from one country to another, since Rowe has observed 12 foreign species on a ship in quarantine at New York.

Life history. Only a few years ago it was supposed that the life histories of most species of mosquitos were substantially identical. The great impetus given to the study of this group by the recent demonstration that certain forms were capable of conveying malaria and yellow fever, has practically disproved this notion, and now we know that there is considerable variation in their life histories and habits, as will be seen by reference to accounts of different species on the following pages.

Hibernation. At one time it was presumed that the winter was passed solely by the adults, and while this is undoubtedly true of certain species, others hibernate in the egg stage and still others as larvae and possibly pupae. Several observers have noted the resistance of larvae of this insect to cold and have placed on record instances where they have been frozen repeatedly and survived.

Eggs. Dr Dyar has made a somewhat extensive study of the oviposition habits of various mosquitos, and has ascertained in the case of the species studied, that those with unbanded legs produce eggs which float on the surface, some in masses, as for example, C. pipiens, while in others they may be deposited singly or in small groups of two or three. The ring-legged species deposit their eggs, like C. sollicitans for example, in dry places where water is likely to collect, a portion hatching after a wetting, so that a series of swarms are produced by high tides and storms from the overwintering eggs. C. canadensis deposits its eggs singly and many sink to the bottom, most of them remaining unhatched till the following spring. C. sylvestris lays its eggs in a similar manner, and the species breeds continuously throughout the season, practically all eggs hatching when covered by water, except possibly those laid in September, which, in the instance under observation, hibernated.

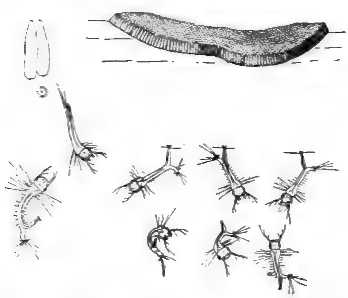

Fig. 1 Culex pipiens. Egg mass, with enlarged eggs at left and young larvae. (Reduced from Howard. U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

Larvae. Mosquito larvae, as a rule, subsist mostly on decaying vegetable matter and algae, though they are also carnivorous in habit, and species of Corethra and Sayomyia entirely so. Certain species have decided preferences in breeding places, some being found only in or near brackish or salt water, others only in fresh water, a few in foul water, some in warm, fresh water, while others prefer cool spring-fed pools and similar places. Dr Dyar observes that larvae with a short air tube are generally found in temporary pools, while those with a long air tube occur in permanent waters. Small fish feed on the larvae so readily, that they are very rarely found where these enemies occur, and consequently practically all breeding is limited to fishless waters, except in the case of some of the more transparent forms like Sayomyia.

Pupae. Pupae of most mosquitos are very similar, active and floating at the surface of the water. This stage is usually short, its duration being greatly modified by the temperature.

Methods of collecting and breeding. Mosquitos are readily captured with a dexterous sweep of the hand, and by exercising a little caution the body will be only slightly crushed and the specimen, therefore, not ruined for identification. They may also be taken by deftly slipping a small cyanid bottle or one containing a little cotton soaked with chloroform over the insect while it is at rest on a wall or person, or inside an insect net, if the latter be used. The fumes of the cyanid or chloroform kill the insects quickly, and they can then be easily transmitted in small vials between lightly placed wads or layers of cotton. The species occurring in and about houses are of special importance.

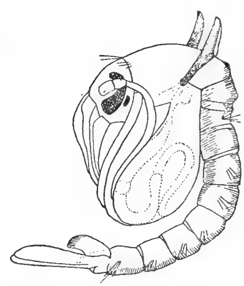

Fig. 2 Culex pipiens. Pupa, enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

Some of the rare forms and perfect individuals of most species can be obtained as easily by collecting the larvae as in any other way. The latter may be found in pools of almost any character where fish do not occur, and sometimes in small numbers even when these enemies are present. Mosquitos have decided preferences in breeding places, and various species may be found under widely different conditions. An examination of almost any small body of water should reveal specimens sometime during the season. A definite idea of breeding places of different species, may be gained by reference to the accounts of various forms. Larvae may be taken by the use of a fine meshed coffee strainer, and if a small porcelain dish or one lined with white enamel is used for the reception of the catch, it will be much easier to detect them. They may be kept alive several hours in small vials partly filled with water, or they may be killed at once by transferring them to 50% alcohol, which is strong enough to preserve them for several days, after which they should be placed in 75 to 85% alcohol. Both larvae and adults may be shipped safely in vials by mail, provided they are packed in a little cotton and inclosed in a stout box.

The life cycle of the mosquito is so short, and the different species so easily reared, that there is little difficulty in obtaining adults from either eggs, larvae or pupae, particularly the latter. Soil gathered in wet places in the spring is very likely to produce larvae, provided it be kept covered with an inch or more of water, and with moderate attention the young should develop to adults without trouble, though it is advisable to imitate natural conditions so far as convenient. Young larvae are usually easily reared, and as they approach maturity there is less danger of death by disease or from insufficient food. Careful breeding work necessitates the isolation of individuals and the preservation of the larval skin with the adult, since it is very easy to confuse species in the larval stage, specially when it is remembered that we have taken larvae belonging to seven species from the same pool and at practically the same time. There is great need of this kind of work, and it is hoped that many will undertake it in the near future, and thus make material additions to our knowledge of the mosquitos of New York State.

Examples of either adults or larvae, together with records of the conditions under which they were taken, will be welcome, and the entomologist will gladly reciprocate by giving advice in individual cases, and specially interesting localities may be closely investigated.

Haunts and breeding places. The haunts and breeding places of mosquitos are of prime importance to one attempting to control the pest, and therefore considerable space will be given to this phase of the subject. We may divide mosquitos in a general way into semidomestic and wild species, the former occurring more or less in the vicinity of dwellings and frequently entering them, while the latter rarely have this habit.

Anopheles. The members of this genus are of great importance in New York State, because of their malarial carrying powers. The adults are frequently found in the vicinity of dwellings, and investigations in September 1902, in the city of Albany, showed that it was comparatively easy to find specimens of Anopheles punctipennis in many of the area ways in different sections of the city. It was observed that the insects were more abundant in the areas where there was only a doorway and consequently poor ventilation. Mosquitos evidently do not like a draft, and in most places where there was a free circulation of air comparatively few were to be found. In view of this fact some relief from

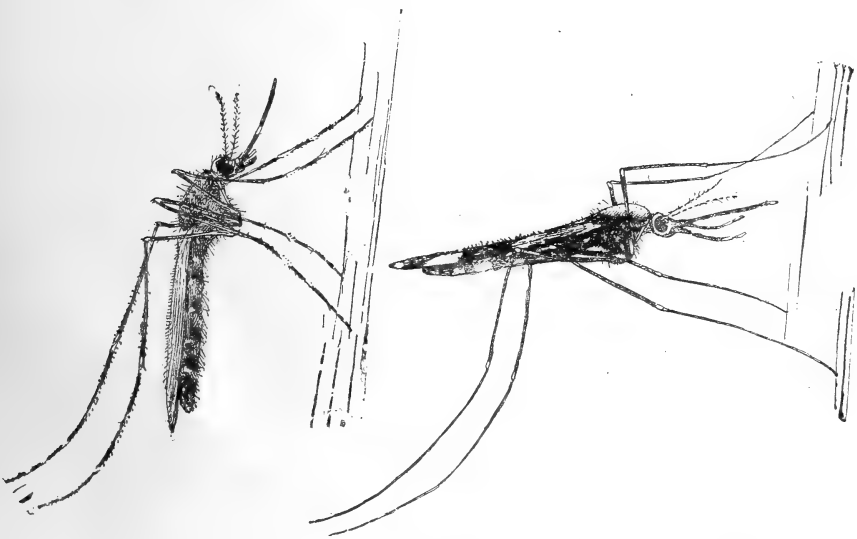

Fig. 3 Resting positions of Culex at left and Anopheles at right. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

mosquitos, particularly Anopheles, might be obtained by providing free ventilation in area ways and other sheltered places like porches, so that mosquitos would be disinclined to take refuge therein. As is well known, these insects may also be found in outbuildings of various kinds, in fact in almost any dry place where there is not too much air. They fly throughout the summer and we have met with specimens on snow in the middle of March.

The natural breeding places of Anopheles larvae, according to Dr Howard, are in the more or less permanent pools of water such as are found in the bed of an old canal in spring, in woodland streams, or in the side pools or shallows of field springs or artificial excavations filled with water. Small larvae are to be found in such places, particularly where there is a certain amount of green scum. Nuttall and Shipley state that in England these larvae are to be found in pools, ditches, backwaters of rivers and

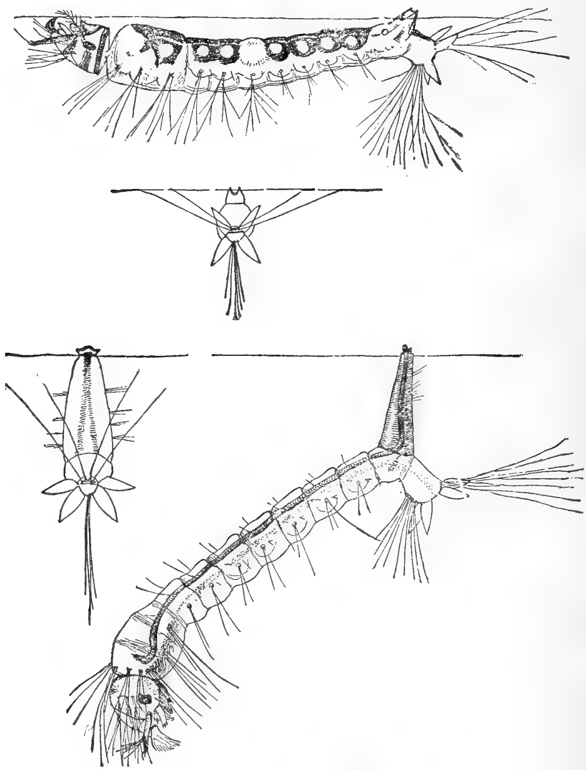

Fig. 4 Characteristic feeding position of Anopheles larva in upper figure, and that of Culex in lower figure. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

canals and in other slow flowing waters, almost invariably in such as are clear, and very rarely in impure or brackish water. They state that the larvae frequent places not shaded by trees, though Dr Howard has found them on several occasions in dense shade. He adds that they are rarely found in water contained in barrels, troughs and fountain basins. Our own experience has been somewhat different, in that we have had no difficulty in obtaining larvae of Anopheles in rain water collected in an old paint pot and in association with Culex. We have also taken numbers from a barrel containing spring water, where there was considerable algae or green scum, while we failed to find specimens in a large spring within 150 feet, though there was much algae at the sides. We have also taken them beside a stream in a depression among the rocks, where there was considerable algae, a single specimen was met with in a barrel of filthy water, and we have found them abundant in weedy, semistagnant pools beside watercourses.

Culex pipiens and other semidomesticated species. The adults of these species have somewhat similar habits to those of Anopheles, and like them were found by us in unventilated area ways in different sections of Albany. It is probable, as pointed out above, that ventilation would result in many of these mosquitos avoiding such retreats. The larvae, as is well known, are found in multitudes in pails and barrels of standing water, and wherever there are holes in the earth, tin cans and other debris holding water we may expect to find larger or smaller colonies of these insects. Cisterns supposed to be tight frequently produce thousands of mosquitos, and they have been detected emerging in considerable numbers from sewers. Gutters with deficient fall may harbor millions, and almost any standing water in the vicinity of a house is likely to produce these insects; one can not look too closely for breeding places.

Salt marsh and other wild mosquitos. The salt marsh mosquito and its ally, C. c a n t a t o r, are the two most important of our wild forms and the ones which cause the most annoyance in the vicinity of seacoasts. These two species breed on the salt marshes, preferably in brackish water, and the work of several investigators has shown that only limited portions of the marshes produce the pest. It has been repeatedly observed after high tides, that the salt marshes along the upland and extending out a distance of 150 to 250 feet, were swarming with larvae. They are largely protected in these places from spraying operations by grass, and it is impossible for fish to get at them. These species breed principally in pools at the head of the marshes to which tides rise only occasionally and in which the water is quite brackish. Here the wrigglers have time to develop before the tide again visits the pools, sweeping away their contents. As a rule none are found in pools not reached by tides or in those containing fish, neither are they found where killifish occur nor in association with fiddler crabs. It will be observed that the breeding places of these two species are confined to limited areas, and consequently, while their control may at first sight appear to be a gigantic undertaking, in reality it is largely simplified by these restrictions.

Other wild species have more or less decided preferences as to breeding grounds, the details of which are given under accounts of the different species. These forms, as a rule, are of minor economic importance, though their habits, as well as those of more annoying mosquitos, should be carefully investigated.

Natural enemies. Small fish are by far the most important among the natural enemies of mosquitos, and the introduction of suitable forms into fishless waters sometimes affords one of the readiest methods of controlling these pests. Almost all of the small carnivorous fish which inhabit swamp pools and still water will feed on mosquito larvae. This includes nearly all of the minnows, particularly those known as top-minnows. The little sticklebacks are very efficient in this respect. The common little sunfish or "pumpkin seed" is also recommended as a voracious devourer of mosquitos, and it has the advantage of the preceding forms, in that its spined rays protect it from some of the larger fish. The common goldfish has also been reported as an important ally in controlling mosquitos. Tadpoles may eat mosquito larvae, though there appears to be some doubt on this point, and as we have observed larvae in association with tadpoles, they can not be voracious devourers of wrigglers. Mr Koebele of Hawaii has observed a salamander devouring larvae.

A number of aquatic insects, such as dragon fly larvae, the young of predatory water beetles and various aquatic bugs feed on mosquito larvae and are undoubtedly valuable aids in controlling this pest, though hardly forms which could be handled and bred or distributed in the same way as fish.

Adult mosquitos are fed on by a number of natural enemies, prominent among which may be listed various birds and bats. Theobald mentions the night hawk, swallows, martins and fly-catchers as being specially valuable. It is well known that dragon flies devour many small flies, including mosquitos, and Dr Howard records, on the authority of Mr E. P. Salmon of Beloit Wis., the presence of a little red louse on mosquitos. Attack by some mite, probably Trombidium muscarum, on mosquitos has also been reported to us by Mr J. G. Lindsley of Oswego N. Y., an observer in whom we have utmost confidence.

Adult mosquitos are also attacked by certain fungus diseases. First, Entomophthora spaerosperma Fersn., attacks many different insects and frequently affects mosquitos. Another species, Empusa culicis Braun., is very similar to the fungus so frequently observed on house flies, and is one, as the name implies, that destroys many of these little pests. A third species recorded by Thaxter as attacking small gnats is known as Empusa papilata, but as the gnats were not determined we can not say that it affects mosquitos. In addition, Prof. R. H. Pettit of Michigan, records attack on mosquitos by a new species of Entomophthora. He states that on Aug. 5 Mr Barlow found a number of adult mosquitos killed by it, and that they were very numerous on the margin of one of the pools in the North Woods, sometimes almost covering the soil and the pieces of bark to which they clung. Recently killed individuals, showed little, if any, external growth, while others were covered with a dull white coat and all were within a few inches of the water and headed away from it. The victims die so close to the water, that they are, as pointed out by Professor Pettit, in an ideal situation to infect their fellows. He states that the appearance of an infected mosquito is very characteristic. The entire body is swollen and covered with a dull white growth, sometimes almost lead color, and it is fastened down by many slender brownish threads. This fungus was also met with by him on several species of Muscidae, on a Chironomid and on a dragon fly, probably Diplax rubicundula. Several attempts were made to introduce the disease in other places, but without success.

Methods of control. Mosquitos have been tolerated from time immemorial. It was a supposed impossibility to do more than to exclude the little pests from dwellings. Abating such a nuisance appears to be a herculean task at first sight, but study and experience have demonstrated that it is eminently practical to reduce the numbers of these insects very materially. There are two important phases to this problem: one, the destruction of domestic species which enter our houses, certain forms of which are capable of conveying malaria to their victims, and the annihilation of the many swarms bred along seashores and other places more or less remote from the habitations of man. These two problems have this in common, that they aim to destroy insects, but the methods of accomplishing the desired end in one case is quite different from that in the other.

Destruction of semidomestic species. The semidomestic species include such forms as Anopheles, Culex pipiens and a few other house species. These insects possess limited powers of flight, and as a consequence those troublesome about a house are bred near by, in many cases within 200 yards, and sometimes within 25 feet of the dwelling. Our main object in the fight against these species is to abolish favorable breeding places in the immediate vicinity. This means that a most careful watch must be kept for uncovered rain barrels, partly open cisterns and cesspools or near-by hollows which may hold water for a short time, broken crockery, tin cans and any other debris, which may afford the necessary conditions for the existence of larvae. Such a campaign calls for the minutest scrutiny of all likely and even unlikely places, to see that they do not supply conditions favorable for developing mosquitos. Drainage has a prominent part, particularly in low places, because we know of instances where houses cover standing water, but in the State at large this is hardly true, and fair drainage prevails. The appearance of considerable numbers of these mosquitos about a dwelling is almost proof that there is a breeding place in the immediate vicinity, and the owner, if he objects to the pests, can do no better than to search for and do away with them in some way or another, either by drainage, sealing, supplying small fish which will feed on the wrigglers, in case this is possible, or treating the surface with kerosene or other oil.

It will usually be necessary to supplement the above measures by carefully screening dwellings, so as to exclude the few remaining insects. This is particularly important in the case of Anopheles, because of its disease-carrying possibilities. Living mosquitos may be stupefied in closed rooms by burning pyrethrum powder, which should be moistened somewhat and molded into little cones and then dried in the oven. These cones may be lighted at the tip and will then smolder slowly, filling the room with a not unpleasant smoke which appears to stupefy the mosquitos. It is said that two or three of these cones will give relief during the entire evening, provided the windows are closed. Dr Howard also calls attention to the modification of a device frequently used for catching house flies. It is nothing more than a tin cup or inverted can cover nailed to a stick and containing a small quantity of kerosene. It is pushed up under a mosquito resting on the ceiling, and as the insect attempts to fly it is caught by the oil and destroyed. Such a device would be very convenient if used in the early evening, to rid sleeping chambers of the pests.

Salt marsh and other wild mosquitos. Mosquitos belonging to this group are usually troublesome only in the vicinity of the seashore, and the common salt marsh mosquito, Culex sollicitans, is by all odds the most serious pest of them all. Acquaintance with its breeding habits has taught us that the larvae occur usually within 100 to 250 feet of the shore, and that they develop largely in places reached only by the higher tides, numbers of eggs hatching after each high tide or heavy rain, thus providing a series of swarms throughout the season. The obvious thing is to either so ditch and drain that no pools will remain after the retreat of high tides, or else by a series of dikes exclude the tides and in this way render large tracts unsuitable for breeding purposes. Extensive areas can be treated in this way, and if diking is followed by proper drainage and reclamation, many acres of land exceedingly valuable for agricultural purposes, or which might be used for suburban residences, could be placed on the market. There are many depressions in salt and other marshes and also on dry land which can be readily transformed from pernicious breeding places to harmless soil by a little filling. Ditching, digging and filling may be regarded as permanent methods of doing away with the mosquito nuisance. This is not always possible, and it is then necessary to resort to temporary measures, such as spraying breeding places with petroleum, in order to destroy the larvae. The succession in the hatching of the eggs of the salt marsh mosquito, and the several generations produced by Culex pipiens in fresh waters, render the repetition of this petrolizing or treatment with oil necessary at more or less regular intervals throughout the breeding season. It is more costly in the long run than the more permanent measures and can be recommended only as a temporary expedient.

The natural enemies of mosquitos are of considerable value in this warfare, and this is particularly true of the small fish mentioned in a preceding paragraph. It not infrequently happens that a fresh or salt water pool affords ideal conditions for the production of millions of mosquitos, a state of affairs that can be easily remedied by the introduction of some of these fish. They may be brought from some distance in the case of isolated pools, but there are many easily connected with fish-inhabited bodies, where even this would not be necessary.

CULICIDAE

Mosquitos are so familiar to most people that a scientific definition of them hardly seems necessary. The most characteristic feature of the adult is the presence of hairlike scales along the veins and margins of the wings. The females of our common species are easily recognized by their hum and bite, while the innoxious males, rarely seen in nature, have conspicuous feathery or plumose antennae.

These small insects may be separated from closely allied flies by the long, slender abdomen, narrow wings, the plumose an-

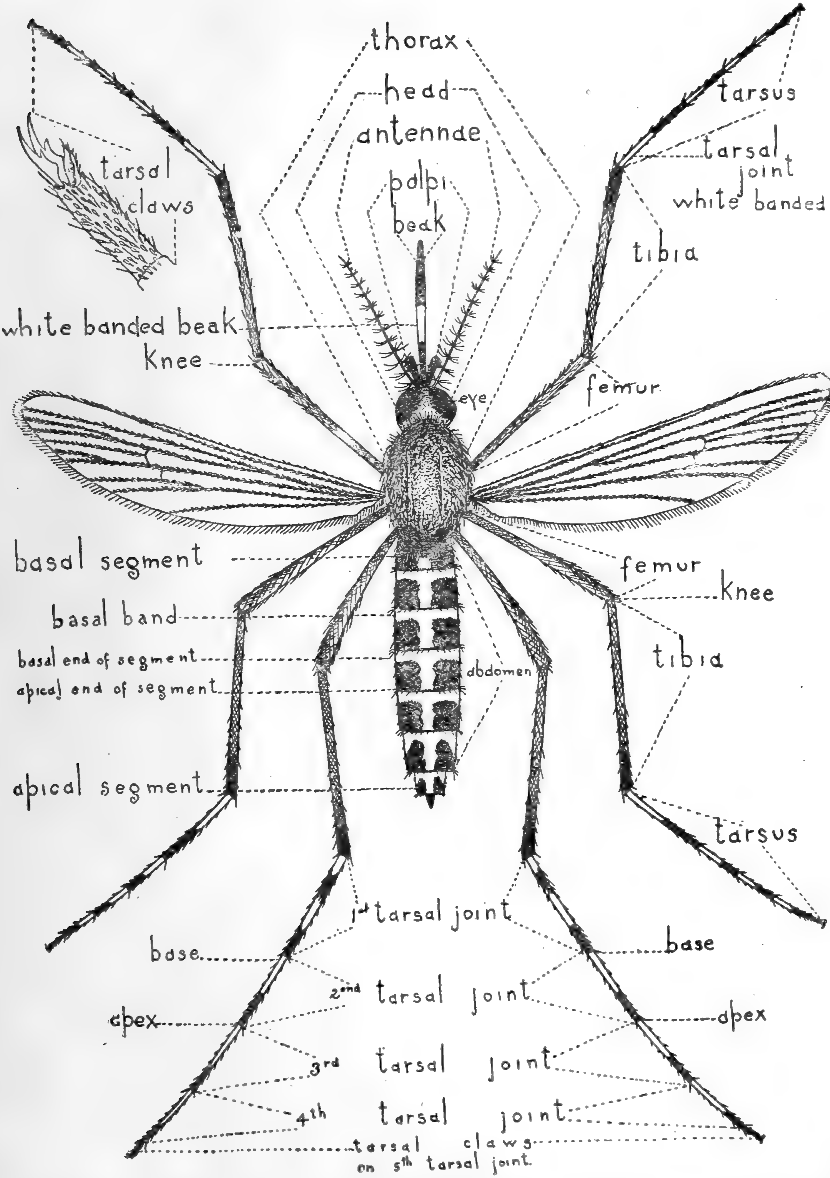

Fig. 5 Mosquito showing parts used in classification (After Smith, N. J. Agric. Exp. Sta. Bul. 171. 1904)

tennae of the male and the usually long, slender proboscis of the female. The thorax lacks the transverse V-shaped suture seen in the crane flies, and the most distinct feature, as stated above, is the scalelike hairs on the wings, specially the margins. The larvae of all species, so far as known, are aquatic in spite of the fact that adults have been observed in arid regions far from water.

The characters of greatest service in studying mosquitos, are so plainly shown in figure 5, that no detailed explanation is necessary. It may be well to call attention a little more in detail to the wing structure of this group, which is very interesting not so much on account of variations in the veins as in the structure and distribution of the scales. The more important wing veins may be easily recognized by running back from the costa as follows: subcosta, first longitudinal, second longitudinal, third longitudinal, fourth longitudinal, fifth longitudinal and sixth longitudinal, the second and fourth longitudinal veins having the characteristic fork cells, that of the former frequently being termed the first submarginal cell. These two veins are connected by an important cross vein known as the anterior cross vein. It may be easily recognized because it is intercepted near the middle by the third longitudinal vein. The posterior cross vein connects the fourth longitudinal and the anterior branch of the fifth longitudinal veins. The relative distance between these two cross veins and the relative length of the petioles and their fork cells is of considerable service in classification. The male wing may be recognized by the much longer petioles, sparse scales and the absence of oblique scales along the greater portion of the posterior margin. The scales of Culicids vary exceedingly, ranging from almost linear in Corethra and Sayomyia to the lanceolate ones of Anopheles or the very much dilated scales of Uranotaenia. The latter is remarkable for the diverse structure of its wing scales. The genus Culex presents very interesting variations in wing scales. Generally speaking there are two classes—the long and the short, the longer ones being slender, frequently strap-shaped and as a rule extending some distance on each side of the veins, while the short scales are more or less broadly triangular and usually closely appressed to the vein. The scales of the fringe also present important characters. Usually a row of long and another of medium scales constitutes the fringe proper, though in the females of the Pipiens group the fringe scales form three or four rows of different length [pl. 26, fig. 2]. In addition, there is a row of short, oblique scales along the greater portion of the posterior margin in the females, which is usually absent in the males along the inner two thirds or four fifths. The different characters of the wings of the various species are so well shown on the plates that no further description is necessary.

The accessory male genital organs, as pointed out by Professor Theobald, possess specific value, and in the case of the species studied by us, present most remarkable variations as will be seen by reference to illustrations on plates 29–40. As an aid to identification a tabulated statement of the differences follows. It is practically a key to the males studied and supplementary thereto we give a brief explanation of the terms employed. The more conspicuous lateral organs have been termed the clasps; these are composed of two segments: a large basal one, which presents considerable modification in form, and bears, particularly in the Pipiens group, very characteristic appendages near the apical third, and near the base more or less peculiar chitinous spines in a number of species. The terminal segment of the clasp is more slender and, in some species, bears at its apex two apical teeth, while others possess a more or less developed spine, apparently a rudimentary third segment. The harpes, lying just within the clasps and originating near their base, are normally next in size to these important organs and may usually be recognized by the pronounced angle frequently present near the more or less perfect fusion of two segments. These organs are remarkably diverse in structure and presumably occur in all species, though in certain forms, owing to lack of material, we have been unable to detect them. The harpagones are paired, smaller, clasping organs, usually strongly curved and terminated by a stout, somewhat recurved hook. The unci, as we have identified them, consist of a pair of usually fused processes on the ventral margin, which present considerable variations in structure. In addition, there is frequently present anterior to the unci, a pair of peculiar, rudimentary, spine-tipped organs, which apparently belong to the preceding segment, and for the purpose of identification they have been termed appendages of the eighth abdominal segment. Lack of material has prevented working out thoroughly the homologies of these organs.

It may be well in this connection to call attention briefly to some of the more important characteristics of mosquito larvae. The antennae vary somewhat in form and coloration, and particularly in the position and size of the antennal tuft [fig. 64]. The labial plate presents characteristic variations in certain species [fig. 12, 44]. The more important characters, however, are found in the air tube, its form and relative length and in the rows of posterior pecten or teeth at its base [fig. 21, 45]. There is wide variation in the number of teeth, their serrations, degree of development [fig. 22, 40], and within certain limits considerable constancy obtains. There is also an interesting patch of scales or spinelike scales on each side of the eighth abdominal segment, which for the sake of brevity has been termed the comb. The size of this patch varies considerably and there are marked differences between the various species in the number and structure of the component scales [fig. 13, 28, 48] and in our experience there is a much greater constancy in the number of comb scales than has been recorded by some. In the interests of clearness and brevity the term pecten has been limited to the structures occurring on the air tube, while the component members of the comb are designated as scales. Several characters of less general importance are mentioned in treating of the various species.

Key to subfamilies

a Proboscis long, formed for piercing; palpi long in both sexes; wings usually spotted..Anophelinae

b Palpi short in female; wings not usually spotted............Culicinae

bb Palpi short in both sexes..............................Aedeomyinae

aa Proboscis short, not formed for piercing.................Corethrinae

SPECIES	CLASPS		HARPES	HARPAGONES	UNCI	APPENDAGE OF EIGHTH SEGMENT
	Second segment	Basal segment				
Psorophora ciliata	Irregular, setose, 2 apical spines	Subconic	Strongly curved, irregular, furcate, inner branch setose, outer falcate	Curved, with stout apical hook	Curved, with stout apical hook	
Anopheles punctipennis	Slender, curved, small apical spur	Subcylindric, with 2 very long, straight basal spines	....	....	Narrow, fused, furcate	
A. maculipennis	Slender, curved, small apical spur	Subconical, with 2 long, curved basal spines	....	....	Narrow, fused	
Culex sylvestris	Stout, expanding, furcate, inner apex with stout tooth	Stout, curved, with internal basal tufts	Cylindric, short, setose apically	Slender, nearly straight, spined apically	Curved, slender, platelike	Papillate, rudimentary
C. cantans	Slender, flattened, strongly curved, with long apical spur	Dorsal lobe apically, a stout, curved basal spine	Flattened, strongly curved, apical portion falcate	Curved, with stout apical tooth	Flattened, broad	Distant, with stout apical setae
C. sollicitans	Flattened, strongly curved, with stout apical tooth	Subconic, with basal papillate elevation	Strongly curved, setose basally, falcate apically	Irregularly curved, with stout apical tooth	Slender, acute	Distant, with stout apical setae
C. cantator	Rounded, curved, with stout apical tooth	Lobed apically, with stout, curved, tapering basal spine	Curved, setose basally, strongly curved, falcate apically	Strongly curved, with stout apical tooth	Rather stout, acute	Distant, with stout apical spines
C. canadensis	Slender, curved, with long apical spine	Apical lobe and basal papillate, setose elevation	Basal portion stout, rounded; apical slender, bent, acute	Strongly curved, with stout apical spine	Slender, furcate, acute	Approximate, with stout apical spines
C. cinereoborealis	Strongly curved, with stout blunt spine	Large apical lobe, basal enlargement and a peculiar, dark, capitate process	Very long, bent, irregular	Small, with strongly recurved point	Approximate, curved, with stout spine	
C. taeniorhynchus	Basal portion enlarged, apical spine long	Subcylindric, with slight basal enlargement	Basal portion curved, apical curved, falcate, with retrorse spine	Slender, swollen, with stout apical hook	Divergent, slender, acute	Rudimentary, with long, straight spines
C. abserratus	Flattened, strongly curved, with long, stout apical spine	Short, thick	Flattened, strongly curved	....	Curved, slender, acute	Long, with stout apical spines
C. impiger	Flattened, twisted, with stout apical spine	Large apical lobes, a pair of stout internal spines midway and a large basal spine	Rudimentary branch curved, apical portion broadly falcate	With stout apical hook	....	Short, distant, with stout apical spines
C. lazarensis	Flattened, strongly curved, with long, stout apical spine	With apical lobe and basal prominence bearing a stout, tapering, curved spine	Curved basally, apical portion falcate, with recurved tip	Curved, with stout apical spine	....	Distant, with short apical spines
C. absobrinus	Slender, tapering, with short apical spine	Nearly conical, with small basal papillate enlargement	Stout, black, curved, tridentate	Irregular, strongly curved, stout apical spine	....	Approximate, margined with even black chitinous spines
C. magnipennis	Stout, curved, with stout apical spine	Subconical with papillate spined process at basal third	Stout, strongly curved, acute, bidentate	Dorsally curved, with 2 or 3 stout teeth	....	Distant, black, with many irregular, long spines
C. territans	Triangular, curved with short, stout apical spine	Subconical, with 2 stout, recurved processes and several spines in a group at the inner apical third	Short, curved, apex rounded, setose	....	....	Distant, thickly spined apically
C. pipiens	Stout, tapering, with short apical spine	Subconical, with group of 3 stout, several smaller spines and a spatulate organ at inner apical third	Short, strongly bent, acute tip	Curved, with stout apical spur	....	Distant, thickly spined apically
C. restuans	Rather slender, strongly curved, with short apical spur	With 3 large and a smaller, strongly recurved spine and a spatulate organ at inner apical third	Strongly curved with stout, apical hook	....	....	Distant, thickly spined apically
Aedes fuscus	Subapical, strongly curved, with broad base and subapical tooth	Conical, with basal papillate, setose area	Short, furcate, inner branch shorter both obtuse, setose	Widely separated, rounded, papillate and finely setose apically	Confluent, terminating in a slender beak	
Uranotaenia sapphirina	Rather short, excavated, dentate apically, subapical triangular spine	Subconical, rounded	Flattened, with stout apical hook	Short, stout, with stout subapical spine	Short, stout, with lateral apical teeth	Approximate, with short terminal spines
Sayomyia hudsoni	Long, stout, apex rounded	Subcylindric	Short, flattened, spatulate, with short, subterminal spine			
S. rotundifolia	Rather slender, tapering, apex rounded	Subcylindric	Strongly curved, with stout apical and subapical spine			
Eucorethra underwoodi	Stout at base, slightly curved, with short apical spur	Subconical, with conspicuous subapical group of spines internally	....	....	....	Distant, fingerlike

Generic key of culicid larvae

Mosquito larvae are preeminently important in any work designed to reduce the abundance of adults, because most of it must be done before the mosquitos attain maturity, and ordinarily it is impracticable to breed out the insects in order to ascertain whether a pool is liable to produce an annoying or dangerous species or not. This makes identification of larval forms of great importance, and the following generic table modified from that prepared by Mr Johannsen, is given as an aid in identification.

a Air tube on last abdominal segment
- *b* Antennae pendant, with four large, curved, apical spines......Corethra
- *bb* Antennae not pendant
  - *c* Antennae fold back against the head and terminate in two or three claws ....Corethrella
  - *cc* Antennae usually with only a few small erect bristles and one or two pointed processes
    - *d* Brush projecting sidewise from the mouth, mandibles long, sharply toothed. A large species, half an inch or more long...............................Psorophora (c i l i a t a)
    - *dd* Brush of hairs projecting forward from the mouth
      - *e* No ventral brush on last abdominal segment. With two anal blood gills; the pecten of the air tube wanting. Small species occurring in water of pitcher plants.......Aedes (s m i t h i i)
      - *ee* Last segment with ventral brush
        - *f* Anal blood gills dilated; lateral comb of eighth segment a single transverse row of spines with elongate bases; anal segment without hair tufts before barred area Stegomyia (f a s c i a t a)
        - *ff* Anal blood gills slender
          - *g* Anal blood gills sharply pointed; pecten unidentate, apical 2 or 3 distant, flattened; lateral comb of eighth segment with 12 large spines in a single or partly double row Aedes (f u s c u s)
          - *gg* Not as above in all respects
            - *h* Pecten teeth with semitransparent serrate margin, stellate hairs on the abdomen, a small species..Uranotaenia
            - *hh* Not as above..................................Culex

aa No air tube on last abdominal segment
- *b* Last segment usually with hooks; no spiracles apparent; larvae transparent, glasslike...Sayomyia
- *bb* Last segment with a flat dorsal area in which may be seen two spiracles
  - *c* Medium sized species with anal segment cylindric.........Anopheles
  - *cc* Large species with the anal segment bladderlike; mandibles strongly developed ....Eucorethra

ANOPHELINAE

ANOPHELES

This genus is of particular interest, because certain species at least, are known to transmit malaria. Members of this group may be recognized by the nearly straight beak or proboscis, and more easily when at rest by the peculiar position, since the body, head and beak are almost in a straight line, whereas there is a marked angle between the body and the head and beak in our common mosquitos. The palpi in both sexes are almost as long as the proboscis, the body colors are brown and yellow, and the wings are usually spotted. Three species occur within the State and may be separated by the characteristics given below.

Anopheles punctipennis Say

Pl. 1, 14, 29, 48, fig. 1, 2, 3; 1, 2; 1; 1 respectively

This is the species we found abundantly about Albany. We have seen it on Long Island, in the Adirondacks and other

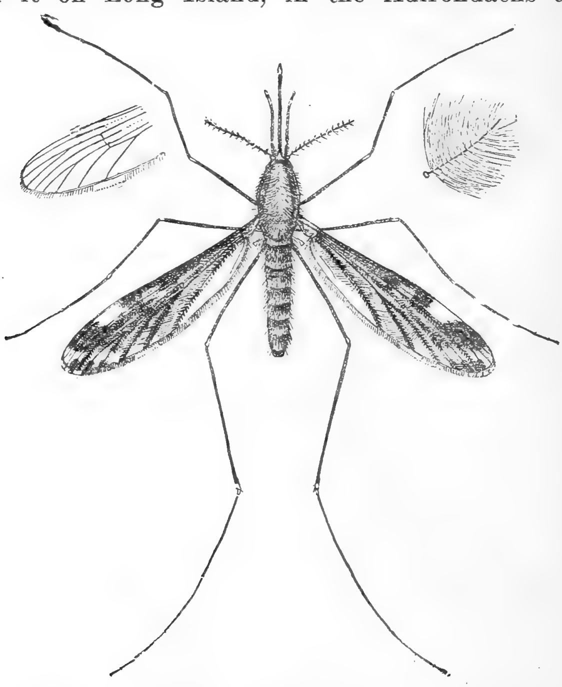

Fig. 6 Anopheles punctipennis, female, with male antenna at right and wing tip showing venation at left. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

places, indicating a wide range. It may be easily distinguished from the closely allied A. maculipennis, by the yellowish white marginal spot near the apical fourth of the wing. This insect has been characterized by Dr Howard as our handsomest species. This larva with its conspicuously spotted head may be recognized by its nearly horizontal position at the surface of the water, and particularly by the five conspicuous, plumose hairs extending from each side of the thoracic and anterior abdominal segments much like oars. A closer examination will show that the larva normally feeds with its head reversed. It is only about 5 or 6 mm long when full grown. Both sexes and larvae and pupae have been carefully described by Johannsen.

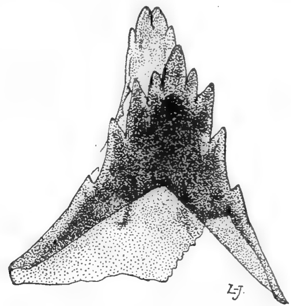

Fig. 7 Labial plate of the larva of A. punctipennis

This species has an extensive range, having been reported from a number of Eastern states, as far south as Texas, west to Oregon, and from Canadian localities. It is probably somewhat generally distributed in this country.

We have taken the larvae from water puddles, pools containing algae, and from other standing waters. This species breeds throughout the summer in favorable localities, and the larvae are occasionally quite abundant.

Anopheles maculipennis Meig.

Pl. 1, 14, 25, 29, 48, fig. 4, 5; 3, 4, 4; 2; 2 respectively

This rather insignificant species may be recognized by its yellow colored wings bearing four somewhat small dark spots. It is also peculiar in possessing black palpi and in having the scales of the last vein of the wing entirely black. The female and larva of this species have been carefully described by Johannsen.

Male. Palpi and proboscis about equal, dark brown, except that the tip of the latter is light brown. Antennae dark brown, shorter than the palpi, segments sparsely clothed with basal whorls of long, black hairs and numerous much shorter, light brown ones. Eyes coarsely granulate, strongly emarginate, with bright greenish reflections. Occiput rather thickly clothed with black and creamy white scales, the latter forming a pair of submedian patches, dark scales being specially abundant laterally. Thorax brown, sparsely clothed with short, golden yellowish

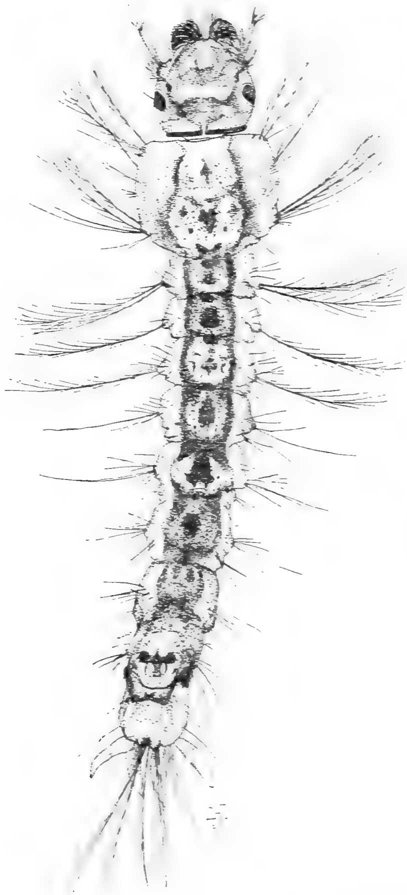

Fig. 8 Dorsal view of the larva of Anopheles

hairs arranged in a rather plain median line with submedian rows, a sublateral and a lateral row posteriorly, the hairs of the two latter being longer, coarser and browner. Scutellum slaty gray. Halteres, basal portion, pale yellowish white; apical portion, capitate, fuscous. Dorsal portion of abdomen plumbeus, with irregular, fuscous markings and rather sparsely clothed with long, golden yellow hairs. Pleura and ventral portion of abdomen plumbeus. Legs brownish with yellowish apical bands on the femora and tibiae. Wings hyaline, thickly clothed with scales and with darker spots at the base of the second longitudinal vein, the region of the cross veins and the tips of the fork cells. Posterior cross vein almost interstitial with mid cross vein. Petiole of first fork cell about two thirds the length of the cell, that of the second about equal.

This insect occurs on Long Island and about Albany, and it is accorded an extensive range by Theobald, who states that it is widely distributed over Europe. It has been recorded from a number of the Eastern states, and is found from Florida and Texas, north to Canada and Manitoba.

Dr Dyar found the larvae more or less commonly in nearly every pool and pond, and even in rain water barrels at and about Bellport and Amaganset L. I., and Dr Howard states that this species appears to be universally distributed in the suburbs of New York, where it appears to be more numerous than farther north. The larvae occur about Albany only in midsummer and are not abundant then.

The life history of this insect has been worked out by Dr Howard, who states that the eggs are deposited in loose masses on the surface of the water. He adds that they are somewhat oval in outline, float on one side, and that they hatch in three or four days. The larva usually remains near the surface, keeping its body in a nearly horizontal position. The head of the larva revolves easily, and though its normal position is with the back upward, its head is frequently reversed to facilitate feeding on algae, bits of dust and other floating matter. The specific gravity of this larva is slightly less than water; consequently it requires an effort on its part to sink, the reverse of what obtains in Culex. The larva period lasted 16 days in the case observed by Dr Howard, and the pupa from 5 to 10 days, dependent on the weather. The life cycle may be summarized as follows: egg 3 days, larva 16 days, pupa 5 days, making a total of 24 days, a portion of which was passed in somewhat cool weather. The larval comb of this species and that of the preceding are illustrated on plate 48.

Anopheles cruicians Wied.

We have not met with this species. Dr Dyar records it as the commonest Anopheles in houses about Bellport and Amaganset L. I. It may be recognized by the white bases of the last four segments of the palpi, the white scales on the last vein, and the three black spots on the wings.

Adults and larvae of this species were met with by Dr Smith almost daily from Aug. 3 to Sep. 28 in the Cape marsh. He states that the females begin their attack before sundown and are active for a little time after sunrise.

This insect has been recorded from a number of Southern states, where it appears to be somewhat abundant in certain localities, since Weidemann states that it is very common on the Mississippi.

The larva, according to Dr Smith, does not differ in general appearance from those of A. maculipennis and A. punctipennis, and ranges only from 5½ to 6 mm in length. The head is broader just behind the eyes, narrowing to a rounded front and is variably marked, the larger blotches, as a rule, being central. There is a transverse row of six branched hairs before the middle of the head and the antennae, borne on distinct sclerites, are set with little spines and are shorter, stouter and much darker than in allied species. The mandibles differ from those of its allies by having four instead of three curved spines on the dorsal surface. The thorax is subquadrate, angles rounded and with six lateral tufts of branching hairs and similar ones on the dorsum. The comb on the eighth segment consists of from six to eight long teeth separated by from one to four short, compound teeth. The tracheal gills are less than one half as long as those of allied forms.

CULICINAE

This subfamily includes by far the largest number of species, and its representatives are the ones most commonly met with about houses and in woods. The females have short palpi, while they are long in the male. We have in this subfamily several genera, such as Janthinosoma, which latter agrees closely in all structural details with Culex except for the densely scaled legs and is separated from other genera possessing this character by the venation of the wings, which is the same as in Culex, and by the broad, spindle-shaped scales of the head. This subfamily also includes among native forms the giant Psorophora ciliata Abr., a species with densely scaled legs, and Stegomyia, which is of particular interest because certain species are known agents in disseminating yellow fever. A number of other genera have been separated on minor structural differences.

Key to genera[1]

a Legs densely clothed with coarse erect scales..............Psorophora
aa Legs densely clothed with somewhat appressed scales; joints of posterior tarsi usually white..........................Janthinosoma
aaa Legs uniformly clothed with flat scales
  b Head scales all flat and broad..........................Stegomyia
  bb Head scales narrow, curved and with upright forked ones and flat lateral ones
    c Lateral scales of wings linear.............................Culex
    cc Lateral scales of wings elongate, oval or lanceolate.............. Taeniorhynchus

[1]Prepared by D. B. Young.

Psorophora ciliata Abr.

Giant mosquito

Pl. 2, 15, 30, 41, fig. 1, 2; 1; 1; 1 respectively

This species is the giant of its family and may be recognized by its extremely large size and the peculiar legs, which latter

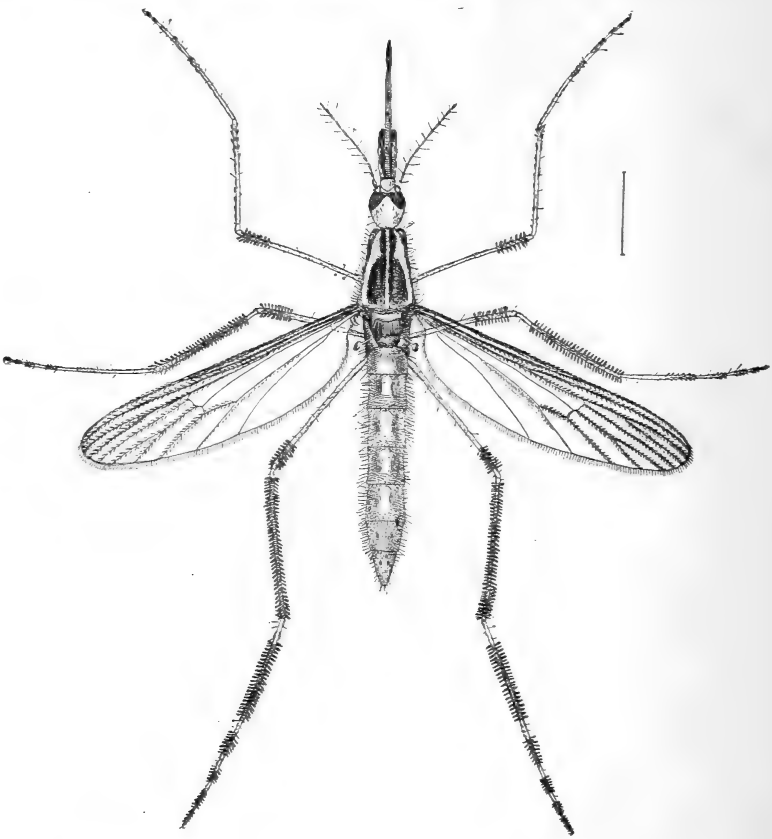

Fig. 9 Female enlarged, Psorophora ciliata. (After Howard. U. S. Dep't Agric. Div. Ent. Bul. 25, n. s. 1900)

are thickly clothed with nearly or quite erect scales [fig. 10]. Under a lens this giant mosquito is a beautiful object with its median band of golden yellow scales on the prothorax, flanked with a smooth, jet black area and more laterally with a somewhat irregular patch of whitish scales. It presents a greater contrast than any mosquito known to us, which is hightened by the apparently clubbed femora, due to the bands of nearly erect scales at their extremities and the basal yellowish white bands of the tarsi. The wings are clothed with thin, easily abraded

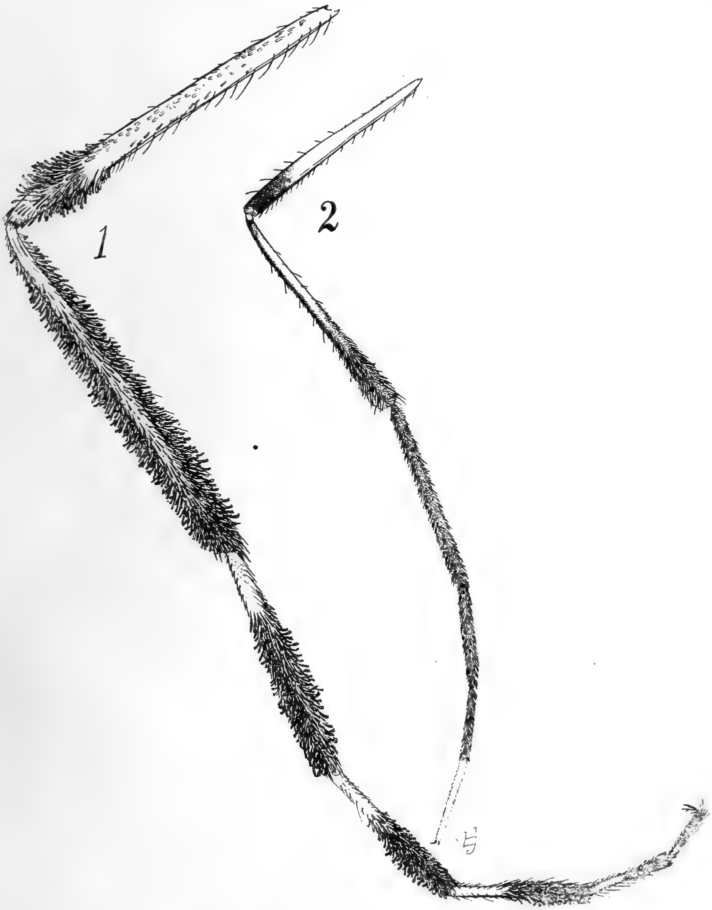

Fig. 10 Legs showing peculiar scaling and marking: 1 Psorophora ciliata, 2 Janthinosoma musica, both equally enlarged

scales. This insect is really yellowish, though somewhat dark in general appearance.

The larva is equally remarkable in appearance and when full grown is stout and half an inch or more in length. It is culicid in type and presents some very interesting structural modifica tions. The head is nearly square viewed from above. The antennae are rather stout, tapering uniformly and tipped with two rather large tapering spines and a very short, stout remnant of a segment. There are also several minor conical processes. The man-

Fig. 11 Larval mandible of Psorophora ciliata

dibles are extremely well developed, being provided with three major processes. The two ventral ones are coarsely dentate. The triangular labial plate is remarkable because its 17 teeth are at nearly right angles to the plate, the two lateral ones on each side being very large. The comb is present on the eighth segment and is remarkable on account of its interesting modification. Its posterior border is marked by a semicircle of about 15 stout scales with large, spatulate bases, each bearing a large, apical spine and one or two smaller ones on each side. In addition, there are anterior to these larger scales many smaller, beautiful, platelike organs, each margined posteriorly with from about 8 to over 20 fine, rather evenly set spines. The chitinous portion of

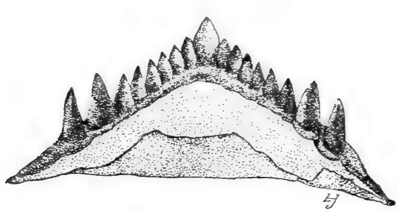

Fig. 12 Labial plate of the larva of Psorophora ciliata

the air tube is set on a fleshy elevation, which is probably extensile. The chitinous portion of the tube proper is about four times as long as its greatest diameter. The double row of posterior pecten is present but remarkably modified, consisting of small

Fig. 13 Superimposed combs of Psorophora ciliata, showing the peculiar, small scales in front of the larger ones

tubercles bearing one very long, slender seta and a very short, conical process of about equal size.

Habits and life history. This species appears to be widely distributed in New York State, having been taken in several localities. The mosquito is vicious and bites readily in the daytime. It has been reported by various authors from a number of the Eastern states, ranging as far south as Texas and west to California. It has also been reported from several South American countries, but so far as known to us it has not been taken in the eastern hemisphere.

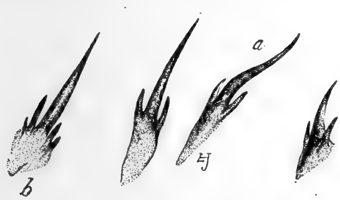

Fig. 14 Several larval comb scales of Psorophora ciliata very much enlarged

The life history of this insect was unknown till August 1900, when some of its giant larvae were obtained by Dr Howard from depressions in the bed of a small stream and in similar hollows in small ponds, all of which were dry the greater part of the summer. We have also met with the larvae in some numbers in temporary pools at Karner, they being found only in the early part

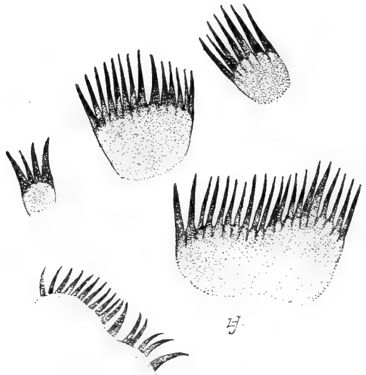

Fig. 15 Several small comb scales of Psorophora ciliata very much enlarged

Fig. 16 Middle tarsal claw of Janthinosoma musica

of June. The larvae are predaceous and devour large numbers of Culex, with which they are associated, and are consequently beneficial. The duration of the pupa state has been reported as from four to five days. The eggs of this species were obtained by Dr H. F. Harris of Atlanta Ga., who states that they are black and measure about .7 mm in length, and that when viewed with a high power lens they are found to be distinctly convex on one side and slightly concave on the other, having an oval form when seen from either of the surfaces.

Janthinosoma musica Say

Big wood mosquito

Pl. 2, 15, fig. 3, 2 respectively

This species may be recognized by the densely scaled legs, and by having the last two joints of the posterior tarsi white [fig. 10]. The peculiar character of the claws is shown at figure 16. These differ considerably from Theobald's drawings made from South

American specimens, but examination of specimens from that country reveals very little if any difference.

This mosquito is said by Howard to be rather rare. It has been taken, though not bred, in New Jersey by Dr Smith and was described by Say from Indiana. Theobald records it in addition from Rio Janeiro, British Guiana and South Amazon. He states that it seems to be an abundant South American form, and our observations show that it was present in considerable numbers in woods near Poughkeepsie in July. It is a large, handsome mosquito with bluish reflections in the sunlight. It is one of the most vicious biters we have seen and at the same time one of the most wary, since it takes to wing much quicker than other species on the approach of a net or cyanid bottle. It was found indifferently in both sunlight and shade.

CULEX

Members of this genus may be recognized by the more or less erect forked scales on the head, and the linear, lateral scales of the wing veins. Most of the characters used in the separation of the species are well illustrated in figure 5 reproduced by permission of Dr J. B. Smith, state entomologist of New Jersey.

Key for determining females of the genus Culex[1]

a Tarsal joints banded at the base
- *b* Proboscis without a white band
  - *c* Claws all toothed
    - *d* Bases of anterior abdominal segments with patches of yellowish white scales
      - *e* Scales of sides and pleura pale yellow; posterior cross vein less than its own length from one above.....squamiger, p.281
      - *ee* Scales of sides and pleura white; posterior cross vein its own length at least from one above.............fitchii, p.281
    - *dd* Bases of abdominal segments distinctly banded with whitish scales
      - *e* Tarsal bands broad..........................cantans, p.284
      - *ee* Tarsal bands narrow....................sylvestris, p.289
  - *cc* Posterior claws simple; tarsal bands narrow....cantator, p.293
- *bb* Proboscis with a more or less distinct white band
  - *c* Abdomen with a central stripe of yellowish scales on dorsum ....sollicitans, p.294
  - *cc* Abdomen without such stripe

[1]Prepared by D. B. Young.

d Wings spotted.............................**d i s c o l o r**, p.297

dd Wings with 1 black spot where the 3d longitudinal vein meets the cross veins, tibia spotted..........**j a m a i c e n s i s**, p.298

ddd Wings not spotted

e Femora without white band.......**t a e n i o r h y n c h u s**, p.301

ee Femora with white band..................**c o n f i n i s**, p.302

aa Tarsal joints banded at middle

b Metatarsi with a broad median band; femora also with a broad yellowish ring near the black apex...............**a n n u l a t u s**, p.303

aaa Tarsal joints banded at both ends

b Petiole of 1st submarginal cell more than ½ as long as cell

c No median white stripe on dorsum of abdomen **c a n a d e n s i s**, p.303

cc Median white stripe on dorsum of abdomen **o n o n d a g e n s i s**, p.304

bb Petiole of 1st submarginal cell less than ½ as long as cell

c Last joint of hind tarsi white................**a t r o p a l p u s**, p.305

cc Last joint of hind tarsi not white..................**d y a r i**, p.306

aaaa Tarsal joints not banded

b Abdomen with cross bands of whitish scales at apex of the segment ....**t e r r i t a n s**, p.307

bb Abdomen with cross bands of whitish scales at base of segment

c Posterior cross vein of wing its own length or less from mid cross vein

d Claws toothed

e Species large, 6-7 mm long

f Thorax vittate with 2 dark brown lines..**l a z a r e n s i s**, p.309

ff Thorax not vittate; curved scales of head white **c i n e r e o b o r e a l i s**, p.312

ee Species small, 4½–6 mm long; curved scales of head golden brown ....**i m p i g e r**, p.316

dd Claws simple

e Basal bands white.....................**a b s o b r i n u s**, p.318

ee Basal bands orange mesally, yellowish white laterally; legs flecked with white scales............**m a g n i p e n n i s**, p.322

cc Posterior cross vein of wing its own length or more from mid cross vein

d Thorax with spots; apex of tarsal joints slightly whitish **r e s t u a n s**, p.325

dd Thorax spotless

e Cross bands of abdomen distinct

Relative length of petiole of first submarginal cell

f 1/7 length of cell, claws simple.............**p i p i e n s** p.328

ff ½ length of cell, claws toothed.......**a b s e r r a t u s** p.329

fff ⅔ length of cell, claws simple...............**d y a r i** p.306

ffff Longer than cell, claws toothed.....**n e m o r o s u s** p.332

ee Cross bands of abdomen indistinct, widest in middle, a smaller species ....**s a l i n a r i u s**, p.332

bbb Abdomen without cross band of whitish scales
c Thorax vittate or distinctly striped with white or yellow
d Thorax with 2 broad yellowish stripes, 1 each side of a central dark brown one........................t r i v i t t a t u s, p.333
dd Thorax with 1 median creamy gray stripe....s e r r a t u s, p.334
ddd Thorax with broader median, creamy gray stripe, species smaller ....d u p r e e i, p.334
cc Thorax not vittate with white or yellow
d Some of the claws toothed
e Scales on side of mesonotum white......t r i s e r i a t u s, p.335
ee Scales on side of mesonotum golden yellow...a u r i f e r, p.336
dd Claws simple...........................m e l a n u r u s, p.337

Key for determining Culex larvae

Characters employed in earlier published keys have been used wherever they could be employed to advantage.

a Air tube long, at least 4 times as long as the diameter of its base
b Air tube very long, slender, slightly constricted in the middle; antennae white banded...........................t e r r i t a n s, p.307
bb Air tube very long, stout, tapering uniformly
c Comb scales 60, pecten teeth 3–4 branched...s a l i n a r i u s, p.332
cc Comb scales about 80, pecten apparently simple......d y a r i, p.306
bbb Air tube about 5 times the width of its base, tapering
c Pecten teeth pale, divided into 3–5 long, slender processes
d Antennal tuft before the middle..............r e s t u a n s, p.325
dd Antennal tuft at outer third..................p i p i e n s, p.328
cc Pecten teeth almost black, 20, with small basal dentitions; comb scales about 25 (*See also* p.381)................f i t c h i i, p.281
aa Air tube very short, not more than 1½ to 2 times as long as broad
b Pecten teeth dentate on both sides; comb with 16–24 scales; head maculate ....t a e n i o r h y n c h u s, p.301
bb Pecten teeth dentate on one side only
c Antennal tuft normal
d Comb scales 28–40, pecten teeth about 14, head generally immaculate...................................s o l l i c i t a n s, p.294
dd Comb scales 5, pecten teeth 7–9..............s e r r a t u s, p.334
cc Antennal tuft reduced to a single hair; pecten extending nearly to apex of air tube; comb scales about 46.....a t r o p a l p u s, p.305
aaa Air tube moderate in length, from about 2 to over 4 times longer than its greatest diameter
b Comb scales not more than 10
c Comb scales quadrate, with a very long median spine and shorter lateral ones
d Comb scales 5–8, attached to a slight band; pecten teeth 5–8, dividing into 2–4 very long, slender spines.........d i s c o l o r, p.297
dd Comb scales 7, in a curved row, with 3–4 pecten teeth, each with a long median tooth and several small serrations at its base
j a m a i c e n s i s, p.298

cc Comb scales rather broadly spatulate at the base, few, arranged in a curved line

d Comb scales 5, pecten teeth 7–9, minutely serrate near middle serratus, p.334

dd Comb scales 6, pecten teeth 12–16, stoutly toothed near middle abserratus, p.329

ddd Comb scales 8–10 in a curved line; 12 pecten teeth with short basal spines....dupreei, p.334

bb Comb scales ranging from 10 to about 24

c One or more pecten teeth widely separated from a continuous row

d 2 rows of slight tufts of hairs on the dorsum of the air tube; comb scales 14–16, usually four pecten teeth widely separated from the remainder of the row....cinereoborealis, p.312

dd No such dorsal tufts on the air tube

e Air tube slender, tapering equally, the continuous pecten extending only to the basal 5th of the air tube; pecten teeth 2–3 toothed; comb scales 10–14 (Smith 18–20) sylvestris, p.289

ee Air tube stouter, slightly swollen, continuous pecten extending to the basal 3d of the air tube; pecten teeth 1–2 toothed; comb scales 14, in a somewhat triangular patch, spatulate, each with a stout, rather short, terminal spine; pecten teeth 15–18, each with 2 or more basal teeth....impiger[1], p.316

cc Pecten in a continuous row, distal teeth not widely separated

d Comb scales digitately divided, 12, in an irregular double row....triseriatus, p.335

dd Comb scales elliptic, with a terminal spine, 14–22 trivittatus, p.333

bbb Comb scales over 25

c Antennal tuft before or at the middle

d Pecten pale, prolonged into setae; comb scales digitately divided

e Comb scales 50, pecten teeth with 1 or 2 basal processes absobrinus, p.318

ee Comb scales 40, pecten teeth with 2 or 3 basal processes magnipennis, p.322

dd Pecten not as above

e Tuft of antenna reduced to a single hair; comb scales about 46 in 5 rows; several pecten teeth widely separated from the remainder....atropalpus, p.305

ee Tuft of antennae normal

f Comb scales with stout apical spine, 28–64, narrowly spatulate at base; tip of antennae dark....canadensis, p.303

ff Comb scales each with a stout apical spine, broadly spatulate at base

g Antennae moderately long with a slight swelling near the base; 26–50 scales in the comb and 16–24 pecten teeth; head immaculate....cantans, p.284

[1] Aedes fuscus larvae also come out here and may be distinguished from this Culex by the comb scales being in a somewhat irregular line, the pecten teeth usually with a single tooth, the apical 2 or 3 pecten teeth distant and somewhat flattened.

gg Antennae shorter, without a swelling near the base, spines and scales as above; head maculate.....c a n t a t o r , p.293

fff Comb scales with 4–6 stout apical spines, somewhat spatulate at base, about 60 in number.......l a z a r e n s i s , p.309

c Antennal tuft beyond the middle

d Comb scales about 80 in a triangular patch of 10 rows d y a r i , p.306

dd Comb scales fewer in number

e Pectan pale, 10–15, each tooth with 3 or 4 long basal teeth; comb scales about 50, in a triangular patch.........p i p i e n s , p.328

ee Pecten small, 14–20, minutely toothed; comb scales 25–30 a u r i f e r , p.336

Culex squamiger Coq.

This species was described from California, and as Dr Smith has found it in New Jersey, there is a strong possibility of its occurring in this State.

Description. The original description follows:

Head and its members black, middle of proboscis brownish, scales of occiput mixed golden and pale yellow, many black ones along the eyes, palpi black scaled, those at base, before the middle and at apex white; body black, scales of middle of mesonotum golden brown, those along the sides and on the pleura pale yellow, bristly hairs of thorax mostly black, those of scutellum chiefly yellow; scales of abdomen black, a large patch at base of each segment and several scales scattered over the remainder pale yellow, scales of venter pale yellow; femora and tibiae brown, the scales mixed black and yellow, not forming distinct bands, posterior side of the femora yellow and yellow scaled; tarsi black, the scales mixed black and yellow, a band of whitish scales at bases of the last four joints, claws toothed; wings hyaline, veins yellow, densely covered with rather broad mixed brown and whitish scales and with many very narrow ones in the apical third of the wing, petiole of first submarginal cell about two thirds as long as that cell, cross vein at apex of second basal cell less than its length from the one above it; halteres yellow, the knobs marked with brown; length, 5 mm.

Culex fitchii Felt & Young

Pl. 2, 3, 15, 41, 48, fig. 4; 1; 3, 4; 2; 3 respectively

This species was bred from a woodland pool at Karner N. Y., larvae being obtained May 10 and adults emerging May 16.

Description. *Female.* Basal segment of antennae clothed interiorly with broad white scales. Proboscis dark brown, long; palpi dark brown, segments narrowly ringed at the base with white; occiput clothed with brown scales, with a row of silvery ones just above the eyes and along the median line. Thorax with a broad,

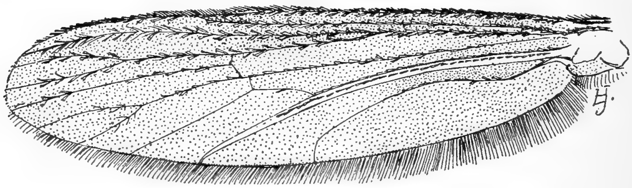

Fig. 17 Wing of Culex fitchii

brown, central stripe bordered with a rather well defined, silvery, slightly broader, lateral stripe containing a few brown blotches. Pleura rather thickly clothed with patches of silvery white scales.

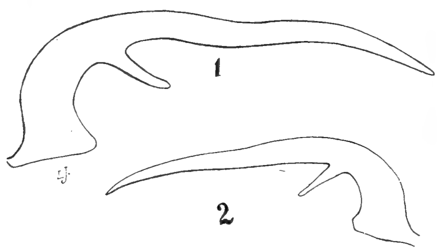

Fig. 18 Tarsal claws: 1 C. cantans, 2 C. fitchii

Abdomen brown, with broad, basal, yellowish white patches, those of the anterior three segments being distinctly prolonged on the median line and with a slight indication of the same laterally, giving a somewhat lobular appearance; the other segments with

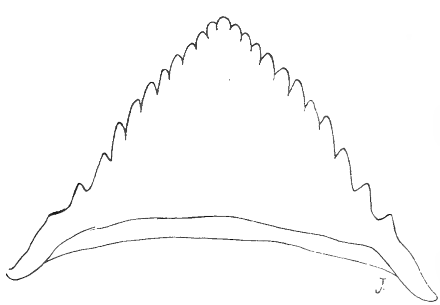

Fig. 19 Labial plate of C. fitchii

a rather broad basal band, slightly wider in the middle. Ventral surface thickly covered with silvery white scales. Coxae clothed with white scales; inside of femora and tibiae thickly mottled with the same; dorsal surface brown. Tarsi dark brown, almost black; basal portions of segments ringed with yellowish white, except the first segment of the anterior legs. Claws unidentate, concave surface of teeth finely serrate. Wing veins dark, thickly clothed with mixed yellow and brown scales. Petiole of first submarginal cell shorter than the cell, that of the second, longer; posterior cross vein about its own length from the mid cross vein. Length $\frac{3}{16}$ inch.

Bred from an isolated larva and described while fresh.

Male. Palpi brown, tipped with grayish yellow hairs, and with a broad, yellowish white band near the base of the third seg-

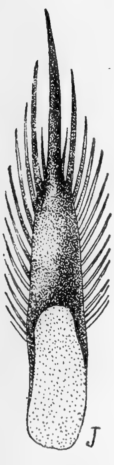

Fig. 20 Comb scale much enlarged of C. fitchii

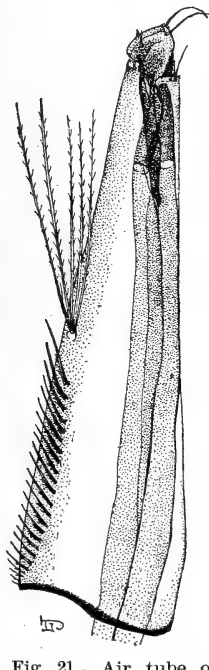

Fig. 21 Air tube of C. fitchii

Fig. 22 Pecten tooth of C. fitchii much enlarged

ment; underside of second, whitish. Thorax with a broad stripe of golden brown scales separated by a narrow, median, brown line and bordered laterally by a broad area of silvery gray scales with a few brown patches interspersed. Abdomen brown, with broad, basal bands on first and second segments, narrow on the following ones. Legs marked as in the female, except that the tarsal bands are broader; ungues unidentate; claws of anterior and middle legs unequal, the longer claw of the middle leg being nearly straight and quite different from the sinuous one of C. cantans. Petiole of first submarginal cell distinctly longer than the cell, and posterior cross vein less than its own length from the middle cross vein. Length ¼ inch.

Bred from isolated larva taken from permanent pool at Karner May 12, adult appearing May 16.

Larva. About 1/4 of an inch long. Head probably pale brown; antennae slender, slightly curved, dark at tips; tuft just before the middle, and the curved surface thickly clothed with fine scales, giving the edge a peculiar serrate appearance. Labial plate broadly rounded, with 23 teeth. Comb is composed of about 25 triangular, stoutly spined scales arranged in two or more rows; some of the scales have a very stout, terminal spine with smaller ones along each side, while others have the tips somewhat rounded and the spines more nearly of a size. Air tube fully five times as long as its greatest diameter, tapering somewhat regularly and with a slight bend and contraction near the middle. Basal rows of pecten, each consisting of about 22 closely set teeth bearing at their bases usually two larger and three or four finer serrations. There is a compound bunch of hairs slightly beyond the row of pecten, all on the basal half of the tube. Ventral tuft rather thick, confined to the barred area; dorsal tuft composed of one rather large, compound hair and two very long, slender hairs, the latter being about half the length of the body.

Described from cast skins of isolated larvae from which adults were bred.

This larva was associated with C. canadensis, C. cantans, C. cinereoborealis, C. impiger and Aedes fuscus in a rather permanent woodland pool. It proved quite difficult to rear.

Culex cantans Meig.

Brown wood mosquito

Pl. 3, 16, 30, 41, 49, 50, fig. 2, 3; 1, 2; 2; 4; 3; 1 respectively

This common mosquito (C. stimulans of Coquillett's table) may be distinguished from others having basal bands on the tarsi, by their being wider as compared with those of C. sylvestris [fig. 24], and from the other three native species because all the claws bear a tooth. Theobald and Johannsen were both mistaken in supposing that the posterior claws were simple [fig. 23], and the former has corrected the error in his third volume on the *Culicidae of the World.*

Fig. 23 Posterior claw of Culex cantans

This species was taken at Delmar in a woodland pool, Ap. 25, 1903, and a number of adults bred therefrom up to June 19, and at

Karner, May 1904. It was associated with C. canadensis, C. impiger, C. cinereoborealis and Aedes fuscus.

Larva. Head, dark brown; the antennae pale brown, darker at tip and with scanty tuft arising before the middle of the joint. Labial plate triangular and toothed as illustrated in the figure.

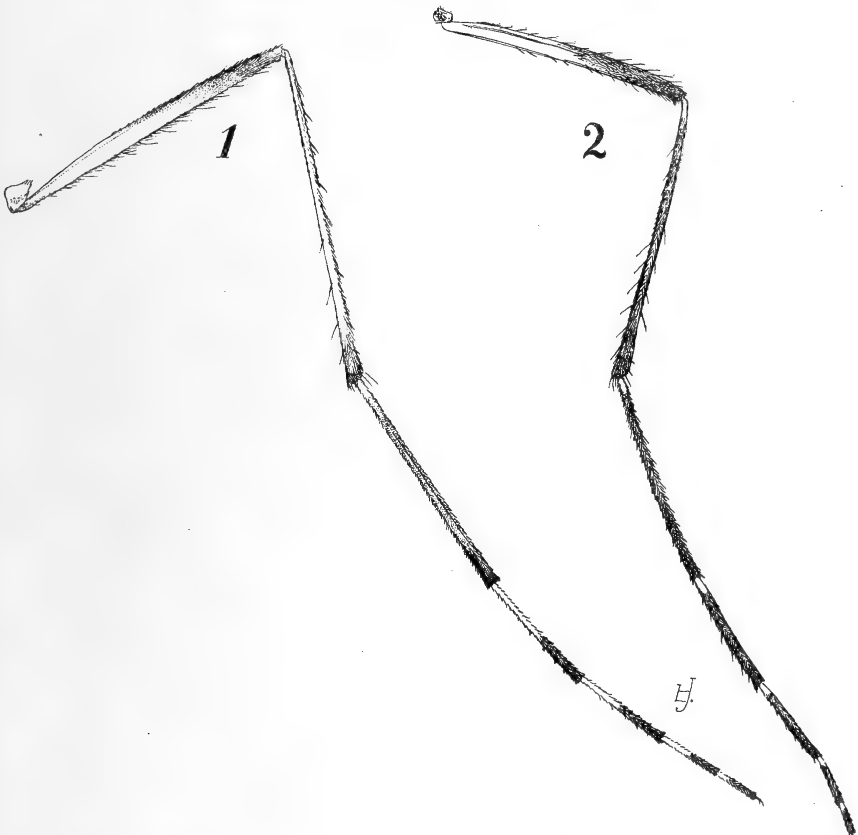

Fig. 24 Legs illustrating banding; 1 C. cantans, 2 C. sylvestris

Thoracic hairs fine, weakly barbuled, arising from large dark tubercles; abdominal hairs much finer, simple. Anal segment with a broad dorsal plate extending nearly to the ventral line but not inclosing the segment. Dorsal and ventral tufts as represented in figure 26. Air tube nearly cylindric, tapering slightly, and with double row of pecten, each terminated by a branched hair, pecten with three prominent and several smaller serrations [fig. 30]. The comb consists of a somewhat irregular patch of scales arranged in about three rows, each scale being somewhat spatulate and tipped with numerous fine hairs and a terminal coarser spine [fig. 28].

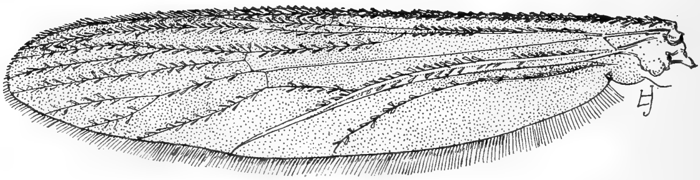

Fig. 25 Wing of C. cantans

This larva according to Dr Smith is somewhat larger and more robust than C. canadensis, which latter is frequently found in woodland pools and springs associated with

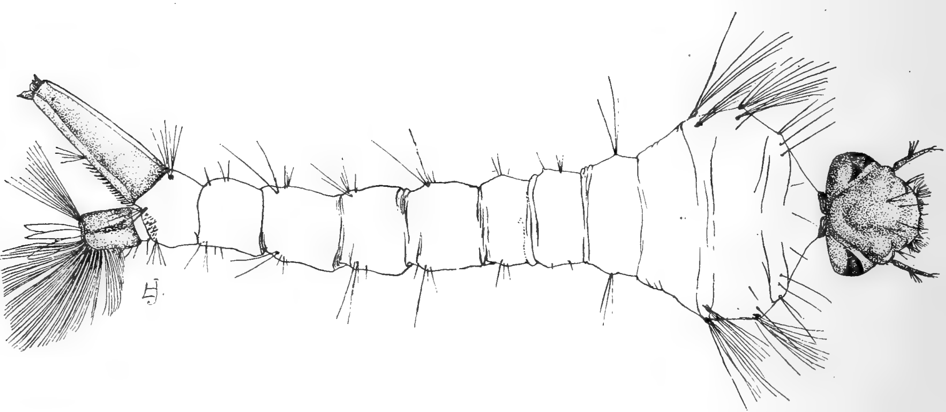

Fig. 26 Larva of C. cantans

this species. The two larvae are not easily separated, though this form has shorter, stouter antennae. Both have short breathing tubes, but that of C. cantans is shorter and approaches the form of C. sollicitans, with which it is also associated in brackish pools on salt meadows. The latter has still shorter, more slender antennae and has the labrum oblong, truncate, while in C. cantans it is rounded, and as a whole, somewhat heartshaped.

Dr Dyar states that the labial plate of the full grown larva is broadly triangular with coarse teeth at the sides and fine ones near the apex. He states that the regularly tapering, long air tube

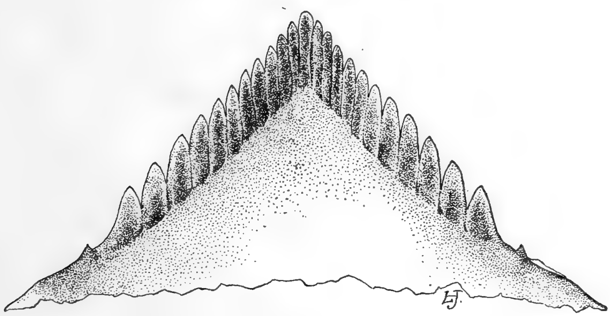

Fig. 27 Labial plate of C. cantans

is fully four times as long as wide, and that the basal pecten on the air tube are distant, the last two spines being large and detached, followed by a single hair tuft at about the middle of the

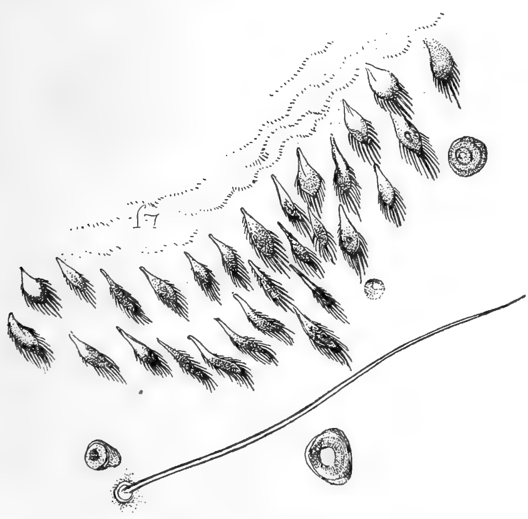

Fig. 28 Comb of C. cantans

tube. The comb consists of a patch of about 28 single, thorn-shaped scales which are minutely divided nearly to the base. This description agrees closely with illustrations published by Dr Smith, who represents the comb as containing about 29 scales and states that the number ranges from 26 to 50, each scale bearing a central spine, with others more slender and nearly as long on each side and extending down the base. Mr Johannsen states that the comb of this species consists of from 35 to 40 scales. There is also a difference in the pecten on the air tube, as illustrated by

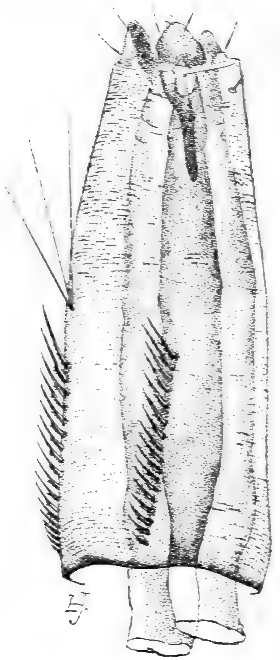

Fig. 29 Air tube of C. cantans

Fig. 30 Pecten tooth much enlarged

Drs Smith and Dyar. Dr Dyar states that the eggs are elliptic, the thickest part one third from the micropyle, one side flattened; finely marked with elongate reticulations.

The larvae from which we have reared this species do not present any such marked variation as a rule. The number of scales on the comb ranges from about 28 to 32, the air tube is only about three times as long as broad, and the pecten is continuous, with no isolated spines near the tip, and slightly beyond there is a compound hair, as represented in the figure.

Both sexes, larva and pupa, have been carefully described by Johannsen.

Distribution. This species is widely distributed in America, having been recorded by Howard from a number of New England and New York localities, from Ottawa, Canada, and in the Saskatchewan river, British America, Colorado, Arizona, New Mexico and Mexico, while Theobald lists it on the authority of various writers, from England, Germany, Scandinavia, Russia, Italy, India and Australia.

Life history and habits. This mosquito is very common at Poughkeepsie, and according to Dr Dyar flies most of the summer, though there is but one generation. The larvae appear to survive the winter in this latitude, though Dr Dyar states that they hatch from overwintering eggs very early in the spring, and that the growth is not rapid, a month probably being required for the production of adults. Our belief is based on the fact that full grown larvae are first observed in the spring and as their appearance is nearly coincident with that of other aquatic forms, we doubt the possibility of their developing from eggs in this latitude. Dr Dyar states that this species flies some weeks before depositing eggs and becomes common in the woods of British Columbia in July, disappearing soon after. A female taken by him, in New Hampshire, was kept alive from July 20 to Aug. 12, and another captured Aug. 8 laid eggs the 16th. A female taken June 15 in British Columbia oviposited the 30th, the eggs remaining unhatched till the following year, the wrigglers appearing as soon as the ice had melted from the jar the next spring. The eggs are laid singly and readily sink in the water. Dr Smith states that the larvae of this mosquito occur in woodland pools and springs in early spring with those of C. canadensis.

Culex sylvestris Theo.

Swamp mosquito

Pl. 3, 16, 31, 42, 49, fig. 4, 5; 3, 4; 1; 5; 1 respectively

This exceedingly common species about Albany has been taken in widely separated New York localities. It greatly resembles C. cantans according to Johannsen, and also agrees fairly well with the description of C. vexans Meig. and with Walker's description of C. stimulans. It differs from the first in having an unmarked thorax, and only the immediate base of the tarsal joints white [fig. 24]. The male also has the long claw of the middle tarsus slightly curved, though not sinuous. It may be separated from C. stimulans by the posterior forked cell being wider and shorter than the anterior, while in C. stimulans according to Giles they are of about equal length and breadth. The male differs from the above, in having a white band on the middle of the second joint of the palpus. This is probably Culex sylvestris Theo. though a specimen received from him has the hind claws simple and a lateral white stripe on the side of the head, whereas our form has toothed hind

Fig. 31 Claw of Culex sylvestris

Fig. 32 Wing of C. sylvestris

claws and the lower, lateral portion of the head entirely white, as a rule. A very few specimens agree with the one received from Theobald. It is possible that we have two species. This can be determined only by rearing extensive series. The tarsal bands are much narrower than in C. cantans, and the species is readily separated from C. jamaicensis by the petiole (in the female) of the first submarignal cell being considerably more than one third the length of the cell.

Description. The eggs according to Dr Dyar are laid singly or in groups, adhering by capillary action only, floating for a time and ultimately sinking. They are elliptic and fusiform with ends rounded, pointed and about alike, one side more flattened than the other. They are smooth, shining black, free of mucilage, without granulations, coarsely reticulate, and the reticulations much elongated lengthwise of the egg, forming long lines of chains. Length, .6 mm.

The larva is rather stout, medium size, and has a rounded, light brown head, slender, moderate antennae, slightly tapering, a small tuft before the middle. The labial plate is shown at figure 33. The tube is moderate, about two and one half times as long

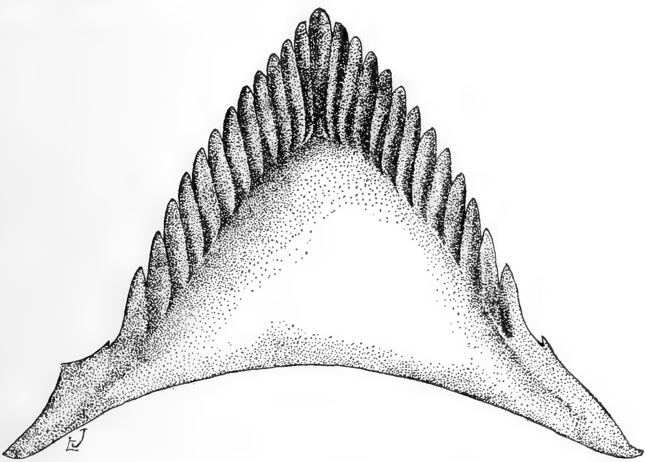

Fig. 33 Labial plate of C. sylvestris

as wide, slightly tapered, with double posterior pecten on the basal half, each row consisting of about 20 dark spines, three toothed, the terminal two or three usually detached and larger. The lateral comb consists of about 12 large thorn-shaped scales in an irregular partly double row. Dr Smith gives the number at 18 to 20 while our specimens have but 10 to 14. The pupa is normal, rather large, with slender funnel-shaped moderate air tubes.

Life history and habits. This species appears to be common in New York State, since we have taken the larvae in numbers from June till late fall, they occurring even after ice had formed on the pools. The winter is possibly passed in this stage in New York, though larvae brought in continued to mature till the first of December. This species has also been taken at Ithaca.

Dr Dyar has met with this species in New Hampshire, where the larvae occurred in all sorts of temporary pools, swamps, meadows, roadside puddles and the like. They were associated with C. canadensis and Aedes fuscus, and he states that the three species have essentially similar habits. He records collecting all the larvae from a roadside puddle, and on visiting it after the next rain found it filled with the same three species, and he therefore inclines to the belief that the eggs were lying in that place and that some hatched after each rain. Dr Smith states that this species occurs throughout New Jersey, and that it is the most common of the fresh-water swamp mosquitos after midsummer and till well along into fall. It bites readily, often occurs in considerable swarms, flies quite a distance and frequently enters houses. He adds that this species prefers rather open swamps and is as common in New Jersey in the marshy stretches near the Delaware, as in the low areas of the Great Piece meadow region. He states that it is rarely found in dark woodland swamps or in cat-tail areas, but that it occurs in more open water. It breeds in larger, more permanent meadow or lot pools and rarely in clean gutters. It is not a foul water mosquito and does not ordinarily occur in tubs, pails or rain barrels, nor has he ever found it in rain water or in open ponds.

Dr Smith states that the winter is passed in the egg stage and usually at the bottom of a pool, though the eggs may be laid at the edge of a puddle or in a damp depression likely to become filled with water. Dr Dyar states that eggs obtained by him from captive females were essentially like those of C. canadensis and C. cantans, laid singly, sinking in the water. They were obtained by him late in the season and did not hatch. Dr Smith records several broods during the season and states that the number depends on the amount of rain that falls and forms or maintains the normal breeding areas. The species breeds in both permanent bodies of water and temporary pools, provided the latter are suitable. The time of development is about 10 days.

He states that this mosquito is to open fresh-water marshes what C. sollicitans and C. cantator are to salt marshes and adds that he has evidence that it flies some distance, say half a mile, though there appear to be no real migrations.

Dr Dyar met with this species in British Columbia, where he states adults occurred in small numbers during July, associated with C. cantans.

Culex cantator Coq.

Brown salt marsh mosquito

Pl. 4, 17, 31, 42, 49, fig. 1, 2; 1, 2; 2; 3; 2 respectively

This is another form which appears to be largely confined to the coast region and to prefer brackish water for breeding purposes. We have taken larvae at Sheepshead bay in a ditch where the salt water entered only at high tide. This form may be separated from C. sylvestris, which it resembles, by its simple posterior claws and by the cross bands on the abdomen being yellowish instead of white.

Description. Dr Smith finds this species associated with C. sollicitans and C. taeniorhynchus, and states that it is a stout, hairy, yellowish brown mosquito with obscurely banded legs, very different from the bright contrasts found in C. sollicitans.

Larvae. Dr Smith states that the larvae of this species often occur in the same pools with those of C. sollicitans and look so much like them that they can not be readily distinguished, except that the anal siphon is obviously longer and the head bears a median, lunate mark with two lateral, slightly smaller posteriolateral ones. He adds that the antennae are shorter, without a basal swelling, and that there are 16 to 24 pecten teeth in each row and that the comb consists of from 26 to 50 spatulate, thorn-tipped scales arranged in about three rows. The labial plate is somewhat rounded and has 21 fine teeth.

Dr Smith states that as a rule this species breeds on salt marshes only. He adds that its power of flight is equal to that of C. sollicitans, and his observations in 1903 indicate that

C. cantator appears earlier and may fly long before the salt marsh mosquito appears in large numbers. He also considers C. cantator more northern in range, since it equals or exceeds the salt marsh mosquito on the Raritan and Newark marshes; it is hardly noticeable from Barnegat bay southward.

Culex sollicitans Walk.

White banded salt marsh mosquito

Pl. 4, 17, 18, 32, 42, 50, fig. 3, 4; 4; 1; 1; 2; 3 respectively

This mosquito is by far the most abundant of our coast species, and the one of greatest economic importance along our seashores.

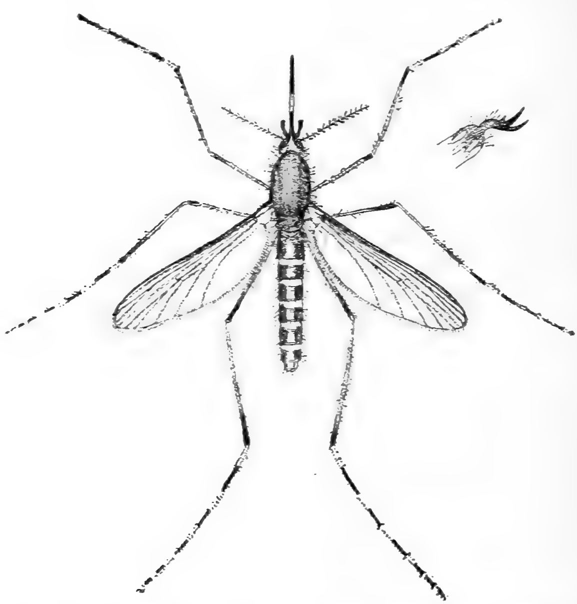

Fig. 34 Female and toothed front tarsal claw, Culex sollicitans. (After Howard. U. S. Dep't Agric. Div. Ent. Bul. 25. 1900)

It is the species, more than any other, against which extensive efforts have been directed in attempts to reduce its annoying, pestiferous hordes.

Description. This is one of the few species in which the proboscis is marked near the middle with a light colored band. It is readily separated from C. taeniorhynchus Wied. by the yellow median stripe along the dorsum of the abdomen. Abraded specimens may often be distinguished from closely allied forms by the much darker sides of the thorax compared with the dorsum.

The egg has been described by Dr Smith, as spindle-shaped, just a little curved, shiny and usually black when deposited.

The larva according to Dr Smith is light slate gray in color, head yellow, and without markings of any kind. The anal siphon is short, stout; the antennae short, slender, black at the tip and without obvious set-off or prominent tufting. The shape of the head, and specially of the vertex, is quite characteristic. The labial plate is represented at figure 35. The comb consists of 28 to 40 spatulate, thorn-tipped scales. Larvae of C. cantans and C. taeniorhynchus resemble this species closely and are not easily separated.

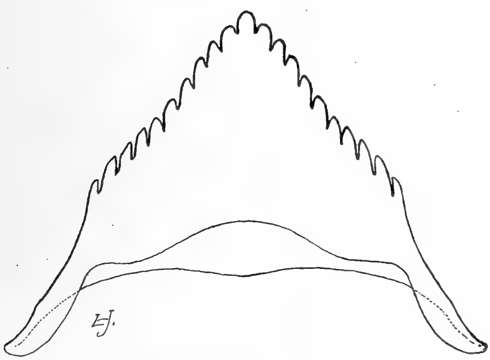

Fig. 35 Labial plate of C. sollicitans

The pupa presents no characteristic features.

Distribution. This mosquito has been recorded from various localities along the coast from Maine south to Florida; and from Jamaica. We have taken it about Lake Onondaga, N. Y. Theobald lists it doubtfully from the Galapagos islands and from Tamsui, Formosa.

Life history and habits. This species is such an abundant and annoying form, that considerable space may well be given to a discussion of its habits. The investigations of Dr J. B. Smith, state entomologist of New Jersey, who is doubtless the best posted regarding this mosquito, show that the winter is passed by this species in the egg stage. The eggs remain on or in the black mud, or at the base of grass stems, till hatched by floods of water at the proper temperature. The first generation is usually small and does not get far from the marshes. These females oviposit in the mud, where the eggs *must* lie dry or nearly so for three or four days before they can hatch, after which the larvae may appear in immense numbers after a high tide or heavy rain. Most of the eggs are high enough, so that they are reached only by exceptional tides or storm-driven water, and as a consequence swarm after swarm of mosquitos may hatch from the same ground at irregular intervals, depending on high tides, unusual rain or storms. This may continue even till early September. Dr Smith's observations show that no gravid females occurred on the Newark meadows between early September and the middle of October, and that consequently most of the eggs must have been deposited prior to that time.

The salt marsh mosquito is somewhat unique on account of its traveling long distances either by flight or by allowing itself to be conveyed by prevailing winds. Dr Smith states that the migration begins soon after the adults emerge and that after the middle of July the entire pine region of South Jersey gradually becomes filled with these insects, where they swarm miles from any water, and at least 40 miles from any point where larvae of this species have ever been found. This migratory habit is remarkable compared with what is known of other species, yet Dr Smith has obtained incontrovertible evidence. It is, however, only fair to state that we have failed to note such extended migrations on Long Island, and we are inclined to the opinion that, as a rule, local control by township or village affords excellent protection from this mosquito. Dr Smith has also given some interesting observations relative to the possibility of this species being conveyed by trains. He has repeatedly noticed the influx of mosquitos when trains entered a region infested by this species, and likewise observed their departure as the infested area was passed, showing that relatively few were conveyed in this manner.

The breeding places of this species are of great importance wherever any attempt is made to reduce its numbers. The salt marsh mosquito prefers brackish or salt water, but occasionally occurs in some numbers in fresh water. It never breeds in any numbers in localities where small fish or fiddler crabs occur, and ideal conditions are found in puddles and ditches, where there are no enemies, and particularly in holes and hollows on flats covered only by unusual tides or during storms. The flood of water hatches the eggs, and the pools remaining swarm with larvae a day or two after the deluge. The prolificacy of this species is strongly illustrated by Mr Viereck's estimate of 10,600,000 larvae occurring in a pool containing some 1894 sq. ft. This species does not breed on areas flooded by normal tides, or among grass or cattails, where there is considerable shade.

Culex discolor Coq.

Pl. 46, 48, fig. 4, 5 respectively

This is a yellowish brown, moderate sized mosquito with body mottled and variegated with brown, the legs and beak banded and the wings spotted, according to Dr Smith.

Description. The original description follows:

Palpi with a cluster of white scales at the apexes, upright scales of occiput yellow, whitish cross bands of abdomen prolonged forward in the middle, crossing or almost crossing the segments, scales on posterior side of front and middle tibiae and on anterior side of the hind ones almost wholly pale yellow, first tarsal joint bearing many yellow scales, black and yellow scales of wings not evenly distributed, the black ones forming a distinct spot at forking of the second vein with the third, another on upper branch of fifth vein at the hind cross vein, and a third on the apical third of the last vein, remaining scales of this vein wholly yellow; length 4 mm.

The larva according to Dr Smith is from ¼ to about $\frac{5}{16}$ inch in length and is yellowish brown in color. The head is almost as large as the thorax, being a little excavated before the antennae. The latter are white, almost as long as the head, thickest near the middle and with a double curve, the tips pointing outwardly. The tuft of a dozen hairs, well before the middle, does not reach the tip. The mandibles are peculiar in that they have but one dorsal spine. The comb consists of five to eight scales attached to a narrow band like a fringe and not directly to the skin. Each scale is oblong with setose sides, two long spines at the angles and a very long central process. The air tube is small, about three times as long as wide, with two curved spines at the apex and an unusually large tuft below the spines. Pecten consists of from five to eight spines each bearing two to four very long, slender teeth. The anal gills are twice as long as the siphon, taper to almost a point and are well provided with tracheae.

Habits. This species is abroad in New Jersey the latter part of June, in July and early August. Mr W. P. Seal, who took the larvae at Delair N. J., states that they are rare and have the habit of remaining below the surface and feeding at or near the bottom. Dr Smith states that the larva has a peculiar habit of resting on the bottom, back down, with the antennae pointing upward and mouth brushes in constant motion. A single larva was also received by Dr Smith from Mr Brakeley, who took it at Lahaway N. J.

Culex jamaicensis Theo.

Pl. 44, fig. 2

This mosquito may be separated from the closely allied C. sylvestris by the shorter petiole of the submarginal cell, it

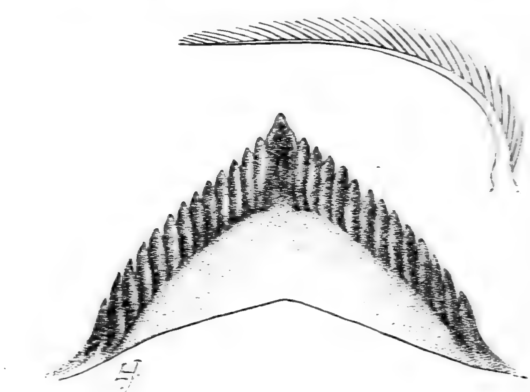

Fig. 36 Labial plate of Culex jamaicensis, with hair from same much more enlarged

being one third or less than one third as long as the cell. In other respects it agrees very much with the above named species.

Description. The larva has been described by Dr Dyar, who states that it has a round, flat head, narrow anteriorly, the antennae long, slender, uniform, with the outer two thirds black, middle tuft slight, often folded and invisible. The air tube is brown, sub-

Fig. 37 Comb of C. jamaicensis

fusiform, about three times as long as wide, with a normal pecten, comb with only a few scales, each with a dentate, platelike base

Fig. 38 Middle spine of comb of C. jamaicensis

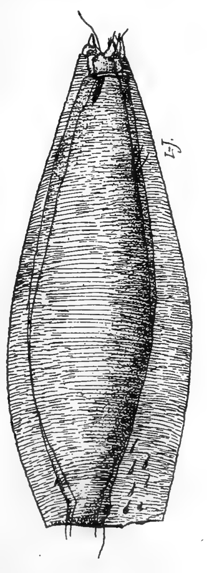

Fig. 39 Air tube of C. jamaicensis

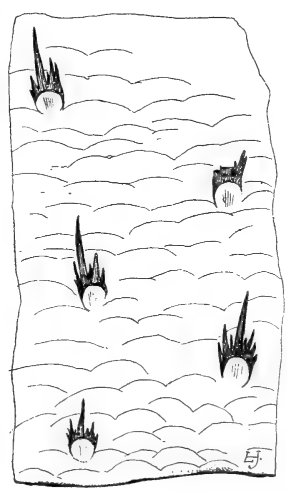

Fig. 40 Pecten of C. jamaicensis more enlarged

[fig. 37]. The labial plate and posterior extremity of the larva are also shown [fig. 36, 42].

Life history. The life history of this insect has been partially worked out. Dr Grabham states that the eggs are laid singly, and Professor Herrick found that the larvae invariably appear in pools within 12 hours after their formation by rain. This led him to believe that the eggs are deposited on the mud and hatched when soaked by rain, and the correctness of this conclusion is further substantiated by Dr Smith's observations on C. sollicitans. The young larvae were first met with by Professor Herrick, in an

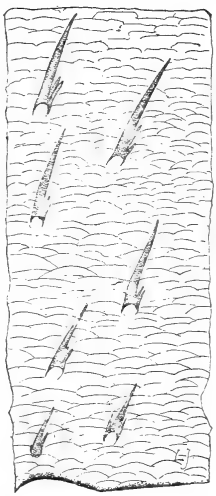

Fig. 41 Pecten of another larva equally enlarged

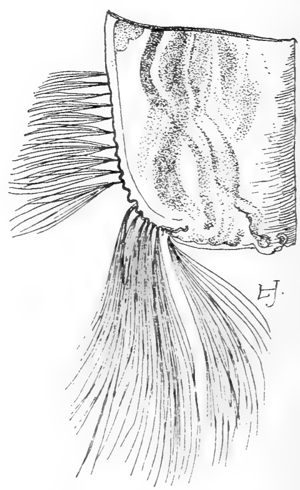

Fig. 42 Last segment of larva of Culex jamaicensis

open sewer drain, though later he more often found them in rain water pools, and his attention was attracted on account of their large size as compared with those of C. fatigans. The larvae frequently rest in a nearly horizontal position, much resembling Anopheles in this respect. Professor Herrick states that, when the larvae first rise to the surface they assume a position very similar to that of most species of Culex, but after a few moments, if left undisturbed, there is a slight jerk and the body quickly assumes an approximately horizontal position, the head being on a level with the surface of the water. He observed that the body after a few minutes, instead of lying nearly horizontal, as does that of Anopheles, hangs suspended like a piece of slack rope, between the head and the respiratory tube and considerably below the surface of the water.

Distribution. This species has been listed from Jamaica by its describer, is abundant in Mississippi according to Professor Herrick, was obtained by Dr Dyar in a mud pool of rain water at Cabin John Md., has been sent to this office in the larval state from Staten Island, and taken by Dr Smith in New Jersey.

Culex taeniorhynchus Wied.

Small salt marsh mosquito

Pl. 4, 5, 18, 33, 42, 53, fig. 5; 1; 2, 3; 1; 1; 1 respectively

This coast species occurs in the same situation as the salt marsh mosquito, and on account of its banded proboscis [fig. 43],

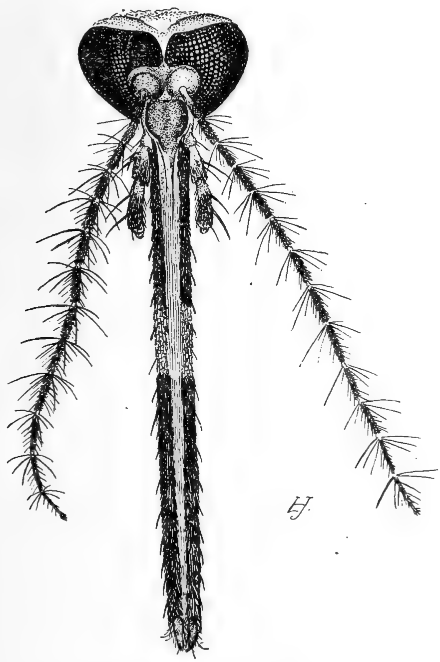

Fig. 43 Head and appendages of Culex taeniorhynchus showing white band on the beak

may be confused with it. This form more frequently haunts patches of woodland and may be recognized by the absence of the yellow stripe in C. sollicitans, while the basal bands of the abdominal segments are clear-cut, of a more uniform width and nearly or quite white.

Description. This larva has rather stout, dark tipped antennae with the tuft at the middle. Labial plate triangular with 21 or 23 teeth. The comb consists according to Dr Smith of 16 to 24 somewhat spatulate scales bearing a row of coarse setae, the longer ones at the apex. The air tube is very short, about one and one fourth times as long as broad with about 15 closely set pecten teeth with three to six or seven minute serrations on each side.

Dr Dyar states that the larva differs from C. sollicitans, by its shorter tube and the differently shaped teeth of the lateral comb.

Distribution. This appears to be a widely distributed form, since it has been recorded by Theobald from New Amsterdam, British Guiana, St Lucia, Florida, Honduras and Brazil, and it also occurs rather commonly in New York and New Jersey.

Life history and habits. This species probably passes the winter in the egg stage, in mud or at the base of grasses, in the same manner as C. sollicitans, since Dr Smith has bred it from eggs in the same piece of sod, and he states that the two species have the same habits, having reared adults of both, without previously suspecting that he was dealing with two insects.

Culex confinis Arrib.

This species has been listed from New Jersey by Dr Smith, who took it at Delair, July 10, and at New Brunswick, Aug. 3. It very probably occurs in New York State, and the following description by Theobald should prove of service in its recognition.

Very like Taeniorhynchus taeniorhynchus Arribalzaga but of smaller size and darker color, while the band on the proboscis is broader, but differs especially in the form of the wing scales. The broad white proboscis band extends from near the base to the middle; legs fuscous, fore femora sparsely decorated with scattered white scales, with a narrow white band a little before the apex; tibiae speckled white externally, uniformly colored inside; knees white; fore and mid tarsi with the first three, and the hinder with four, or all the joints with basal white bands; metatarsi distinctly shorter than tibiae. Abdomen dark fuscous, with coffee-colored scales above and narrow whitish bands; grayish below.

Length, 4.5 to 5 mm.

Habitat, Chaco in Formosa, Argentina.

Culex annulatus Schrank.

This mosquito may be easily separated from others having banded tarsi, by the broad band on the posterior tarsi.

Distribution. Dr Howard has recorded this insect from New Bedford Mass., Lincoln Neb., Santa Fé N. M., Stanford Cal., and Logan, British Columbia. It has also been recognized by Mr Ludlow at Fort Baker Cal. It appears to be widely distributed in this country, specially as it has also been reported from Mexico. Theobald states that this species is common throughout Europe, from Scandinavia to Italy, and also occurs in India.

Giles states that this large gnat is believed by Ficalbi, to feed only on the juices of plants, and he thinks that it does not attack man or animals.

Culex canadensis Theo.

Woodland pool mosquito

Pl. 5, 18, 19, 34, 42, 50, fig. 3, 4; 4; 3; 1, 4; 2 respectively

This comparatively large, rather handsome mosquito may be easily recognized by the last segment and each extremity of the other segments of the tarsi on the posterior legs being white. The petiole on the first submarginal cell is about two thirds its length, a character readily separating this species from C. atropalpus, which according to Coquillett has the petiole less than one half the length of the cell. The claws are all unidentate in specimens received from Theobald. This mosquito is at no time very abundant.

Description. The eggs according to Dr Dyar are laid singly, not adherent, fusiform, with ends rounded, black. The full grown larva has a pale brown head, with antennae brownish throughout, though darker on the outer third, a slight tuft a little before the middle. The air tube is conical, tapered, about two and one half times as long as wide, with two rows of pecten at the base. The comb consists of a triangular patch of small scales over three rows deep. Dr J. B. Smith states that the larva of this species is associated with that of C. cantans, which it resembles so closely that the two are not easily separated. We have bred this species, from woodland pools where it was associated with C.

canadensis, C. impiger, C. cinereoborealis and Aedes fuscus.

Distribution. This species was described from specimens received from DeGrasse point, Lake Simcoe, Ont. We have taken it about Albany and at Poughkeepsie. Dr Smith records it from New Jersey, and it is very common at Center Harbor N. H. according to Dr Dyar, who also met with it rather abundantly early in the season in British Columbia.

Life history and habits. Dr J. B. Smith states that the eggs are laid in the mud of dried up pools or in the pools themselves, sinking to the bottom in the latter case. The larvae hatch in New Jersey in January or February, often when the pools are covered with ice, and grow slowly, maturing and transforming to pupae late in April. The adults emerge during early May, and of the eggs laid by them only a portion seem to develop, because the second brood is smaller than the first and so on, and while larvae and adults are found throughout the season, they are stragglers and simply supply eggs for another year. Almost every low swampy woodland and nearly every pool swarms in April with the larvae of this species. Many of the pools dry up by the time the insects mature, and remain so till the following spring; nevertheless larvae again appear with the approach of warm weather. Dr Smith states that this is the earliest and latest occurring mosquito in New Jersey, and that it never becomes a nuisance in towns or houses, even though the latter be only a few rods from a pool. It seems as though the larvae of this species must hibernate in New York State, since they are of considerable size when they first appear in the spring along with other aquatic forms. Adults are on the wing about Albany in early May.

This species breeds by preference in woodland springs, pools or ditches carrying spring water.

Culex onondagensis n. sp.

Pl. 5, 17, fig. 2, 3 respectively

A specimen of this mosquito was taken in the vicinity of Lake Onondaga, Syracuse, Sep. 19, 1904, and as it differs so markedly from previously known forms, it is described herewith.

Antennae dark brown, sparsely clothed with fine whitish hairs, with sparse basal whorls of dark brown hairs on the segments, basal one brown, clothed internally with yellowish scales. Palpi, short, dark brown, with a few silvery white scales toward the apex. Apical portion of proboscis dark brown, basal part lighter with a few whitish scales. Occiput rather thickly clothed with yellowish and silvery scales, with a few black ones interspersed. Prothorax ornamented with a thick covering of golden yellowish scales, becoming grayish posteriorly (in the specimen this portion is somewhat rubbed). Scutellum similarly clothed and with no long setae. Halteres capitate, basal and apical portions fuscous. Pleura brownish, clothed with rather thick irregular patches of whitish scales. Abdomen dark brown, with a distinct broad median and somewhat broken lateral stripes of silvery gray scales slightly tinged with yellow. Basal bands of first and second abdominal segments somewhat indistinct, those of the third and fourth well marked, the dorsum of the remaining segments nearly covered with silvery white scales. Ventral surface sparsely clothed with silvery gray and yellowish scales. Femora and tibiae mostly yellowish with somewhat brown scales, which are flecked where thick with white. Fore and mid tarsi brown with apical white rings, hind tarsi with the apex and the extremities of the segments distinctly ringed, except the distal of the fourth, fifth snow white. Claws unidentate. Wings hyaline, clothed with intermixed brown, straw yellow and colorless scales, the narrow long ones mostly transparent. Petioles of the first and second fork cells about three fourths the length of their respective cells.

Culex atropalpus Coq.

Pl. 5, 6, 19, 32, 44, 55, fig. 5; 1; 2, 3; 1, 2; 5; 3 respectively

This mosquito resembles C. canadensis, though it may be separated from it by the length of the petiole of the first submarginal cell, as given above. This species has been recorded from several localities near New York State, and Prof. G. H. Hudson has taken it near Plattsburg N. Y.

Description. The egg has been described by Dr Dyar, as black elliptic with ends abruptly narrowed. They are deposited in groups, adherent to the surface on which they are placed. The full grown larva has a dark brown, nearly black head, the antennae are slender, small, uniform, with the tuft at the middle of the joint reduced to an inconspicuous hair. The air tube is short, not over twice as long as broad, slightly tapered, with double posterior pecten, a small tuft and several pecten teeth beyond the tuft. The comb consists of a long triangular patch of small scales about five rows deep. Dr Dyar states that this larva resembles that of C. canadensis, but the tube is shorter, the anal plate smaller, and the anal finger-shaped processes contain conspicuous tracheae.

Distribution. This species was described from specimens received from Virginia, Maryland, Pennsylvania and New Hampshire.

Life history and habits. Dr Dyar has met with larvae in small pools in the flat surface of a rock beside a stream on the side of Mt Ossipee N. H., and he adds that it did not occur near Center Harbor, where there were no rock pools. It was also found breeding abundantly in water-filled potholes on the edge of the Potomac river, above Plummers island Md., and was associated with C. territans, as in New Hampshire.

Culex dyari Coq.

Pl. 10, 21, 35, 43, 54, 55, fig. 1, 4, 1, 4, 1, 4 respectively

This mosquito has the tarsi ringed at the base, and simple claws, according to Coquillett, which readily separates it from others in this group, unless it be C. jamaicensis, from which it may be distinguished in the same manner as C. sylvestris. This form was taken by Dr Dyar, at Center Harbor N. H., and it would not be surprising if it was also found in New York State.

Description. This larva according to Dr Dyar has a rounded, pale brown head and stout antennae, the tuft at the outer third and the part beyond, smaller; strongly infuscated at tip, narrowly so at base, the center of the joint broadly pale whitish. Air tube about four times as long as broad, tapering rather abruptly beyond the middle, the tip not tapered. Basal pecten small, double, approximate, not followed by hair tufts. Anal segment completely ringed; chitin darker and covered with numerous little spines, dorsally; pierced ventrally by seven little holes for a series of tufts that precede the barred area. Brush and tuft normal. Comb, a large patch of numerous small scales many rows deep. He figures about 10 rows composed of over 80 scales. Pupa normal, with funnel-shaped air tubes.

Life history and habits. Larvae were obtained by Dr Dyar in a cold permanent spring, and he is of the opinion that there is only an early spring brood, the species hibernating in the egg. Dr Dyar has also met with this species in British Columbia, where it is early and by no means common. He found one larva in a slow cold stream in the woods, May 29; it pupated at once, indicating that the breeding season had practically passed.

Culex territans Walk.

Little black mosquito

Pl. 6, 19, 20, 34, 43, fig. 2, 3; 4; 1; 1, 2; 6 respectively

This rather common, small mosquito has unbanded tarsi, and may be easily recognized by the cross band of whitish scales at

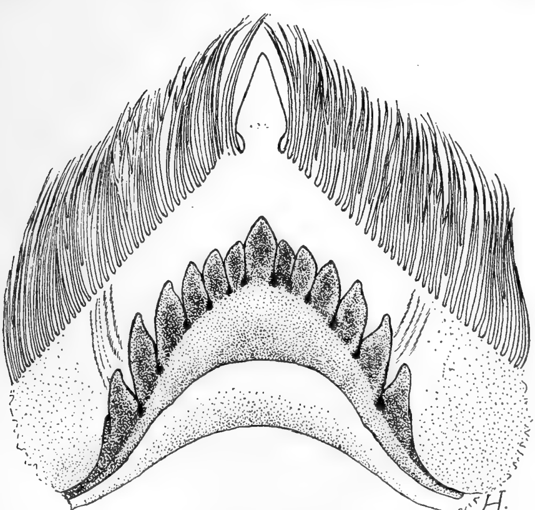

Fig. 44 Labial plate of Culex territans

the apex of the abdominal segments. It is widely distributed in the State, having been taken by us at Poughkeepsie, Karner and

Elizabethtown, in which latter larvae occurred in a pool with numerous small polywogs. The larva differs from all others in the enormously long, slender air tube [fig. 45] and by the broad head with prominent antennae. The latter are black at the tip and have a tuft of long hairs a little beyond the middle. The peculiar labial plate is also illustrated [fig. 44].

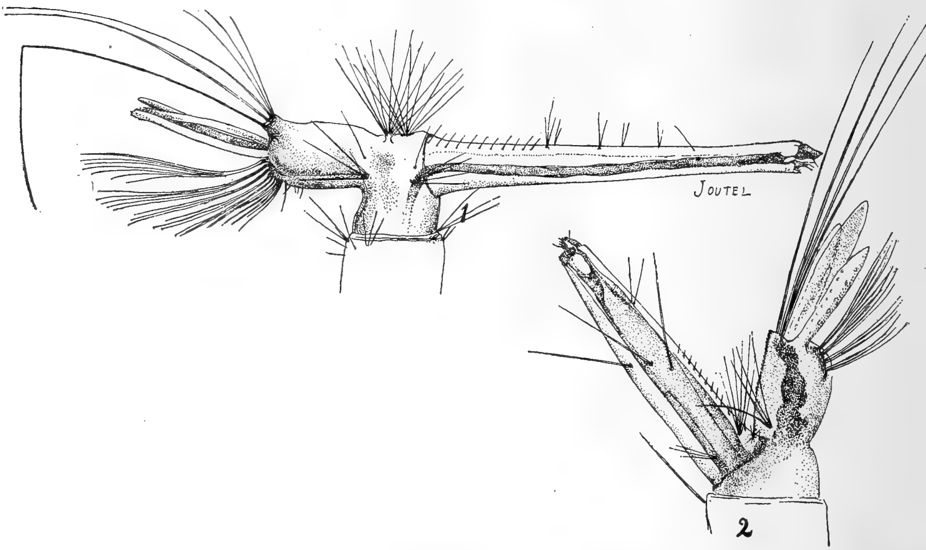

Fig. 45 Air tubes and anal appendages; 1 C. territans, 2 C. restuans

Distribution. This species is a rather common form in New York State, likewise in New Jersey and New Hampshire, according to Messrs Smith and Dyar. The latter has also taken it in British Columbia, and it is probably widely distributed in the northern United States.

Life history and habits. We have found it breeding in many places throughout the summer, and Dr Smith states that the larvae occur almost everywhere, in running or stagnant waters, fresh or brackish, though he has not found them in real foul or salt water. Dr Dyar states that the larvae prefer cold water, and that he took the same in a cold spring some 20 feet in diameter, and that they were not found in a warm, scummy pool which yielded other species freely. He adds that in New Hampshire larvae occurred in every suitable pool, and after the middle of July they were the most abundant Culex larvae to be found, being present throughout the summer. Dr Dyar obtained some eggshells, which he believed to belong to this species, from a pool full of C. territans larvae. They were on the surface of the water in little boats composed of three or four eggs, each adhering by their flat sides, the mass floating sidewise on the water. They were so minute that a lens was necessary to ascertain their true character. He states that the life cycle occupies about three weeks, and that breeding is continuous as with C. pipiens, the winter probably being passed as adults.

Dr Smith states that this little mosquito is rarely troublesome in the early part of the summer, but sometimes late in the season it seems to become possessed with a furious desire for blood. At such times it forces its way through the netting of window screens, endeavors to find openings around them, or works up between the windows if they are imperfectly closed. This lasts for a short time and then the mosquitos suddenly leave. It is somewhat of a puzzle to account for their appearance in such numbers. This form is seldom recognized in house captures, since when collected in alcohol it has proved almost impossible to separate it from C. pipiens.

Culex lazarensis Felt & Young

Pl. 6, 20, 35, 43, 51, fig. 4, 5; 2, 3; 2; 3 respectively

Pupae of this well marked, beautiful species were taken in a deep, cold mountain pool at Elizabethtown N. Y., June 9, adults emerging the 10th. Larvae occurred at Karner N. Y., May 3.

Description. Occiput and thorax thickly clothed with golden yellow scales except for a narrow median dark brown line and on the thorax a broad submedian brown line on each side, all interrupted at the posterior fourth. More laterally and near the posterior end of the submedian stripes there is on each side a short, broader stripe. The golden vestiture is interspersed with scattering long, black hairs. Pleura clothed with patches of golden yellow and whitish scales. Abdomen dark brown or black, with broad, basal white bands, specially in the male, slightly continued on each side, particularly in the female. Legs dark brown except the yellowish white coxae, inner side of femora and posterior side of the tibiae; tip of femora clothed with yellowish white scales.

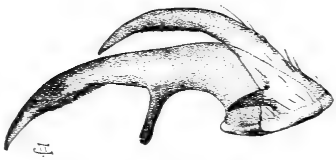

Fig. 46 Unequal claws of Culex lazarensis

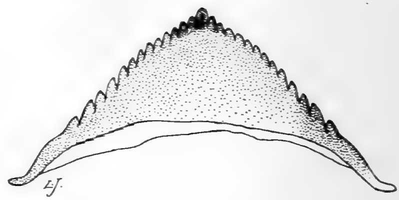

Fig. 47 Labial plate of C. lazarensis

Ungues unidentate. Wings hyaline, veins clothed with rather long scales; posterior cross vein about its own length from mid cross vein; petiole of first submarginal cell about one third the length

Fig 48 Comb of C. lazarensis

of the cell, that of the second submarginal cell about equal. Length of body $\frac{3}{16}$ in.; wing spread, $\frac{3}{8}$ in. Coloration nearly the same in both sexes.

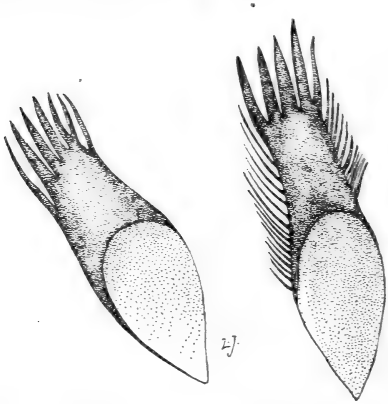

Fig. 49 Two comb scales of C. lazarensis

Female. Antennae clothed with sparse gray hairs. Palps brown, frequently well sprinkled with white scales, short, about one fifth the length of the long, brown proboscis. Abdominal cross bands decidedly narrower in the middle and well prolonged laterally, ventral surface suffused with white scales. Terminal segment not marked and ovipositor acute at the tip.

Male. Plumes of the white banded antennae, grayish. Palps very long, slender, and clothed with purplish brown scales. White abdominal bands very broad, covering nearly the basal half of the segment, and with a slight median and lateral prolongation. Under surface of abdomen sparsely clothed with white scales, posterior fourth of segments brown. Basal segment of clasp stout, distinctly clubbed and somewhat lobed apically, bearing a long, slender, curved segment tipped with a stout spine. Ungues unidentate, except outer claw of fore leg, which is simple; tooth on inner claw almost capitate.

Described from many bred specimens, including several reared from isolated larvae.

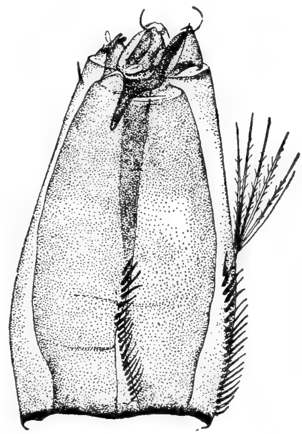

Fig. 50 Air tube of C. lazarensis

Larva. Nearly ½ inch long when full grown, frequently greenish, turning to a slaty color after death. Antennae slightly darker at the tip, nearly straight, tapering uniformly and with tuft at the basal third, tip bearing one very long and two medium sized, slender processes, one shorter, much stouter, almost conical process and a very stout, knoblike remnant of a segment. Labial plate triangular, with about 27 fine teeth. Compound, finely spinose hairs on thoracic segments, usually simple ones on the abdominal segments. Comb

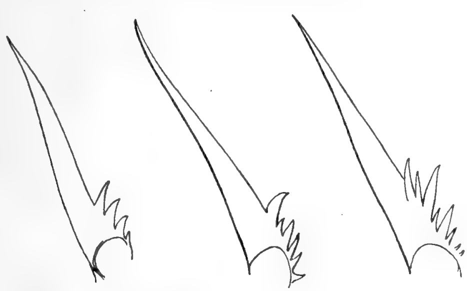

Fig. 51 Pecten teeth of C. lazarensis much enlarged

consisting of a triangular patch composed of about 60 rather stout scales, each tipped with about four to seven stout, equal spines. Air tube short, a little over twice as long as broad, slightly swollen at the basal third, bearing a double row of posterior pecten, each row with about 20 short, black, stout spines, usually with two well marked teeth at the extreme base. A compound hair occurs near the extremity of each row of pecten. Barred area short, on the posterior half of the anal plate and composed of only about 12 bars, each bearing a compound hair. Anal gills slender, acute at the tip.

Culex cinereoborealis Felt & Young

Pl. 7, 20, 21, 26, 36, 45, 52, 55, fig. 1, 2; 2; 1; 4, 1; 1, 5; 1 respectively

We have been unable to refer this form to any described species. It is closely allied to C. n e m o r o s u s Meig., though Theobald's description does not permit its reference to that species.

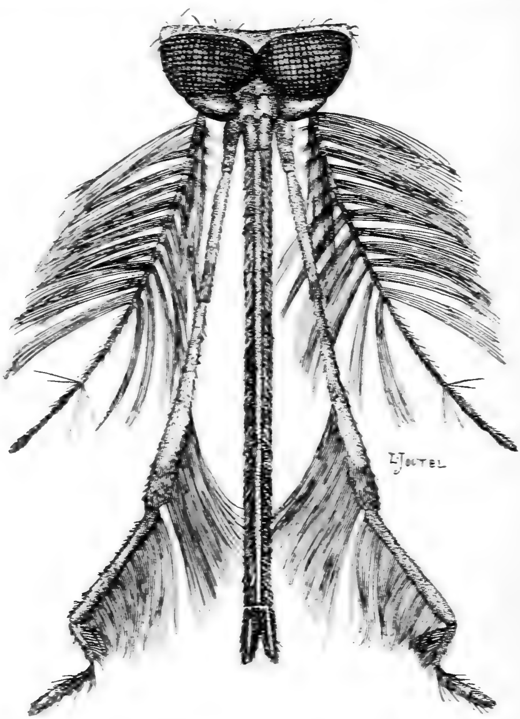

Fig. 52 Head and appendages of C u l e x c i n e r e o b o r e a l i s

Description. Thorax brownish gray, with central portion browner; abdomen brown, with basal white bands expanded at the sides; legs dark brown; coxae pale; femora light beneath; ungues unidentate in female, unequally toothed in male. Length, 7 mm; wing spread, 6 mm.

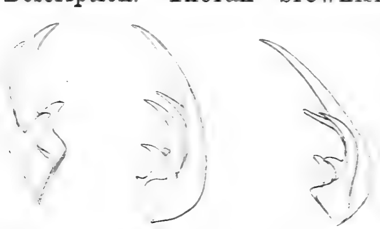

Fig. 53 Tarsal claws of male, C. c i n e r e o b o r e a l i s

Female. Brownish gray; proboscis long; palpi dark brown with base lighter than tips; occiput with white, narrow, curved leaflike scales at center, broad truncate ones at the sides; numerous upright, narrow, forked, yellowish or dark scales are interspersed

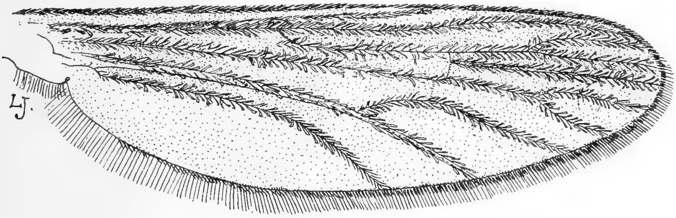

Fig. 54 Wing of female, C. cinereoborealis

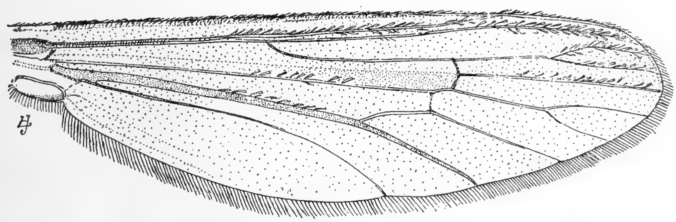

Fig. 55 Wing of male, C. cinereoborealis

among the others; black bristles extend forward with a few yellowish ones on the median line; antennae dark brown, base of first

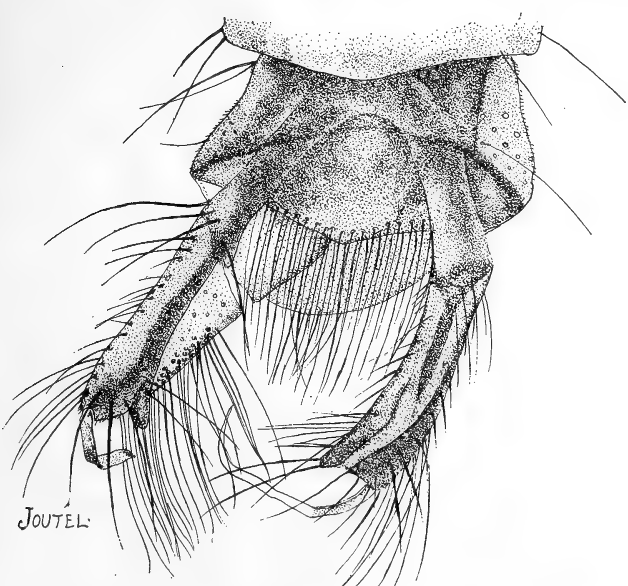

Fig. 56 Male genitalia, C. cinereoborealis

joint pale. Thorax brownish gray, a brown spot at the middle, becoming wider behind the middle with the sides often separated from the central part by a narrow white line, lighter at the sides, with yellowish or golden scales. Pleura thickly clothed with white scales. The denuded thorax shows a median narrow brown line bordered with a lighter almost plumbeous one on each side. Abdomen brown, with a broad white band, somewhat expanded laterally, at the base of the segments. Yellowish white scales are scattered over the abdomen, while clusters almost form a median stripe, which is more apparent in bred or unabraded specimens. Ventral surface clothed with white scales. Legs, dark brown;

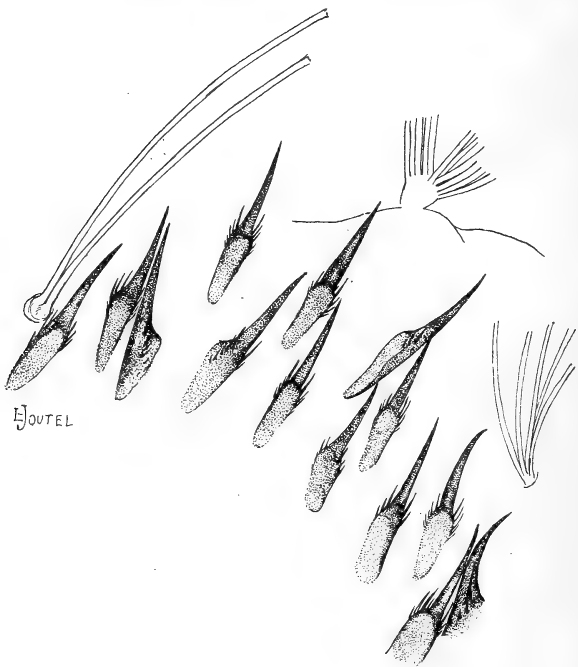

Fig. 57 Comb of C. cinereoborealis

femora yellowish, lighter beneath and almost black at apex. Anterior and mid tibiae lighter beneath, posterior tibiae show dark purple reflections in sunlight. Tarsi unicolorous, almost black; ungues unidentate. Wings large, thick, venation strongly marked; petiole of the first submarginal cell almost as long as cell; posterior cross vein less than its own length from the nearly equal mid cross vein.

Male. Head, similar in color to that of female; the antennae and palpi uniformly brown; thorax with brown spots more extended, more golden or yellowish scales, and with fewer white scales laterally and on the pleura. Abdomen more slender than in the female; basal bands narrower, with very few scattered yellowish scales, numerous long flying hairs becoming quite dense at the apex. Legs long, same color as female; first joint of posterior tarsi almost as long as tibiae; posterior ungues equal, unidentate; the fore and mid feet bear one large claw with two teeth and a smaller one with one tooth. Wings longer and narrower than in the female; petioles of the first and second submarginal cells longer than cell, posterior cross vein about its own length from the mid cross vein.

Larva. Length about $\frac{5}{16}$ inch; head light or yellowish brown, widest just behind the black eyes; antennae nearly straight, almost cylindric, slightly darker at the somewhat enlarged base and with a scanty tuft arising at the basal third. Labial plate broadly triangular, with 25 fine teeth. Thorax, lateral angles somewhat marked and each bearing a group of compound, finely barbuled hairs. A similar group also occurs at the anterior angle which is less sharply defined, and also on the dorsal surface. Hairs of the body mostly simple, those on the first and second abdominal segments compound and weakly barbuled. Comb of the eighth abdominal segment consists of 14 to 16 scales, each having a somewhat spatulate base and terminated by a stout spine, at the base of the latter on either side is a much smaller spine followed by a series of still smaller, weaker ones. Anal segment, with a broad dorsal plate extending nearly to the ventral line but not inclosing the segment. Air tube is about two and one half times as long as broad, tapering rather gradually to the apex, with two posterior pecten, each consisting of about 18 spines closely placed together and four others at a much greater distance. Each pecten tooth is stout and with one or two denticulations; dorsal surface of the air tube with a double row of hair tufts, each consisting of about four tufts composed of a pair of weakly barbuled hairs.

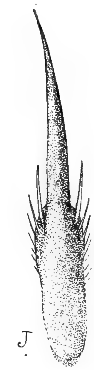

Fig. 58 Comb scale of C. cinereoborealis

Life history and habits. This large species is a frequenter of woodland pools in the vicinity of Albany, where it occurs in association with C. canadensis, C. impiger, C. cantans and Aedes fuscus. We believe this species winters in the larval form, since with the opening of the spring and appearance of life in the various pools, only nearly full grown larvae were to

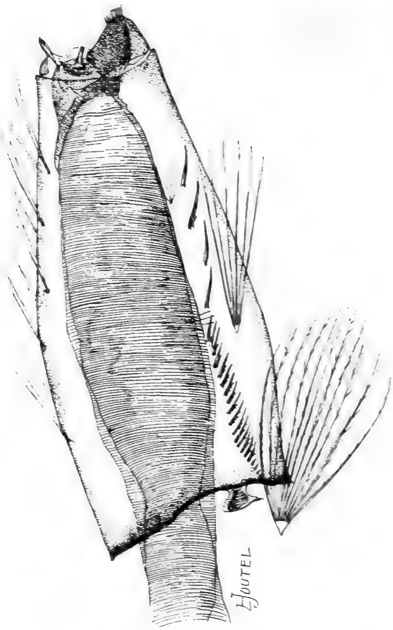

Fig. 59 Air tube of C. cinereoborealis

be found. The adult insects appear from the early part to the middle of May.

Culex impiger Walk.

Pl. 7, 21, 36, 43, 52, fig. 3, 4; 2, 3; 1; 1; 1 respectively

This very common New York mosquito with a basal white band on the dorsum of the abdominal segments, may be readily separated from C. consobrinus by the toothed claws. This species was met with in early spring as larvae frequenting woodland pools where it was associated with C. canadensis, C. can-

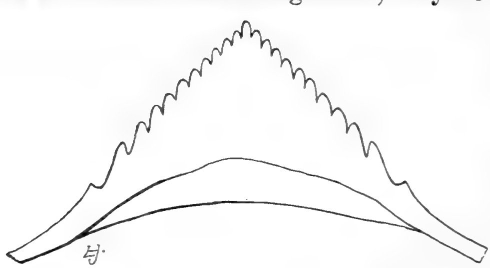

Fig. 60 Labial plate of Culex impiger

tans, C. cinereoborealis and Aedes fuscus, adults appearing in early May. It probably winters in the larval form.

Description. This is one of the two species in which the posterior cross vein of the wing is very close to the first cross vein. Theobald makes C. impiger a synonym of C. nigripes, but Howard states that the latter does not occur

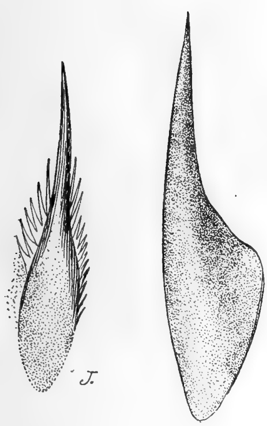

Fig. 61 Two views of comb scales of C. impiger

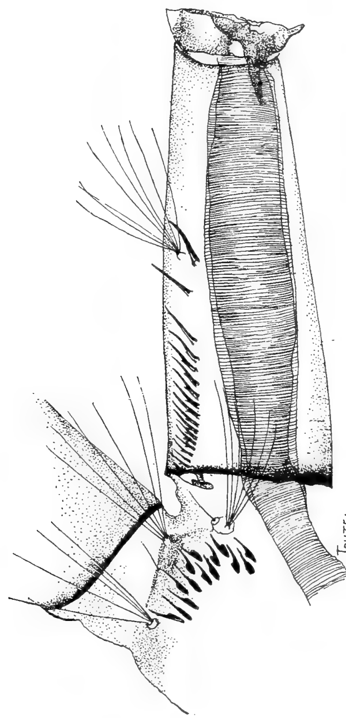

Fig. 62 Air tube of C. impiger

in this country or Canada. The male of C. nigripes has the abdomen covered by black scales, while the male of C. impiger has cross bands of light colored scales on the abdomen. Larva about $\frac{5}{16}$ inch long; head, rather dark brown; sides somewhat angular; antennae, fuscous at tip with a slight tuft arising at the basal third. Labial plate rather broadly triangular with 11 teeth on each side of the median one. Thoracic hairs finely barbuled and arising in groups of three or four; abdominal hairs more slender, some double, and all finely barbuled. The comb consists of a somewhat triangular patch of about 14 scales, each with the finely setose spatulate base prolonged into a stout spine. Air tube three to four times as long as broad, slightly conical, in each row 15 to 18 pecten teeth, the distal two widely separate and all of the continuous row with one or more basal teeth.

Fig. 63 Pecten tooth of C. impiger

This larva was taken in a woodland pool at Karner, May 3, 1904, where it seems to be somewhat abundant.

Distribution. This species evidently has a wide distribution in North America, since it has been recorded by Dr Howard from several British Columbian localities and a number of states, occurring as far south as Georgia, the Isle of Pines and Jamaica, West Indies, and the city of Mexico, and it probably ranges across the continent, because Theobald lists it provisionally from California, and referring this form to C. nigripes, also lists it from Lapland; Greenland; the arctic circle generally; Cashmere, India; and Virgin bay, Alaska.

Culex consobrinus Desv.

Examples presumably of this species have been recorded by Dr Howard from the Catskills. He also lists it from a number of states, and if the species from various localities is the same, it evidently has a wide distribution, ranging from Canada south to Louisiana and across the continent. The female kindly lent us for study varies about the cross veins [pl. 9, fig. 1] from the following two, specially the first, and there are other differences.

Culex absobrinus n. sp.

Pl. 8, 22, 37, 45, 51, fig. 1, 2; 1, 2; 1; 4; 2 respectively

Larvae, first referred to Culex consobrinus Desv., were taken in a cold mountain pool at Elizabethtown N. Y., July 8, where they were found in small numbers. A few adults were captured in the same locality the latter part of August.

Female. Proboscis about as long as the abdomen, dark brown; palpi light brown, rather sparsely clothed with yellowish white scales. Antennae black, sparsely clothed with short, brown hairs and with several long, black ones at bases of joints. Eyes coarsely granulate, greenish. Occiput sparsely clothed by and margined anteriorly with white scales, and with a thick tuft of the same at the juncture of the eyes; numerous erect, scattering, black scales occur among the yellowish white ones. Thorax brown, clothed with a fine, appressed pile; a median line of dark brown or black scales, golden yellow anteriorly and terminating at the posterior third in an irregular, rather loose group of golden yellow hairs; a submedian line of golden yellow hairs bordered internally with long, black ones and extending anteriorly into a somewhat irregular patch. Anterior margin of thorax with golden and yellowish white scales, the lateral margin bordered by long, blackish hairs, and internally with a few yellowish white scales. Scutellum brownish, clothed apically with a row of long, brownish hairs and with a pair of submedian patches of whitish scales anteriorly; postscutellum brownish, naked. Pleura clothed with irregular patches of whitish and yellowish white scales. Dorsal surface of abdominal segments dark brown, with well marked, creamy white basal bands; under surface suffused with fine, creamy white scales. Wing veins dark, thickly clothed with dark brown scales; posterior cross vein less than ½ its length from mid cross vein. Legs light brown, with darker brown scales forming indistinct bands, there being lighter rings at the apex of femora and tibiae. The markings are too faint to be construed as bands. Claws simple. Petiole of first submarginal cell about ½ the length of the same, and that of the second over ½. Fringes and scales clothing the veins mostly dark fuscous, thick, scales very long, narrow. Fringe composed of scales of several lengths as in the pipiens group. Halteres capitate, stem and base yellowish, tip black anteriorly.

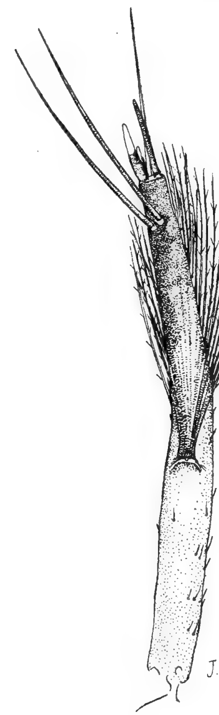

Fig. 64 Larval antenna of Culex absobrinus

Male. Palpi long, purplish brown, without conspicuous plumes; 4 segmented, the apical two joints being slightly larger than the longer basal ones, the second longer than the first. Proboscis the same color, length and general appearance of the palpus. Antennae rather sparsely ornamented with brownish plumes, brown, each segment annulate with white. Eyes rather

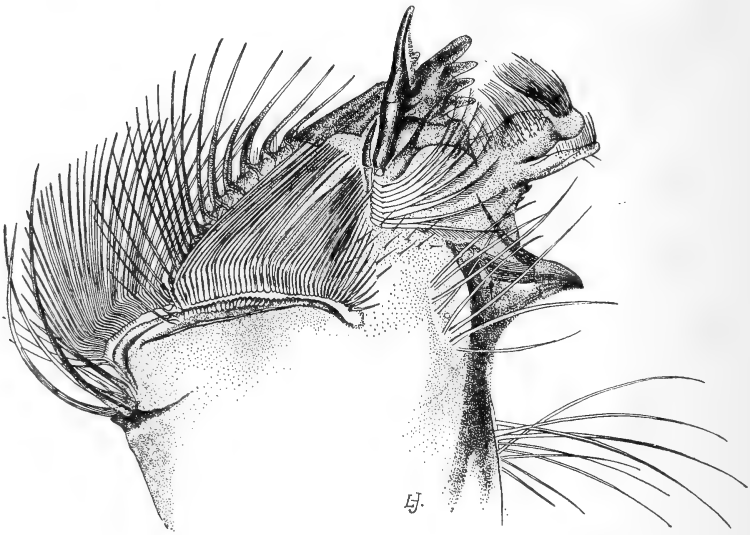

Fig. 65 Larval mandible of C. absobrinus

coarsely granulate, greenish black. Occiput rather sparsely clothed with silvery yellow scales, which form a distinct line on posterior border of the eyes, a sparse median tuft at their juncture, and also have a somewhat linear arrangement each

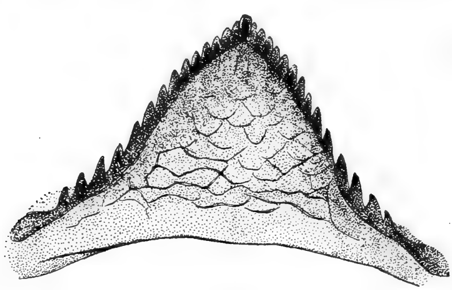

Fig. 66 Labial plate of C. absobrinus

side of the median line; erect black forked scales rather sparse. Thorax with a median line of mixed black, golden yellow scales, obsolete posteriorly. Humeri sparsely clothed with an irregular patch of golden yellow scales, with a few black ones intermixed. There is a submedian line of coarse hairs bordered outwardly by golden yellow scales, and traces of similar sublateral ones near the base of the wings. Posterior portion of prothorax smooth, bordered anteriorly by an irregular patch of golden yellow scales, with black hairs intermixed. Scutellum crowned with long, black hairs and with somewhat irregular, obsolete, submedian patches of golden yellow scales; postscutellum smooth, slaty gray. Pleura sparsely clothed with irregular patches of

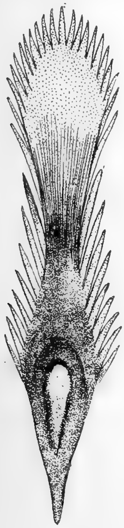

Fig. 67 Comb scale of C. absobrinus much enlarged

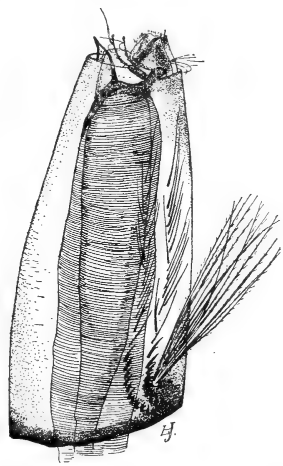

Fig. 68 Air tube of C. absobrinus

silvery yellow scales. Abdomen dark brown, with rather narrow, basal bands of silvery white scales; sparsely clothed, specially laterally, with slender, golden yellow hairs. Basal portion of clasp stout, thickly haired, yellowish brown; apical portion slender, uniformly curved, yellowish brown. Ventral surface brownish black, that of the second, third and fourth segments being sparsely clothed with silvery yellow scales, and each of the latter with a distinct basal band of the same color. Wings hyaline; anterior margin and first longitudinal vein rather thickly clothed with dark brown scales, others with lighter colored ones; fringe slaty gray. Petiole of first submarginal cell about equal in length to the cell, that of the second about one-fourth longer. Posterior cross vein less than its own length from mid cross vein. Halteres, basal portion pale yellowish white, apical portion capitate, dark brown. Coxae slaty gray, golden yellow apically. Legs dark purplish brown, with apexes of femora and tibiae clothed with golden yellow scales. Anterior and mid ungues uneven, one claw bidentate, one unidentate, posterior simple. Posterior legs enormously prolonged; tarsal segments extremely attenuate and fragile.

Described from a freshly bred specimen July 14, 1904.

Larva. Antenna rather stout, curved, with a thick, well developed tuft of plumose hairs at its basal third and a pair of long, slender spines at the apical fifth, in addition to one long spine and two rudimentary, tapering processes at the apex. Labial plate subtriangular, with about 29 rather fine teeth, basal portion with distinct, rather coarse reticulations. Thoracic and anterior abdominal segments clothed with numerous stout, black, plumose hairs, the other abdominal segments bearing slightly compound, weakly plumose hairs. In addition, there are smaller groups of compound hairs. The comb consists of a triangular patch of about 60 scales arranged in five irregular rows, each scale with a brown, basal, somewhat spatulate enlargement and terminated by an expanded, nearly colorless tip bearing a series of rather fine subequal, apical spines, smaller spines extend on each side to the extreme base. Air tube about four times as long as wide, slightly inflated and with two rows of pecten at the basal fifth, each consisting of about 14 closely set teeth bearing at their bases one or two conspicuous processes; pecten extended by a well marked row of about 16 simple bristles reaching to the apical fifth of the air tube. There is a posterior pair of compound, plumose hairs at the base of the air tube. Ventral tuft short and consisting of about 14 well developed, compound hairs attached to the barred area, with three anterior. Dorsal tuft composed of a single, stout, compound hair and a pair of very long, slender, simple hairs.

Culex magnipennis n. sp.

Pl. 8, 22, 23, 37, 45, 51, 55, fig. 3, 4; 3; 1; 2;; 3; 1; 2 respectively

Larvae of this large and interesting species were taken in a shaded pool at Sodus Point N. Y., Aug. 25, adults emerging the 29th. The female is remarkable on account of her large wings with broadly rounded anal lobes.

Description. *Male.* Proboscis long, curved, yellowish, specked with black, tip jet black. Palpi four segmented, longer than the proboscis, not plumose; basal segment globose, second sparsely, third moderately, fourth and fifth rather thickly clothed with small, brown, appressed scales, a few longer, black, ventral setae on the apical portion of the third and fourth segments. Antennae black, basal segment reddish, subglobular; others ringed with white and bearing basal whorls of long, black hairs, except the two apical ones, which are very long, slender and sparsely clothed with yellowish white plumes. Eyes greenish, deeply emarginate. Occiput sparsely clothed with golden yellow scales, a distinct line occurring along the posterior margin of the eyes, forming a median tuft. Prothorax with distinct median and sublateral black lines, sparsely clothed with short, golden yellow scales, slightly thicker on each side of the black lines, lateral portions bearing longer, black setae. Pleura sparsely clothed with short, yellowish scales. Scutellum rather prominent, irregularly fuscous, bearing long, yellowish setae; postscutellum naked, yellowish, rounded. Halteres: basal portion irregularly expanded, yellowish, transparent, apical part capitate, fuscous. Abdomen brown, mottled dorsally with dark brown, nearly black scales; laterally there is an indistinct row of yellowish scales; antepenultimate segment irregularly mottled with yellowish scales. Ventral surface suffused with orange yellow scales. Coxae clothed with golden yellow scales; femora yellowish beneath, dark brown above, rather thickly mottled with yellowish scales. Tibiae and tarsi black, except that the former are sparsely mottled with silvery white scales. Ungues of fore and mid legs unequal, one claw bidentate, the other unidentate, posterior claws simple. Wings hyaline, sparsely clothed with brownish scales; fringe slaty gray; posterior cross vein less than its own length from mid cross vein; petiole of first submarginal cell about two thirds the length of the cell, that of the second about three fourths.

A rather large mosquito measuring about 5 mm, wing spread, about 10 mm.

Female. Antennae dark brown, sparsely ornamented with very fine, yellowish white scales, and with short basal whorls of long, black hairs; basal segment subglobose with an inner patch of whitish scales. Proboscis longer than the abdomen, light brown, tipped with dark brown and ornamented laterally and ventrally with whitish or yellowish scales. Palpi short, brown, second joint and apex of terminal segment rather thickly clothed with yellowish white scales. Eyes coarsely granulate, dark green. Occiput rather densely clothed with yellowish scales, which form a line along the posterior margin of the eyes; erect black scales rather sparse. Prothorax light brown, with distinct, narrow, median and submedian lines, each bordered by a rather thick row of golden yellow scales; other portion of prothorax rather sparsely clothed with golden yellow scales and ornamented laterally with long, black setae. Pleura clothed with irregular patches of silvery white scales. Scutellum slaty brown, with median and lateral patches of golden yellow spines; postcutellum smooth, pinkish. Base of halteres semitransparent, pinkish, apical portion capitate, dark brown. Abdomen dark brown, profusely ornamented with orange and yellowish white scales in the form of broad, basal bands, the median portion being narrow and composed of orange scales, while the lateral portion extends almost the entire length of each segment and forms a nearly complete, lateral, yellowish white line; median and posterior portions of each segment dark brown with a few orange and yellowish white scales, the latter nearly covering the antepenultimate segment. Abdomen clothed laterally with long, silky, white hairs; ventral surface suffused with silvery white scales. Wings hyaline, clothed with dark brown scales, the fringe being a slaty gray and composed of scales of various length, as in C. pipiens, and the costa and subcosta flaked with silvery white scales. Petiole of first submarginal cell nearly one half the length of the cell, that of the second about three fourths. Posterior cross vein close to the mid cross vein and sometimes almost interstitial. Coxae whitish, semitransparent; under surface of femora and tibiae whitish, other portions dark brown flecked with yellowish white scales and with apical white bands; tarsi black, sparsely flecked with white scales, claws simple.

Described from a freshly bred specimen.

The larva of this species was found in association with those of Anopheles punctipennis, Culex territans and C. sylvestris. It was easily recognized in the water by its size and dark color, it being about as large as the larva of C. cantans or C. cinereoborealis, and occurred singly in water several inches deep, coming to the surface only after rather long intervals.

Antennae rather stout, slightly curved and somewhat enlarged at the base, apical portion fuscous; a well developed tuft of plumose hairs slightly before the middle; two long subapical, two long apical spines and a short, stout process on the tip. Labial plate broadly rounded, triangular, with about

25 coarse teeth; mandible very similar to that of C. absobrinus, figure 65. Thoracic and anterior abdominal segments clothed with numerous stout, black, plumose hairs, the larger abdominal segments bearing slightly compound, weakly plumose hairs. The comb consists of a triangular patch of about 40 scales arranged in about five irregular rows, each scale with a dark brown, basal, somewhat spatulate enlargement and terminated by an expanded, nearly colorless tip, bearing a series of rather fine, subequal, apical spines, smaller spines extending on each side to the extreme base. Air tube about four times as long as wide, slightly inflated and with two rows of pecten at the basal sixth, each consisting of about 14 closely set teeth bearing at their bases two or three conspicuous processes, pecten extended by a well marked row of 17 simple bristles reaching to the apical third or fourth. There is a posterior pair of compound, plumose hairs at the base of the air tube. Ventral tuft short and consisting of about 15 well developed, compound hairs attached to the barred area. Dorsal tuft composed of a very stout, compound hair and a smaller one with many more branches.

This larva closely resembles that of C. absobrinus and may be separated therefrom by the smaller number of comb teeth (which are also shorter and stouter), the greater number of basal processes on the pecten, and the decidedly different character of the labial plate. There are also other differences as will be seen by reference to the above description.

Culex restuans Theo.

White dotted mosquito

Pl. 9, 23, 38, 44, 53, fig. 2, 3; 2, 3; 1, 2; 3; 2 respectively

This species has been confused with C. pipiens, and according to Theobald's description may be separated therefrom by the spotted thorax, but in our experience this character is somewhat variable either on account of abrasion or nonexistence in some cases.

Description. Theobald states that the wing venation is almost exactly alike, but in specimens before us, the stem of the first submarginal cell is from one sixth to one fifth its length in this form, while in C. pipiens it is but one seventh. This species may also be recognized by its light color, the whole body having a yellow tinge, and by the basal bands of the abdomen

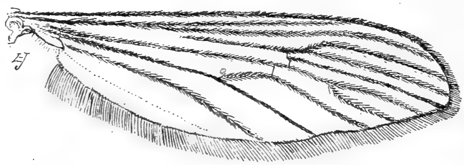

Fig. 69 Female wing of Culex restuans

being more uniform and straight. Perhaps the best character of all, discovered by Coquillett, is the short pale banding at the extreme ends of the hind tarsal joints, which is absent in C. pipiens.

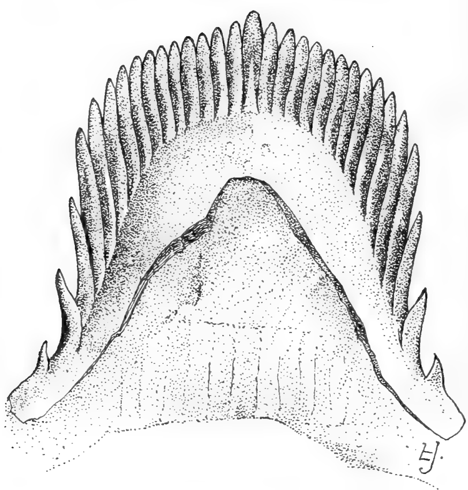

Fig. 70 Labial plate of C. restuans

The eggs according to Dr Dyar are laid in a large boat-shaped mass as in C. pipiens, adhering by their sides and standing perpendicularly to the water, the mass floating freely. The individual eggs are elliptic, fusiform, with sharply tapered ends.

The larva may be distinguished by its long breathing tube [fig. 45], at least five times as long as wide, and the presence of the antennal tuft before the middle of the joint, since other long tubed larvae have the tuft at or beyond the outer third. The labial plate is shown at figure 70. The pale double pecten (each spine four or five toothed) is followed by a few long hairs, and the comb consists of a triangular patch of little scales four rows deep. Dr Dyar describes the pupa as normal, air tubes cylindric, curved, rather long and not funnel-shaped. This species has been carefully described by Johannsen.

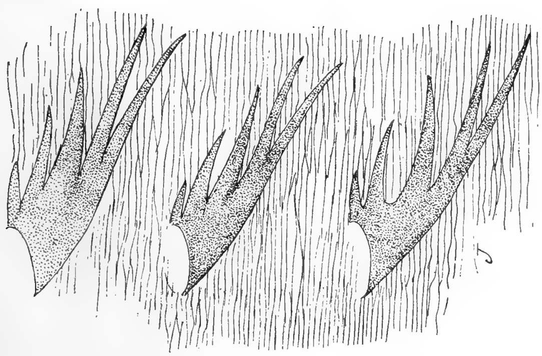

Fig. 71 Several pecten teeth of C. restuans much enlarged

Distribution. This species was described by Theobald, from Ontario, Canada, and has been taken by us in widely separated New York localities, notably, Adirondacks, Albany and Westfield. It was obtained at Center Harbor N. H. and Cabin John Md. by Dr Dyar, and at Lahaway N. J. by Mr Brakeley.

Life history and habits. Our own experience indicates that this larva is found in much the same situation as C. pipiens, except that we have not taken it in filthy water, it seeming to prefer an open barrel or vessel containing clear rain water. This is confirmed by Dr Smith's observations. We have also taken this species at Lake Placid, an elevation of 2000 feet, in a large hollow burned in a pine and partly filled with rain water. The same species was met with at Big Moose in a tub of rain water. Dr Dyar records taking it from cold spring pools in New Hampshire, though he states that it is not confined to such places. He has met with it in pools shaded by bushes, and even in rain puddles. He states that the larvae pass through four stages as usual, and that they may be found all summer and fall, and possibly may survive the winter in favorable situations.

Culex pipiens Linn.[1]

House or rain barrel mosquito

Pl. 9, 23, 24, 26, 38, 44, 53, fig. 4, 5; 4; 1; 2; 3, 4, 5; 1; 3 respectively

This is the commonest mosquito about Albany, and undoubtedly throughout the State. It may be separated from others of this group by the very long first submarginal cell, and the abnormally short petiole, it being but one seventh the length of the cell.

Description. The larva has been described by Dr Dyar, who states that the head is rounded, full at the sides, pale; that the antennae are large and long, completely infuscated, or in pale specimens somewhat lighter at the base, a tuft being at the outer third of the joint and the part beyond more slender than the basal

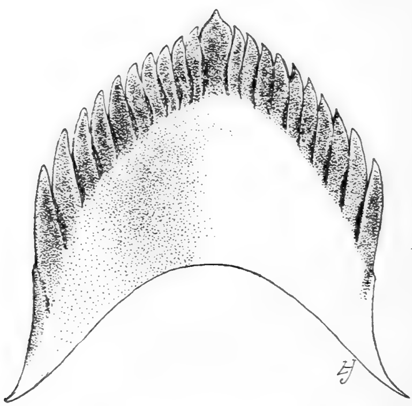

Fig. 72 Labial plate of C. pipiens

portion. The labial plate is as illustrated [fig. 72]. The air tube is four times as long as wide, strongly tapered at its terminal half, pale brown, with small, weak, double posterior pecten followed by several tufts of hair. The comb consists of a large patch of small spines in a low triangle about four rows deep. The different stages have been minutely described by Johannsen.

Distribution. This species appears to be widely distributed throughout the world, since Dr Marlatt records having met with it in such distant countries as Japan, China and Java, while Theobald states that it occurs in Europe generally, from Scandinavia to Italy, and in North America.

Life history and habits. This mosquito appears to love human habitations and may be found breeding throughout the warmer months in any open receptacle containing fresh water. One or two rain barrels are sufficient to produce millions of the pests, and in places remote from the seashore this or the preceding species are the ones most likely to cause annoyance on account of their abundance about habitations. The eggs are deposited on the water, hatch quickly, and the life cycle may be completed in about 16 days.

Culex abserratus Felt & Young

Pl. 10, 24, 45, fig. 2, 2, 2 respectively

The adult of this species is very close to C. impiger, while the larva has a general resemblance to C. serratus. It was

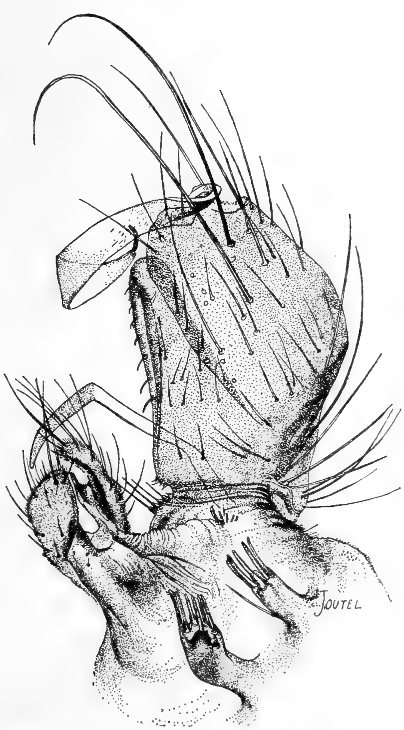

Fig. 73 Genitalia of Culex abserratus

bred June 14 from a larva taken in a cold mountain pool near Elizabethtown N. Y. June 9. A second larval skin was also met with in the collections but no other adult was obtained. It was associated with C. lazarensis, C. cinereoborealis, Eucorethra underwoodi, and Corethra lintneri.

Description. Antennae thickly clothed with brownish gray plumes, that of the male annulate and of the female unicolorous. Basal segment globular, light brown, sparsely clothed with scattering white scales. Eyes deeply emarginate. Occiput sparsely and the thorax thickly clothed with golden yellow scales, except that the latter has a very narrow, median, dark line and a semicircular, lateral one on the posterior third. Abdomen dark brown, almost black, with broad, basal white bands, slightly prolonged laterally.

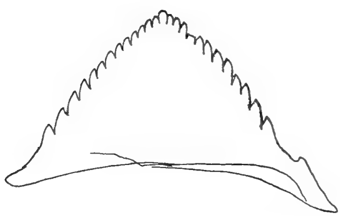

Fig. 74 Labial plate of C. abserratus

Ventral surface uniformly suffused with whitish or creamy white scales. Coxae, base, apexes and inner face of femora, and to a less extent the posterior side of tibiae, creamy yellow; other portions of legs brown, with a sparse clothing of whitish scales. Claws unidentate. Wings, with almost fuscous veins well clothed with dark scales. Petiole of first submarginal cell about one third the length of cell; that of the second submarginal cell about equal, breadth of latter cell one third its length; posterior cross vein more than its own length from mid cross vein. Length of body about 5 mm; wing spread, 10 mm.

Described from a single bred, bisexual individual, the right side being male with the cephalic appendages largely female, while those of the posterior extremity are largely male. The male antenna is normally plumose, while that of the female has elongate segments sparsely clothed with long hairs. The male palp is well developed and tipped with a conspicuous mass of plumes as in normal specimens. The female palp appears to be normal for the other sex, is four segmented, basal one nearly globular, the distal three subequal, the third somewhat capitate at its apex and the fourth strongly constricted near its middle. Proboscis well developed and about as long as the body. Basal segment of male clasp stout, irregularly curved, rounded. Apical portion nearly strap-shaped, describing almost a semicircle and with a curved,

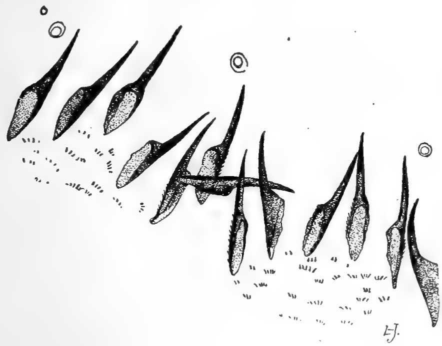

Fig. 75 Combs of C. abserratus, showing those of both sides

blunt spine apically. Harpe long, irregularly curved, pointed. Organs on opposite side poorly developed, distorted. At the extreme base slightly anterior of the basal segment of the clasp there is a pair of short, fleshy organs tipped with four or five stout spines. Ungues of the front tarsi on the male side unequal, all others and those of the female side equal.

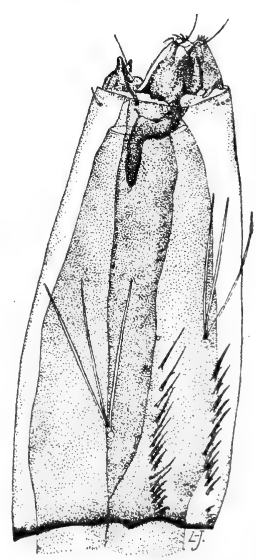

Fig. 76 Air tube of C. abserratus

Larva. Antennae rather stout with a slight basal enlargement tapering almost uniformly therefrom; tuft at basal third. Apex bearing one long and one medium, slender process, a smaller one and also a much stouter rudimentary segment. Labial plate rather broadly triangular, bearing 27 fine, triangular teeth. Thorax with compound, finely barbuled hairs; abdomen mostly with simple ones. Comb consisting of six or seven scales arranged in a curve, each with a large, finely setose, spatulate base and with a large, apical spine. Air tube about three times as long as wide, tapering regularly, with double posterior pecten on basal third, each row consisting of from 12 to 15 closely set (except the slightly separate terminal three) stout, black spines, each bearing near the basal third one large and usually a smaller tooth. Barred area short, dense, bearing numerous long, branching hairs. Anal gills long, slender, uniformly tapering.

Culex nemorosus Meig.

This large species may be separated from others in the group, by the very long petiole of the first submarginal cell, which is longer than the cell itself. It has been recorded by Theobald, from Lapland to Italy and has been received by him from a number of Canadian localities. It should occur in New York State, though we have not met with it.

Culex salinarius Coq.

Unbanded salt marsh mosquito

Pl. 10, 24, 39, 43, 53, fig. 3, 4; 3, 4; 1, 2; 5; 4 respectively

This species was known under the name of C. nigritulus Zett. in this country till Mr Coquillett showed that it could not be identical with the European form and proposed the above name therefor. It is closely related to C. pipiens, but may be distinguished from it by the indistinct abdominal cross bands which are widest at the middle. It is also a smaller species.

This larva may be easily recognized, according to Dr Smith by its dirty white color and the very long, moderately stout air tube. The labial plate is broadly triangular with eight teeth on each side. It has double pecten, each tooth coarsely three spined, and scattered hairs beyond. The comb consists of a patch of about 40 narrow long fringed scales in three rows.

Distribution. This salt marsh form has been recorded by Dr Smith in association with C. sollicitans. We have taken it in small numbers in New York State.

Life history and habits. Dr Smith states that, though the larva may occur anywhere on the marsh, in brackish as well as fresh water, it seems to prefer pools near the upland which are mostly formed by rains and by springs working down from the highlands. This form appears to hibernate as an adult and never gets far away from the edge of the salt marsh. Dr Smith states that the mosquitos hide wherever they can find shelter, by preference in cellars, and cites the case of a factory just at the edge of a marsh where thousands were found. It does not begin to appear till rather late, and very little is seen of it till June. The eggs are laid in boat-shaped masses similar to those of C. pipiens, hatch in the same manner, and unlike other marsh forms, it occurs also in the more permanent pools where other salt marsh species are not found.

Culex trivitattus Coq.

This is the first of a series in which the abdominal bands are wanting, though in some there are light colored hairs or reflections which give that appearance at first sight.

Description. This very distinct species is easily recognized by the two broad yellowish thoracic stripes on each side of the central dark brown one. It was described from Chester N. J., and we have taken specimens in association with Anopheles punctipennis at Bath-on-Hudson and also at Poughkeepsie N. Y.

Larvae of this species were taken in New Jersey in woodland pools on the hills back of South Orange. Adults occur in New Jersey during July, August and early September.

Larva. It has been characterized by Dr Smith as about $\frac{1}{4}$ inch in length with a comparatively small head one third wider than long. The antennae are less than half the length of the head, sparsely set with rather large spines and tipped with one long and one short spine, a bristle and a stout articulated process. The tuft is just before the middle and is composed of several hairs. The comb consists of an irregular patch of 14 to 22 spatulate scales tipped with a large spine and bearing on either side long slender setae. The air tube is short, chunky, bearing a double row of somewhat curved pecten, each spine usually with two or three basal teeth.

Culex serratus Theo.

Pl. 44, 52, fig. 4, 4 respectively

This species is a moderate sized, well marked form, and may be recognized by the prominent silvery white stripe in the middle of the thorax.

Description. The larva has a dark brown head, somewhat flattened, tapering anteriorly. The antennae are darker at the tip, not quite half the length of the head, and are terminated by four articulated spines, and the tuft of hair arises near the middle. The triangular labial plate has 35 fine teeth. The air tube is about twice as long as wide, a little dilated before the middle, with posterior pecten, each consisting of seven to nine spines minutely toothed near the middle and with a conspicuous terminal tuft. The comb is composed of five somewhat spatulate scales arranged in a short curved line.

Distribution. A larva of this species was received in September from J. R. de la Torre Bueno who took it in a fresh-water pool on Staten Island. This species has been recorded by Theobald, from several South American localities, and Dr Smith states that it ranges the full length of the state of New Jersey.

Life history and habits. Larvae and pupae of this species were taken by Dr Smith in a low swampy woodland in New Jersey, July 29, and adults began to appear the next day. A few larvae were also taken in early September, and adults were met with near dried up pools the middle of the month. These pools became filled with water and produced larvae and pupae Sep. 30, and adults emerged early in October. The species appears to be a woodland form, since Dr Smith states that he has never received it in miscellaneous lots collected near and in towns and villages.

Culex dupreei Coq.

Pl. 46, 53, fig. 3, 6 respectively

This small mosquito, originally described from Louisiana, ranges in color from grayish brown to nearly black. There is on the dorsum of the thorax a silvery white stripe with diffuse edges, which is continued on the head occupying most of the space between the eyes. This species resembles a small C. serratus, but the stripe is not so well defined and the marking on the abdomen differs.

Description. The larva of this species, as described by Dr Smith, has the head almost twice as broad as long, the antennae are half as long as the head, almost uniform in thickness two thirds from the base, then taper slightly to the tip where there are four articulated spines and a stout, short segment. The sparse tuft of hair is slightly beyond the middle. The air tube is about four and one half times as long as its width at the base, and tapers rather evenly to the tip. Each pecten is composed of about 12 uniformly tapering spines, the latter with three sharp, well defined teeth near the base. The comb is composed of from 8 to 10 flattened, somewhat diamond-shaped scales arranged in a slightly curved row. Dr Smith states that this larva can be at once recognized by its unusually long anal gills and the apparent absence of a breathing tube.

Life history and habits. The young of this species were met with in a woodland pool and are remarkable because of their remaining near the bottom. They were never observed in confinement to rise voluntarily to the surface for air, and when disturbed they sail rather than wriggle upward and immediately descend as soon as quiet is restored. They are so inconspicuous and transparent that a jar containing them would be set aside as empty unless closely examined, and this in connection with their habit of hiding among the leaves at the bottom of the pools renders them difficult to secure. Pupae were met with by Dr Smith, July 29, and adults appeared July 30 and 31, and also at various times during August. Larvae were also obtained early in September, and one adult was bred the 15th. There seems to be continuous breeding from the latter part of July to the end of September, and it may begin earlier in the season.

Culex triseriatus Say

Pl. 10, 25, 46, 53, fig. 5, 1, 6, 5 respectively

This mosquito has the anterior and mid tarsal claws toothed, the posterior ones simple. It may be separated from C. aurifer by the color of the scales on the side of the mesonotum, which are white, while in C. aurifer they are golden yellow.

Description. The larva according to Dyar has the head well rounded, flattened, brown, darker on the vertex. The antennae are long, brown, slender and with a single haired tuft at the middle. The air tube is about three times as long as broad, tapering outwardly, its pecten teeth considerably elongate. The comb consists of a small patch of about 12 stout, rather elongate spines with finely digitately divided tips. They are arranged in an irregular single row.

Distribution. We have taken this species rather sparingly at Poughkeepsie and Albany, while Johannsen has met with it at Ithaca. It has been listed by Dr Howard, from New Hampshire, Connecticut, New Jersey, Pennsylvania, Maryland and Virginia.

Life history and habits. Dr Smith found the larvae of this species in an iron pail half filled with water. He states that they resemble those of Stegomyia fasciata and adds that they are at once recognizable by the intensely black head and the short, black anal tube. Dr Dyar states that captive females deposit their eggs in patches or singly at the edge just below the surface of the water, where they adhere slightly and remain unhatched till spring. We met with adults at Poughkeepsie and Dr Dyar took them at Center Harbor N. H. between June 20 and July 8, he adds that they become somewhat more common, continuing all summer. He believes the species to be single brooded, though he is unable to account for fresh specimens flying all season, and this may possibly be due to a portion of the eggs hatching after each heavy rain, as in the case of C. sollicitans.

Culex aurifer Coq.

Pl. 11, 25, 33, 46, 52, 55, fig. 1, 2; 2, 3; 2; 5; 2; 5 respectively

This form is closely related to C. triseriatus Say, and may be separated therefrom by the golden yellow scales on the sides of the mesonotum. It has been taken in New Hampshire and New Jersey by Messrs Dyar and Smith and we have captured it at Elizabethtown N. Y. Larvae were met with by Mr Brakeley at Lahaway N. J. late in April and in May 1902, where they occurred at a few points only in larger bodies of water associated with C. canadensis. They were present in one cranberry bog, which was dry during the summer of 1902 and till so late in the fall that all adult mosquito life had gone into hibernation or disappeared. The larvae were found so early as to lead Dr Smith to conclude that they must have hibernated as eggs.

Description. The larva has been described by Dr Smith as being from 1/4 to about 3/8 inch in length, brownish black, tapering a little. The transverse, elliptic head is almost as broad as the thorax and is widest just behind the eyes. The white antennae are tipped with black, almost half as long as the head, thickest near the base and tapering slightly to about the middle, then curving inwardly to a blunt point. The tuft of 6 to 10 hairs is just beyond the middle. The transverse thorax is angulated, each segment marked by a tuft of long hairs arising from a tubercle. The comb consists of patches of from 25 to 30 spatulate spine-tipped scales bearing fine setae. The air tube is about three and one half times as long as wide with double posterior pecten, each consisting of from 14 to 20 small slender spines with two to five serrations near the base.

Culex melanurus Coq.

Pl. 46, 48, fig. 1, 6 respectively

This species may be separated from those without abdominal cross bands and prominent stripes on the thorax by the claws being simple.

The larva is stated by Dr Dyar to be very characteristic on account of its dark infuscated tube and plates, and its peculiar comb which resembles a grating, the spines appearing like long bars in a single row.

Distribution. This species has been taken at Center Harbor N. H. and may be expected to occur in New York State.

Life history and habits. Dr Dyar states that the larva is slow in development and very deliberate in all its motions, remaining long at the bottom of the water. It inhabits permanent spring or deep rock pools. The thin black shelled eggs are laid singly on the surface of the water, and breeding is probably continuous, the adult hibernating.

STEGOMYIA

The legs are uniformly clothed with flat scales in this genus, while those of the head and scutellar space are broad and flat. The third longitudinal wing vein is not usually continued into the basal cell as in Culex.

Stegomyia signifer Coq.

This species is very similar to Culex fasciatus Fabr., but may be distinguished from it, according to Coquillett, by the simple tarsal claws, that is, without teeth, and by the tarsal joints being banded at both ends. This is the only species of the genus liable to occur in the State. It has been taken in New Jersey.

Description. The larva is abnormal for this genus, according to Dr Dyar. He states that the peculiar dorsal platings at the end of the body occur also in Corethrella brakeleyi, but not in any other culicid that he has seen. The short antennae and the elongate head suggest Uranotaenia and Anopheles.

Larva. The following characteristics are from Dr Dyar's description:

Head, rounded, elliptic, slightly flattened, black; antennae very short, small tuft before the middle; eyes, black, transverse; seventh abdominal segment with a round, dorsal plate, incised anteriorly. An angulated transverse plate on the eighth segment anteriorly, reaching below the middle of the sides, with the comb at its posterior border but not united with it. The comb consists of long scales in a transverse row and a shorter second row, finely divided on the side next to the body. Air tube is about three times as long as wide, slender, rather small, without pecten but with a hair tuft beyond the middle; a small, linear, transverse, lateral plate on the last segment anteriorly; segment trigonate, ringed by its plate; tuft and brush normal, the latter confined to the barred area; no anal processes visible.

This species was described by Coquillett from the District of Columbia and British North America, and it has also been taken in New Jersey. Dr Smith states that the larva occurs in somewhat foul water, and that it may be recognized by its robust build and rather sickly white thorax, contrasting with the darker abdominal segments. The antennae differ from those of either Culex or Stegomyia, and the anal siphon has no rows of spines or teeth.

Taeniorhynchus perturbans Walk.

Pl. 11, 26, fig. 3, 3 respectively

This species may be identified by the large elongate, oval, lanceolate, lateral scales of the wing veins. This mosquito is the only one of the genus occurring in the State, and it has previously been referred largely to the genus Culex. Dr Howard has listed this species from a number of localities in the United States and from Porto Rico and Cuba. It is probably widely distributed south of Canada. Its peculiar scales are illustrated on plate 26, figure 3.

AEDOMYINAE

This subfamily contains those mosquitos having very short palpi in both sexes. There are two genera, both of which have been found in New York State. The first, Aedes, is nonmetallic, while the second, Uranotaenia, has metalliclike stripes of flat scales on the thorax.

Key to genera

a Thorax without metallic stripes of flat scales; fork cells normal...Aedes
aa Thorax with metallic stripes of flat scales; fork cells very small ....Uranotaenia

Aedes fuscus Osten Sacken

Pl. 11, 26, 27, 39, 43, 52, fig. 4, 5; 4; 3; 3; 3 respectively

This mosquito may be recognized by its basal abdominal cross bands of cream-colored scales. The larva was met with in early spring at Nassau and Karner where it was associated with Culex cinereoborealis, C. canadensis, C. cantans and C. impiger. We have also taken it at Poughkeepsie. Dr Dyar reports taking it in company with C. canadensis and C. sylvestris, and adds, that like them, it possesses a short breathing tube.

The larva of this species so nearly resembles that of C. sylvestris and C. impiger that it is difficult to separate them. It may be distinguished from that of A. smithii

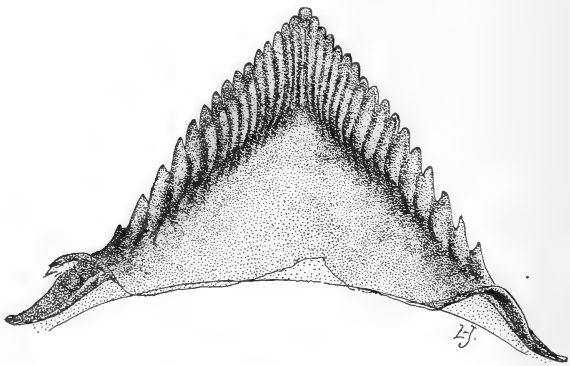

Fig. 77 Labial plate of Aedes fuscus

according to Johannsen by the four long, narrowly tapering blood gills instead of two.

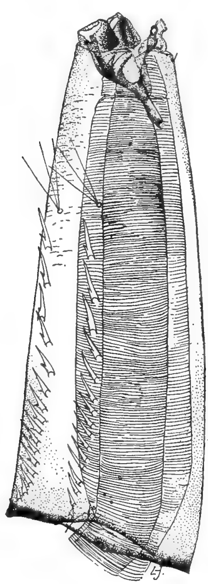

Fig. 78 Air tube of A. fuscus

Larva. Length about $\frac{3}{16}$ inch. Head brown; antennae fuscous at the tip, light brown at the base and with a scanty tuft arising from before the middle; apically there are four rather long bristles and a small, conical process. Labial plate elongated, triangular and with 25 rather fine teeth, those near the apex being smaller than the others. Hairs of the thorax compound, weakly barbuled, those of the abdomen simple. Comb composed of a practically single row of 12 narrow scales, each with a somewhat elliptic, finely setose base and a stout apical spine. Air tube slender, about three times as long as broad, with double posterior pecten, each consisting of about 13 closely set spines, with three flattened isolated ones beyond. Each spine bears a tooth near its base. Anal plate covers the dorsum only of the last segment.

Aedes smithii Coq.

This black species may be separated from the preceding form, by the absence of the cross bands of yellowish scales at the bases of the abdominal segments.

Description. Dr Dyar states that the larva has a rounded, pentagonal, flattened head, and small, slender antennae, possessing an imperceptible tuft. The comb consists of a single row of 15 to 20 scales, and the air tube is shorter than the two abdominal segments, moderate, narrowed at the tip, and with two rows of hairs on the upper and two on the lower aspect. The larva has been minutely described by Johannsen.

Distribution. This species was described from New Jersey, where it occurs in pitcher plants growing in cold bogs, and as this plant flourishes in some portions of New York State, the chances are very good that this species occurs within our limits. Mr Coquillett has also received it from Florida, where it breeds in an orchid.

Life history and habits. This insect is remarkable in that the larvae have been found only in pitcher plants. They pass the winter in such situations, notwithstanding repeated freezing and thawing, pupate late in May and adults appear a week or 10 days later. The eggs are laid in leaves singly or in small groups fastened to the sides or floating on the surface. The summer broods mature in about a week, and there are probably three, if not four generations, but there is so much overlapping that breeding is practically continuous. Late in the season the adults select the new leaves for oviposition, even if they are dry. This species, while apparently limited to pitcher plants, does not breed in all, since examinations in some localities in New Jersey, and a few in New York, failed to discover specimens.

URANOTAENIA Arrib.

This genus presents in many respects the same characteristics as Culex and Aedes. It differs from Culex in having short palpi in both sexes, and from Aedes in possessing violet blue scales on the thorax.

Uranotaenia sapphirina Osten Sacken

Pl. 12, 27, 46, 48, fig. 1; 2, 3; 2; 7 respectively

The single species belonging to this genus is among the smallest of our mosquitos, and may be easily recognized by the line of violet blue scales on the thorax. The larvae were taken in small numbers at East Greenbush in early August.

Description. *Female.* Proboscis nearly as long as the body, dark brown with fine, yellowish hairs. Antennae slender, slightly shorter than the proboscis; segments with sparse, basal whorls of stout, brown hairs and thinly clothed with shorter, yellowish brown ones; basal segment globular, yellowish. Eyes black, coarsely granulate, strongly emarginate; occiput with a conspicuous median patch of bright violet scales extending laterally along the posterior margin of the eyes. Prothorax yellowish or yellowish brown with a bright median line of violet scales becoming obsolete posteriorly; a submedian line of long, coarse, brown hairs and in some specimens a sublateral and lateral stripe of similar hairs; other portions sparsely clothed with shorter, brown hairs; a small patch of violet scales on the anterior lateral margin just behind the head, a few of the same color or a short lateral line at the base of the wings, and a rather conspicuous patch of similar scales on the pleura a little below the wings. Scutellum with a patch of violet scales and bearing a few long, coarse, black bristles; postscutellum yellowish. Halteres, basal portion yellowish white, apical portion fuscous. Abdomen brownish, mottled with yellowish; first and fifth abdominal segments with more or less defined posterior patches of violet scales. Ventral surface of abdomen brownish, sparsely clothed with yellowish brown scales. Legs mostly dark brown, with apexes of femora and tibiae ringed with white. Wings, veins black, membrane hyaline with bright metallic reflections, large, flat scales on second longitudinal vein; basal portion of fifth longitudinal vein thickly clothed with a double row of bright violet scales similar to those on the body.

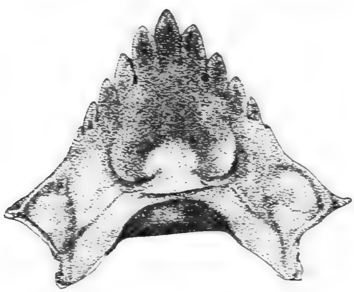

Fig. 79 Labial plate of Uranotaenia sapphirina

Male. Proboscis long, brownish, flecked with yellowish brown scales. Antennae with dark brown plumes, jet black, segments with basal, yellowish rings. Occiput crowned with several patches of purplish scales. Prothorax brownish, with a median and lateral stripe of bright violet scales, a submedian and sublateral line of dark, coarse bristles. Scutellum nearly black, ornamented with violet scales and tipped with a few very long, black bristles. Abdomen dark brown, flecked with yellow particularly on the fifth, sixth and seventh abdominal segments, the posterior lateral angles of which are narrowly yellowish, the third and fifth with a median, posterior, subtriangular whitish patch, that on the latter segment being much larger than the other; genitalia yellowish. Pleura with several irregular patches of yellowish white and a line of violet scales. Legs mostly dark brown, yellowish beneath and with narrow, white bands at the apexes of femora and tibiae; ungues simple. Wings subhyaline; veins brownish or black, anterior veins thickly clothed with nearly black dilated scales; a double row of violet scales on basal half of fifth longitudinal vein; fringe silvery gray; basal portion of halteres whitish, apical portion capitate, fuscous; first submarginal cell very short, with petiole bearing about six very large spatulate scales, second fork cell a little over one half the length of the petiole; posterior cross vein a little less than its length from the mid cross vein.

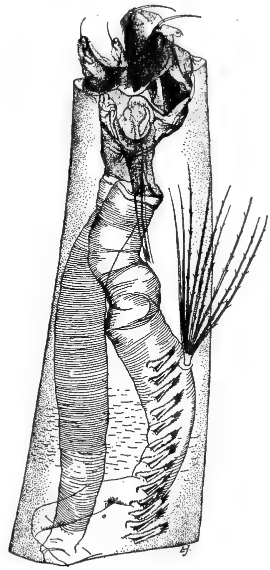

Fig. 80 Air tube of U. sapphirina

Larva. Head jet black in early stages, distinctly longer than wide and presenting an appearance very similar to that of Anopheles. Antennae jet black, short, swollen at the base, the inconspicuous tuft a little before the middle. Apex bearing two longer, slender processes, a medium and a large, shorter one. Labial plate narrowly triangular with about 10 conspicuous teeth, and appears to be double like that of Anopheles. Dorsum of head with two subdorsal pairs of barbed spinelike processes. Compound groups of plumose hairs also occur on the head and on the prothorax, and are continued on the abdominal segments except that in the case of the latter, the hairs are not plumose. Thorax and abdomen greenish yellow, the thoracic segments being distinctly broader, margined laterally by fuscous, and the entire body with a broad, fuscous stripe along the median line. Comb consisting of about seven simple, conical teeth attached to the posterior border of a lateral plate. Air tube about three times as

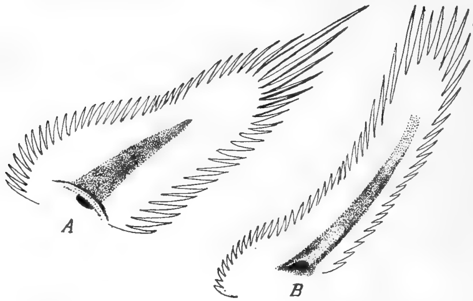

Fig. 81 Pecten teeth of U. sapphirina; A apical, B basal

long as wide, subcylindric, somewhat curved, and with a pair of apical valves, each about as long as one half the width of the tube. Pecten extend nearly to the basal half of the air tube, where there is a conspicuous pair of compound hairs, composed of about 13 teeth, which are unique on account of the nearly conical portion bearing a lateral and apical, semitransparent, serrate fringe, which extends beyond the dark tip a distance almost equal to the basal portion, the apical pecten teeth with a longer median spine, the basal ones with apical spines subequal. Ventral tuft composed of about six stout, compound hairs, the dorsal extremity of last segment bearing a pair of compound hairs; posterior margin of the same ornamented with peculiar groups of small spines.

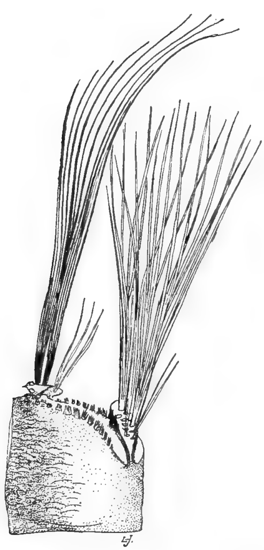

Fig. 82 Terminal segment of U. sapphirina

Distribution. This species was described from specimens taken on Long Island and has been met with in New Jersey by Dr Smith, and according to Theobald it has been obtained by Dr Howard at Ithaca.

Life history and habits. This species is neither common nor troublesome, according to Dr Dyar. The larvae were found in a large pool near a cold stream and in a warm marshy pool at Bellport L. I., occurring sparingly here and there. Both places were permanent bodies of water and contained aquatic plants. The eggs are deposited as a boat-shaped mass, which floats on the water, much as Culex pungens, but the mass is smaller, contains fewer eggs and is less regularly elliptic. The normal feeding position of the young larva resembles Culex, but the body is more nearly parallel to the surface. The larvae are fond of resting under the leaves of Lemna, where they remain with the air tube penetrating the surface film. There appear to be four larval stages, and the species seems to breed throughout the summer, preferring warm, stagnant pools of some size containing Spirogyra.

CORETHRINAE

This subfamily includes some very interesting forms which have been largely neglected, probably on account of their relatively slight economic importance and also because of their retiring habits. So far as known, all are predaceous and therefore more or less beneficial. Among them we find a most efficient destroyer of mosquito larvae, Eucorethra underwoodi, which is unfortunately a form of small value because of its extremely local habits, since it appears to be confined almost entirely to very cold spring pools in deep woods. The peculiar, nearly transparent, phantomlike larvae of Sayomia belong here, and the still more interesting Corethra larvae, which appear to be intermediate in structure between those of Sayomia and Culex, are also members of this subfamily. Eucorethra has been known only since 1900, and Corethrella, represented by a species with very interesting habits, is a more recent discovery.

Key to genera

a First tarsal segment longer than the following segment
  b Species less than $\frac{3}{16}$ in. in length; tarsal claws simple
    c Antennae verticillate with hairs i. e. in whorls.... Sayomyia
    cc Antennae wholly covered with hairs, legs densely haired .... Corethrella
  bb Large species ⅜ in. or more in length; tarsal claws bifid. Eucorethra
aa First tarsal segment shorter than the following segment.... Corethra

CORETHRELLA Coq.

This genus was erected for a peculiar species presenting characters similar to Sayomyia and Corethra, but differing from both in having the antennae fully covered with hairs and the apical joint shorter than the intermediate ones. The larva also presents differences from the ordinary culicid type.

Corethrella brakeleyi Coq.

This species has been described by Mr Coquillett, as follows:

Dark brown, the antennae, halteres, knees and tarsi yellow; plumosity of male antennae yellow, mesonotum opaque, gray pruinose except three narrow vittae and a few spots near the humeri, hairs of thorax brownish, those of the abdomen yellow, tibiae and tarsi bearing many long hairs; first joint of front tarsi slightly shorter than the tibia; wings whitish hyaline, marked with a brown cross band near one third and two thirds its length, the first one oblique, the second band produced triangularly near middle of its inner side, costal margin on each side of this band strongly tinged with golden yellow, fringe white, marked with a brown spot at posterior end of each cross band and on either side of the extreme wing tip; length, 1.5 mm.

The larva resembles that of Corethra much more more closely than that of Sayomyia. This curious form is about 1/8 inch in length, light reddish in color and very hairy in appearance. The head is broad and the body tapers gradually to the short, obtuse anal siphon, giving it a somewhat triangular appearance. It differs from the former, according to Johannsen, in having the antennae attached near the middle line of the head, at the extreme anterior end, and hinged so that they move in a horizontal plane, normally folding back against the side of the head. Dr Smith states that there is no mouth brush, that the eyes are rounded, and the abdominal hairs unequal.

The pupa is brown in color, and floats upwardly to the surface with the long, slender air tubes slightly projecting. The larva and pupa have been minutely described by Johannsen.

Habits and life history. This interesting culicid was discovered by Mr J. Turner Brakeley at Lahaway N. J. in little pools near the head of a swamp spring. The first captures were taken June

1, and July 27, and a number of others were obtained in grassy shelters around the edge of a lily pond full of fish. Dr Smith states that the little creatures remain almost motionless for hours, some at the surface, others below at various points, the former in a position intermediate between that assumed by Anopheles and that characteristic of Culex. Larvae transformed the last of July, and the pupae were just as odd as the larvae, reminding one of Lycaenid chrysalids with breathing tubes. They remained at the surface, seemed to have little motive power and were easily submerged and drowned. Adults appeared Aug. 2, giving a period of four and one half days for the pupa. Larvae were also met with Aug. 13, Sep. 17, Oct. 14 and 20. In each case half to full grown specimens were found.

CORETHRA

This genus is remarkable because the first tarsal segment is shorter than the second, and in the four species we have studied there is only a pseudo-articulation between the two. It appears to be a case where reduction is in progress. The larva is not less remarkable than the adult and presents an intergrade between the ordinary culicid form and that of Sayomyia. It may be easily recognized by the possession of a culicid air tube in connection with the enormously swollen thorax containing a pair of large air vessels and a smaller pair in the somewhat enlarged seventh abdominal segment. The larvae remain almost motionless and horizontal at variable depths in the water and very rarely come to the surface. This is probably due to the large supply of oxygen in the air vessels mentioned above. We have adopted Coquillett's reference of this form, hitherto known as Mochlonyx, to Corethra, and the species commonly known under the latter name we have transferred to the genus proposed by the same author, namely, Sayomyia.

Corethra karnerensis n. sp.

Two larvae belonging to this species were taken from a stagnant pool at Karner N. Y., May 14, 1902, and one male obtained. This species was originally referred to the European C. velutina.

Giles and Theobald are both of the opinion that there is but one European species, and as our species in both adult and larval form

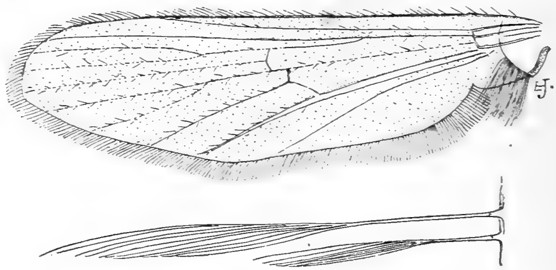

Fig. 83 Wing of Corethra karnerensis

presents some difference from specimens sent us by Dr Meinert of Copenhagen, Denmark under the name of Mochlonyx culiciformis, we have decided to characterize it as new.

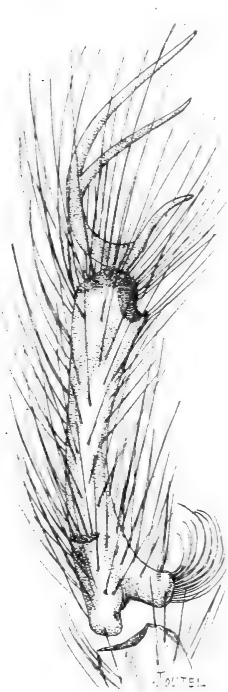

Fig. 84 Last tarsal segment and one claw of C. karnerensis

The adults agree very closely, but we find that in the male of C. culiciformis the posterior cross vein is less than its own length from the mid cross vein, while in our species this distance is greater than its length. The tip of the posterior marginal cell is nearer the base of the wing in C. culiciformis, whereas in C. karnerensis the tip of the anterior marginal cell is nearer the base of the wing. The larvae present more striking differences than the adults. The peculiarly dentate scales bordering the labial plate in C. culiciformis have about eight apical teeth, whereas in C. karnerensis there are but three or four. The mandibles of C. culiciformis have from seven to eight teeth, and in C. karnerensis there are eight to nine. Other differences would probably be detected with abundant material of this American species, which is unfortunately lacking at the present time.

Description. *Male.* Head, light brown, transverse; eyes, large laterally, emarginate; antennae, plumose, verticillate, 14 joints, the basal reddish, nearly globular; palpi five jointed, first and

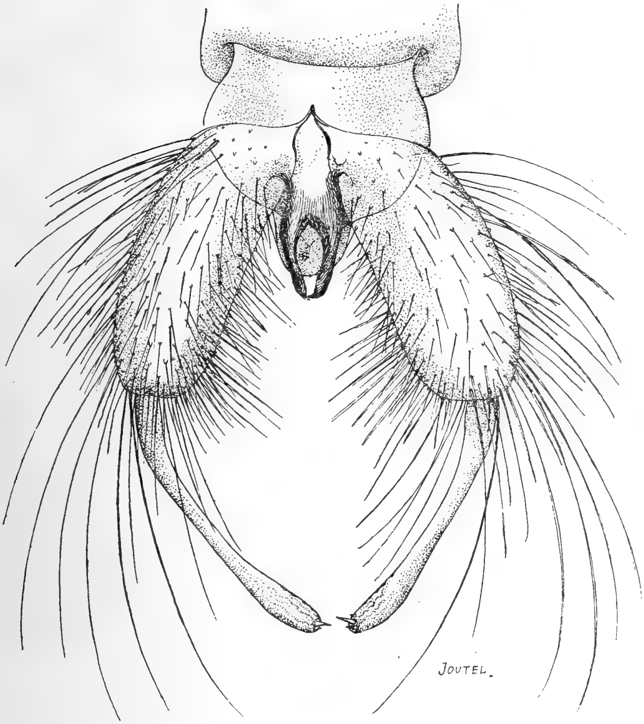

Fig. 85 Dorsal aspect of genitalia of C. karnerensis

second short, each bearing several long, stout setae, the third and fourth nearly equal in length, and the fifth slender and nearly twice the length of the fourth, the distal three sparsely clothed

Fig. 86 Side view of larva of C. karnerensis

with short setae. Labium short, rounded at apex, bearing on what appears to be a tactile surface, a few scattering setae. Ventral aspect rather thickly clothed with stout setae.

Thorax brown, evenly swollen, the arched scutellum rather prominent; abdomen yellowish, with posterior lateral brownish or black markings on each segment. Basal segment of clasp stout, swollen; apical nearly equal in length, more slender and bearing

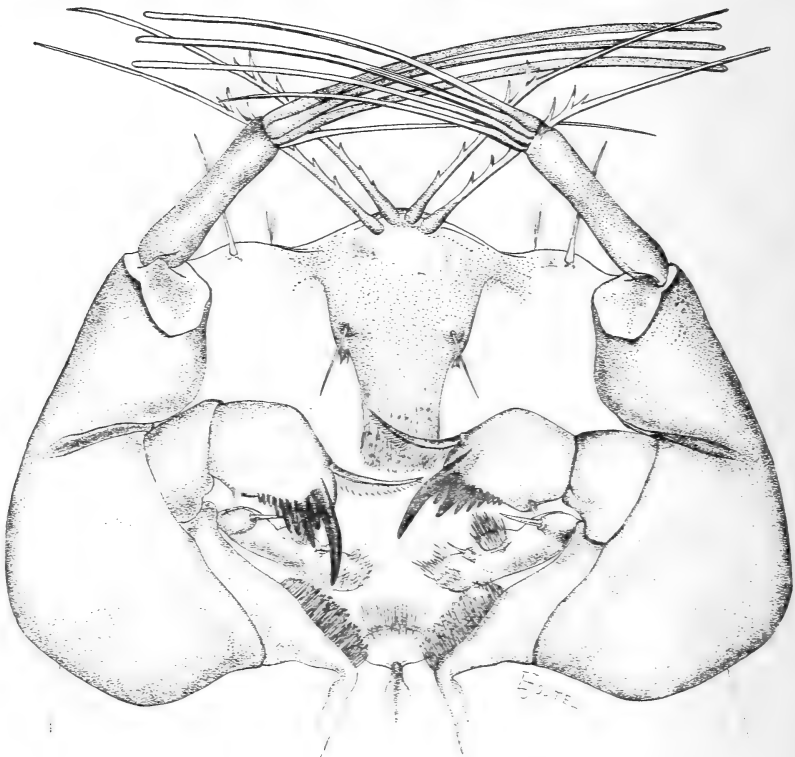

Fig. 87 Ventral aspect of head of C. karnerensis

at its apex a short, stout spine. Harpes short, irregularly curved and tipped with a stout, short point.

Legs, pale yellowish, sparsely clothed with rather coarse hairs. Femora and tibia nearly equal in length, first tarsal segment about one fifth the length of the second, the articulation between the two being rudimentary; third tarsal segment about one half the length of the second, the fourth one third shorter than the third, and the fifth a little shorter than the fourth, with a basal, knoblike posterior enlargement. Claws equal, two toothed, one at the base and the other about midway of the curve.

Wings, slender, sparsely fringed with hairs, posterior cross vein a little more than its length from the mid cross vein. Both submarginal cells longer than their petioles.

Larva of the normal Corethra type with the prothoracic and seventh abdominal segments enlarged and containing air reservoirs.

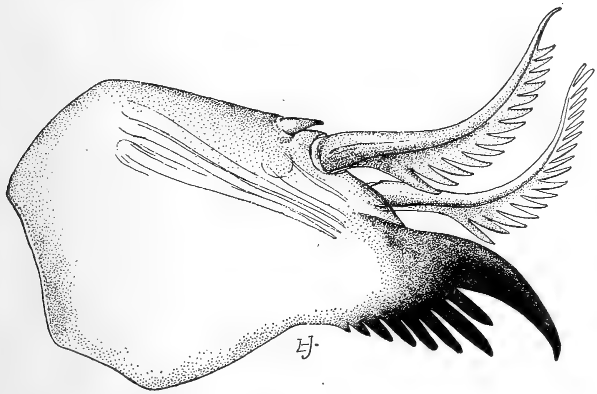

Fig. 88 Dorsal aspect of larval mandible of C. karnerensis much enlarged

Head, light brown, flattened; eyes dark brown, nearly black; the median four frontal setae barbed along the basal half, the

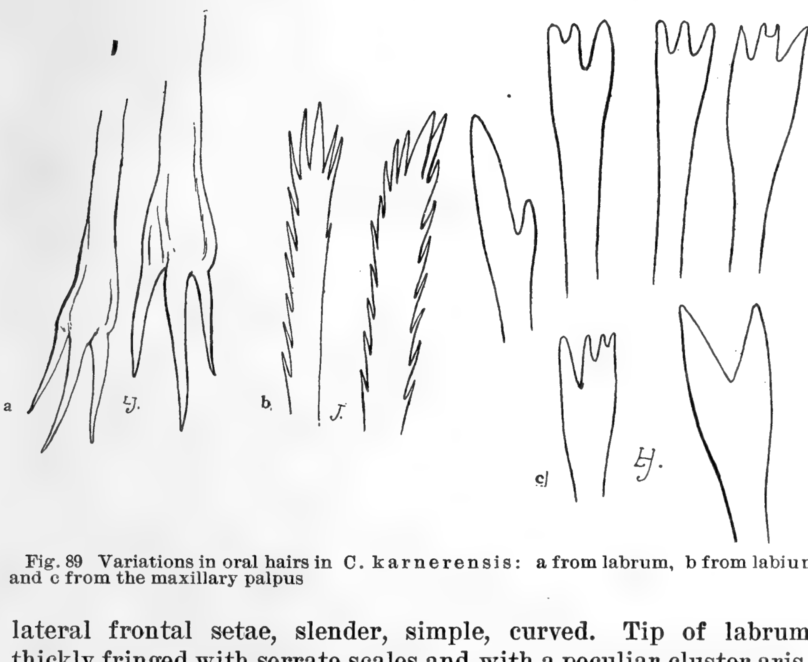

Fig. 89 Variations in oral hairs in C. karnerensis: a from labrum, b from labium and c from the maxillary palpus

lateral frontal setae, slender, simple, curved. Tip of labrum thickly fringed with serrate scales and with a peculiar cluster arising from a pocketlike depression on either side; there is a pair of

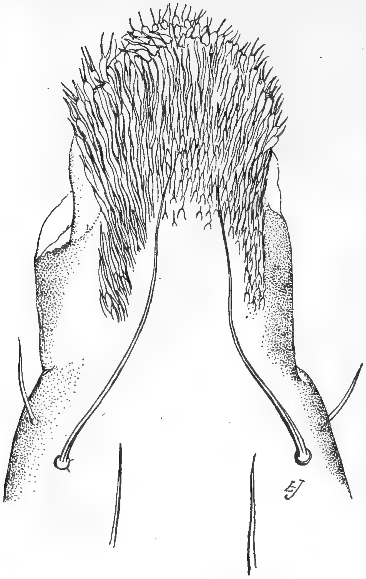

Fig. 90 Labrum of C. karnerensis

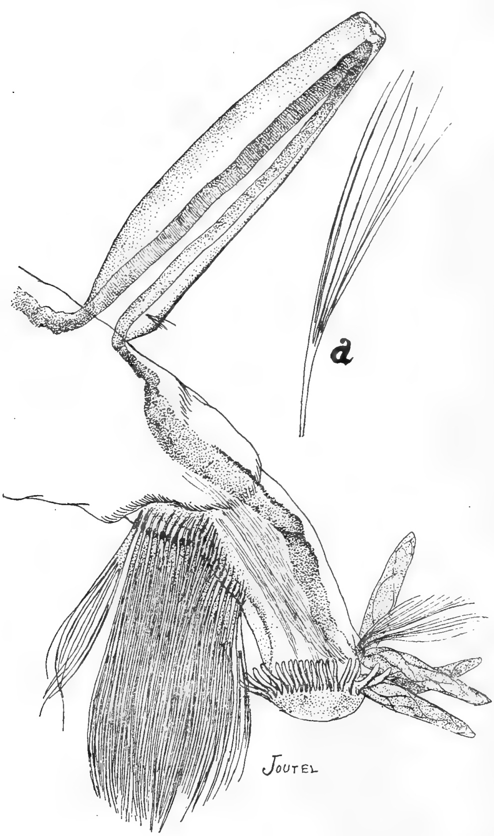

Fig. 91 Side view of siphon and anal segment of C. karnerensis

long, slender, somewhat curved spines on each side near the middle. Basal segment of antennae short, cylindric, and tipped with three nearly equal simple processes and a fourth slightly over half the length of the others. Mandibles nine toothed, and bearing two barbed processes with a rudimentary spine at the base of the second. Siphon somewhat fusiform, its length about four times its greatest diameter and the anterior respiratory trachea joining the posterior one before reaching the tip of the siphon. Ventral tuft of the anal segment thick, extending along the entire barred area and consisting of numerous branched hairs; dorsal tuft small and composed of only a few hairs. Anal processes fleshy, four, tapering to an obscure point; the tip of the segment bordered by numerous short, recurved, fleshy processes.

Corethra lintneri n. sp.

Pl. 27, fig. 4

Larvae of this species were taken June 9, 1904, in a cold mountain pool near Elizabethtown N. Y., where they were associated with larvae of Culex lazarensis, C. abserratus, C. cinereoborealis and Eucorethra underwoodi. Several adults emerged June 16 and 17.

Description. *Female.* Antennae slender, sparsely clothed with yellowish hairs, slightly fuscous apically, and each segment with

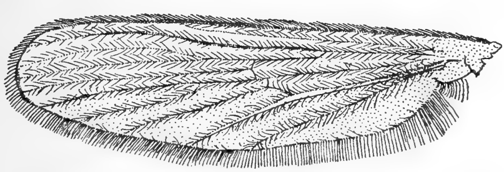

Fig. 92 Wing of female of Corethra lintneri

a narrow, basal, fuscous ring. Palpi fuscous, basal segment short, subglobose, second to fourth subequal, rather densely clothed with coarse hairs, the terminal one remarkably distorted. Labial palpi very short, subglobose. Occiput and thorax densely clothed with long, golden yellow scales, the latter with a pair of submedian, naked lines on the anterior two thirds. Pleura semitransparent, yellowish. Abdomen yellowish, irregularly marked with fuscous, specially along the posterior margin of the segments, sparsely clothed with long, yellowish hairs. Dorsal plate of terminal segment rounded, with a marked, median indentation. Ventral surface yellowish, sparsely clothed with fine, yellowish hairs, with the posterior portion of the segments naked and lighter. Legs, yellowish, apexes of tarsal segments somewhat fuscous, sparsely clothed with fine, fuscous hairs; ungues unidentate, the basal tooth being so strongly serrate that it is almost pectinate. Halteres knobbed, uniformly yellowish. Wings straw yellow, rather sparsely clothed with slightly fuscous hairs. Petiole of first submarginal cell about one third the length of the extremely long, narrow cell; that of the second posterior cell about one half its length. Posterior cross vein a little over its own length from the mid cross vein.

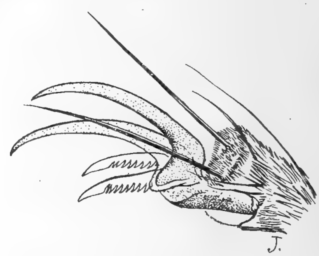

Fig. 93 Female claws of C. lintneri

Male. Antennae with long, grayish plumes annulated with white, basal segment hemispheric, deeply excavated distally. Eyes, green in life, palps grayish fuscous clothed with rather coarse hairs. Thorax sparsely clothed with long, golden yellow scales. Pleura slaty gray, under surface of abdomen semitransparent, whitish. Abdomen yellowish white with lateral, irregularly triangular blotches near the middle of each segment; laterally, sparsely clothed with long, yellowish hairs. Legs, nearly uniformly straw yellow. Halteres knobbed, pale yellowish at tip, almost semitransparent at base. Coloration of legs about as in female, ungues bidentate, the basal tooth on the fore leg slightly pectinate at base, that on middle leg slightly serrate and on the hind leg plainly so. Dorsal plate uniformly rounded. Basal segment of clasp much enlarged, uniformly rounded exteriorly and sparsely clothed with long, rather stout hairs, specially internally on the distal third. Distal segment very long, slender, rather irregular and tipped with a small, rather stout, slightly curved spine. Harpes irregularly curved and tipped with a stout, short spine.

Fig. 94 Labrum of C. lintneri

Larva. About 8 mm long with head brownish, fuscous. Eyes and portions of antennae black; body brownish, and with air vessels in the enlarged prothoracic and seventh abdominal segments. The larva is not readily seen in the water though not transparent. Antennae, basal segments stout, uniform, and bear-

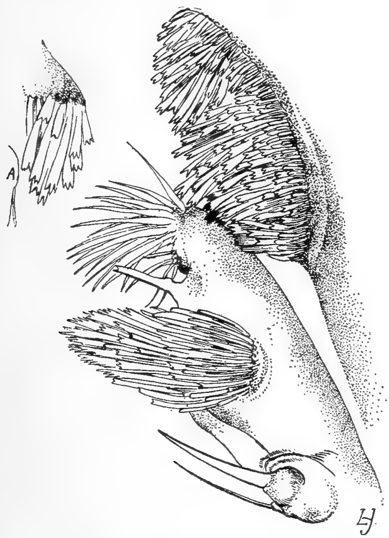

Fig. 95 Maxillae and labium of C. lintneri

ing three long and one shorter decurved processes; median four frontal setae with few small spines near distal third. Labrum with the sublateral, long, wavy, serrate, tipped scales arranged in rows on its distal fourth, the scales at its extremity being long, irregular, slender, expanded apically usually into three large spinelike processes. Mandibles fuscous with eight powerful teeth, bearing at the base two barbed hairs, one long and a short rudimentary spine, basal cluster composed of about four large, simple processes. Labial scales and those of other parts much like those of C. karnerensis. Siphon slightly fusiform, about three times as long as its greatest diameter. Ventral tuft on the anal segment thick, extending along the entire barred area and consisting of numerous branched hairs. Dorsal tuft small and composed of several compound hairs. Anal processes rather stout, somewhat short, tapering to an obscure point. Obscure

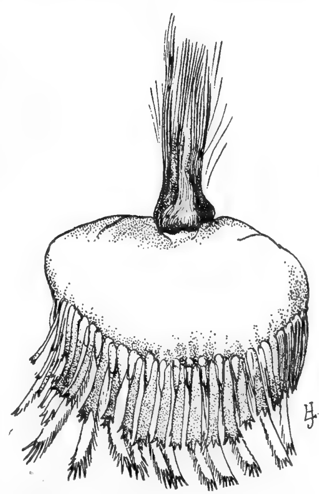

Fig. 96 Labium of C. lintneri

comblike structures appear to form a dark colored lateral patch near the posterior third of the segment, the bases of the spines being fused together.

Corethra cinctipes Coq.

Pl. 28, fig. 1

This species was described last year by Mr Coquillett, who had received specimens several years before from Franconia N. H., and also from Mt Vernon Va. It was bred by us from larvae taken in a woodland pool at Karner May 10, 1904, adults appearing May 15. This species according to Mr Coquillett may be readily recognized by its banded legs and mottled wings.

Description. The original description of the adult is as follows:

Blackish brown, the apices of the antennal joints except the last joint, the halteres, bases of the segments of abdomen in the male, base and under side of femora, a broad band near four fifths of their length, their extreme apices, bases of tibiae and a band near one fourth of their length, also bases of the first three or four joints of the tarsi, yellow; hairs of male antennae brown, their bases yellow, those at tips of antennae almost wholly yellow; thorax grayish pruinose, marked with four black vittae; wings grayish hyaline, hairs of veins black and with yellow ones as follows: on the bases and apexes of the veins, on the first vein where the second issues from it, on the second vein where the third issues from it and at the point where it forks, on the fourth vein at the insertion of the cross vein and also where this vein forks, and on the fifth vein where it forks; first submarginal cell nearly twice as long as its petiole, cross vein at apex of second basal cell less than its length before the one above it; tarsal claws of male each bearing two long, slender teeth on the under side, one near the base and the other near the middle, those of the female with a single tooth near the base of each; length, 3 to 4.5 mm.

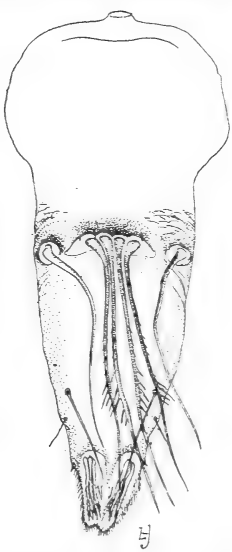

Fig. 97 Labrum of larva of C. cinctipes

Larva. About ¼ inch long. Head light brown, eyes dark brown. Tip of labrum thickly fringed with serrate scales and with a peculiar cluster of much longer spined ones arising from a pocketlike depression on either side; there is a pair of long, slender, somewhat curved spines on each side near the middle. Median four frontal setae, each bearing a number of small spines and two longer, stouter processes near the distal third; lateral pair long, simple, slender, much curved. Basal segment of antenna short, bearing four long, stout, and one slender, apical processes. Mandibles stout, black, with about seven teeth, and four well developed barbed processes near the base. Air tube regularly tapering, length about three and one half times its greatest diameter. At the base of the air tube there is an irregular group of many branched, compound hairs comparable in position and general arrangement to the comb scales on the eighth segment of Culex larva. These are detected only on cast skins. Terminal segment slender, not much larger than the air tube. Ventral tuft of hairs thick, extending along the entire barred area; dorsal tuft small and composed of only a few hairs. Fleshy anal processes four, tapering to a rounded point.

EUCORETHRA Undw.

This genus was erected for a large mosquito closely related to Corethra and Sayomyia.

Eucorethra underwoodi Undw.

Pl. 12, 28, 39, 47, fig. 2, 3; 2; 4; 3 respectively

This interesting and till recently unknown larva was met with in large numbers in a cold mountain pool near Elizabethtown N. Y. June 9.

This insect has been carefully described by Mr Johannsen, who was the first to carefully study the species.

Female. Antennae sparsely haired, black; basal segment globular, yellowish; labrum densely haired, much prolonged, black, tipped with brownish yellow; palpi dark brown, rather densely clothed with blackish hairs. Labium, basal portion dark brown, apical portion golden yellow. Anterior and lateral portions of thorax a rich dark brown, sparsely clothed with a median line of bright, golden yellow scales and with a similar lateral patch extending over the humeri and to the base of the wings; anterior portion of this latter with the short, grayish pile showing only in certain lights, because of the rich brown beneath; posterior portion grayish only. Posterior dorsal portion of thorax, scutellum and postscutellum grayish, the scutellum crowned with a row of long, golden brown hairs; sides of the thorax variable, grayish and brown. Abdomen grayish, with the lateral and posterior margins of the segments dark brown, clothed with fine, golden hairs. Ventral surface similarly marked, except that the anterior portion of each segment, as well as its basal margin, is more or less brownish. Coxae gray, clothed with golden yellow and brownish hairs. Femora dark golden, with a nearly black band close to the apex, the articulation at the extreme tip of both femora and tibiae bright golden yellow. Tibiae yellowish, tip golden yellow. Tarsi dark, yellowish; ungues golden. All the legs clothed with rather short, thick, dark

Fig. 98 Antennae and mouth parts of Eucorethra underwoodi

brown hairs. Base of halteres golden yellow; apex enlarged, capitate and fuscous. Wings spotted with dark brown or fuscous; veins rather thickly clothed with narrow, nearly black scales and with three distinct spots along the radius, a large discal spot, a smaller one at the base of the first submarginal cell and a still smaller one at the base of the second.

Petiole of first submarginal cell about one half its length; that of the second twice its length. Posterior cross vein almost interstitial with the mid cross vein.

Described from a freshly bred specimen.

Male. This sex has not been described hitherto.

Antennae densely plumose, brown; basal segment globose, variably brown, others with basal, semitransparent annulations. Palpi dark at base; first segment short, second medium, third and fourth segments subequal, lighter. Prothorax as in female.

Abdomen brownish black, with conspicuous, yellow patches on the six anterior segments, being separated by a darker, median line and the denser color of the anterior and posterior portions of each segment; the dorsum of the posterior segments black and all sparsely clothed with golden yellow hairs. Markings of legs as in female; claws equal, bidentate, much like those of female Corethra. Venation and marking of wings shown in plate 12, figure 2, 3. Scales much thinner as in other male Culicids.

Larva. The larva is about 5/8 inch in length and resembles that of Sayomyia and Corethra in the form of the antennae, which are elongate and tipped with three stout, equal processes. The highly developed mandibles have three conspicuous teeth, the largest with two basal teeth, and this sclerite also has several minor processes. The head is nearly square, as seen from above and the thorax has prominent lateral angles, these and the anterior four abdominal segments being provided with conspicuous lateral tufts of compound hairs, which are specially well developed on the thorax. The dorsum of the eighth abdominal segment bears a short, five-lobed air tube, having a somewhat star-shaped appearance from above. A pair of tracheae end at the base of the anterior lobe. The terminal segment bears a conspicuous, very thick ventral fan and the posterior extremity has a thick, dorsal tuft of compound hairs. The four anal gills slender, long, tapering to a rounded tip.

The pupa resembles that of Culex and Anopheles.

Life history. This species was first brought to our attention in June 1900, when examples from a cold spring at Saranac Inn were submitted for identification to Dr Needham. Larvae of what is undoubtedly this species were found by Professor Underwood in January 1903, in a spring of water in Penobscot county, Me. This species passes the winter as larvae, since they are met with in very early spring and have even been taken from under ice. The larvae, like those of Anopheles, float at the surface of the water in a nearly horizontal position, and when disturbed dive quickly, taking refuge on the bottom where they may remain several minutes, ascending later with a vigorous wriggling motion. They are voracious feeders, not only devouring large numbers of Culex larvae, but in the absence of more suitable food attacking each other, and were it not for its local habits, this species might prove a valuable aid in reducing the numbers of those species of mosquitos annoying to man and the lower animals. This insect is evidently widely distributed, as larvae were met with in 1903 in the Kootenay district, British Columbia, by Dr Dyar, where they occurred in cold pools at Glacier and also in rain water barrels.

SAYOMYIA

Phantom larvae

The small gnats belonging to this genus have a close resemblance to the biting, annoying culícíds. We are happy to state that they are harmless, their short mouth parts being specially adapted to feeding on vegetation. The larvae are the most interesting of all and may at once be separated from those belonging to the genus Culex by the absence of the characteristic air tube. The fore part of the head is much prolonged, and the stout, basal, antennal segment is terminated by four usually equal, pendant filaments and another about half the normal length. These larvae are also remarkable for the eversible pharyngeal tube terminating in a circular papillate organ, evidently for the absorption of food. The almost perfect transparency of the larvae renders them exceedingly difficult to detect, the black eyes and pigment in the air reservoirs of the thoracic and abdominal segments being about the only color. They remain almost motionless some distance below the surface and then with a sudden jerk change from one place to another with a motion so rapid that ordinarily it escapes the eye. The larvae never come to the surface and are predaceous, being credited with feeding not only on small crustaceans but also small dipterous larvae and even young fish. They are said to occur in all kinds of water, specially that which is clear, and, unlike Culex, may be met with where fish abound. The pupae are nearly straight and remain almost upright some little distance below the surface. They are at first white, gradually changing to yellowish brown or green and the segments may even become margined with black.

Sayomyia punctipennis Say

This species has been taken in Pennsylvania, and very likely occurs in this State. Its description is as follows:

Whitish; wings and feet punctured with fuscous. Hair of the antennae yellowish white, the centers of the whorls being fuscous; the shaft of the antennae has a decidedly annulated appearance; eyes black; thorax with three pale yellowish brown abbreviated, broad lines, the middle one originating before and terminating at the center of the disk, the lateral ones originating rather before the middle; feet with numerous small, brown punctures; wings with many very obvious brown spots. Length 6 mm.

Sayomyia trivittata Loew

Pl. 12, 13, 28, fig. 4; 4; 3 respectively

This species has been met with at Elizabethtown, where larvae and pupae occurred in a cold mountain pool June 9, adults appearing the next day. Dr Dyar records this species from Center Harbor N. H. Osten Sacken's description of the adult follows:

Pale yellowish, with three thoracic stripes, the metanotum, fasciae of the abdomen, with apical rings of the femora, and basal

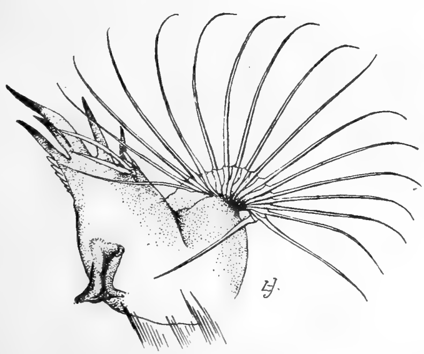

Fig. 99 Mandible and mandibular fan of Sayomyia trivittata

and apical rings of the tibiae, fuscous black; the wings with cinereous spots. Length 4.3 mm. Wing 5 mm.

Pale yellowish, with long, mostly subfuscous pile. Antennae black, annulated, densely verticillate with subfuscous hairs. Dorsum of thorax with three black stripes, the double median one posteriorly, the lateral stripes anteriorly, much shortened. The sides of the scutellum fuscous; metanotum fuscous black; the abdomen fasciate with fuscous. Legs pale yellow; the tarsi from the tip of the first joint pale fuscous; an apical ring on each of the femora and an apical and a basal ring on each tibia is blackish. The wing variegated with some small cinereous black spots.

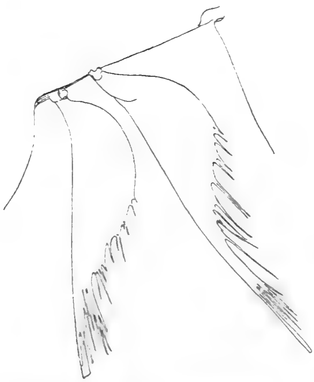

Fig. 100 Leaflike appendages of S. trivittata

Fig. 101 Processes much enlarged of terminal segment of S. trivittata

Pupa. Air tube with irregularly hexagonal cells, about four times as long as wide; inner edge nearly straight, outer more or less regularly curved. Apex with a rather distinct, chitinous tip. Ventral surface of abdominal segments thickly clothed with rather long, slender hairs usually extending laterally. Apical three fourths of the inner margin of the hind paddle distinctly serrate, each tooth bearing a short, colorless spine. Terminal appendages consisting of two pairs of conic processes, the outer ones ending in a colorless spine, concave and inclosing the bases of the inner, shorter, more strongly curved ones. At the extreme base of these posterior processes there are a pair of chitinous, irregularly curved, blunt hooks.

Fig. 102 Ventral hook of S. trivittata

Larva. Head, somewhat elongate, subconic. Basal segment of antennae long, deeply notched at base and tipped with four nearly equal, tapering processes and another just about one half their length. Just behind the antennae are 10 long, light brownish filaments, five on each side, the filaments of the third metamere of Meinert. Leaflike appendages long, terminated by an extremely long, slender spine, followed by an irregular series of slender ones along the oblique posterior border, anterior margin gently rounding to a rather broad base. Maxillae irregularly rhomboidal, maxillary palpus tapering gradually, nearly straight. Labrum subquadrate, distinctly wider at the base and with the apex slightly curved and thickly clothed with rather coarse hairs. Mandibles with three fine and several minor teeth, the mandibular fans consisting of about 16 long, spinelike processes. Eyes and air sacks of thoracic and seventh abdominal segments deeply pigmented. Ventral brush of terminal segment composed of about 26 stout hairs. Apical ventral plate fulvous, bearing a stout, curved, chitinous hook pointing anteriorly. Lateral posterior margin of terminal segment bordered with a row of stout, curved, comblike processes, each with a conspicuous tooth at its base. Just behind these and apparently arising from the same chitinous ridge, there are long, curved, corrugated, blunt, ribbed processes which appear to project backward. Extreme dorsum of last segment with four conspicuous plumose bristles. Anal gills long, tapering rather irregularly to acute points.

The pupa remains upright in the water or resting on the bottom, rarely coming to the surface. It is yellowish at first, becoming a dark green with black margined segments. This species has been taken by Dr Dyar, in British Columbia and is recorded by Osten Sacken from Maine, California and Alaska.

Sayomyia albipes Johans.

Pl. 47, fig. 2

Larvae of this species were met with at Bath-on-Hudson June 16, a male emerging the 23d, and we give herewith descriptions of the hitherto unknown male, pupa and larva. The type of this species was taken by Mr Johannsen at Ithaca, in August 1901, and his description of the female follows:

Female. Entire insect pale yellow in ground color; head and antennae wholly pale yellow; dorsum of thorax with three longitudinal stripes, pale buff in color, the lateral ones abbreviated anteriorly, the median one posteriorly, the latter divided longitudinally by a pale yellow line. These stripes all narrowly margined with brown, and on the anterior and outer margins of the lateral stripes are a few tiny black specks. Scutellum with a pale buff posterior margin; pleurae yellow, sparsely sprinkled with small, irregular black specks; abdomen yellowish white beneath, pale buff colored above, lateral margin sparsely sprinkled with small irregular black specks; legs pale yellowish, unspotted, fourth and fifth tarsal joints slightly darkened; claws simple; legs and abdomen covered with long, loose yellow hair; wings uni-

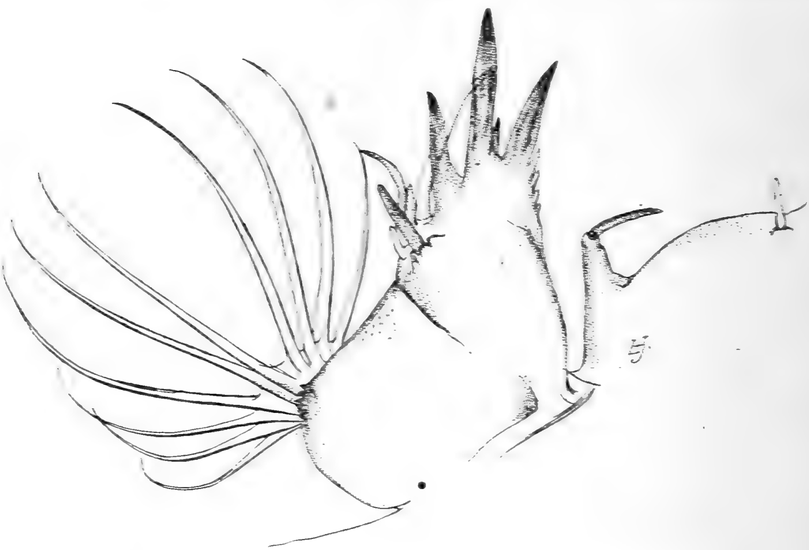

Fig. 103 Mandible and mandibular fan of Sayomyia albipes

formly pale yellowish, the veins, the hair on them and the halteres same color. Length 5½ mm.

Male. Antennae thickly clothed with long, black grayish plumes; basal segment subglobose, yellowish; other segments semi-transparent, annulate with yellowish. Palpi short, thickly clothed with dark brown or almost black hairs. Basal segment rather short, subconic, second and third equal, stout; terminal segment slender, nearly twice the length of the third. Eyes, black. Thorax with submedian, straw yellow lines abbreviated posteriorly and margined laterally with dark brown; sublateral stripes of the same color posteriorly, margined with dark brown anteriorly and toward the middle and with a rather broad, lateral, white stripe; sparsely clothed with rather long, fulvous hairs. Abdomen whitish, with an irregular, bluish tint in places and irregular fuscous spots at the anterior lateral margins of the first to sixth segments inclusive; several minute dorsal, black spots on the posterior abdominal segments. Ventral surface unicolorous,

Fig. 104 Leaflike appendages of S. albipes

semitransparent, whitish. Basal segment of clasp straw yellow, nearly cylindric, densely clothed with long, yellowish hairs, apical portion slender, nearly straight, dark brown. Harpes near base of claspers, chitinous, claw-shaped. Legs, pale straw yellow, rather sparsely clothed with pale straw yellow hairs. Anterior tarsi and terminal segment of middle and posterior tarsi distinctly shaded with gray, ungues simple. Wings, pale straw yellow, veins sparsely clothed with similar colored scales; posterior fringe pearly white. Posterior cross vein less than half its length from mid cross vein. Petiole of first submarginal cell about one third the length of cell, that of posterior submarginal cell nearly one half the length of cell.

Described from a recently emerged, well colored individual.

The larva of this species is as transparent and difficult to detect in the water as the species met with at Poughkeepsie, and its transparency is likewise retained in balsam.

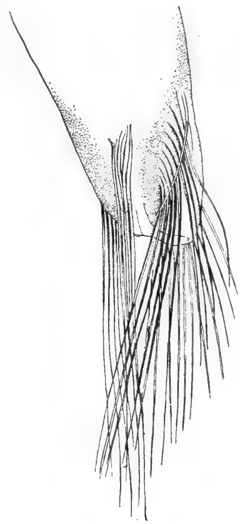
Fig. 105 Labrum of S. albipes

Pupa. Air tube with irregularly hexagonal cells, about four times as long as wide, inner margin nearly straight, outer more or less uniformly arcuate; tip light brown, chitinous. Posterior three fourths of the inner edge of the inner paddle distinctly serrate, a few teeth near the tip at almost right angles to the margin. Posterior appendages simple, subconic, with inner margin slightly irregular, serrate near the apical fourth, and at their base an inconspicuous pair of subtriangular lobes.


Fig. 106 Ventral hooks of S. albipes

Larva. Head, somewhat elongate, subconic. Basal segment of antennae long, deeply notched at base and tipped with four nearly equal, tapering processes and one about half as long. Just behind the antennae are 10 long, light brownish filaments, five on each side. These are the filaments of the third metamere of Meinert. Leaflike appendages slender, rounded anteriorly to a narrow base and terminating acutely with fine serrations on the nearly straight, anterior margin. Labrum quadrate, elongate, obliquely truncate, tipped with an irregular tuft of hairs. Maxillae subtriangular with slightly curved tip. Maxillary palpus slender, tapering, curved. Mandibles with three prominent and two minor teeth; posterior margin slightly serrate. The conspicuous mandibular fans consist of about 10 long, curved spines. Eyes, deeply pigmented. Air sacks of thoracic and seventh abdominal segments with many purplish, pigmented cells; the eversible pharynx with a circular, papillate tip or base and a central, straight and two lateral curved papillae. Ventral tuft of terminal segment composed of about 22 stout hairs. Ventral plate fulvous, finely serrate anteriorly and armed on its hind margin with a pair of stout, evenly curved, fulvous hooks pointing anteriorly. Lateral margin of terminal segment bordered with three rows of fine teeth, the anterior row rather stout with a very inconspicuous line of fine serrations at its base, the teeth of the two posterior rows irregular, long, slender, curved. Dorsal extremity with four finely plumose hairs.

Sayomyia rotundifolia n. sp.

Pl. 13, 40, fig. 2, 3; 2 respectively

This species is very close to Sayomyia albipes Johans., but differs in several particulars in both adult and larval stages, as will be seen by reference to descriptions.

A female was bred July 11 from larvae taken in a woodland pool at Karner and a second Aug. 2.

Description. *Female.* Labrum pale yellowish, margined with fuscous. Palpi rather slender, long, four segmented, somewhat fuscous, sparsely clothed with rather long, coarse hairs. Antennae straw yellow, the segments annulated with pale white; first segment globular, second elongated, both semitransparent, straw color. Frontal portion of head whitish, semitransparent; occiput with a median black spot, the lateral and posterior portions of head sparsely clothed with long, straw yellow hairs. Prothorax with a pair of broad, submedian, fulvous lines anteriorly and a similar pair of broader, sublateral ones posteriorly, inner margin of both stripes bordered by dark brown and outlined with a row of rather short, yellowish brown hairs, the area between the submedian and sublateral lines clothed with a rather broad row of coarse, brownish and yellowish hairs; the latter stripe is bordered laterally by a few coarse bristles, and the margin marked by several irregular, black specks. Scutellum light brown, crowned with conspicuous rows of long, yellowish and brown hairs. Abdomen greenish yellow, finely spotted with fuscous, and with larger, black, irregular spots on the posterior portion of the segments, and on the antepenultimate these markings form a very irregular, basal band, the apical portion of the antepenultimate segment bearing a pair of subdorsal, irregular, black spots; terminal segment with a pair of sublateral, black spots, bearing a pair of straw yellow, somewhat elongate appendages. Pleura semitransparent, irregularly marked with black specks. Ventral surface of abdomen pale greenish yellow, with irregular, black spots about the middle of each segment. Halteres capitate, pedicel swollen, nearly colorless; apical portion semitransparent with a greenish tinge. Wings rather thickly clothed with straw yellow scales, being particularly abundant on the costal and subcostal veins. Petiole of first submarginal cell one third its length, that of second, one fourth. Posterior cross vein less than its length from mid cross vein. Legs uniform, straw yellow, rather sparsely clothed with long, somewhat coarse hairs.

Male. A specimen of this sex was bred from larvae taken in a woodland pool at Karner, an adult emerging July 7. Antennae thickly clothed with long, grayish yellow plumes; basal segment subglobose, yellowish; other segments semitransparent, annulate with brown. Palpi rather short, thickly clothed with dark brown, nearly black hairs, as is also true of the labium. Eyes jet black. Thorax with a slender, tapering, straw yellow, submedian stripe obsolete posteriorly and margined on the posterior half of the lateral border with dark brown. There is also a broad, lateral stripe margined internally, with dark brown. Scutellum pale yellow, bearing at its apex very long, brownish yellow hairs; postscutellum irregularly marked with brown. Abdomen semitransparent thickly clothed with yellowish hairs and with irregular, black markings at the anterior and lateral margins from the first to sixth segments inclusive; several dorsal black spots on the posterior abdominal segments. Ventral surface nearly unicolorous, semitransparent, whitish. Basal segment of clasp subcylindric, rather strongly curved, yellowish, and clothed with coarse, brownish yellow hairs. Apical segment brownish, black toward the tip, strongly curved. Legs nearly uniform, straw yellow, rather thickly clothed with long, yellowish hairs; ungues simple. Wings pale straw yellow, veins sparsely clothed with similarly colored scales; posterior fringe grayish. Petiole of first submarginal cell about one third its length, that of the second nearly half its length. Posterior cross vein about its own length from the mid cross vein. Halteres yellowish, capitate.

Pupa. The cast pupal skin has practically the same characteristics as those given for S a y o m y i a a l b i p e s Johans.

Larva. Head somewhat elongate, subconic; basal segment of antenna deeply notched at base and tipped with four nearly equal, tapering processes and one about half as long. Just behind the antenna are eight pale, long filaments, four on each side, the filaments of the third metamere of Meinert. Leaflike appendages extremely slender, rounding gradually anteriorly to a somewhat slender base. Posterior margin nearly straight, terminating in an extremely long pointed process, the latter being nearly half the entire length of the appendage; at its base, anteriorly, there are several rather large, irregular teeth. Labrum quadrate, elongate, obliquely truncate, tipped with an irregular tuft of stout hairs. Mandibles with three conspicuous teeth, the middle one with a small dentition near its base; there are two long, curved processes and two shorter, conical ones around the teeth proper. Mandibular fan composed of seven long, curved spines. Eyes deeply pigmented, as is also the case with the air sacks of the thoracic and seventh abdominal segments. Ventral tuft of terminal segment composed of about 16 rather stout, simple hairs. Ventral plate very pale fuscous, bearing stout, evenly curved hooks pointing anteriorly; lateral margin of terminal segment bordered with rows of inconspicuous teeth extremely difficult to detect. Dorsal tuft composed of four long, finely plumose hairs.

Sayomyia americana Johans.

This species occurs according to Johannsen in New York, New Jersey, Illinois and Minnesota. It was first characterized by him as a variety of S. p l u m i c o r n i s Fabr., but on comparison with European specimens, kindly sent us by Dr Meinert of Copenhagen, we conclude that Johannsen's form is entitled to specific rank. His description follows:

Male. Reddish brown; abdomen yellowish; the antennal joints yellow with brown tips, basal joint brown; the hairs pale brown; the front, the upper surface of the proboscis, and the palpal joints brown; the incisures of the latter yellow, the vertex, the cheeks and the underside of the proboscis and neck pale yellow; thorax pale brown above with three dark reddish brown stripes, the middle one divided by a fine, pale brown line; the lateral stripes abbreviated anteriorly, the median one posteriorly; the pectus and the margins of the pleural and jugular sclerites reddish brown; scutellum pale brown; metathorax dark brown; abdominal segments subequal in length except the first and last, which are less than one half of the others. The dorsal surface is brown with pale yellow incisures. The brown coloring is darkest anteriorly, gradually becoming paler caudad, so that the posterior margin of the segment is almost as light in color as the incisure. This is particularly true with segments 3, 4 and 5. On segments 6, 7 and 8 the brown color is almost wanting excepting a triangular lateral spot which is prolonged caudad in a fine line. The outline of this spot, however, is not distinct, but is blended in with the color of the dorsum. A pair of very small pale yellow spots with a narrow brown border are more or less distinctly visible on each segment. The hypopygium consists of two jointed hooks, is pale brown in color, nearly as long as an abdominal segment . . . Venter and the legs are pale

Fig. 107 Leaflike appendages of the European Sayomyia plumicornis

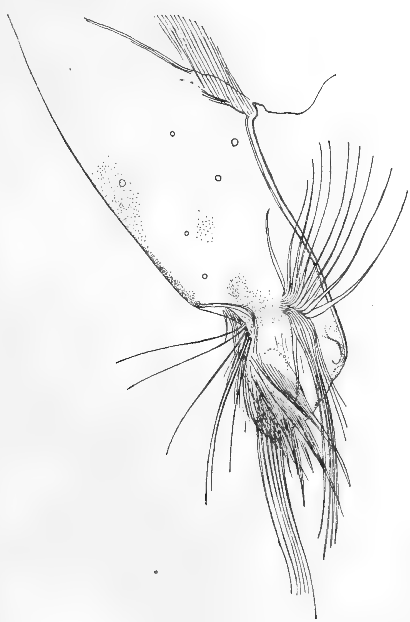

Fig. 108 Labrum of the European S. plumicornis

yellow, the last two or three tarsal joints slightly infuscated. Legs and abdomen densely but delicately haired; wings yellowish, the veins scarcely dark . . . halteres pure white. Length $5\frac{1}{2}$ mm.

Female. Differs from the male in the following particulars. Antennae entirely yellow, basal joint, palpi and upper surface of proboscis with a tinge of brown; frontal spot brown; scutellum with a fine median line and its posterior margin pale yellow; abdomen yellow, dorsal surface with a tinge of brown, specially on the posterior margin. The two little white spots with pale brown margins also present on each segment. Anal segment brown, genitalia yellow, venter, legs, halteres, etc. as with the male . . . Length 5 mm.

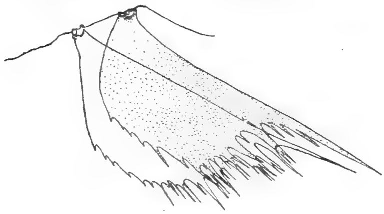

Fig. 109 Leaflike appendages of S. americana

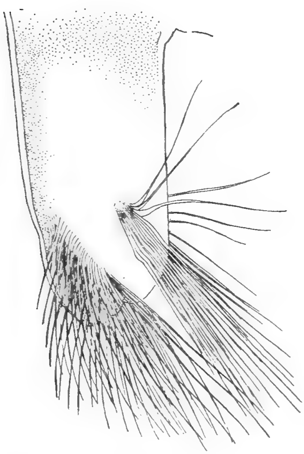

Fig. 110 Labrum of S. americana

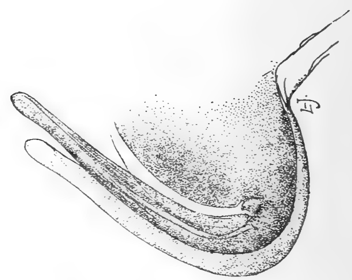

Fig. 111 Ventral hooks of S. americana

Through the kindness of Dr Meinert we have been able to compare the larva described by Johannsen with the European form. It differs from the European S. plumicornis Fabr. in the following particulars. The four long appendages of the antennae are of equal length, while in the European form one is distinctly shorter than the rest; there is a marked difference in the leaflike appendages; and also in the ventral hooks of the last segment.

The larva has been described by Johannsen in detail in Museum bulletin 68. The pale yellow pupa resembles that of Culex.

Sayomyia hudsoni n. sp.

Pl. 13, 28, 40, 47, fig. 4, 5; 4; 1; 1 respectively

Larvae of this interesting species were taken in small numbers at Poughkeepsie June 17, and several males bred therefrom June 26 and 27.

Description. *Male.* Antennae thickly clothed with long, grayish black plumes. Basal segment subglobose, yellowish, other segments semitransparent, annulate with brown. Palpi short, thickly clothed with grayish brown hairs. Basal segment rather short, subconic; second about three times the length of the first and one fourth longer than the third; both stout, nearly uniform, except that the second has a distinct enlargement internally near the anterior fourth. Terminal segment slender, about twice the length of the third. Labrum ornamented with thick, brownish or silvery gray hairs. Eyes, jet black. Occiput and posterior portion of head yellowish, clothed with pale yellowish hairs. Thorax with submedian, slaty brown lines abbreviated posteriorly and divided by a slender, fulvous, median line, which latter is ornamented by a well defined, double row of long, yellowish hairs. Sublateral stripes of the same color, abbreviated anteriorly, and the space between the sublateral and submedian dark lines clothed with yellowish hairs arranged in more or less definite rows. Oval posterior portion of thorax and that between the sublateral lines, a uniform, pale brown with a median black spot at the posterior border. Pleura, anterior and lateral portions of thorax semitransparent, whitish. Scutellum prominent, with a few long, lateral bristles and its posterior surface ornamented with the brown bases of others with a slight median space naked. Postscutellum dark brown. Abdomen semitransparent, greenish or yellowish, obscure, irregular, somewhat variable, with lateral black markings at the posterior boundary of each segment; third, fourth and fifth segments with a pair of submedian, obscure, circular, whitish marks near the middle of each segment; sparsely clothed with long, yellowish hairs. Basal segment of clasp subcylindric, slightly curved, yellowish, with light brown markings internally and thickly clothed with long, yellowish hairs. Apical segment of clasp pale brownish yellow, nearly straight, terminating in an obscure point. Legs, uniform, straw yellow, rather thickly clothed with long, yellowish hairs; ungues simple. Wings, hyaline, anterior veins ornamented with pale straw yellowish scales, those of the other veins slightly darker. Petiole of first submarginal cell

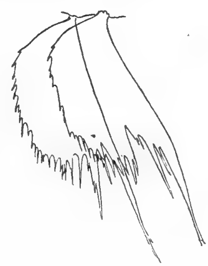

Fig 112 Leaflike appendages of Sayomyia hudsoni

a little over one half its length; that of the second about three fourths its length, the cell being decidedly wider than the anterior one. Posterior cross vein less than its own length from the median cross vein. Halteres pale straw yellow.

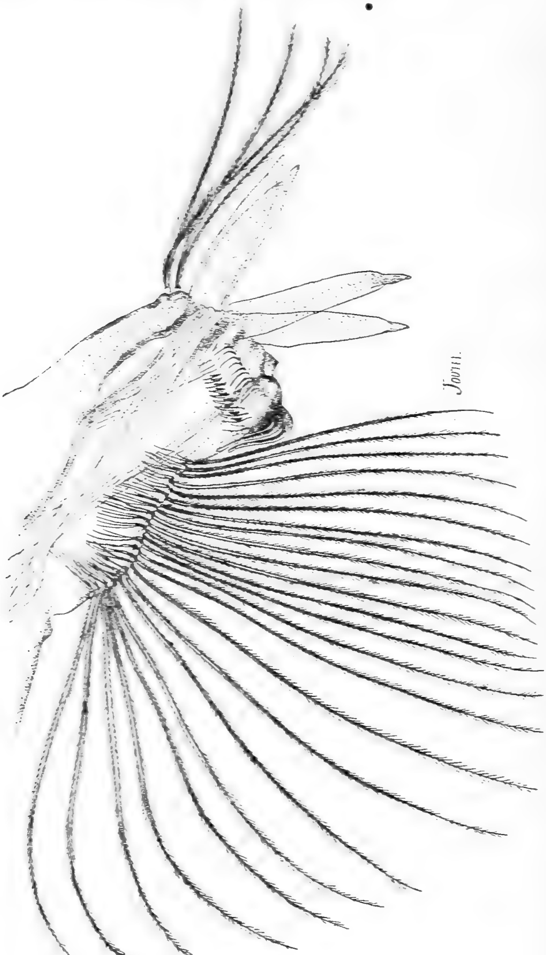

Fig. 113 Posterior extremity of S. hudsoni

A second male bred Aug. 5. differs in description in having the prothorax darker with lateral dark spots on the scutellum, jet black ones on the base of the wings; a broad, irregular, marginal white stripe anteriorly. Pleura also whitish with irregular, jet black spots. The anterior tarsi are somewhat darker than the tibiae.

Female. Antennae pale straw yellow, verticillate with a number of stout bristles arising from the base of each segment; basal segment stout, subglobular, yellowish; second segment stout, somewhat swollen. Eyes jet black, very prominent, slightly emarginate anteriorly. Palpi rather short, grayish brown, and thickly clothed with hairs of the same color; basal joint thick, subconic, second slender, longer than the slightly stouter third, the fourth very slender, nearly twice the length of the preceding. Labrum yellowish white basally, the anterior margin dark brown and the dark color extending some distance on each side. Occiput and posterior portion of the head straw yellow, slightly darker on median line. Thorax with a pair of submedian, yellowish brown lines tapering posteriorly and becoming obsolete at the posterior third; narrow median line yellowish and with double row of yellow, slender scales. A sublateral, broad, yellowish stripe is present posteriorly and is separated from the submedian stripe and its opposite by a yellowish area thickly clothed with slender, yellowish scales; a small, black spot near the middle and a little to one side of the submedian stripes. Pleura and lateral anterior margin of prothorax and base of scutellum yellowish brown, posterior margin of latter thickly clothed with long, yellowish hairs. Abdomen greenish yellow and with irregular, sooty spots, particularly along the sublateral line, and clothed with rather short, pale hairs. Ventral surface similar, apical segment paler, terminal processes blunt, slightly curved, bearing many rather long, curved setae. Legs pale straw yellow, ungues simple. Wings pale straw yellow, clothed with similarly colored scales, which are slightly thicker along the anterior longitudinal veins. Petiole of first submarginal cell about one fourth its length, that of second nearly one half; posterior cross vein interstitial with mid cross vein. Halteres pale straw yellow, base somewhat enlarged, pedicel very slender, tip rounded, spatulate.

Described from a specimen bred June 28, 1904.

Pupa. Air tube with irregularly hexagonal cells, nearly four times as long as wide; internal margin nearly straight, outer, rather regularly curved and the apex distinct, chitinous, brown. Posterior two thirds of the inner margin of the inner paddle, fringed with long, nearly colorless spiny processes. Posterior appendages nearly conic, simple, and at their base an inconspicuous pair of subtriangular lobes.

The larva, remarkable on account of its transparency, is very difficult to detect in water, the only portions visible being the deeply pigmented eyes and air sacks in the thoracic and abdominal segments. This transparency is retained in alcoholic specimens and also in those mounted in balsam.

Larva. Head, somewhat elongate, subconic. Basal segment of antennae long, deeply notched at base and tipped with four nearly equal, tapering processes and a smaller one about half as long. Just behind the antennae are 10 long, light brownish filaments, five on each side. These are the filaments of the third metamere of Meinert. The pair of leaflike appendages are rounded anteriorly to a narrow base, terminating in one large, posterior spine and a series of irregular ones along the nearly truncate apex. Labrum elongate, slightly curved, obliquely truncate and tipped with an irregular tuft of hairs. Maxillae subtriangular with a somewhat curved tip. Maxillary palpus slender, tapering, curved. Mandibles with three prominent and two minor teeth, posterior margin serrate. The conspicuous mandibular fans each consist of about 16 long, spinelike processes. Eyes, deeply pigmented. Air sacks of thoracic and seventh abdominal segments with many purplish, pigmented cells. The eversible pharynx with a circular, papillate tip or base bearing two lateral, stout, curved papillae. Ventral brush of terminal segment composed of about 24 stout hairs. Apical ventral plate fuscous, finely serrate anteriorly and bearing a pair of dark, stout hooks pointing anteriorly. Lateral margin of segment bordered with three rows of teeth, the anterior consisting of stout processes with almost inconspicuous, extremely fine serrations at their extreme base. The teeth of the two posterior rows are long, slender, curved. Dorsal extremity with four long, finely plumose hairs.

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1903 ——— Report on the Mosquito Investigations. N. J. Agric. Exp. Sta. Ent. Div. Rep't, 1902. p.511–93 (General account of work with special reference to C. sollicitans and Anopheles)

1903 **Snow, F. H.** Preliminary List of the Diptera of Kansas. Univ. Kan. Sci. Bul. 2, p.211–12 (List of Culicidae)

1903 **Theobald, F. V.** A Monograph of the Culicidae or Mosquitos. 3:1–359 (Supplementary to preceding volumes)

1903 ——— Notes on Culicidae and their Larvae from Pecos, New Mexico, and Description of a New Grabhamia. Can. Ent. 35:311–16 (Notes on Theobaldia incidens, Culex kelloggii, C. consobrinus, Grabhamia curriei and G. vittata, the latter described, the larva figured, together with the larva of C. kelloggii)

1903 **Underwood, W. L.** A New Mosquito. Science, 18:182–84 (Notes on the larva of Eucorethra underwoodi)

1903 ——— Mosquitos and Suggestions for their Extermination. Pop. Sci. Mo. 53:453–66 (Brief general account, with mention of various species, particularly Anopheles maculipennis, Stegomyia fasciata, Culex sollicitans and Eucorethra underwoodi)

1903 **Weeks, H. C.** Some Practical Suggestions on Mosquito Extermination in New Jersey. Reprint from Med. News, Mar. 7, 1903, p.1–17.

1903 ——— Summary Report on the Sanitary-economic Improvement of the Southern Part of the Borough of Brooklyn, p.1–24.

1903 ——— The Concurrence of the Anopheles Mosquito and Malaria. N. Y. State Jour. Med. 3:272–75.

1904 **Coquillett, W. F.** Notes on Culex nigritulus. Ent. News, 15:73–74 (C. salinarius proposed)

1904 ——— Several New Diptera from North America. Can. Ent. 36: 10–11 (Culex dupreei and Conchyliastes varipes described)

1904 ——— New North American Diptera, family Culicidae. Ent. Soc. of Wash. Proc. 6:166–69 (Taeniorhynchus nigricans, T. signipennis, Culex nivitarsis and C. pullatus described, the first from Panama, the second from Mexico)

1904 **Dyar, H. G.** Notes on the Mosquitos of British Columbia. Ent. Soc. Wash. Proc. 6:37–41 (Biologic notes on the following species:

Culex impiger, C. cantans, C. reptans, C. canadensis, C. incidens, C. punctor, C. sylvestris, C. varipalpus, C. territans, C. dyari, C. tarsalis, C. perturbans, C. curriei, C. spencerii, C. consobrinus, Anopheles maculipennis, Aedes fuscus)

1904 ——— Notes on the Mosquitos of British Columbia; continued (Corethra velutina, Sayomyia trivittata and Eucorethra underwoodi)

1904 ——— The Life History of Culex cantans Meig. [C. vittatus] N. Y. Ent. Soc. Jour. 12:36–38.

1904 ——— The Life History of Culex varipalpus Coquillett. N. Y. Ent. Soc. Jour. 12:90–99.

1904 ——— Brief Notes on Mosquito Larvae. N. Y. Ent. Soc. Jour. 12:172–74 (Notes on the following species: Culex dyari, C. atropalpus, C. aurifer, C. discolor, Janthinosoma musicum, C. salinarius, C. vittatus, C. cantans and C. reptans)

1904 ——— Larva of Culex punctor Kirby with Notes on an Allied Form. N. Y. Ent. Soc. Jour. 12:169–71 (Description of larva of Culex punctor Kirby and early stages of C. trichurus Dyar)

1904 **Dyar, H. G. & Knab, Frederick.** Diverse Mosquito Larvae that Produce Similar Adults. Ent. Soc. Wash. Proc. 6:143–44 (Observations on differences in larvae referred to Culex cantans, C. restuans and C. impiger recorded)

1904 **Felt, E. P. & Young, D. B.** Importance of Isolated Rearings from Culicid Larvae. Science, 20:312–13 (Brief description of larvae and adults of the following new species: Culex cinereoborealis, C. lazarensis, C. abserratus and C. fitchii)

1904 **Herrick, G. W.** Notes on the Life History of Grabhamia jamaicensis. Ent. News, 15:81–84.

1904 **Johnson, C. W.** Supplementary List of the Diptera of New Jersey. Ent. News, 15:157–58 (List of Culicidae)

1904 **Knab, Frederick.** The Epistomal Appendages of Mosquito Larvae. N. Y. Ent. Soc. Jour. 12:175–77.

1904 **Ludlow, C. S.** Mosquito Notes No. 2. Can. Ent. 36:297–301 (Mimomyia chamberlaini and Myzomyia rossi var. indefinita described)

1904 **Smith, J. B.** Notes on the Life History of Culex dupreei Coq. Ent. News, 15:49–51 (Observations with illustrations of all stages)

1904 ——— Notes on Some Mosquito Larvae Found in New Jersey. Ent. News, 15:145–52 (Larvae of the following are described and figured: Culex trivittatus, C. discolor, C. aurifer and Anopheles crucians)

1904 ——— The Common Mosquitos of New Jersey. N. J. Agric. Exp. Sta. p.1–40 (Brief, general account with illustrations of Culex pipiens, C. restuans, C. sollicitans, C. taeniorhynchus, C. cantator, C. salinarius, C. cantans, C. territans, C. sylvestris, C. canadensis, Anopheles maculipennis, A. punctipennis, A. crucians and Psorophora ciliata. A table for the separation of the species occurring in the state and of certain larval forms is also given)

1904 ——— Report on the Mosquito Investigation. Agr. Exp. Sta. Rep't. Ent. Dep't, 1903, p.645–59 (Summarized statement of work together with list of species taken in the state)

1904 **Snow, F. H.** List of Diptera. Univ. Kan. Sci. Bul. 2, p.341 (List of Kansas Culicidae)

1904 **Theobald, F. V.** Mosquito Annoyance at Woodford (Essex) and Elsewhere. 2d Rep't on Economic Zoology, p.2–16 (Observations on various mosquitos, specially Theobaldia annulata Meig., with illustrations of pupa and larva of the latter

1904 **Van Dine, D. L.** Mosquitos in Hawaii. Agr. Exp. Sta. of Haw. Bul. 6, p.1–30 (Common Hawaiian forms, Culex pipiens, Stegomyia fasciata and S. scutellaris treated, with discussion of control)

1904 **Wesche, W.** The Mouth-parts of the Nematocera and their Relation to the other Families in Diptera. Roy. Micro. Soc. Jour. p.31, 33, 35–36 (Discussion with illustrations of the mouth parts of various mosquitos)

1904 First General Convention to Consider the Questions Involved in Mosquito Extermination. Proc. Dec. 16, 1903, p.1–84.

The following is a list of the important papers:

Smith, J. B. How a State Appropriation May Be Spent, p.13-15.
Kerr, W. C. What a Rural Community Can Do, p.16-18.
Howard, L. O. The World-wide Crusade, p.19-21.
Matheson, W. J. Does Extermination Exterminate Mosquitos? p.21-24.
Claflin, John. Remarks upon Extermination Work at Morristown, N. J., p.24-25.
Bailhache, P. W. The Extermination and Exclusion of Mosquitos From Our Public Institutions, p.27-30.
Perry, J. C. Government Anti-Mosquito Work, p.31-33.
Lederle, E. J. The Sphere of Health Departments, p.34-35.
Berkeley, W. N. The Exactness of Proofs of Transmission of Malaria by Mosquitos, p.35-39.
Miller, Spencer. The Long Distance Theory, p.42-44.
Whitney, Milton. Value of Reclaimed Swamp Lands for Agricultural Uses, p.46-48.
Gorgas, W. C. Anti-Mosquito Work in Havana, p.48-50.
Cravath, P. D. How the Law Should Aid, p.50-51.
Felt, E. P. New York State's Part in Mosquito Extermination, p.52-55.
Beach, F. C. What the General Government Should Do, p.55-56.
Weeks, H. C. Mosquito Engineering, p.59-61.

ADDENDUM

Culex abfitchii n. sp.

Larvae of this species were taken in some numbers at Karner N. Y. in early May, in association with those of C. fitchii, which latter they closely resemble in general form and structure but may be separated therefrom by the one or two isolated pecten teeth on the air tube, and by the large apical spine of the comb scales being from one half to two thirds the length of the entire structure [pl. 41, 48, fig. 3, 4]. This is the larva which Messrs Dyar and Knab consider the normal form of Culex cantans Meig. [Ent. Soc. Wash. Proc. 6:143]. This species proved difficult to rear, though a number of larvae were obtained.

EXPLANATION OF PLATES[1]

Plate 1

1 Female wing of Anopheles punctipennis. x21
2 Female wing of A. punctipennis var. x21
3 Male wing of A. punctipennis var. x21
4 Female wing of A. maculipennis. x21
5 Male wing of A. maculipennis. x21

Plate 2

1 Female wing of Psorophora ciliata. x11
2 Male wing of P. ciliata. x14
3 Female wing of Janthinosoma musica. x21
4 Female wing of Culex fitchii. x21

Plate 3

1 Male wing of Culex fitchii. x21
2 Female wing of C. cantans. x21
3 Male wing of C. cantans. x21
4 Female wing of C. sylvestris. x21
5 Male wing of C. sylvestris. x21

Plate 4

1 Female wing of Culex cantator. x21
2 Male wing of C. cantator. x21
3 Female wing of C. sollicitans. x21
4 Male wing of C. sollicitans. x21
5 Female wing of C. taeniorhynchus. x21

Plate 5

1 Male wing of Culex taeniorhynchus. x21
2 Female wing of C. onondagensis. x21
3 Male wing of C. canadensis. x21
4 Female wing of C. canadensis. x21
5 Female wing of C. atropalpus. x21

Plate 6

1 Male wing of Culex atropalpus. x21
2 Female wing of C. territans. x21

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[1] Reproduced from author's photomicrographs of balsam mounts prepared by D. B. Young.

3 Male wing of C. territans. x21
4 Female wing of C. lazarensis. x21
5 Male wing of C. lazarensis. x21

Plate 7

1 Female wing of Culex cinereoborealis. x21
2 Male wing of C. cinereoborealis. x21
3 Female wing of C. impiger. x21
4 Male wing of C. impiger. x21

Plate 8

1 Female wing of Culex absobrinus. x20
2 Male wing of C. absobrinus. x21
3 Female wing of C. magnipennis. x20
4 Male wing of C. magnipennis. x21

Plate 9

1 Portion of female wing of Culex consobrinus. x21
(From photograph of an unmounted wing)
2 Female wing of C. restuans. x21
3 Male wing of C. restuans. x21
4 Female wing of C. pipiens. x21
5 Male wing of C. pipiens. x21

Plate 10

1 Male wing of Culex dyari. x21
2 Wing of C. abserratus. x21
3 Female wing of C. salinarius. x21
4 Male wing of C. salinarius. x21
5 Female wing of C. triseriatus. x21

Plate 11

1 Female wing of Culex aurifer. x21
2 Male wing of C. aurifer. x21
3 Female wing of Taeniorhynchus perturbans. x21
4 Female wing of Aedes fuscus. x21
5 Male wing of A. fuscus. x21

Plate 12

1 Male wing of Uranotaenia sapphirina. x 30.
2 Female wing of Eucorethra underwoodi. x 8
3 Male wing of E. underwoodi. x 13
4 Female wing of Sayomyia trivittata. x 21

Plate 13

1 Male wing of Sayomyia trivittata. x 21
2 Female wing of S. rotundifolia. x 21
3 Male wing of S. rotundifolia. x 21
4 Female wing of S. hudsoni. x 21
5 Male wing of S. hudsoni. x 21

Plate 14

1 Portion[1] of female wing of Anopheles punctipennis. x 110
2 Portion of male wing of A. punctipennis. x 110
3 Portion of female wing of A. maculipennis. x 110
4 Portion of male wing of A. maculipennis. x 110

Plate 15

1 Portion of female wing of Psorophora ciliata. x 110
2 Portion of female wing of Janthinosoma musica. x110
3 Portion of female wing of Culex fitchii. x 110
4 Portion of male wing of C. fitchii. x 110

Plate 16

1 Portion of female wing of Culex cantans. x 110
2 Portion of male wing of C. cantans. x 110
3 Portion of female wing of C. sylvestris. x 110
4 Portion of male wing of C. sylvestris. x 110

Plate 17

1 Portion of female wing of Culex cantator. x 110
2 Portion of male wing of C. cantator. x 110
3 Portion of female wing of C. onondagensis. x110
4 Portion of female wing of C. sollicitans. x 110

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[1]The region of the cross veins is the part selected in all cases where not otherwise stated.

Plate 18

1 Portion of male wing of Culex sollicitans. x110
2 Portion of female wing of C. taeniorhynchus. x110
3 Portion of male wing of C. taeniorhynchus. x110
4 Portion of female wing of C. canadensis. x110

Plate 19

1 Portion of male wing of Culex canadensis. x110
2 Portion of female wing of C. atropalpus. x110
3 Portion of male wing of C. atropalpus. x110
4 Portion of female wing of C. territans. x110

Plate 20

1 Portion of male wing of Culex territans. x110
2 Portion of female wing of C. lazarensis. x110
3 Portion of male wing of C. lazarensis. x110
4 Portion of male wing of C. cinereoborealis. x110

Plate 21

1 Portion of female wing of Culex cinereoborealis. x110
2 Portion of female wing of C. impiger. x110
3 Portion of male wing of C. impiger. x110
4 Portion of male wing of C. dyari. x110

Plate 22

1 Portion of female wing of Culex absobrinus. x110
2 Portion of male wing of C. absobrinus. x110
3 Portion of female wing of C. magnipennis. x110

Plate 23

1 Portion of male wing of Culex magnipennis. x110
2 Portion of female wing of C. restuans. x110
3 Portion of male wing of C. restuans. x110
4 Portion of female wing of C. pipiens. x110

Plate 24

1 Portion of male wing of Culex pipiens. x110
2 Portion of female wing of C. abserratus. x110

3 Portion of female wing of C. salinarius. x110

4 Portion of male wing of C. salinarius. x110

Plate 25

1 Portion of female wing of Culex triseriatus. x110

2 Portion of female wing of C. aurifer. x110

3 Portion of male wing of C. aurifer. x110

4 Portion of wing fringe of female Anopheles maculipensis. x110

Plate 26

1 Portion of female wing fringe of Culex cinereoborealis. x110

2 Portion of female wing fringe of C. pipiens. x110

3 Portion of female wing of Taeniorhynchus perturbans. x110

4 Portion of female wing of Aedes fuscus. x110

Plate 27

1 Portion of male wing of Aedes fuscus. x110

2 Portion of female wing of Uranotaenia sapphirina. x110

3 Portion of fifth longitudinal vein of female wing of U. sapphirina, x110, showing the orbicular finely striated violet scales

4 Portion of female wing of Corethra lintneri. x110

Plate 28

1 Portion of female wing of Corethra cinctipes. x110

2 Portion of female wing of Eucorethra underwoodi. x110

3 Portion of female wing of Sayomyia trivittata. x110

4 Portion of female wing of S. hudsoni. x110

Plate 29

1 Male genitalia of Anopheles punctipennis. x110

2 Male genitalia of A. maculipennis. x110

Plate 30

1 Male genitalia of Psorophora ciliata. x 55
2 Male genitalia of Culex cantans. x 80

Plate 31

1 Male genitalia of Culex sylvestris. x 110
2 Male genitalia of C. cantator. x 110

Plate 32

1 Male genitalia of Culex sollicitans. x 110
2 Male genitalia of C. atropalpus. x 110

Plate 33

1 Male genitalia of Culex taeniorhynchus. x 110
2 Male genitalia of C. aurifer. x 80

Plate 34

1 Male genitalia of Culex territans. x 110
2 Appendages of basal segment of clasp of C. territans. x 240
3 Male genitalia of C. canadensis. x 110

Plate 35

1 Male genitalia of Culex dyari. x 110
2 Male genitalia of C. lazarensis. x 110

Plate 36

1 Male genitalia of Culex impiger. x 110
2 Male genitalia of C. cinereoborealis. x 80

Plate 37

1 Male genitalia of Culex absobrinus. x 65
2 Male genitalia of C. magnipennis. x 65

Plate 38

1 Male genitalia of Culex restuans. x 110
2 Appendages of basal segment of clasp of C. restuans. x 240

3 Male genitalia of C. pipiens. x 80

4 Male genitalia of C. pipiens, showing dissected clasp. x 110

5 Appendages of basal segment of clasp of C. pipiens. x 240

Plate 39

1 Male genitalia of Culex salinarius. x 110

2 Appendages of basal segment of clasp of C. salinarius. x 240

3 Male genitalia of Aedes fuscus. x 110

4 Male genitalia of Eucorethra underwoodi. x 55

Plate 40

1 Male genitalia of Sayomyia hudsoni. x 110

2 Male genitalia of S. rotundifolia. x 110

Plate 41

1 Air tube of Psorophora ciliata. x 30

2 Air tube of Culex fitchii. x 55

3 Air tube of C. abfitchii. x 55

4 Air tube of C. cantans. x 55

Plate 42

1 Air tube of Culex taeniorhynchus. x 45

2 Air tube of C. sollicitans. x 45

3 Air tube of C. cantator. x 45

4 Air tube of C. canadensis. x 45

5 Air tube of C. sylvestris. x 45

Plate 43

1 Air tube of Culex impiger. x 45

2 Air tube of C. lazarensis. x 45

3 Air tube of Aedes fuscus. x 45

4 Air tube of Culex dyari. x 45

5 Air tube of C. salinarius. x 45

6 Air tube of C. territans. x 45

Plate 44

1 Air tube of Culex pipiens. x 55

2 Air tube of C. *jamaicensis*. x 25
3 Air tube of C. *restuans*. x 45.
4 Air tube of C. *serratus*. x 55
5 Air tube of C. *atropalpus*. x 80

Plate 45

1 Air tube of *Culex cinereoborealis*. x 55
2 Air tube of C. *abserratus*. x 45
3 Air tube of C. *magnipennis*. x 45
4 Air tube of C. *absobrinus*. x 45

Plate 46

1 Air tube of *Culex melanurus*. x 45
2 Air tube of *Uranotaenia sapphirina*. x 30
3 Air tube of *Culex dupreei*. x 45
4 Air tube of C. *discolor*. x 45
5 Air tube of C. *aurifer*. x 45
6 Air tube of C. *triseriatus*. x 45

Plate 47

1 Larva of *Sayomyia hudsoni*. x 9 (Reproduced from photomicrograph by Joseph McKay, Troy)
2 Air sack of S. *albipes*. x 110
3 Air tube of *Eucorethra underwoodi*. x 21

Plate 48

1 Comb of *Anopheles punctipennis*. x 110
2 Comb of A. *maculipennis*. x 110
3 Comb of *Culex fitchii*. x 110
4 Comb of C. *abfitchii*. x 110
5 Comb of C. *discolor*. x 110
6 Comb of C. *melanurus*. x 110
7 Comb of *Uranotaenia sapphirina*. x 110

Plate 49

1 Comb of *Culex sylvestris*. x 110
2 Comb of C. *cantator*. x 240
3 Comb of C. ?*cantans*. x 240

Plate 50

1 Comb of *Culex cantans*, normal form about Albany. x 240
2 Comb of *C. canadensis*. x 240
3 Comb of *C. sollicitans*. x 240

Plate 51

1 Comb of *Culex magnipennis*. x 240
2 Comb of *C. absobrinus*. x 240
3 Comb of *C. lazarensis*. x 240

Plate 52

1 Comb of *Culex impiger*. x 110
2 Comb of *C. aurifer*. x 110
3 Comb of *Aedes fuscus*, x 110, portion of one scale sketched in
4 Comb of *Culex serratus*. x 110
5 Comb of *C. cinereoborealis*. x 110

Plate 53

1 Comb of *Culex taeniorhynchus*. x 240
2 Comb of *C. restuans*. x 240
3 Comb of *C. pipiens*. x 240
4 Comb of *C. salinarius*. x 240
5 Comb of *C. triseriatus*. x 240
6 Comb of *C. dupreei*. x 110

Plate 54

1 Comb of *Culex dyari*. x 220
2 Comb of *C. atropalpus*. x 240

Plate 55

1 Labial plate of *Culex cinereoborealis* larva. x 220
2 Labial plate of *C. magnipennis* larva. x 220
3 Labial plate of *C. atropalpus* larva. x 220
4 Labial plate of *C. dyari* larva. x 220
5 Labial plate of *C. aurifer* larva. x 220

Plate 56

1 Male genitalia of Janthinosoma musica. x110

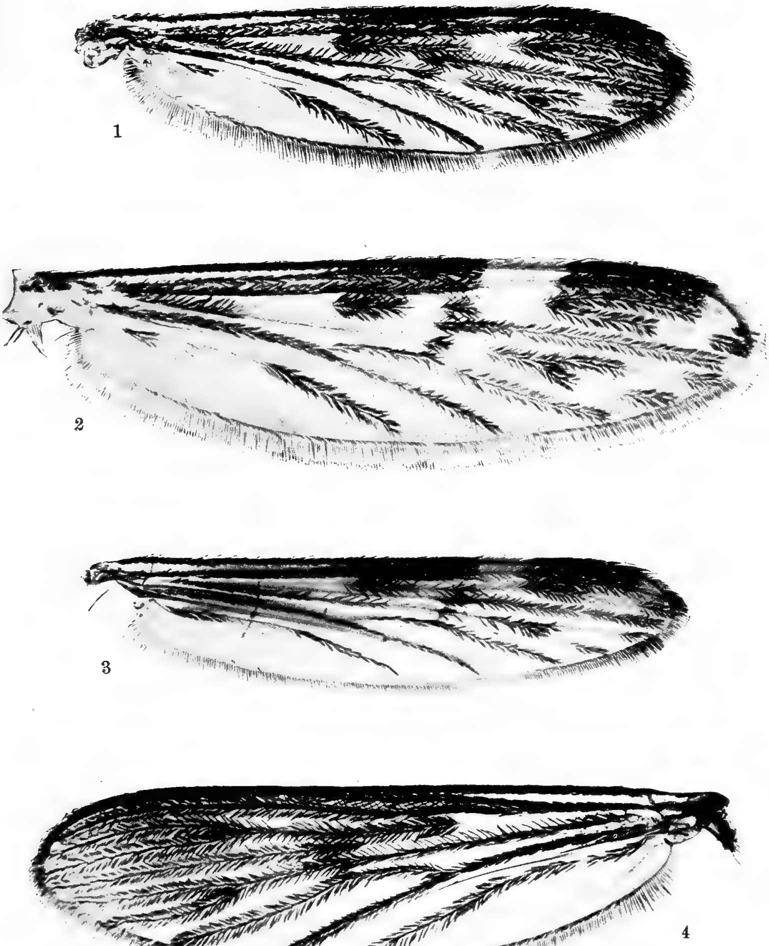
2 Male genitalia of Culex jamaicensis. x110

Plate 57

1 Male genitalia of Culex melanurus. x110

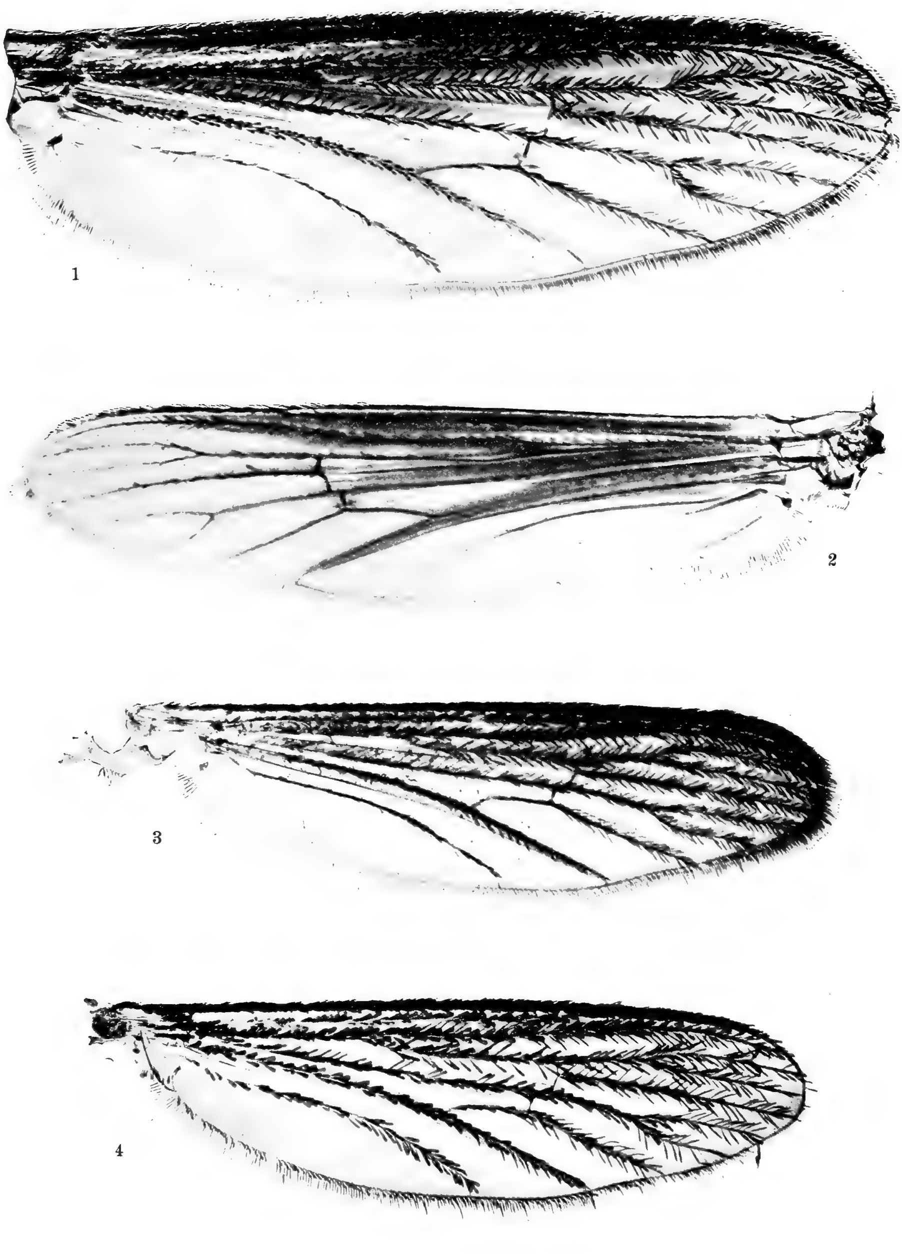
2 Male genitalia of C. triseriatus. x110

Plate 1



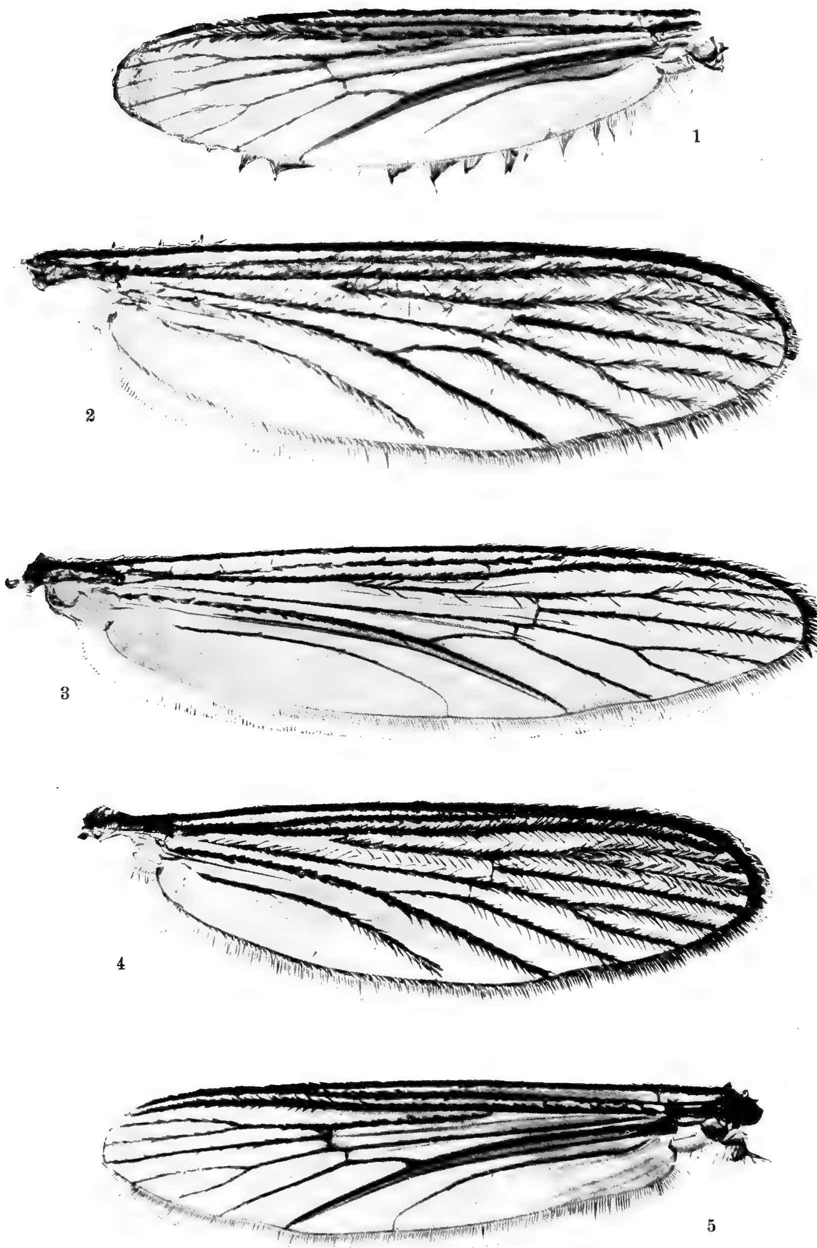
1–3 Anopheles punctipennis. 4,5 A. maculipennis

Plate 2

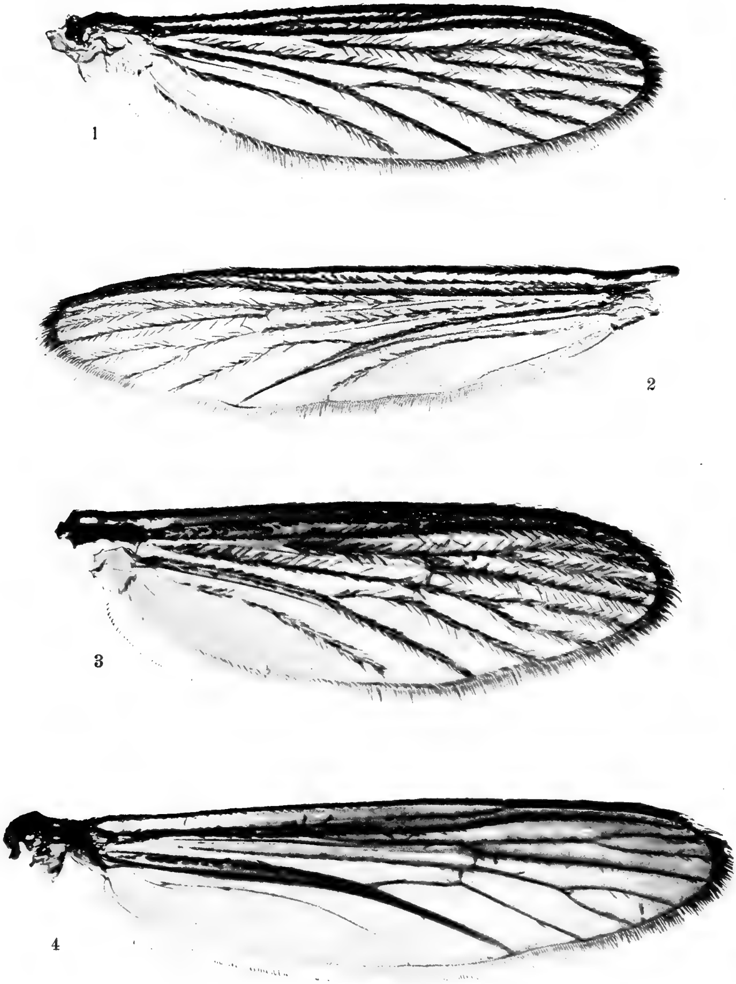


1,2 Psorophora ciliata. 3 Janthinosoma musica
4 Culex fitchii

Plate 3

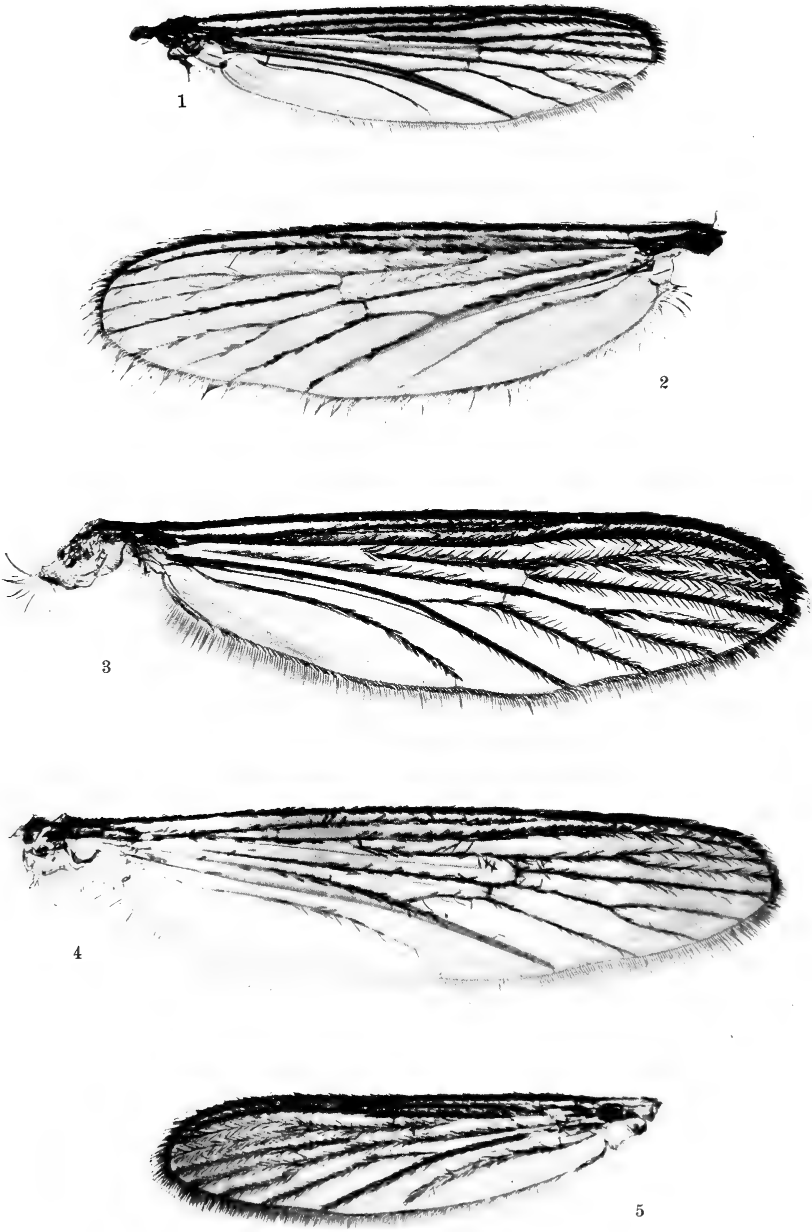


1 Culex fitchii. 2,3 C. cantans. 4,5 C. sylvestris



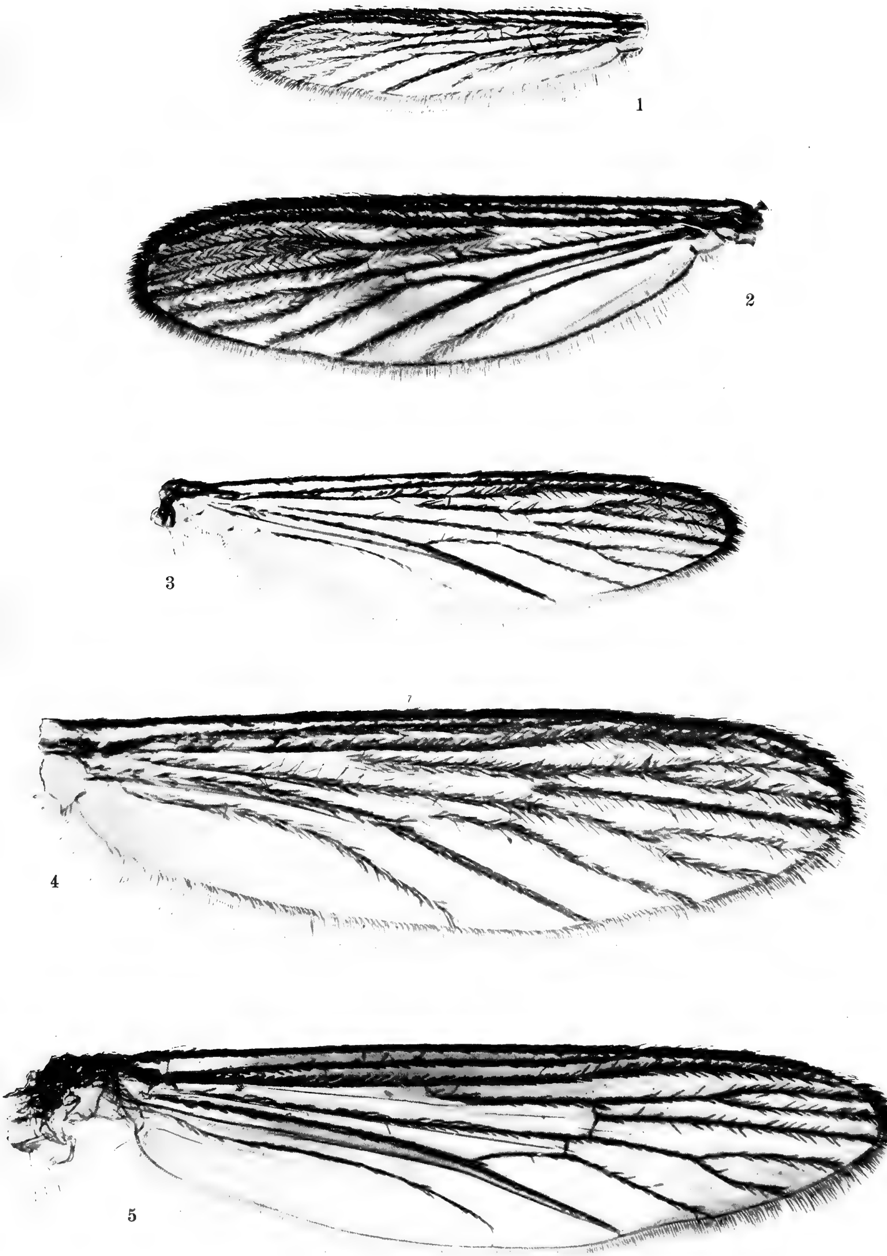
1, 2 Culex cantator. 3, 4 C. sollicitans
5 C. taeniorhynchus

Plate 5



1 Culex taeniorhynchus. 2 C. onondagensis
3, 4 C. canadensis. 5 C. atropalpus

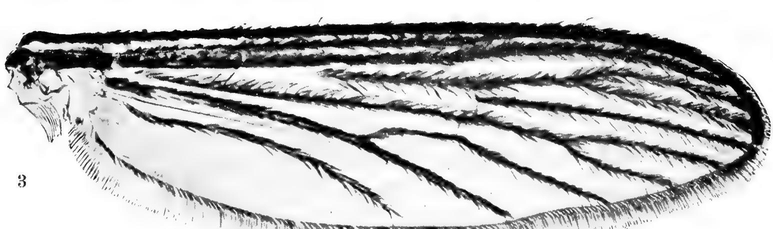
Plate 6



1 Culex atropalpus. 2, 3 C. territans. 4, 5 C. lazarensis

1

2



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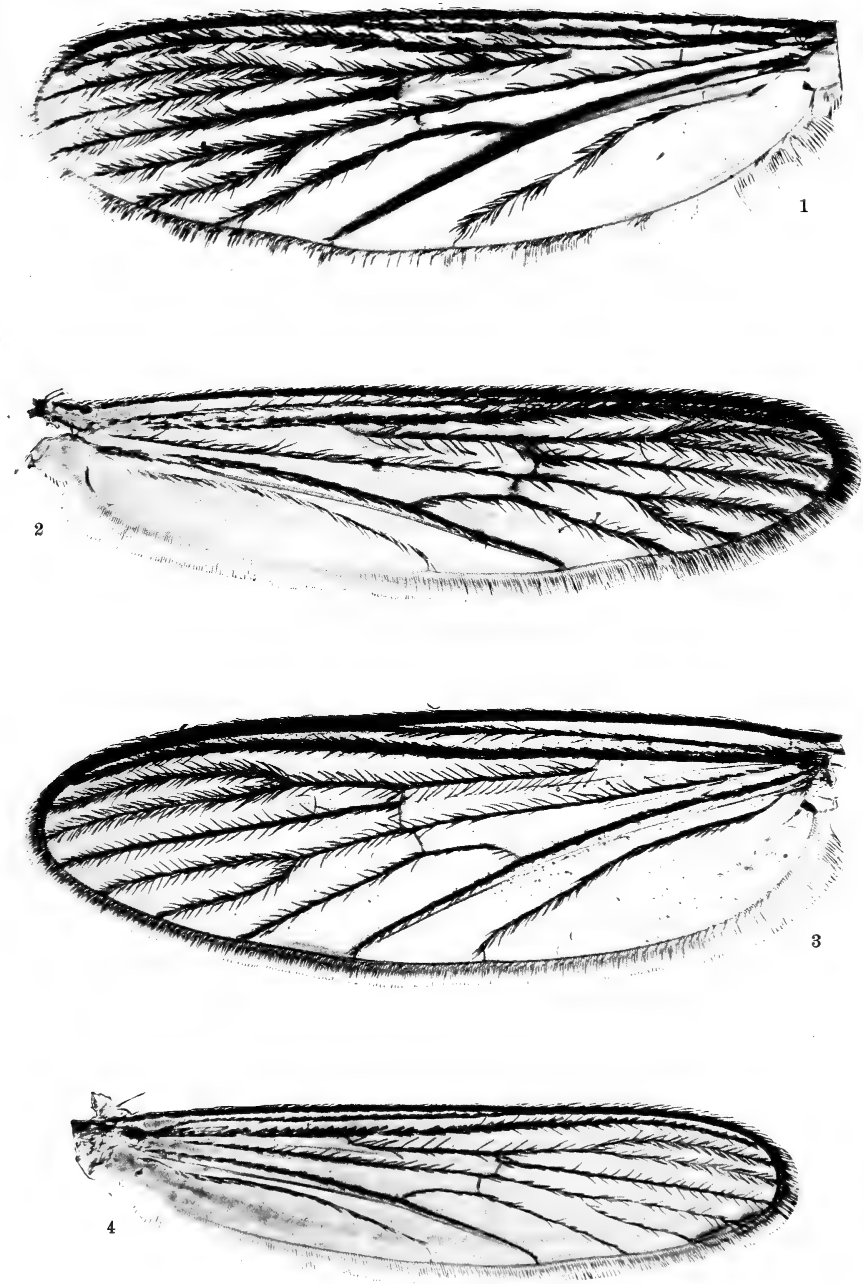
4

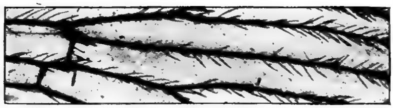
1, 2 Culex cinereoborealis. 3,4 C. impiger

Plate 8



1, 2 Culex absobrinus. 3, 4 C. magnipennis

Plate 9



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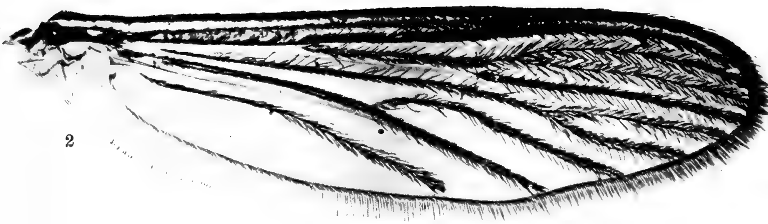

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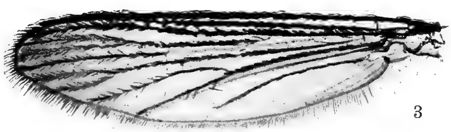

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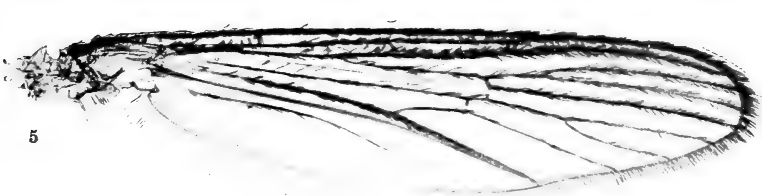
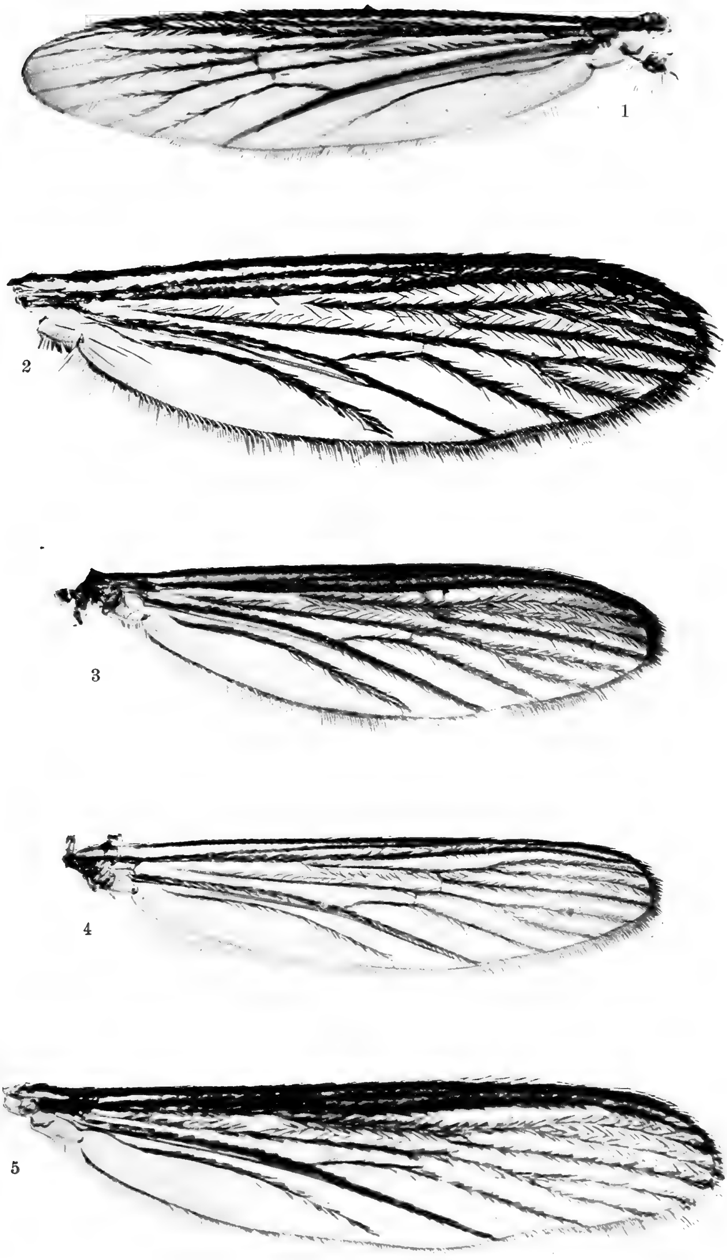


5

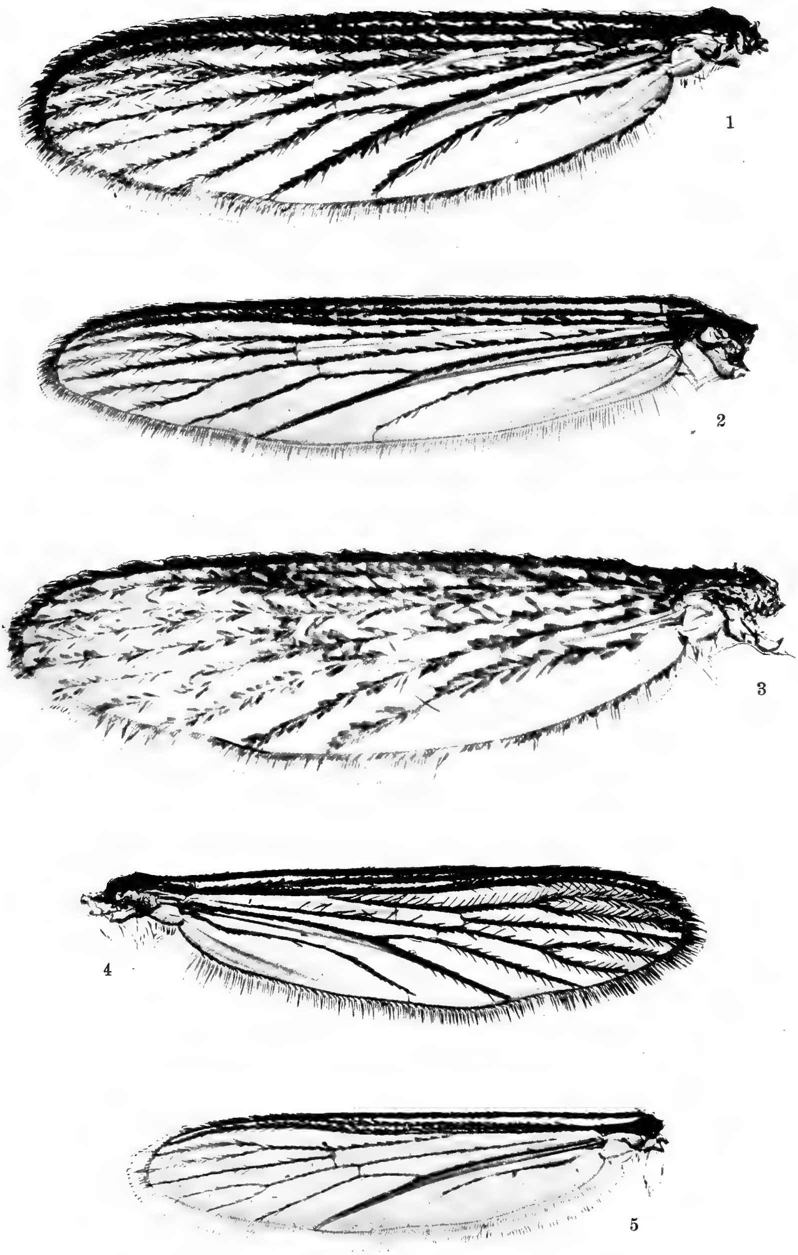
1 Culex consobrinus. 2,3 C. restuans. 4,5 C. pipiens

Plate 10



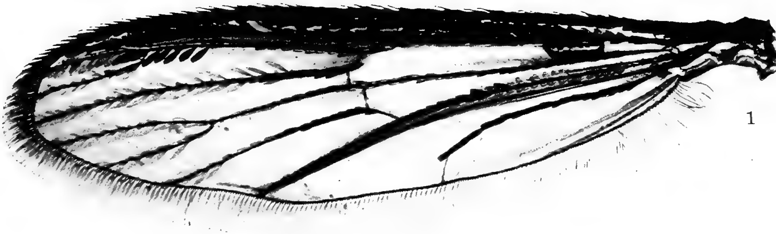
1 Culex dyari. 2 C. abserratus 3, 4 C. salinarius
5 C. triseriatus

Plate 11



1, 2 Culex aurifer. 3 Taeniorhynchus perturbans
4, 5 Aedes fuscus

Plate 12



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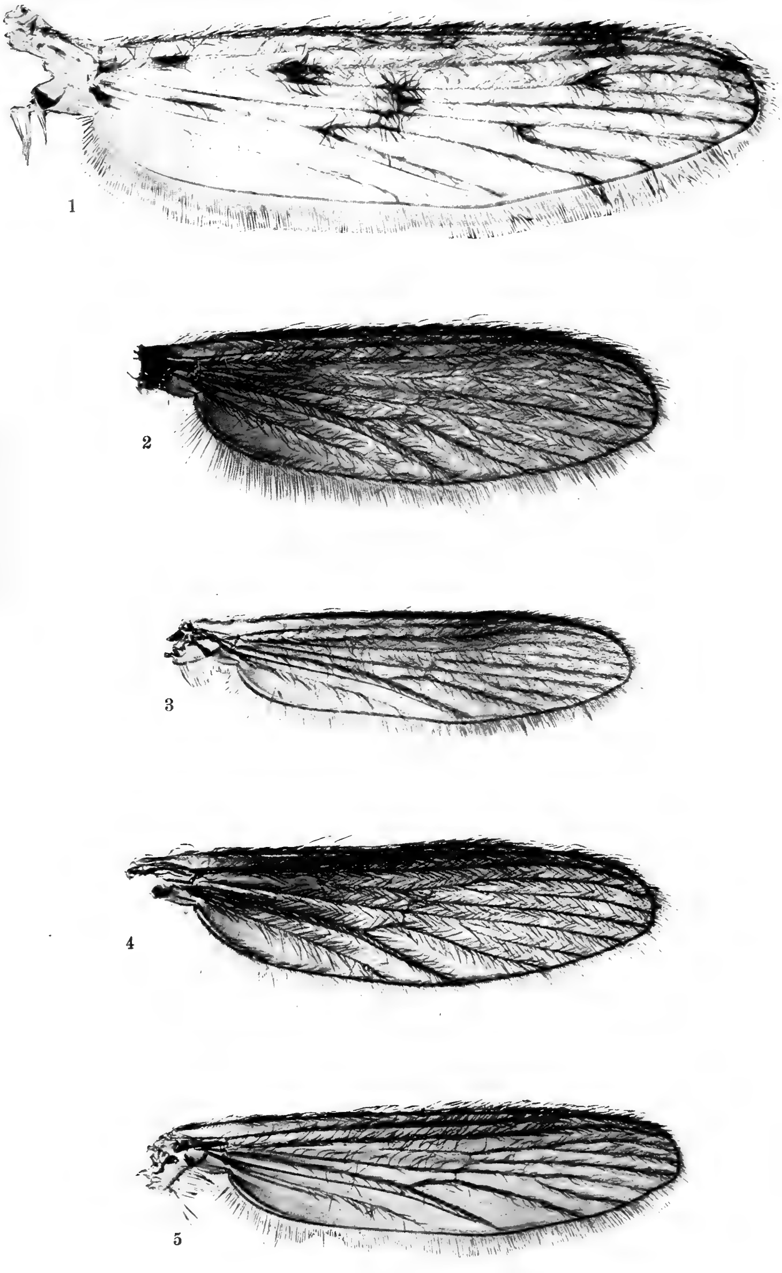
1 Uranotaenia sapphirina. 2,3 Eucorethra underwoodi. 4 Sayomyia trivittata



1 Sayomyia trivittata. 2,3 S. rotundifolia
4,5 S. hudsoni

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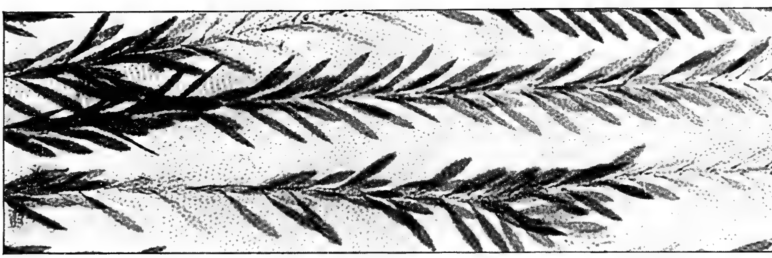

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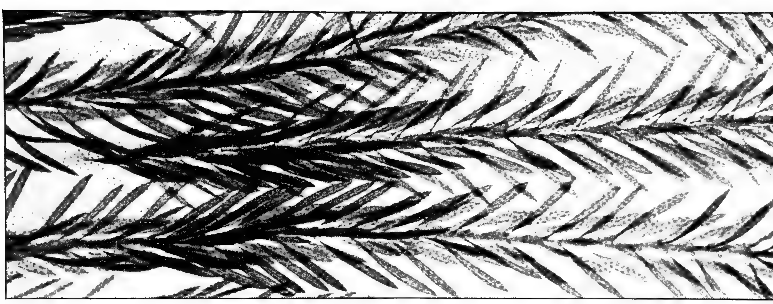

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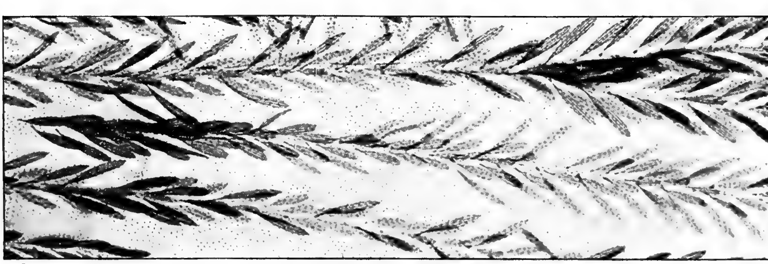
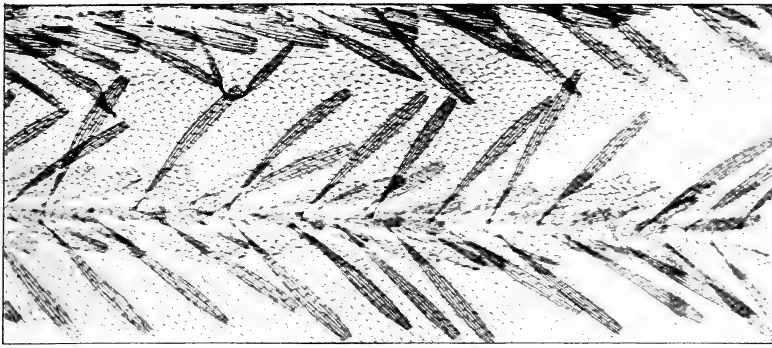


4

1, 2 Anopheles punctipennis. 3, 4 A. maculipennis



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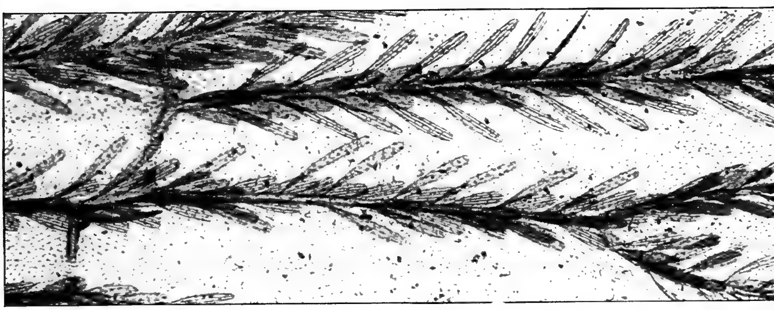

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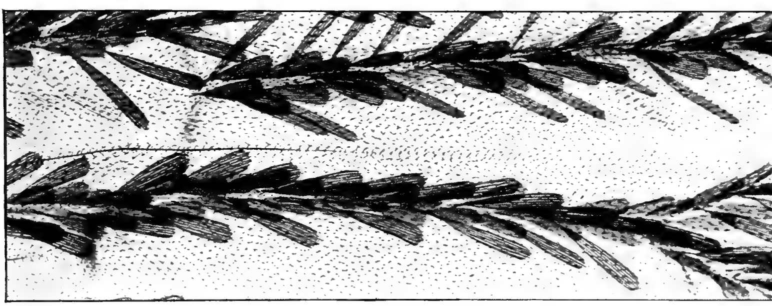

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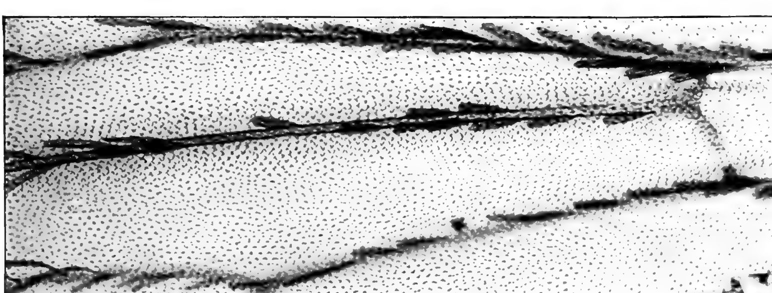

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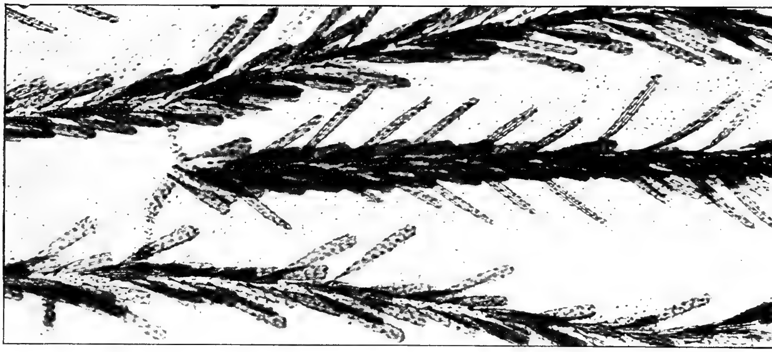
1 Psorophora ciliata. 2 Janthinosoma musca
3, 4 Culex fitchii



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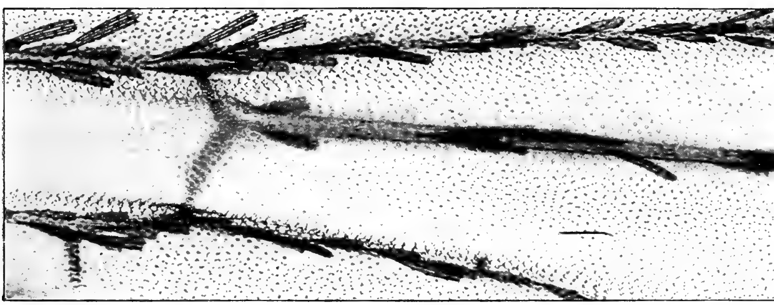

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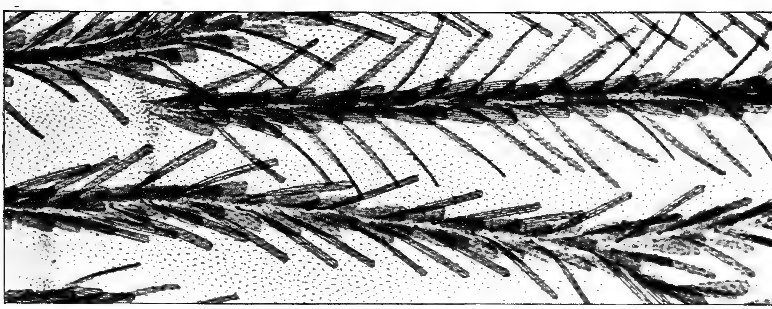

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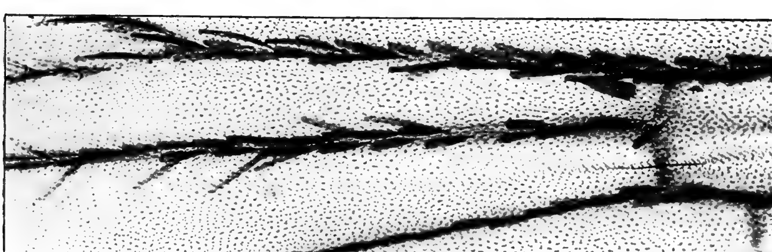

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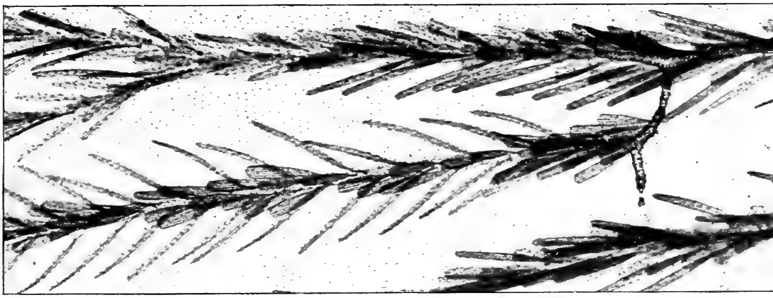
1, 2 Culex cantans. 3, 4 C. sylvestris



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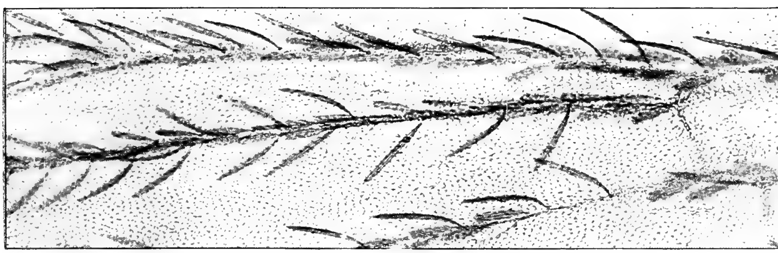

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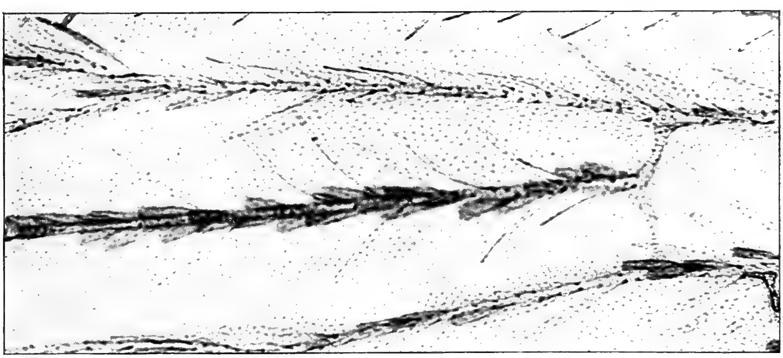

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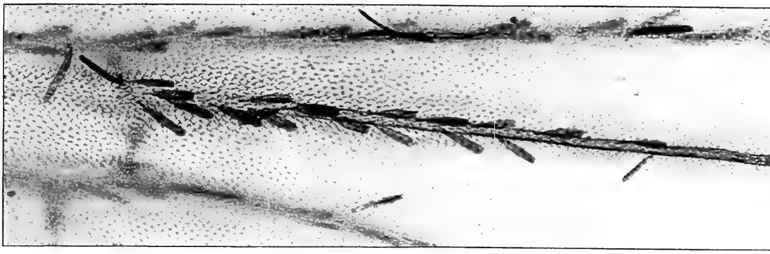
4

1, 2 C. cantator. 3 C. onondagensis. 4 C. sollicitans



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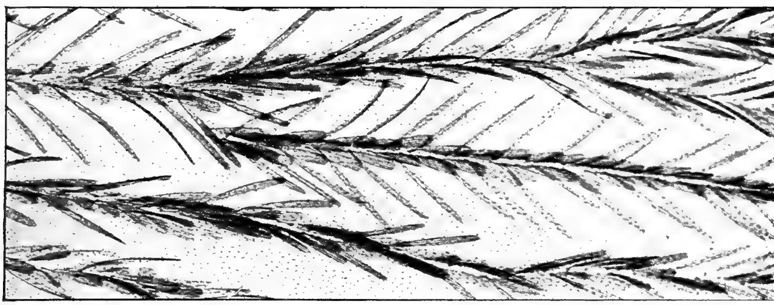

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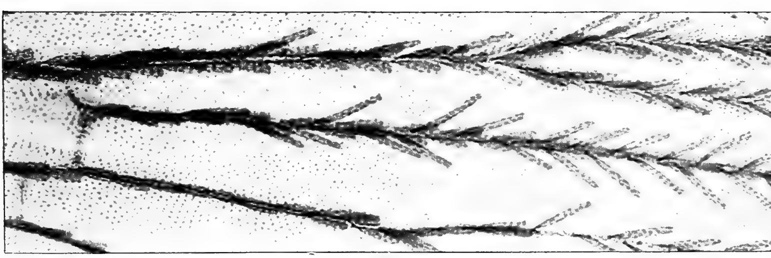

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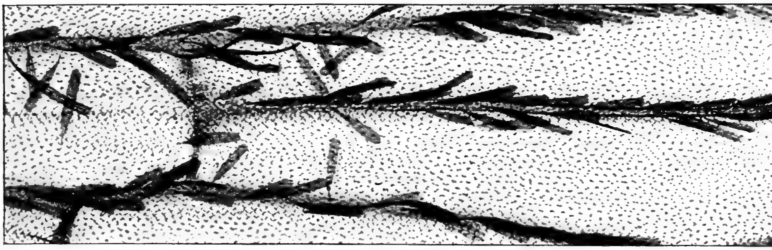
4

1 Culex sollicitans. 2, 3 C. taeniorhynchus.
4 C. canadensis



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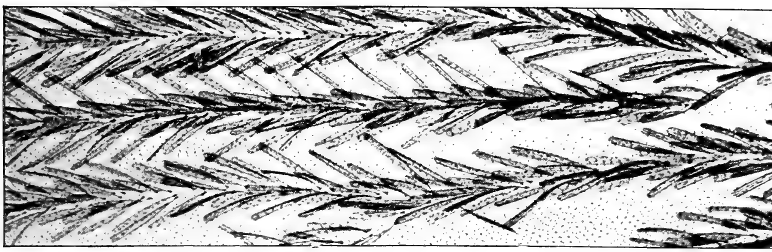

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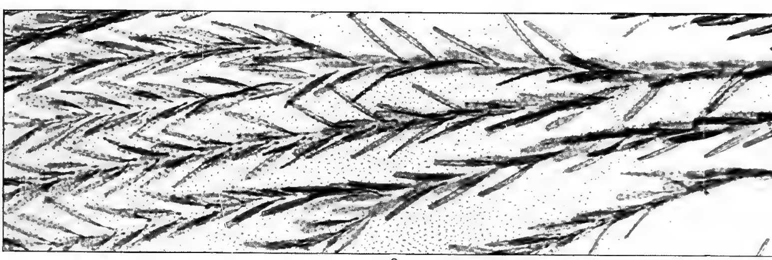

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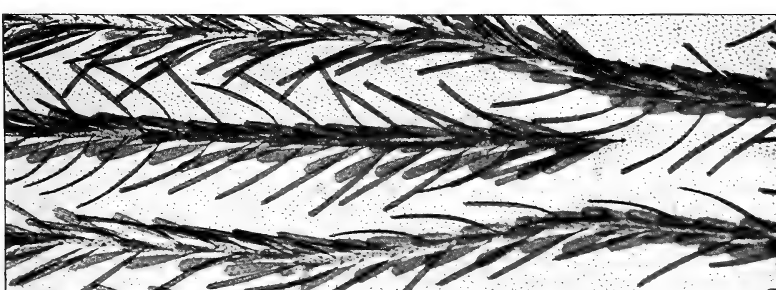

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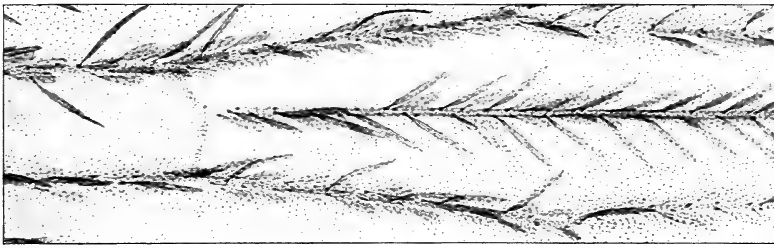
1 Culex canadensis. 2, 3 C. atropalpus. 4 C. territans

Plate 20



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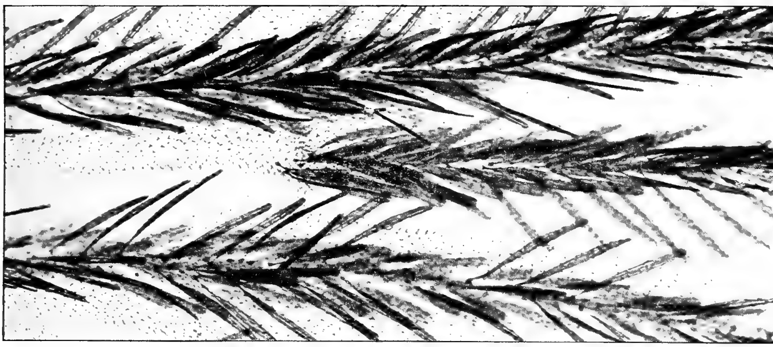

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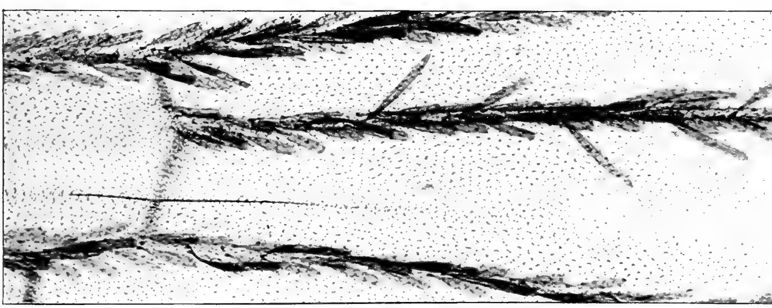

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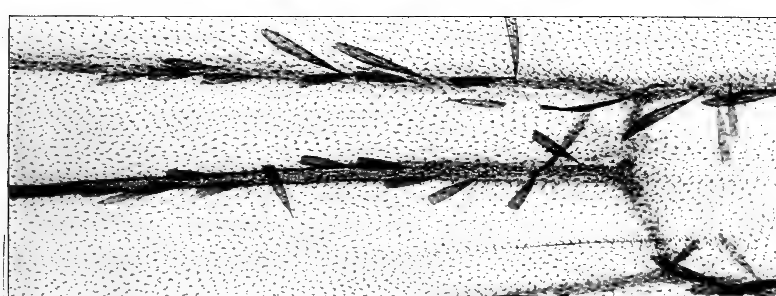
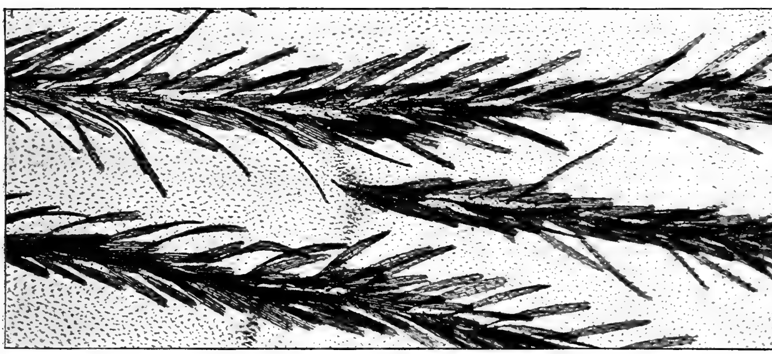


4

1 Culex territans. 2,3 C. lazarensis.
4 C. cinereoborealis

1



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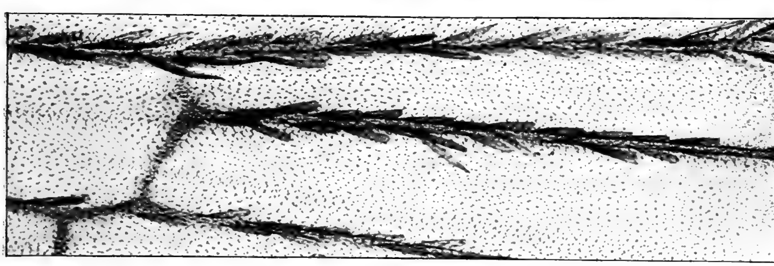

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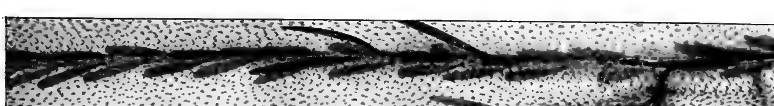


4

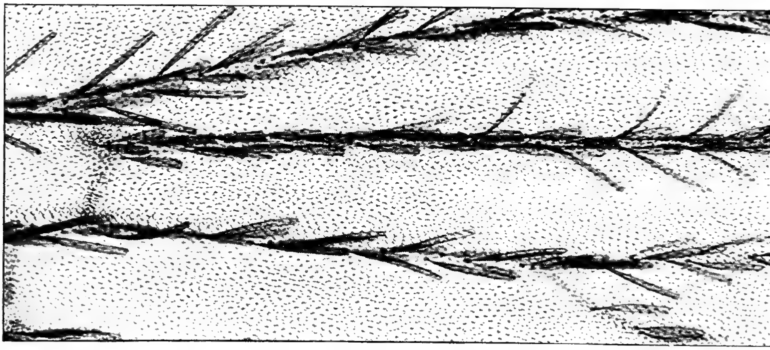
1 Culex cinereoborealis. 2,3 C. impiger. 4 C. dyari

1

2

3

1, 2 C. absobrinus. 3 C. magnipennis



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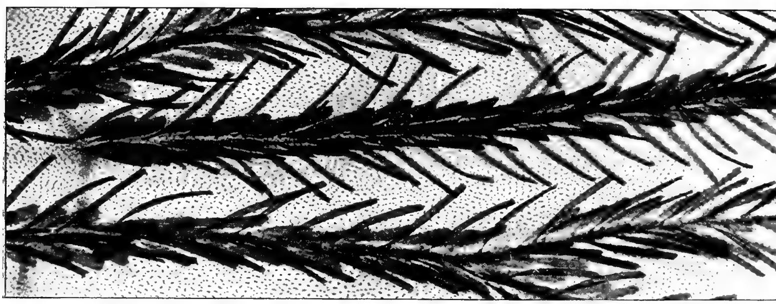

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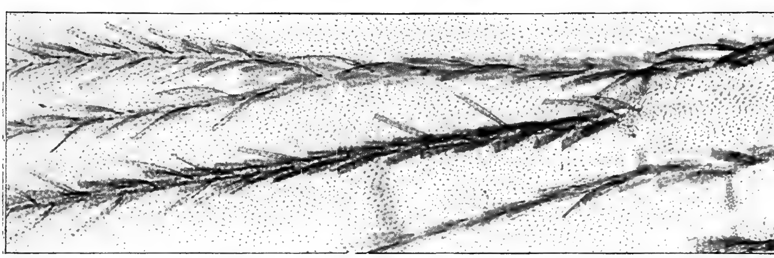

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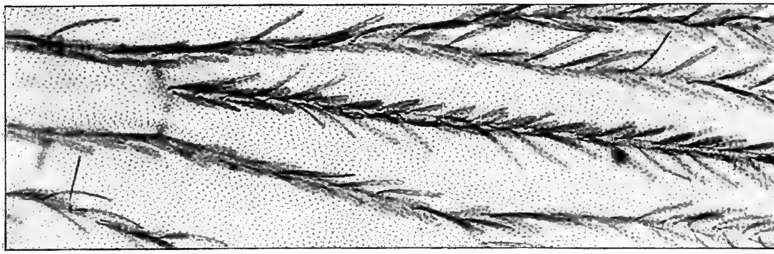
4

1 Culex magnipennis. 2,3 C. restuans. 4 C. pipiens

Plate 24



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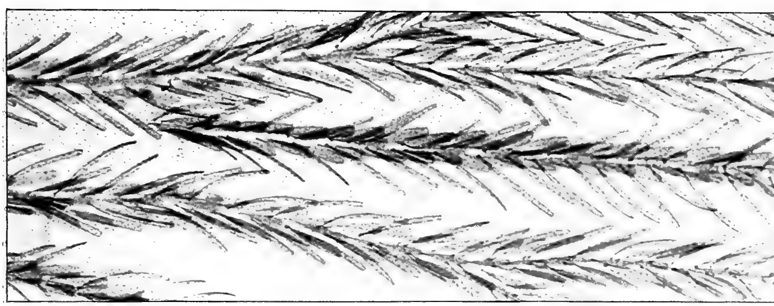

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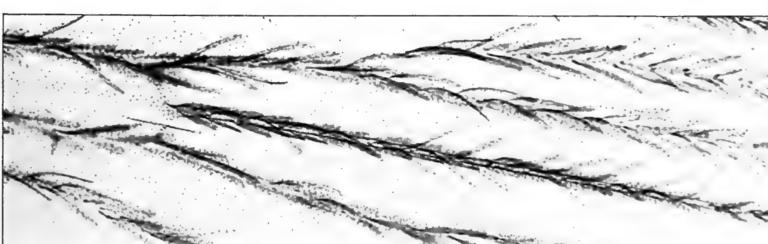
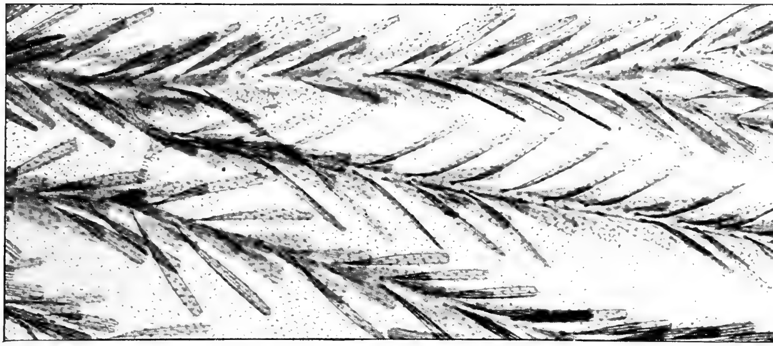


4

1 Culex pipiens. 2 C. abserratus. 3,4 C. salinarius



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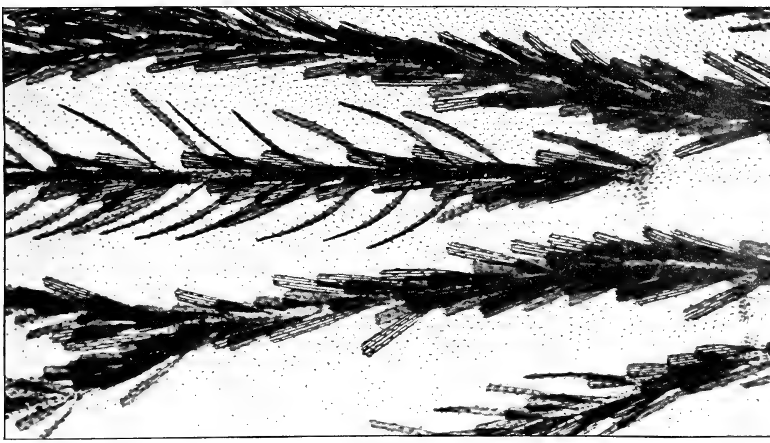

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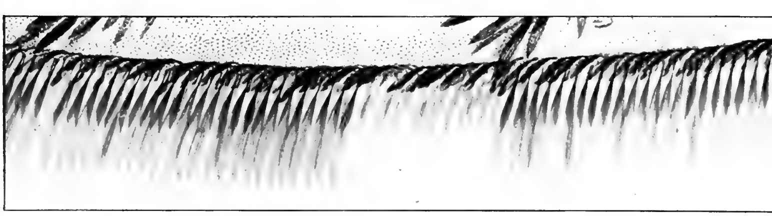
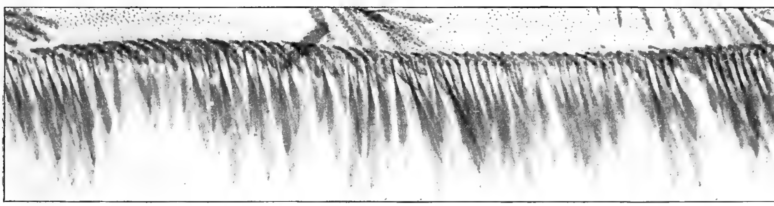


4

1 Culex triseriatus. 2,3 C. aurifer. 4 Anopheles maculipennis

1



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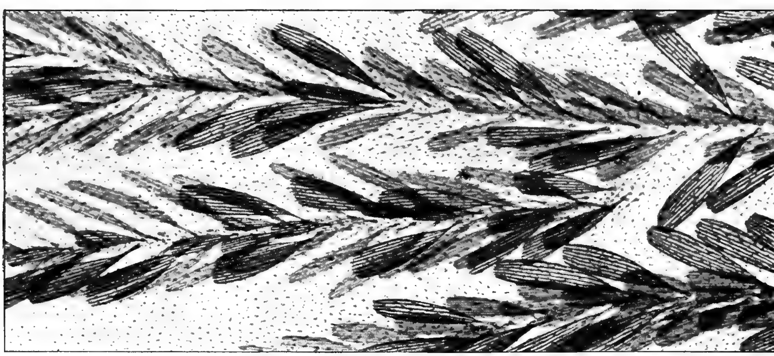

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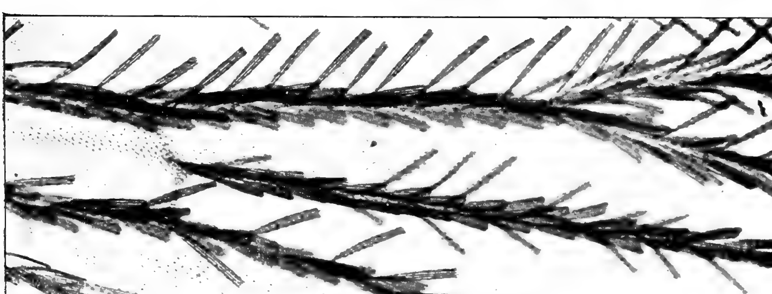
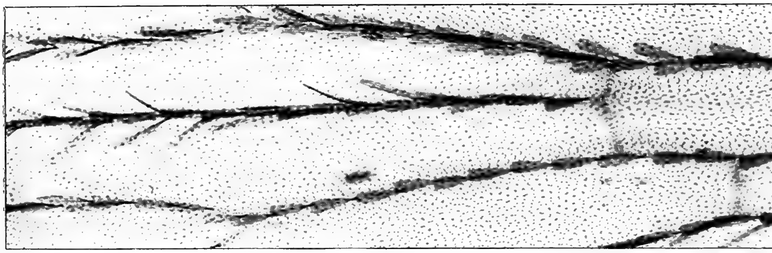


4

1 Culex cinereoborealis. 2 C. pipiens. 3 Taeniorhynchus perturbans. 4 Aedes fuscus



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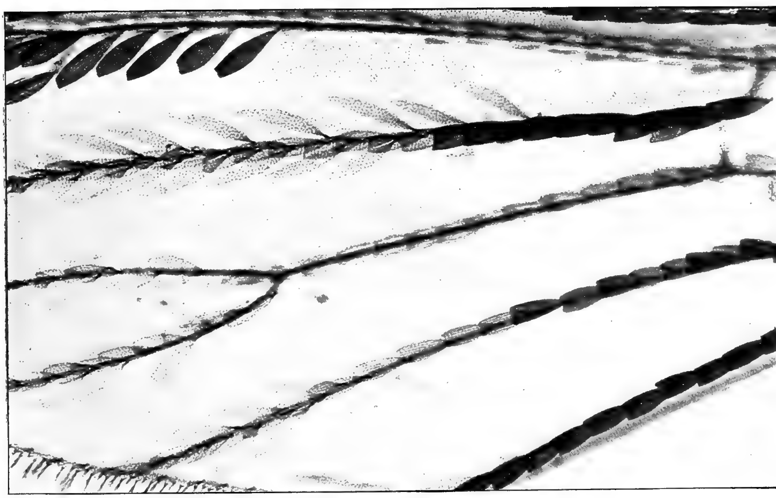

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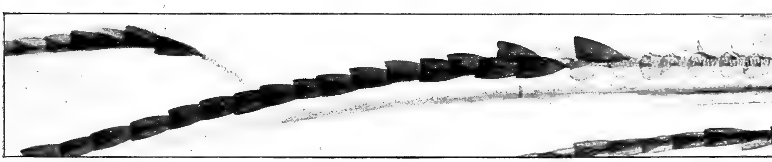

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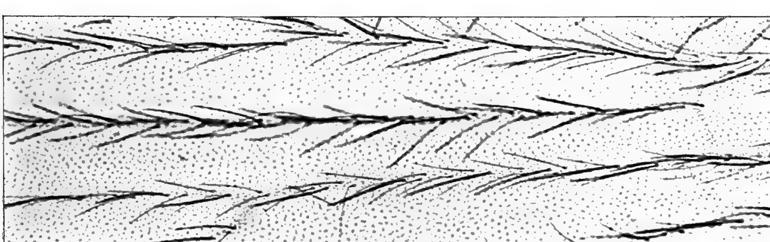
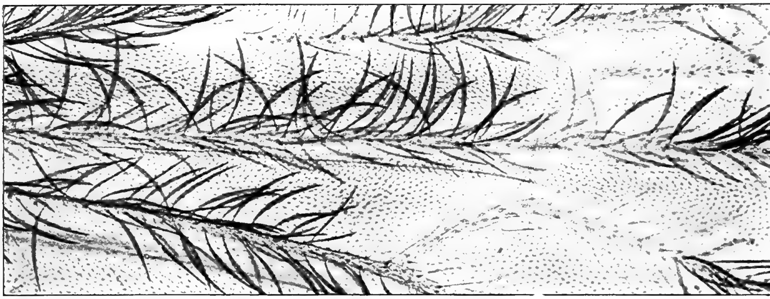


4

1 *Aedes fuscus.* 2, 3 *Uranotaenia sapphirina.*
4 *Corethra lintneri*



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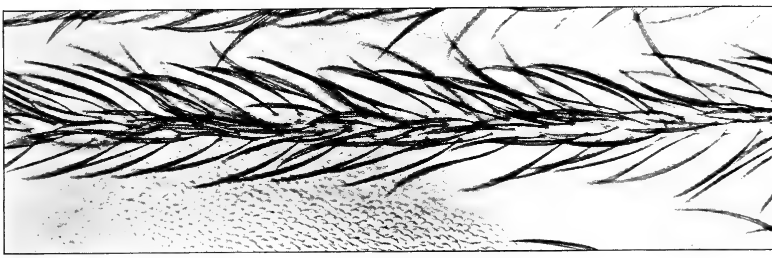

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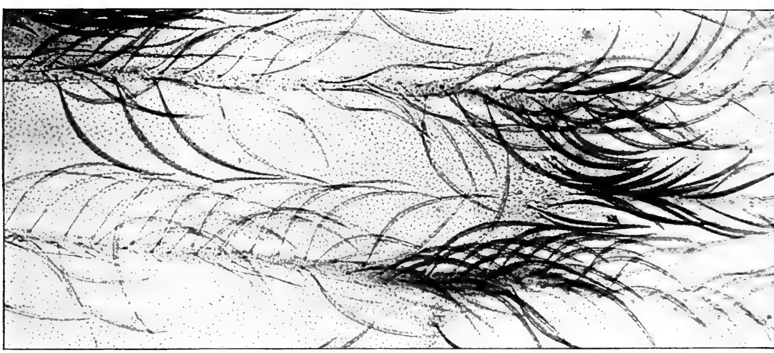

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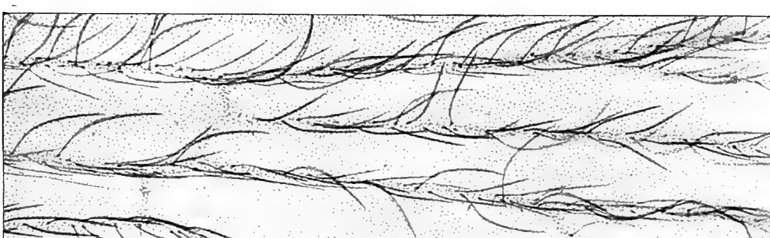
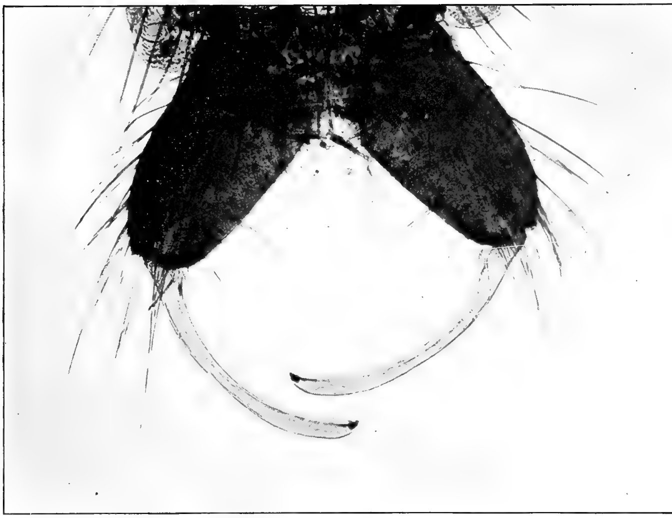


4

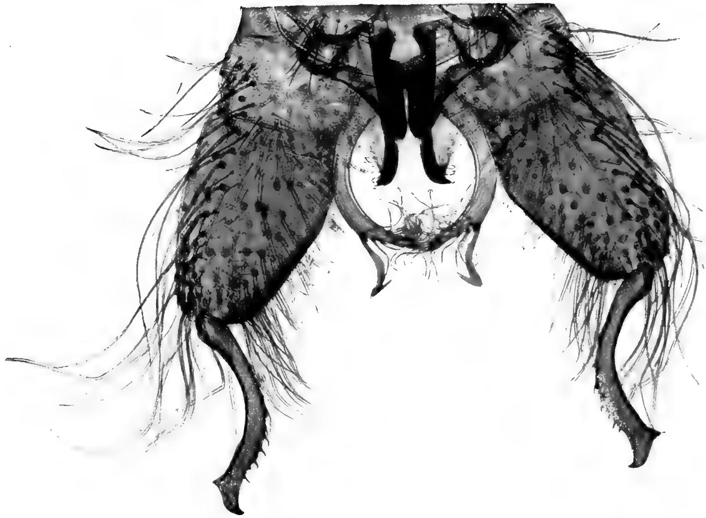
1 Corethra cinctipes. 2 Eucorethra underwoodi.
3 Sayomyia trivittata. 4 S. hudsoni



1

2

1 Anopheles punctipennis. 2 A. maculipennis



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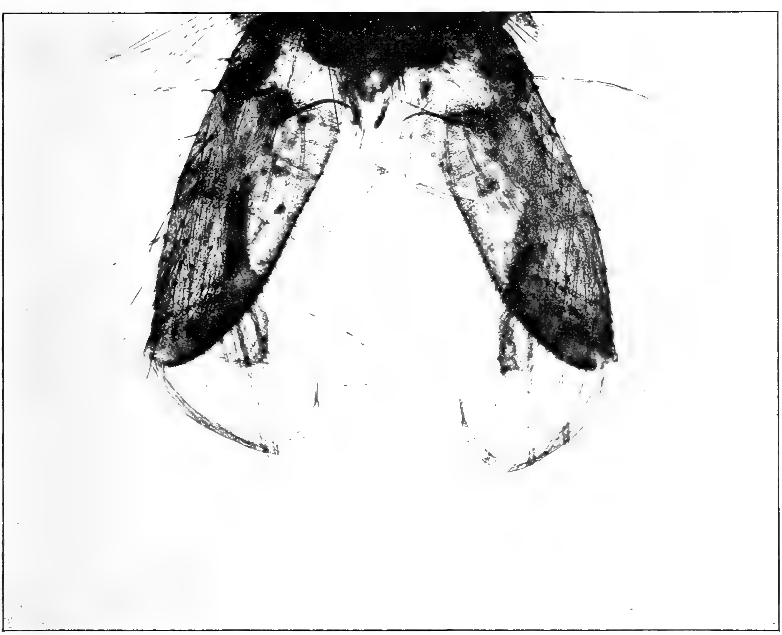
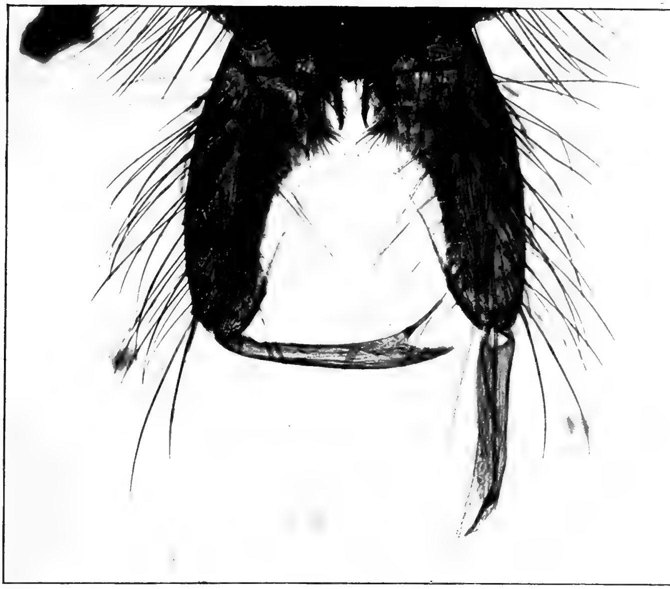


2

1 Psorophora ciliata. 2 Culex cantans



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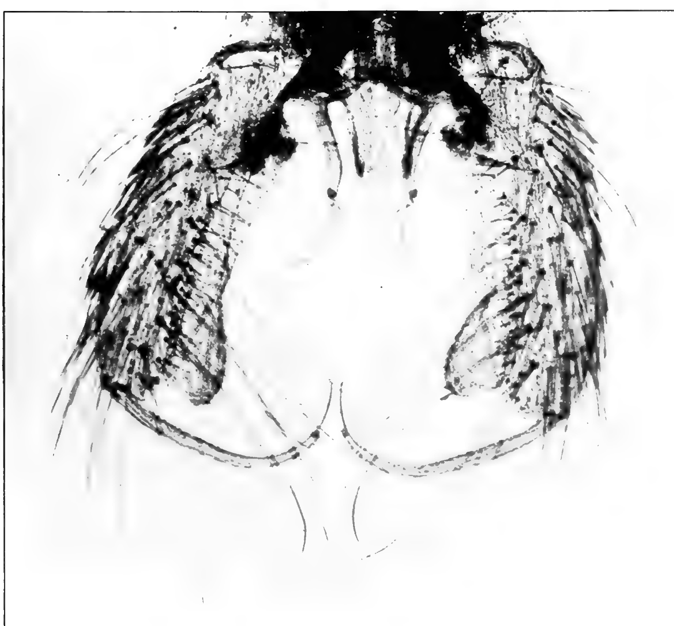


2

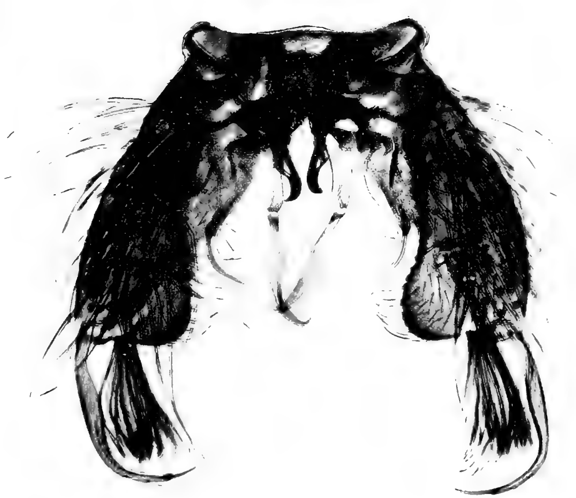
1 Culex sylvestris. 2 C. cantator

1

2

1 Culex sollicitans. 2 C. atropalpus

1

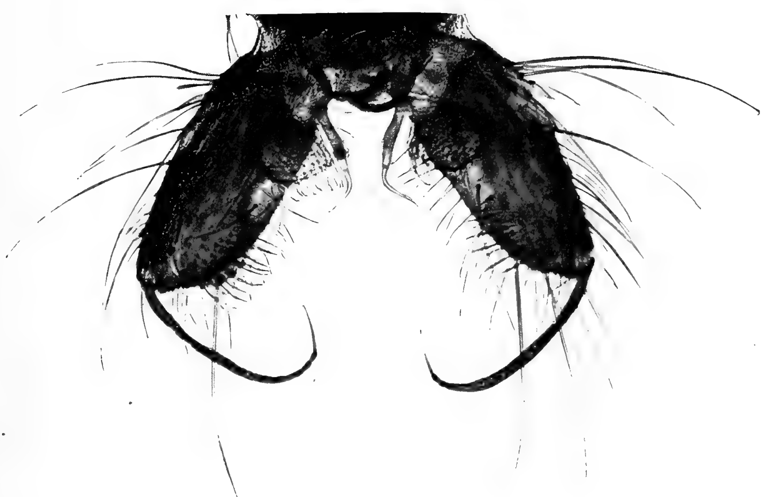


2

1 Culex taeniorhynchus. 2 C. aurifer

1

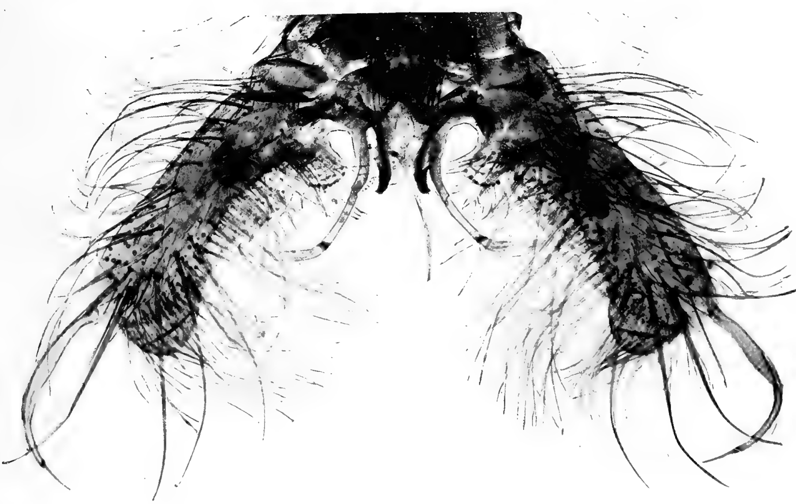
2



3

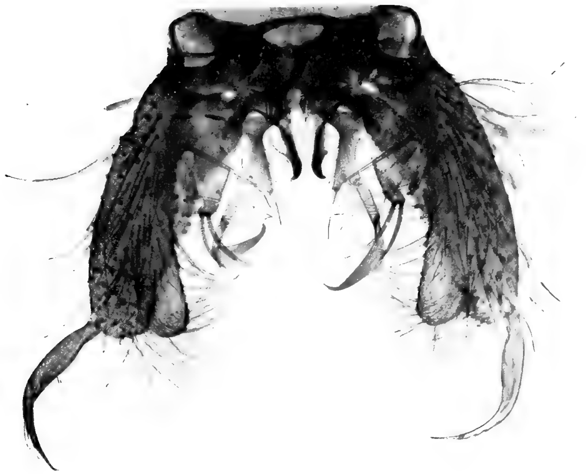
1, 2 Culex territans. 3 C. canadensis

1



2

1 Culex dyari. 2 C. lazarensis



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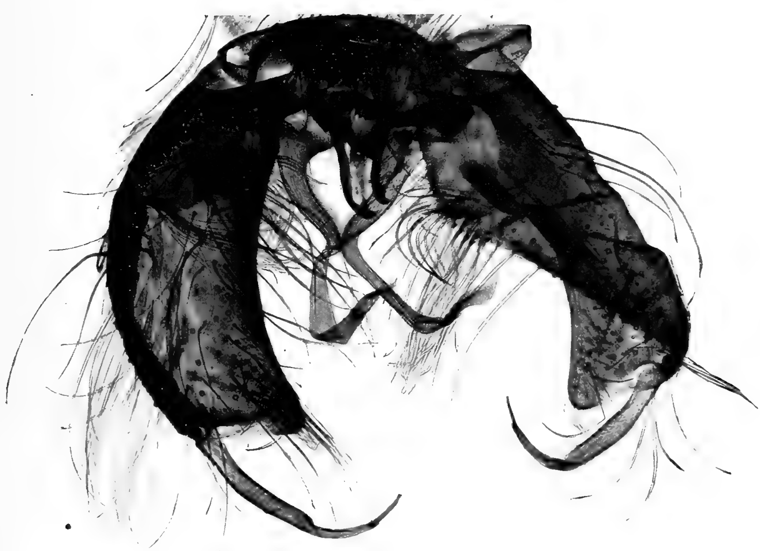
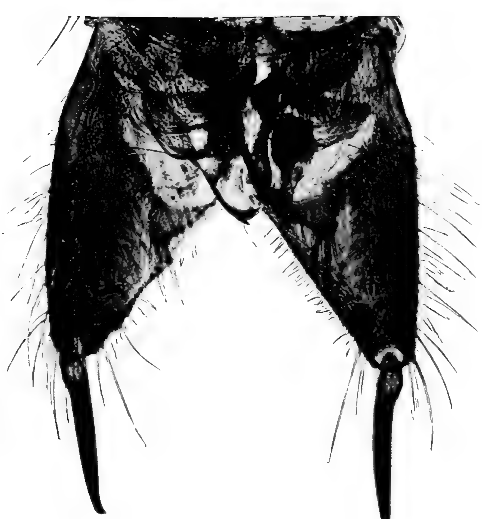


2

1 Culex impiger. 2 C. cinereoborealis

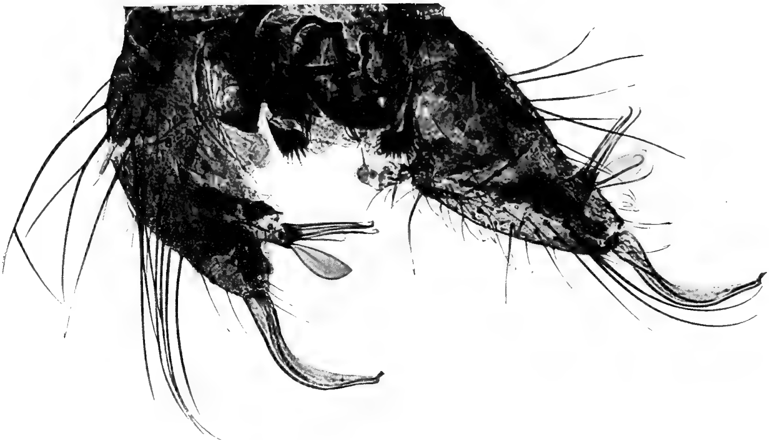
1



2

1 Culex absobrinus. 2 C. magnipennis

Plate 38



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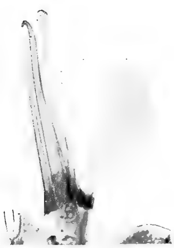

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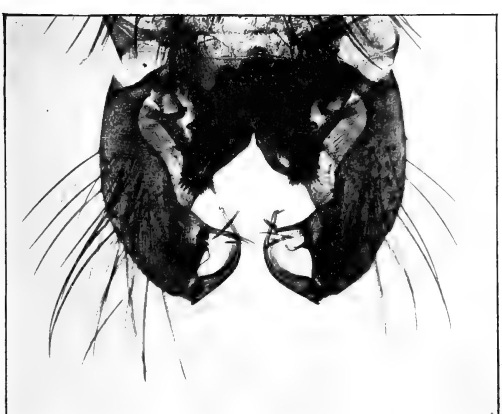
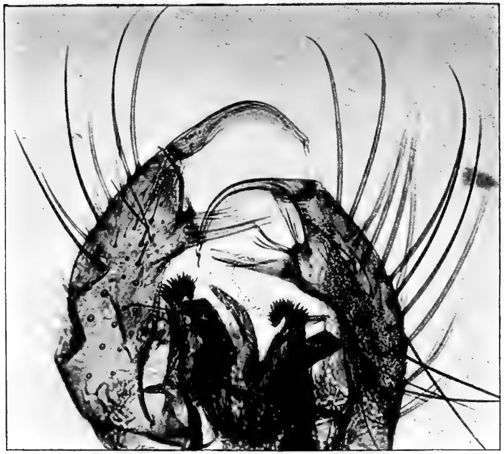


3

4

1, 2 Culex restuans. 3–5 C. pipiens



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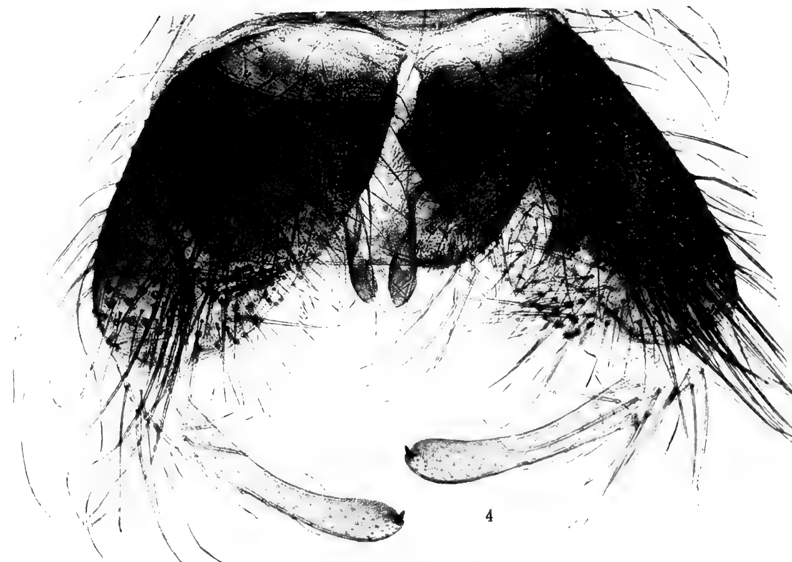
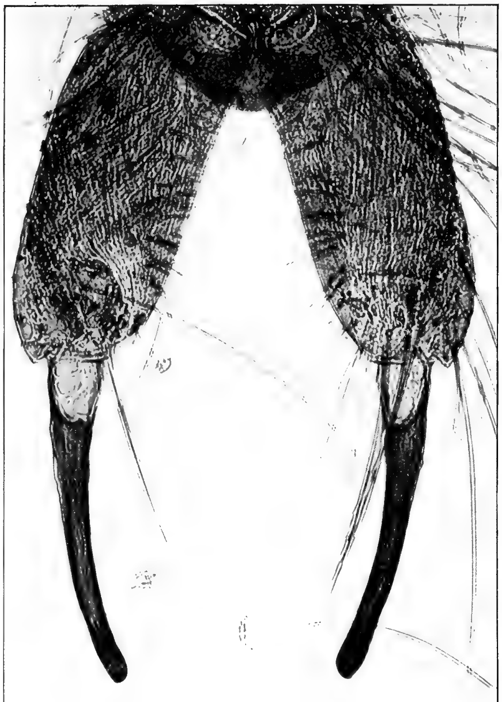
2

3



4

1,2 Culex salinarius. 3 Aedes fuscus. 4 Eucorethra underwoodi



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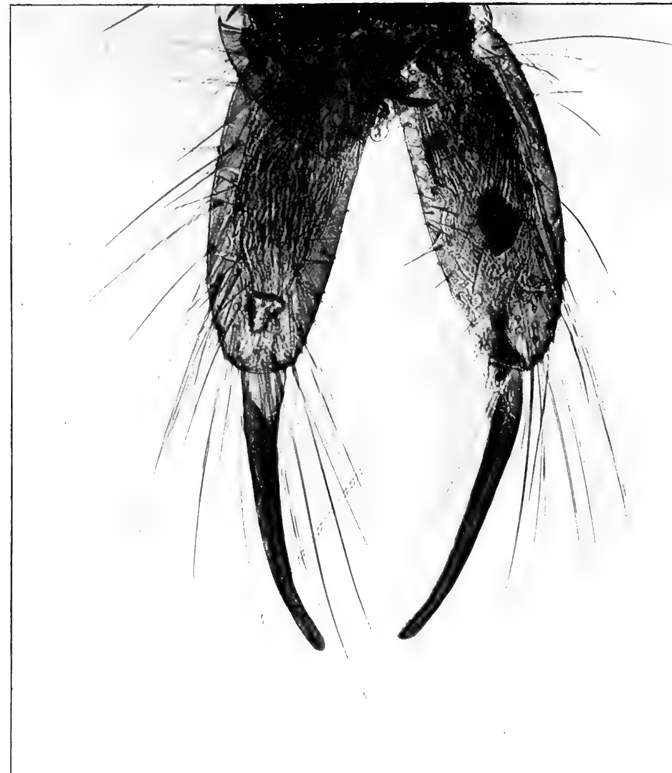
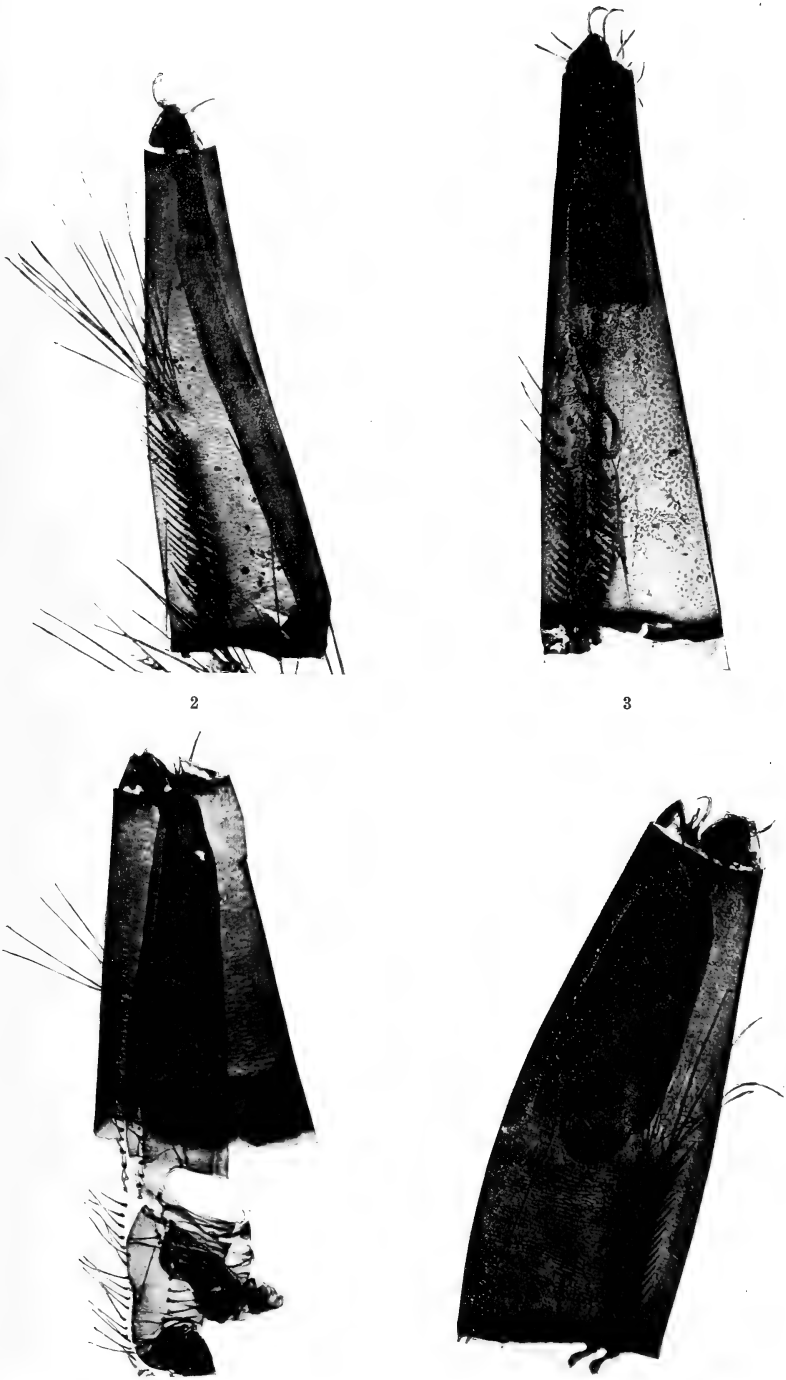


2

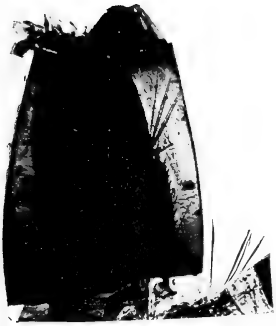
1 *Sayomyia hudsoni*. 2 *S. rotundifolia*

Plate 41



1 Psorophora ciliata. 2 Culex fitchii. 3 C. abfitchii
4 C. cantans

Plate 42



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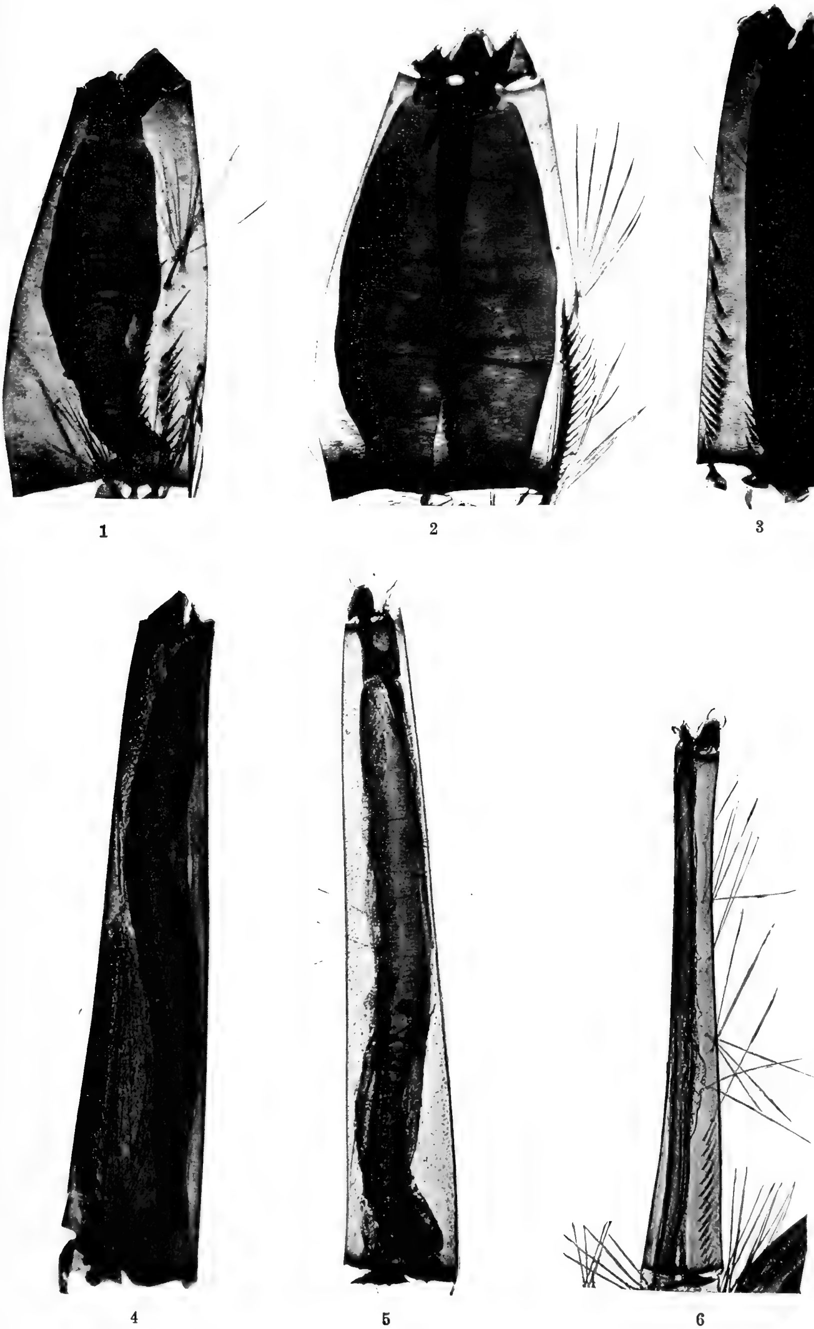
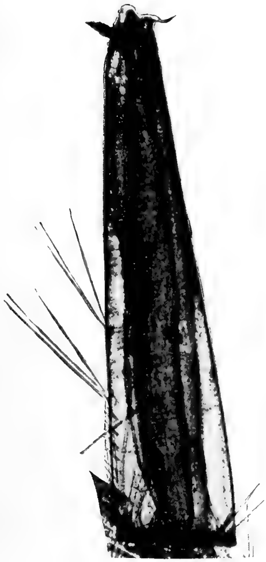
1 Culex taeniorhynchus. 2 C. sollicitans. 3 C. cantator. 4 C. canadensis. 5 C. sylvestris



1 Culex impiger. 2 C. lazarensis. 3 Aedes fuscus
4 C. dyari. 5 C. salinarius. 6 C. territans

Plate 44



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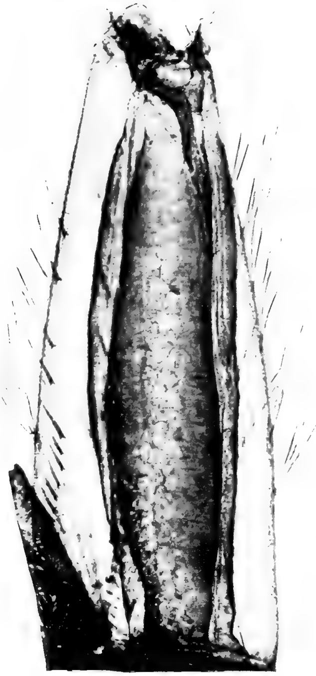
1 Culex pipiens. 2 C. jamaicensis. 3 C. restuans
4 C. serratus. 5 C. atropalpus

Plate 45



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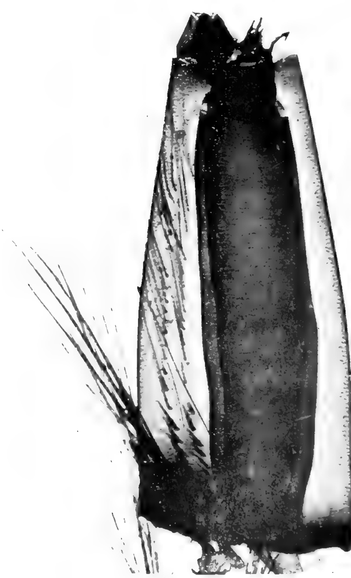

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1 Culex cinereoborealis. 2 C. abserratus. 3 C. magnipennis. 4 C. absobrinus

Plate 46

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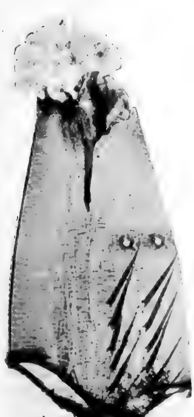

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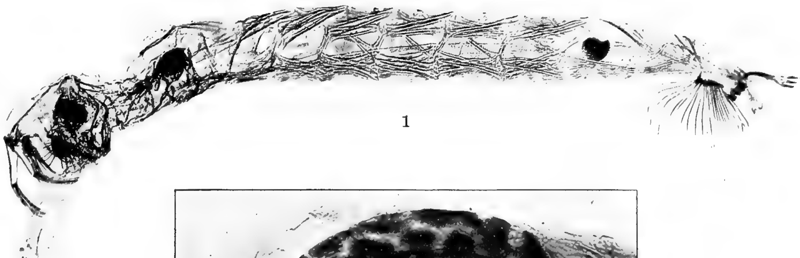
1 Culex melanurus. 2 Uranotaenia sapphirina. 3 C. dupreei. 4 C. discolor. 5 C. aurifer. 6 C. triseriatus

Plate 47



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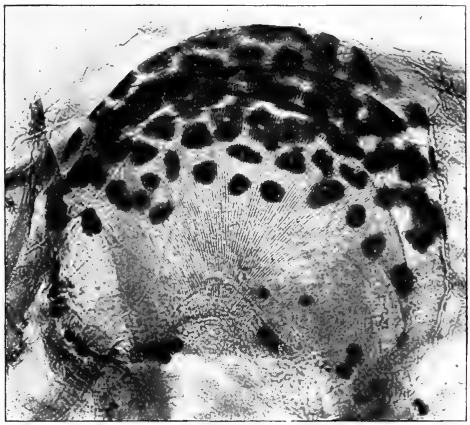

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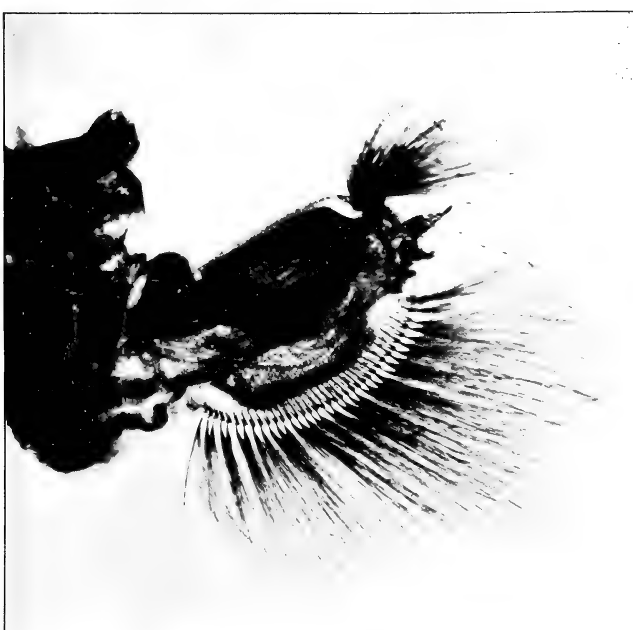

3

1 Sayomyia hudsoni. 2 S. albipes. 3 Eucorethra underwoodi

Plate 48

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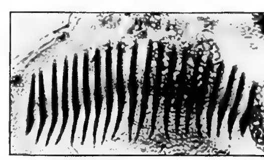

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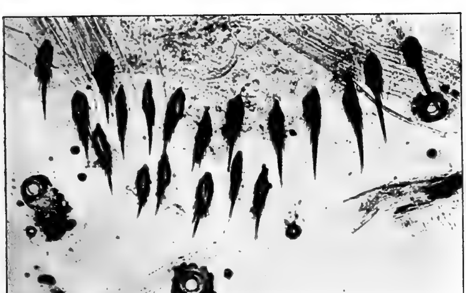

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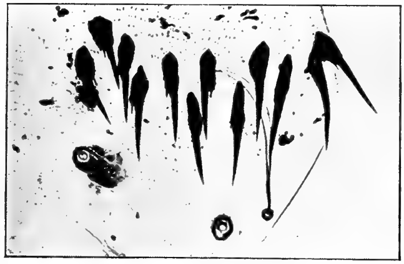
1 Anopheles punctipennis. 2 A. maculipennis. 3 Culex fitchii. 4 C. abfitchii. 5 C. discolor. 6 C. melanurus. 7 Uranotaenia sapphirina



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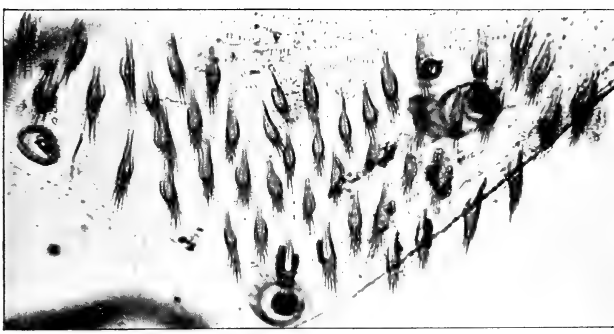

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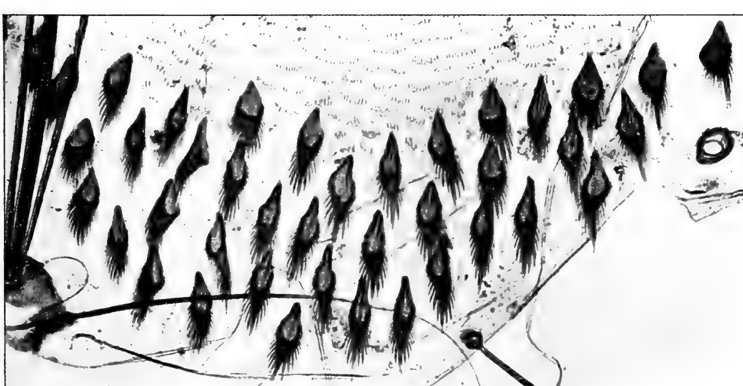

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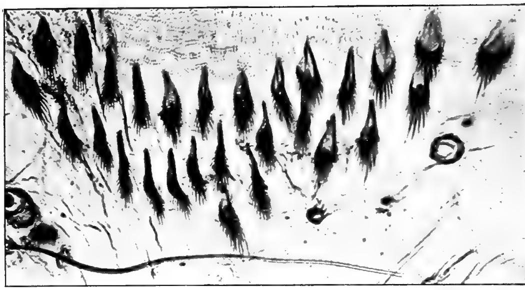
1 Culex sylvestris. 2 C. cantator. 3 C. ? cantans

Plate 50



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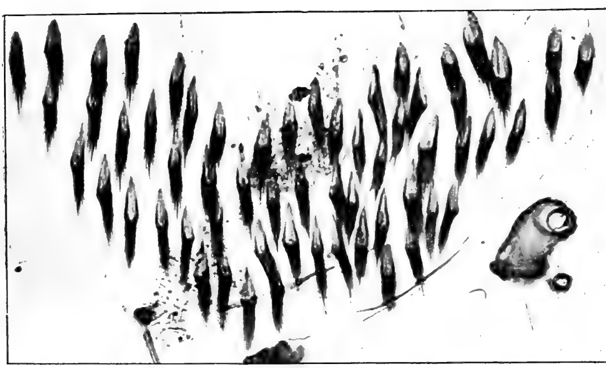

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1 Culex cantans. 2 C. canadensis. 3 C. sollicitans

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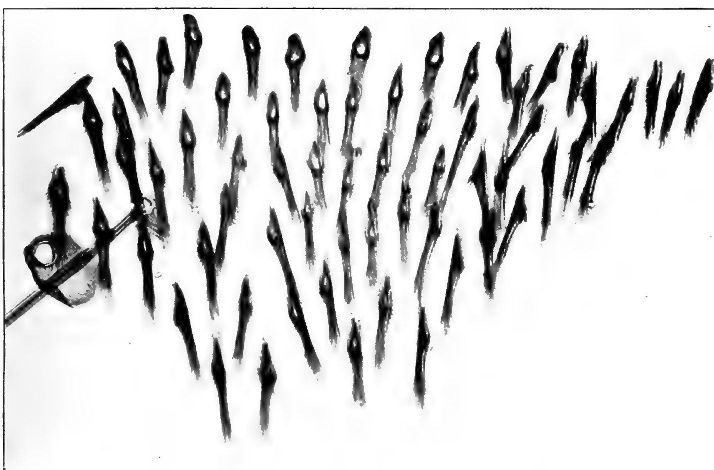

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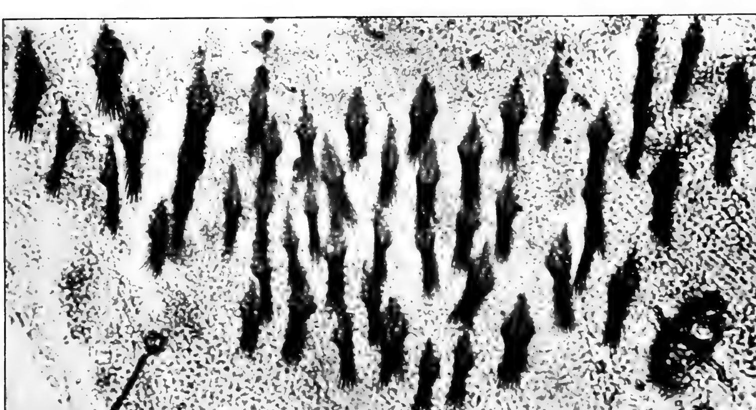

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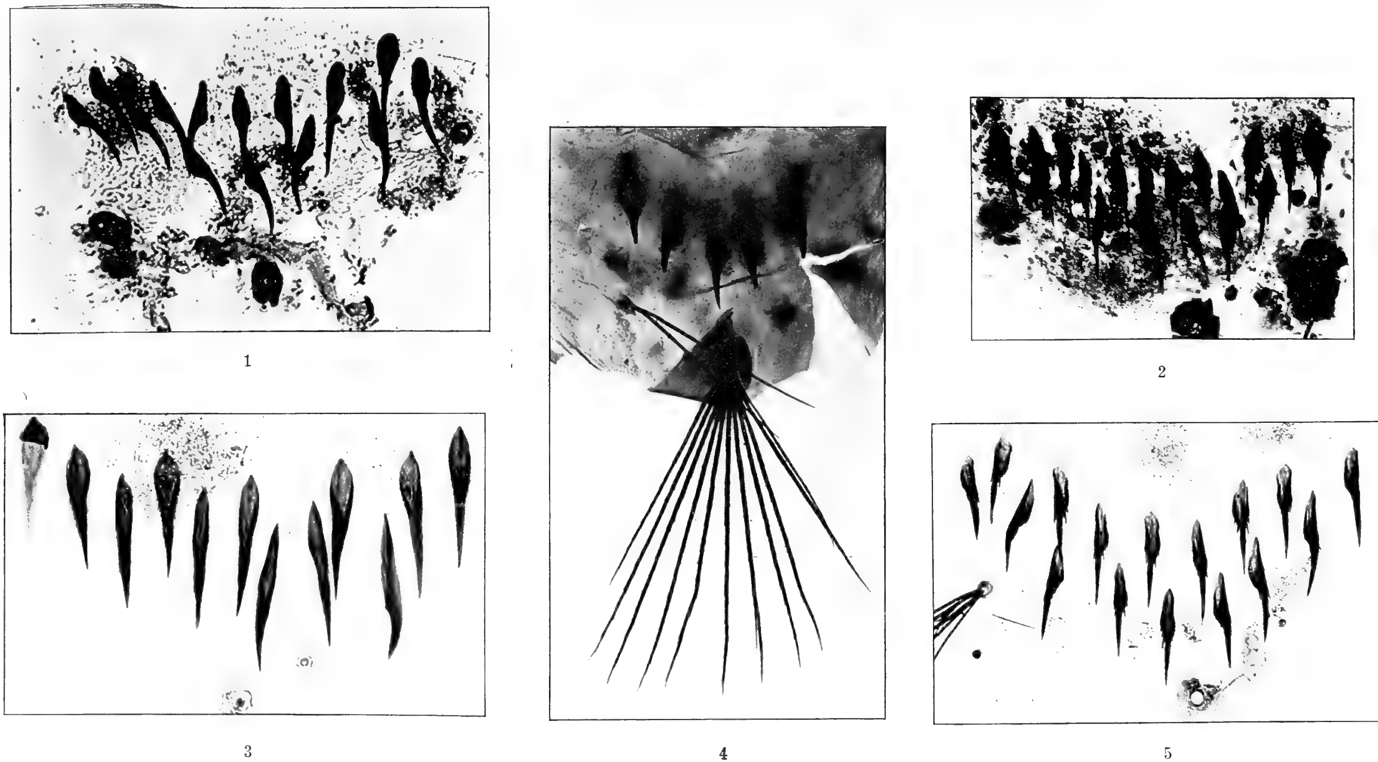
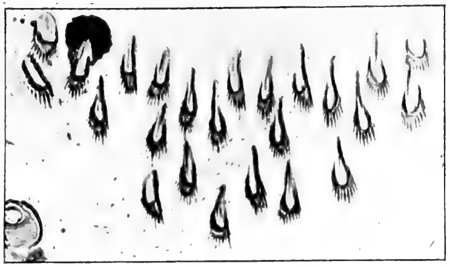
1 Culex magnipennis. 2 C. absobrinus. 3 C. lazarensis

Plate 52



1 Culex impiger. 2 C. aurifer. 3 Aedes fuscus. 4 C. serratus. 5 C. cinereoborealis

Plate 53



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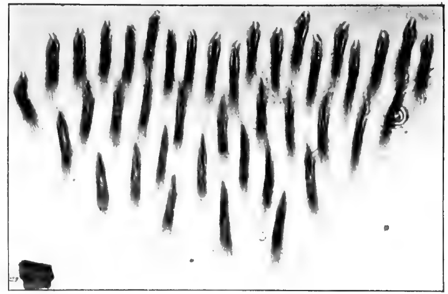

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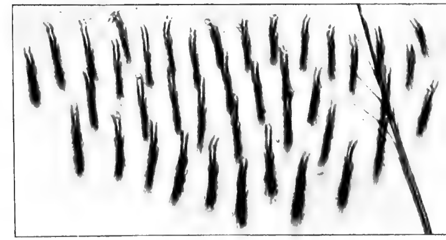

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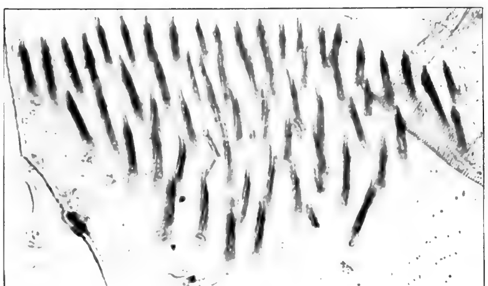

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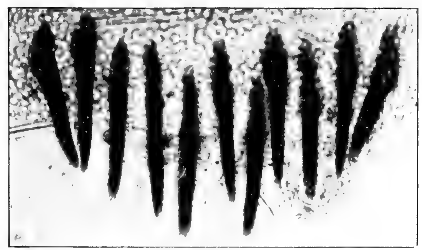

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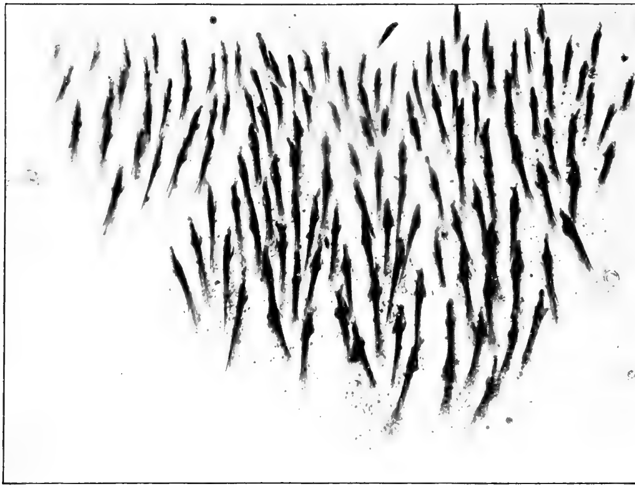
1 Culex taeniorhynchus. 2 C. restuans. 3 C. pipiens. 4 C. salinarius. 5 C. triseriatus
6 C. dupreei



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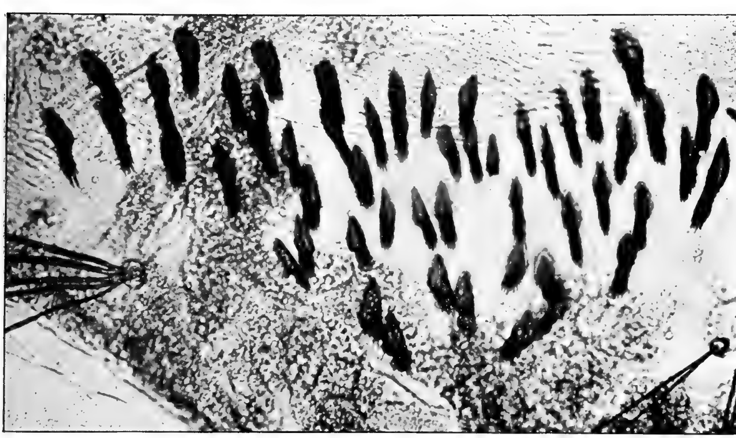

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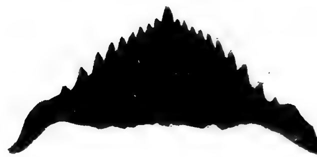
1 Culex dyari. 2 C. atropalpus

2



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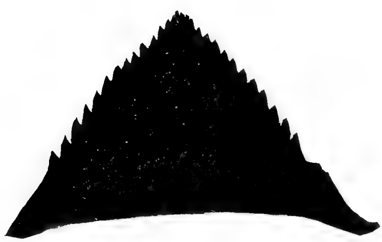

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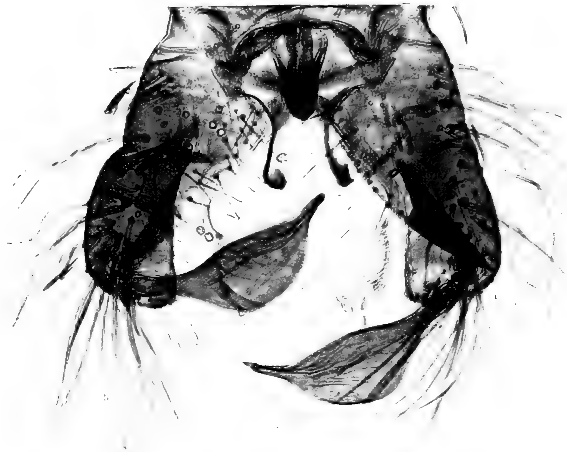
1 Culex cinereoborealis. 2 C. magnipennis
3 C. atropalpus. 4 C. dyari. 5 C. aurifer

Plate 56



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1 Janthinosoma musica. 2 Culex jamaicensis

Plate 57

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1 Culex melanurus. 2 C. triseriatus

APPENDIX

GENERIC REVISION OF CULICIDAE

Our knowledge of Culicidae has progressed so rapidly that our American species are sadly confused, and this opportunity is taken of presenting briefly the results of our taxonomic studies.

ANOPHELINAE

Anopheles. Palpi long in both sexes. Wings usually spotted and thickly clothed with lanceolate scales. First and second longitudinal veins extending beyond the cross veins into the basal cells. Apical clasp segment of male genitalia evenly curved and with an inconspicuous terminal spine. Harpes and harpagones small. Larva with very short air tube and consolidated comb. Species, punctipennis Say, maculipennis Meig. and crucians Wied.

CULICINAE

Psorophora. Petioles of female wing about two thirds the length of fork cells. Posterior cross vein less than its own length from mid cross vein. Lateral scales remarkably distinct; vein scales long, rather broad. Male wing sparsely clothed with scales; petioles about equal in length to their respective fork cells, posterior cross vein less than its own length from mid cross vein. Terminal clasp segment of male genitalia strongly curved and armed with stout spines, basal portion stout. Harpes strongly curved with subapical, falcate organ and terminated by a tuft of loose filaments. Harpagones stout, with several apical teeth. Larva with few comb scales arranged in a semicircle; anteriorly, many minute, smaller, comblike organs, larger comb scales with spatulate base, a large median tooth and conspicuous lateral ones. Species, ciliata Abr.

Janthinosoma. *Female.* Petioles of fork cells about one half the length of their respective cells. Posterior cross vein less than its own length from mid cross vein. Lateral scales of wing broad, well separated from the broadly triangular, closely appressed vein scales. *Male.* Petioles about equal to their respective fork cells. Posterior cross vein about its own length from mid cross vein. Lateral scales broad, well separated from the rather broad, closely appressed vein scales. Terminal clasp segment of male genitalia greatly dilated. Harpes enormously prolonged, tipped with peculiar disklike organs; harpagones rather prominent. Larvae with comb scales few, spatulate, each with a large central tooth and prominent lateral ones. Species, musica Say.

Grabhamia. *Male.* Petioles of fork cells about equal in length to their respective cells. Posterior cross vein remote from mid cross vein. Vein scales rather short, broad. Apical clasp segment of male genitalia broadly dilated; claspette represented by a prominent spined basal lobe and a membranous apical one. Harpes short, curved; harpagones inconspicuous. Larval comb scales few, spatulate, each with a large central tooth and prominent lateral ones. Type, jamaicensis Theo., species. discolor Coq.

Culicelsa n. gen. Petiole of anterior fork cell of female wing about one half its length. Posterior cross vein more than its own length from mid cross vein. Linear scales well separated from the subtriangular, appressed vein scales. Petiole of fork cell in male about two thirds its length. Terminal clasp segment of male genitalia swollen at base. Harpes with a peculiar retrorse spine. Larva with short air tube, the comb composed of numerous, spatulate, spined scales. Type, taeniorhynchus Wied., species. aurifer Coq.

Culicada n. gen. Petiole of first fork cell of female wing nearly equal in length to that of the cell. Posterior cross vein about its own length from mid cross vein. Long scales distinct or shading with the closely appressed, usually thick vein scales. Petiole of first fork cell in male equal in length to that of the cell, posterior cross vein about its own length from mid cross vein. Terminal clasp segment of male genitalia well developed with long apical spine. Claspette usually represented by well defined, apical and basal lobes. Harpes well developed, usually long and varying in shape. Larva with good sized air tube and variable comb scales. Type, canadensis Theo., species, cantans Meig., cantator Coq., sollicitans Walk., onondagensis Felt, atropalpus Coq., triseriatus Say, and probably trivittatus Coq. Also, though possibly constituting a subgenus: cinereoborealis Felt & Young, impiger Walk., lazarensis Felt & Young, pullatus Coq., abserratus Felt & Young, dupreei Coq., and probably squamiger Coq., fitchii Felt & Young and abfitchii Felt.

Ecculex n. gen. Petiole of anterior fork cell of female wing about one half its length. Posterior cross vein more than its length from mid cross vein. Lateral scales long, well separated from the closely appressed, broad vein scales. Terminal clasp segment of male genitalia with subapical spine. Claspette a rather conspicuous basal lobe. Harpes broad, with recurved, terminal spine; harpagones terminated by three long, recurved spines. Larva with well developed air tube, comb scales with spatulate base and stout, terminal spine. Type, sylvestris Theo., species, melanurus Coq.

Culicella n. gen. Petiole of anterior fork cell of female wing about two thirds its length. Posterior cross vein about its own length from mid cross vein. Lateral vein scales well defined. Petiole of anterior fork cell in male equal or longer than its cell, posterior cross vein less than its own length from mid cross vein. Terminal clasp segment of male genitalia slender, slightly curved, with small apical spine. Claspette a large basal lobe with prominent chitinous spine. Larva with very long air tube and with a large comb consisting of linear, ciliated scales. Type, dyari Coq.

Culiseta n. gen. Petiole of anterior fork cell of female wing about one half its length. Posterior cross vein less than its own length from mid cross vein. Scales very large, lateral ones slender, linear; vein scales closely appressed, frequently elongated. Male wing with petiole of first fork cell one half to two thirds the length of the cell and the posterior cross vein about its own length from mid cross vein. Basal clasp segment of male genitalia triangular, apical segment slender, nearly straight. Claspette represented by a conspicuous basal lobe with one or more large, chitinous spines. Harpagones recurved, with several apical teeth. Larvae with pecten prolonged into setae and with stout, spined comb scales. Type, absobrinus Felt, species, magnipennis Felt and probably incidens Thom.

Taeniorhynchus. Petiole of first fork cell of female wing about two thirds the length of the cell. Posterior cross vein several times its length from mid cross vein. Wings thickly clothed with conspicuous dilated scales. Terminal clasp segment of male genitalia slightly swollen. Claspette a conspicuous basal lobe bearing a stout, apical spine. Harpes strongly curved and bearing a series of stout teeth. Species, perturbans Walk.

Stegomyia. We have had no opportunity of studying either larvae or adults of S. signifer Coq., the only species liable to occur in New York State. Judging from descriptions and a print of the male genitalia kindly sent us by Dr Dyar, it probably belongs close to Taeniorhynchus.

Culex. Petioles of fork cells of female wing short, that of the anterior one seventh to about one fifth the length of its cell. Posterior cross vein more than its own length from mid cross vein, lateral scales linear, well defined; vein scales broadly rounded, closely appressed. Petiole of anterior fork cell in male about one third its length. Lateral scales well marked but more sparse than in the other sex. Claspette represented by a prominent tuft of chitinous spines and frequently by a dilated, spatulate organ at the apical third and a rather inconspicuous prominence near the base of the clasp. Larvae with very long air tube bearing inconspicuous basal pecten, and with comb composed of about 50 minute, ciliated scales. Type, pipiens Linn., species, salinarius Coq., restuans Theo. and territans Walk.

Protoculex n. gen. Petiole of anterior fork cell of female wing about one half the length of the cell. Posterior cross vein more than its own length from mid cross vein. The long lateral scales well separated from the appressed vein scales. Petiole of anterior fork cell of the male about equal in length to that of the cell. Terminal clasp segment of male genitalia slender, curved, with stout apical spine. Claspette represented by a conspicuous basal spine-bearing lobe and a longer terminal one. Harpes broadly dilated at base, slender apically; harpagones with recurved apical spine. Larva with medium air tube, comb consisting of a few spinelike scales. Type, serratus Theo.

AEDEOMYINAE

Uranotaenia. Petiole of anterior fork cell of female wing exceedingly long. Posterior cross vein scarcely its length from mid cross vein. Wings remarkable on account of the varied character of the scales. Terminal clasp segment of male genitalia straight, tapering to an obscure point, basal portion stout. Larva with a small, slightly curved, subcylindric air tube, and comb consisting of a few simple spines attached to the posterior margin of a chitinous plate. Species, s a p p h i r i n a O. S.

Aedes. Petiole of first fork cell of female wing about two thirds the length of the cell. Posterior cross vein several times its length from mid cross vein. Lateral scales very distinct from the closely appressed, rather broad vein scales. Male wing nearly the same except for its scantier clothing. Terminal clasp segment of male genitalia subapical with a subapical spine and conspicuous basal lobe. Harpes and harpagones relatively inconspicuous. Larva with moderate sized air tube and comb composed of a few spine-like scales. Species, f u s c o u s O. S.

Wyeomyia. Petiole of first fork cell of female wing nearly one half the length of the cell. Posterior cross vein about its own length from mid cross vein. Lateral scales very distinct from the rather closely appressed broad vein scales. Terminal clasp segment of male genitalia an irregular, semitransparent, trifid, spined structure. Larva with large setae irregularly disposed on the moderate sized air tube, and the comb composed of a few spinelike scales bordered by a transparent, serrate margin. Species, s m i t h i i Coq.

CORETHRINAE

Sayomyia. Petiole of anterior fork cell of female wing about as long as the cell. Posterior cross vein about its length from mid cross vein. Veins rather thickly clothed with almost linear scales. Terminal clasp segment of male genitalia rather slender, tapering, with long apical spine. Harpes and harpagones inconspicuous. Larva predaceous, with pigmented air sacs in thoracic and eighth abdominal segments; no air tube. Species, p u n c t i p e n n i s Say, t r i v i t t a t a Loew., a l b i p e s Johns., r o t u n d i f o l i a Felt, a m e r i c a n a Johns., h u d s o n i Felt.

Eucorethra. Petiole of anterior fork cell of female wing about two thirds the length of the cell, cross veins interstitial or nearly so. Vein scales thick, almost linear. Terminal clasp segment of male genitalia stout, slighty curved, with small apical spine;

basal clasp segment stout. Harpes inconspicuous, broadly dilated. Type, u n d e r w o o d i Undw.

Corethra. Petiole of anterior fork cell of female wing about one third the length of cell. Posterior cross vein its own length or more from mid cross vein. Wing scales linear. Terminal clasp segment of male genitalia long, slender, with small apical spine; basal segment simple. Harpes and harpagones retracted. Larva predaceous, with small air tube and air reservoirs in the thoracic and seventh abdominal segment. Species, k a r n e r e n s i s Felt, l i n t n e r i Felt, c i n c t i p e s Coq.

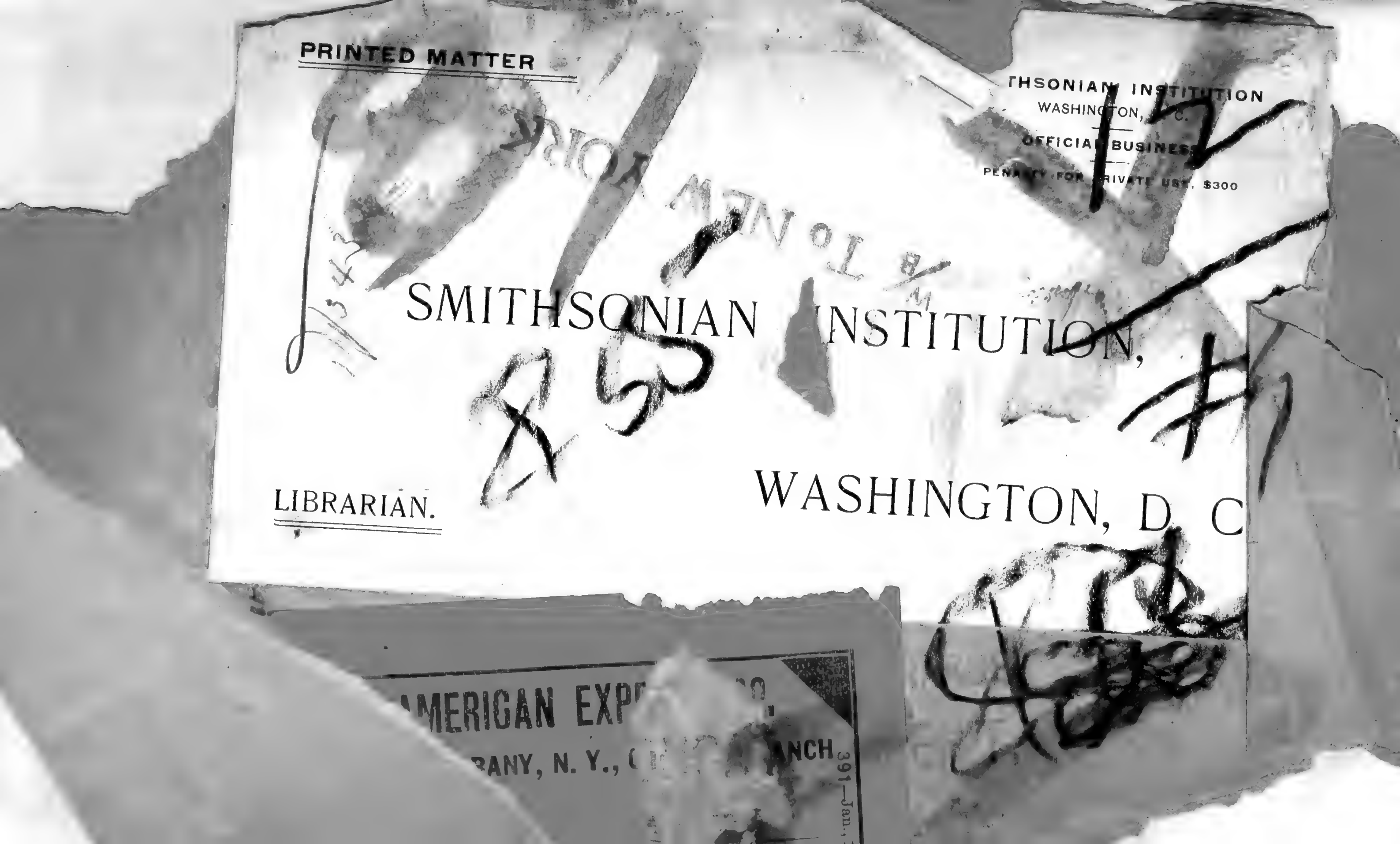
Corethrella. This genus is similar to Sayomyia and Corethra, but differs from both in having the antennae fully covered with hairs and the apical joint shorter than the intermediate ones. The larva is said to resemble that of Corethra much more closely than that of Sayomia. Species, b r a k e l e y i Coq.

ERRATA

P. 339, line 16, for "Aedomyniae" read "Aedeomyinae."

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 378^3 means page 378 beginning in the third ninth of the page, i. e. about one third of the way down. Page numbers referring to descriptions of species are printed in black face type.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