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INSECT LIFE.

Vol. VII.

DEVOTED TO THE ECONOMY AND LIFE HABITS OF INSECTS, ESPECIALLY IN THEIR RELATIONS TO AGRICULTURE.

EDITED BY

L. O. HOWARD, Entomologist,

WITH THE ASSISTANCE OF OTHER MEMBERS OF THE DIVISIONAL FORCE.

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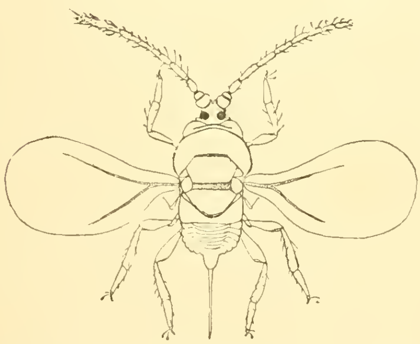

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CONTENTS.

THE CRANBERRY GIRDLER

(*Crambus topiarius* Zell.)

By Samuel H. Scudder, *Cambridge, Mass.*

Late in June of last year my attention was called by Mr. G. R. Briggs, of Plymouth, Mass., to the injury done by some insect to cranberry meadows under his care. He suspected that certain moths then flying in some numbers over the bogs might be connected with it. I visited the plantation on July 3 and September 23 and again this year on July

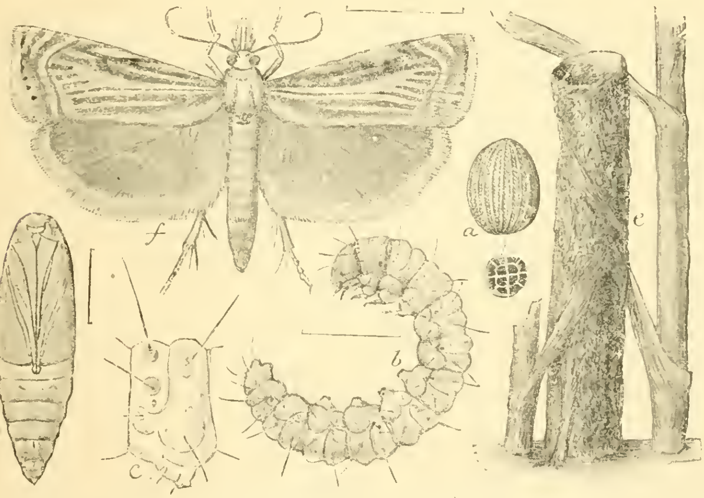

Fig. 1.—*Crambus topiarius*: *a*, egg, with summit much enlarged; *b*, mature larva; *c*, one of the abdominal segments of larva; *d*, chrysalis; *e*, nest of young larva in grass; *f*, imago—all enlarged. (*a* and *e* after Felt; other figs. original.)

18. On the first visit a number of moths were taken, nearly all of one species, which was later determined for me by Prof. C. H. Fernald as *Crambus topiarius* Zell. All the specimens of the moth then brought home alive for breeding proved to be males, but on my visit this year I procured some females, which readily and at once laid in confinement.

It seemed at first improbable that the Crambus could be the cause of the mischief, as the species of this genus, so far as I was aware, were known to feed only on Gramineæ and particularly on common grasses. Mr. Felt has lately found that some of them, including this species, will feed also on Rumex, though all apparently prefer grasses. On my visit last autumn I was better able to examine the nature and extent of the injuries caused by the larva and to obtain specimens nearly or quite mature. The precise depredators had been readily found by Mr. Briggs and the men in his employ at work about the running portion of the plants extending along the surface of sand in the stratum of fallen leaves which always covers an old cranberry bog, and from which the delicate clusters of new rootlets take their rise; square rods of the meadow were scorched as by fire, in some places a half acre or more, and everywhere, but especially along the borders of the portions of the fields attacked, the larvæ could be found in filmy silken galleries following the prostrate stems or runners, into the surface of which they had everywhere eaten their way, destroying the vital part of the plant and often, especially next the base of the runners, deeply girdling the stems.

Besides collecting a number of the largest larvæ and taking them home to rear, a large sod containing others was transported to Cambridge and placed in a favorable position for their hibernation. By cursory examination from time to time it was proved that the larvæ formed their coarse cocoons of mingled sand and silk just at the surface of the ground late in the autumn (about November), remained in the same stage within the cocoons until the latter part of May or early June, when they changed to chrysalis, and after about a month reappeared as moths, when their identity with the supposed culprit flying at large over the bogs in the first days of July was proved. The cages were kept in a cellar until the moths appeared, all of which were males, and came out July 6 and 7.

This would appear to be the normal habit of life of this creature on the Plymouth cranberry bogs, and the record of Mr. Felt shows the moths flying at Ithaca, N. Y., in July only. But Prof. John B. Smith states that he has taken the moths on cranberry bogs in Ocean County, N. J., in May, and Mr. Briggs tells me that some vines which were green immediately after the spring plowing died before the month of July, apparently from the attacks of the same insect, as if caterpillars which had passed the winter fed again in the spring before pupation: so it may be that there is some considerable time variation in the maturity of the larva. Mr. Felt also states that "in the spring the larvæ complete their growth."

The damage done at Plymouth was considerable: great patches of scorched vines could be seen, sometimes a half acre in extent, in which not only the year's crop had failed but the plants were almost entirely destroyed; and considerable areas were seen where the damage of previous years had compelled replanting. There was this, however, to be said: The damage was local and by no means universal, and a localized pest is more easily combated than one which appears everywhere. Some meadows were entirely free, though for no apparent reason. On inquiry I could not find that there was any relation whatever between the affected fields and the vicinity of grass land where the Crambus might also live.

At the time I first visited the spot, Mr. Briggs, thinking it probable that the moth then flying was at the root of the trouble, had lighted torches on the affected bogs, but an examination of the tarred standards on which they were placed did not indicate that they had been very effective; at that time, however, to judge from those captured, only males were flying. Mr. Felt's observations on those captured in Ithaca in trap lanterns (Bull. 64 Corn. Univ. Agr. Exp. Station) show only fifty-nine captured in thirteen nights between July 5 and 28, of which only eight were females. This mode of attacking, therefore, does not appear very hopeful.

Experiments made by Mr. Briggs showed that the larvæ would bear submergence in water in the autumn for more than four days without death, and, therefore, no flooding that would not injure the crop could be undertaken at the period of their greatest ravages. That the wintering caterpillar within its cocoon can endure any amount of submergence is proved by the fact that the flooding of a bog for the entire winter does not destroy the pest upon that bog. It would, however, appear probable that as the larvæ do not go into cocoons until close to, or in, November, and as, by Mr. Briggs' experiments in submerging the bog directly after picking the crop, larvæ were found quite destroyed after five days' immersion, the best means of attacking the insect would be to pick the crop from affected bogs at the earliest time possible, say very early in October at the latest, and immediately to flood the bog for a full fortnight. As a preventive against any serious outbreak it would be well, wherever the insect has been known to do any damage, to flood all bogs for a week sometime in October. In this way it would seem as if at no time would a crop be likely to suffer any serious damage from this insect. A further way, suggested to me by Mr. Briggs, would be, late in autumn or early in spring, preferably in the former, to thoroughly burn over all territory which had actually been destroyed by the insect, a work which the litter of dead leaves would render simple and efficacious. Mr. Briggs has already tried this with success, and has also met with some success in autumn flooding, although he has only tried it for a week or less. A fortnight would hardly injure the plants and would be more surely efficacious.

To render this account more complete we append the few remarks upon it made by Mr. Felt in his recent account of this insect (*l. c.*, pp. 75, 76):

The species is very prolific; one female laid seven hundred eggs, three hundred being laid the first day. This is undoubtedly above the average. The eggs hatch in about ten days. The young larvæ are very active and strong; they soon begin to construct the typical cylindrical nest (see *e*, copied from Felt), composed of web and an outer layer of bits of dry grass. The bits of grass are cut with great regularity, being about 2mm by 75mm. In these nests the larvæ retire when not feeding. The larvæ feed upon the common grasses. Some were observed to eat considerable sheep sorrel (*Rumex acetosella*). The larvæ feed mostly at night, and occasionally a blade of grass was cut off and the end drawn into a nest. As cold weather came on the larvæ became more dormant, the nests were made thicker, and finally in November the tops of the nests were closed. The winter is passed in the larva state. In the spring the larvæ complete their growth and then transform, and emerge in July.

The following are descriptions of the insect in its several stages, so far as yet known:

Imago (*f*): Fore-wings above of a pale straw color, growing pale buff apically heavily marked with blackish fuscous of varying shades and with silver; the latter is mostly confined to two subapical cross-bands, the upper half of the inner and the whole of the outer oblique, the inner bent just above the middle and crossing the entire wing (excepting that it fails to reach the costal margin above), the lower half at nearly right angles to the upper half and subparallel to the outer margin; the inner band is bordered interiorly with brown which extends to the costal margin; a broad stripe of silvery gray tapering apically follows the subcostal vein to the end of the cell and four fuscous longitudinal stripes reach nearly or quite to the inner silvery band, the uppermost more or less mingled with buff following the costal edge for nearly a third its length and then running a little obliquely across the upper extremity of the cell, the next tinged with silver so as to become pearl gray extending along the middle of the cell; the other two follow the median and submedian nervures; three other short longitudinal fuscous lines, much overlaid and concealed by silver, follow the nervules beyond the cell, while a supplementary brownish and oblique line intervenes between the oblique portion of the costal stripe and the inner margining of the inner silvery band; the extreme outer margin of the wing has a black line on the upper half, and on the lower half at the nervule tips three or four black points; the fringe is silvery. Hind-wings uniform silvery gray, narrowly edged on the upper half of the outer border with pale brown, the fringe silvery white. Expanse of fore wings, ♂ 15mm; ♀ 17mm. Described from four bred males.

Egg.—When first laid pellucid white, obovate, broadly rounded at both extremities, but slightly more so at base than at summit, broadest barely below the middle, 0.36mm high and 0.3mm broad, with about twenty-three straight and vertical ribs of slight elevation reaching to the dome of the summit, their interspaces crossed by finer, horizontal, raised cross-lines which traverse also the vertical ribs, giving them a beaded appearance, the surface thus broken up into quadrangular cells whose length (the width of the interspaces between the ribs) in the middle of the egg is 0.04mm, and whose height is scarcely 0.02mm, the surface itself very delicately shagreened. On the dome of the summit the surface is broken into polygonal cells which are about 0.04mm in diameter below and grow smaller toward the apex.

The eggs were laid in confinement upon the stem of the cranberry. They hatched in seven days.

The figure given by Felt, here copied (*a*), represents the egg as less regular than it should be, and the cross lines are not accurately drawn, a feature exaggerated in the copy.

Larva (*first stage*).—Head diameter, 0.2mm; body diameter, 0.125mm; length, 0.99mm. General color, a smutty white; head, a little darker than the rest of the body. Scattered hairs occur on the head; numerous small dark-colored tubercles occur on the body, each bearing at least one hair. (Felt.)

Larva (*last stage*) (*b, c*).—Head shining luteo-castaneous, the ocellar field, labrum and clypeus black. Body pallid fuliginous, the harder parts glistening; dorsal shield of first thoracic segment luteous, inconspicuous; surface covered with longer or shorter erect bristles, which are very fine and taper to an exquisitely fine point; they are blackish at base, but beyond testaceous; the longer ones are nearly as long as the breadth of the body and are situated in lateral and infrastigmatal series; the shorter ones are hardly as long as the segments and are distributed on the sides of the body; there is also a series intermediate in length and laterodorsal in position, situated in the middle of the larger anterior division of the segments, while the lateral series lies on the smaller posterior section; under surface and prolegs pallid; legs pallid, the claws luteous. Length, 15^{mm}.

Chrysalis (*d*).—Nearly uniform, very pale honey yellow, more pallid beneath; the wings, excepting at base, with a very slight olivaceous tinge, all the thoracic and the first two abdominal segments, as well as the wings and legs finely edged at the incisures with dark castaneous, darkest near the head; all the abdominal segments are bordered posteriorly, at least on the dorsal surface, with pale testaceous; lips of spiracles fuscous; cremaster blackish or blackish fuscous. Length, 7.75^{mm}; breadth, 2.25^{mm}.

TWO PARASITES OF IMPORTANT SCALE-INSECTS.

By L. O. Howard.

There is a destructive scale-insect known as *Aspidiotus uvæ* Comst. which infests the lower part of grape-vines, from the ground to the shoots of second year growth, and frequently clusters upon this portion of the vine under the rough outer bark in such numbers as to seriously affect its vitality. The species was originally described from Vevay, Ind., but has since been sent in to the Division on Entomology from Louisville, Ky., Kirkwood, Mo., and Lafayette, Ind., and has been found by Mr. Pergande and Mr. Lull, members of the office force, at Soldiers' Home, D. C., and near Beltsville, Md. A closely allied species occurs in Europe, but Prof. Comstock considers it distinct. Miss Murtfeldt, in studying this insect at Kirkwood, Mo., observed that it is preyed upon by mites of the genus Tyroglyphus and that it is also attacked by a true parasite. In November, 1888, and October, 1889, she sent in a few specimens of this parasite, which proves to belong to the chalcidid subfamily Aphelininæ, in which it forms a new genus. It is described below under the name *Prospalta murtfeldtii* n. g. et n. sp.

The well known and widespread scurfy bark-louse of the apple (*Aspidiotus furfurus* Fitch) is a common denizen of apple orchards throughout the eastern United States. It was first described by Dr. Fitch in the Report of the New York State Agricultural Society for 1856 and was subsequently redescribed by Walsh as *Coccus harrisii* in volume II of the Practical Entomologist. The species affects apple, crab, cherry, pear, quince, currant, and the mountain ash. It occurs from Massachusetts to Kansas and seems to be especially abundant in the State of New York. No parasite of the species has hitherto been discovered. In July, however, of the present year, a number of specimens of a very handsome aphelinine were reared from scales found upon a crab-apple tree on the grounds of the Department of Agriculture.

This parasite proves, on careful examination, to be identical with a form described by Mr. Ashmead as *Centrodora clisiocampæ* (Proc. Ent. Soc. Wash., vol. III, p. 10). The opportunity which this rearing has afforded for a close study of fresh specimens shows that it does not belong to Förster's genus Centrodora and I have felt obliged to erect a new genus to contain it. It is described below as *Ablerus clisiocampæ* (Ashm.). The specific name is unfortunate in its signification, since, in my opinion, the true host is Chionaspis, and not the egg stage of Clisiocampa.

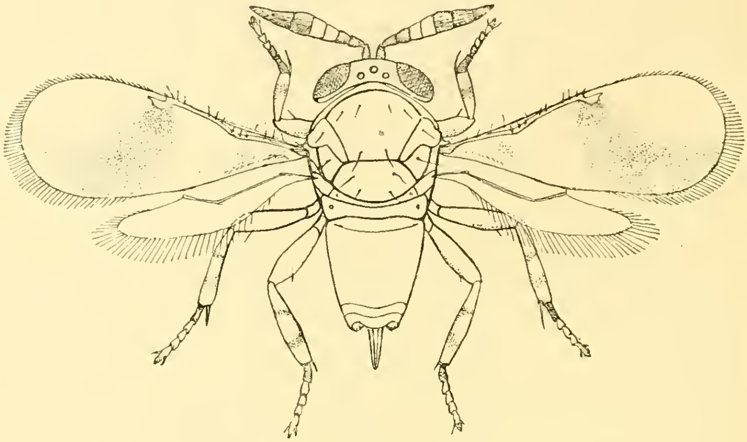

FIG. 2.—*Prospalta murtfeldtii* n. sp.: female, greatly enlarged (original).

Prospalta* gen. nov.

Female.—Anterior wings with no oblique, transverse, hairless line below stigma. Antennæ 8-jointed; club 3-jointed; all joints subequal in length; first joint of club widest. Head transverse; ocelli at corners of an oblique angled triangle. Thorax wider than head; mesoscutar parapsides club-shaped, broadening suddenly on distal side; scapulæ extending anteriorly to swelling of parapsides; metascutellum broad and short; legs rather stout; all tarsi short; first joint of hind tarsi only as long as second; first joint of middle and front tarsi longer than second. Ovipositor slightly extruded. Wings long and broad; submarginal vein reaching nearly to middle of wing; marginal much shorter than submarginal; stigmal very short, its anterior border nearly parallel with costa, its posterior border extending into disk of wing at an angle of 45° with costa; outer margin of fore wing with rather short cilia; under margin of hind-wings with somewhat longer cilia. First abdominal joint much the longest; abdomen on the whole equaling thorax in length; whole body tapering gradually from tegulæ to tip of abdomen.

Prospalta murtfeldtii n. sp.

Female.—Length, 0.69^{mm}; expanse 1.7^{mm}; greatest width of fore-wing, 0.3^{mm}. Surface of body nearly smooth; scutellum slightly shagreened. General color light yellow; mesoscutum with brownish patch covering entire disk; mesoscutellum

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* Πρόσπαλτα, nom. prop.

with two large brown patches, one each side of middle line; scapulæ each with a brown patch; metanotum brownish; base of abdomen brown; tip of abdomen also brown; antennæ brown with the exception of joints 2 and 3 of the funicle, which are whitish; all coxæ and femora light honey yellow, except that hind femora are dusky at base; front tibiæ with a dusky ring near middle; first and second tarsal joints of fore legs dusky; middle and hind tibiæ each with two dusky bands; first tarsal joint of middle and hind legs dusky; wings hyaline with a fuscous basal patch and a triangular median fuscous patch with its apex at stigmal vein and its base reaching somewhat less than half of outer hind margin; entire disk of wing densely, finely, and uniformly ciliate.

Described from five balsam-mounted female specimens reared by Miss Mary E. Murtfeldt, at Kirkwood, Mo., from *Aspidiotus uvæ*. Received November 4, 1888.

To this genus may also be referred *Coccophagus aurantii* How. described in INSECT LIFE (vol. VI, p. 231).

Ablerus * gen. nov.

Female.—Fore-wings with no transverse, hairy streak below stigma. Antennæ apparently only 7-jointed, club appearing unjointed; antennæ simple, slightly clavate; scape slender; pedicel as long as, or slightly longer, than funicle joint 1; funicle joints 1, 2, and 4 subequal in length, 3 rather shorter; club as long as three last

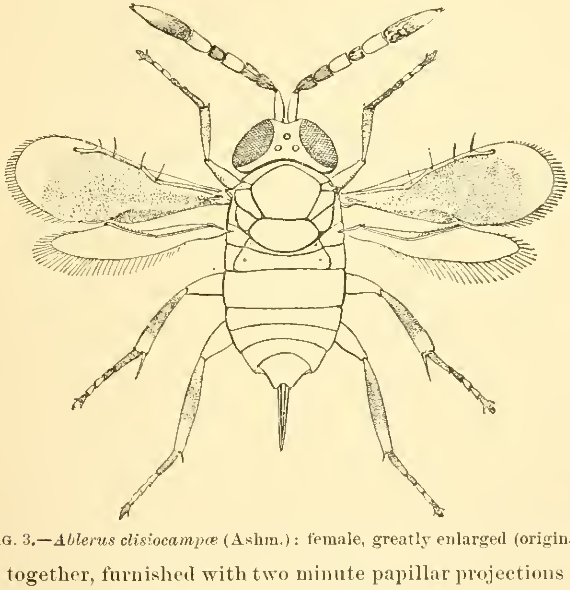

FIG. 3.—*Ablerus clisiocampæ* (Ashm.): female, greatly enlarged (original).

funicle joints together, furnished with two minute papillar projections at tip; mesoscutar parapsides clavate, but not broadening suddenly into a club; mesoscutellum transverse; abdomen semi-ovate; ovipositor extruded for more than half the length of abdomen. Wings short, narrow; marginal vein nearly as long as submarginal; stigmal long, slender, one-third length of marginal, squarely truncate at tip, extending at a very slight angle into disk of wing; marginal vein with three principal bristles, submarginal with one; cilia of border of wings as with Prospalta; hind border of fore-wings with a longitudinal hairless streak and a slight fold extending from base of wing nearly to middle; thickening of anal margin opposite tip of mar-

* "Αβληρος, nom. prop.

ginal vein of hind wings seems to extend forward into this fold; marginal vein of hind-wings with closely set row of minute bristles. First tarsal joint of all legs as long as two succeeding joints together. Middle tibial spur as long as corresponding first tarsal joint.

Ablerus clisiocampæ (Ashm.).

Female.—Length, exclusive of ovipositor, 0.7^{mm}; ovipositor, 0.18^{mm}; expanse, 1.5^{mm}; greatest width of fore wing, 0.19^{mm}. Hairs of anal spiracle nearly as long as ovipositor. General color black, somewhat metallic, notal sclerites of thorax having a greenish luster, while abdomen appears bluish; antennæ black, with funicle joints 2 and 4 silvery white, and apical three-fourths of club light brown, with a somewhat silvery tinge. Head in life, and shortly after the insect has issued, whitish, with occiput yellow-brown and occipital line black; brown patch including ocelli. Eyes bright red. In dry mounts the head shrivels considerably and becomes light brown in color. Legs dark brown; all tibiæ with a silvery white distal apex. Spurs of middle tibiæ black; tarsal joints 1, 2, and 5 dark brown or black; 3 and 4 whitish. Fore-wings with proximal three-fourths deeply and uniformly infuscated, except two light longitudinal streaks near base; apical one-fourth hyaline; discal cilia very minute, but closely placed; sparse, however, towards distal anal portion and towards base of wing.

Redescribed from ten freshly-issued females reared July 6 and 7, 1894, from female specimens of *Chionaspis furfurus*, District of Columbia.

THE BUFFALO TREE-HOPPER

(*Ceresa bubalus* Fab).

By C. L. Marlatt.

The adult of this little grass-green insect is one of the best known of the common species frequenting vegetation, and often attracts the curious on account of its triangular shape, quick, active flight, and considerable vaulting powers. It receives its peculiar popular name from a supposed similarity in shape to the male buffalo or bison. The thorax, or pronotum, is greatly enlarged anteriorly, projecting laterally in two strong horns, and is distinctly triangular, as shown in the illustration (Fig. 4*a*). It is this peculiar shape rather than any knowledge of its habits that has given it its popular interest. During the last eight or ten years, however, it has become important on other and strictly economic grounds. In the Mississippi Valley, especially from the Missouri northwards, well up into Canada, it has been the cause of very great damage in orchards, particularly to young trees and nursery stock, not, however, confining itself to fruit trees, but attacking also all sorts of shade trees. The injury is due solely to the cutting up of the limbs by the female with her saw-like ovipositor (Fig. 4. *f*, *g*) in the deposition of her eggs, in which particular the injury is not unlike that caused by the periodical cicada, and frequently is scarcely less in amount on account of the great numbers in which the Ceresa occurs. On entering a badly infested orchard in the latter part of August, or in September, the buffalo tree-hopper will indicate its presence by flying away with a loud buzzing noise from the trees approached, and, as it is a very shy insect, there is some difficulty in coming close enough to see it at work and observe its methods. Once well engaged in oviposition, however, it becomes for the time being fearless and may be closely watched, even under a hand lens.

The Department has received rather frequent reports of damage by this insect of late, in such states as Kansas, Iowa, Illinois, and Missouri. The smaller limbs of trees are often completely scarified over their upper and lateral surfaces, so that the trees become dwarfed or bark-bound, make a sickly growth, and are rendered more liable to the attacks of wood-boring insects. This latter source of injury was first

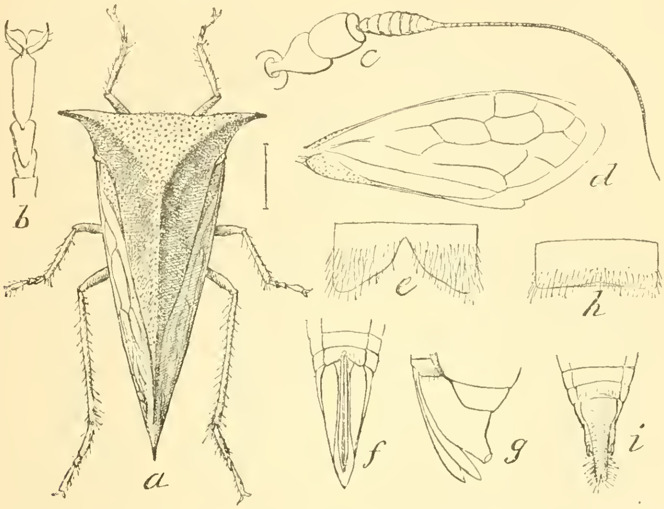

FIG. 4.—*Ceresa bubalus* Fab.: *a*, female; *b*, enlargement of anterior foot of same; *c*, do. of antenna; *d*, do. of wing; *e*, last ventral segment of female; *f*, ventral view of tip of abdomen of female, showing terminal segments and ovipositor; *g*, do. lateral view; *h*, penultimate ventral segment of male; *i* ventral view of tip of abdomen of male—all enlarged (original).

prominently brought to our notice in a communication from Mr. J. A. Pettigrew, superintendent of Lincoln Park, Chicago, who described the attacks of a borer in the smaller branches of the cottonwood (*Populus monilifera*), which caused the limbs to break off and fall to the ground in great numbers. Examination of the twigs submitted by him showed at once that they had been oviposited in very abundantly by the buffalo tree-hopper a year or two before, and that the old scars from the egg-punctures of this insect had furnished favorable conditions for the attacks of a wood-boring beetle, *Oberea schaumii* Lec. This beetle had deposited its eggs in the diseased points left by the Ceresa, and the larvæ of the beetle had burrowed up and down the twigs, weakening them and causing them to break off and fall as described. Healthy twigs would be distasteful or unsatisfactory to this insect, but the diseased condition, and particularly the dead spots left by the Ceresa, furnished the very conditions most favorable for this wood-borer, as similar injuries do for many other wood-boring insects.

HISTORY OF THE SPECIES.

Brief reference to the work of the Ceresa in orchards have been made by various western entomologists, but no general account of it has appeared in any publication accessible to fruit growers. Its habits were first correctly described in an article by the writer in the Transactions of the Kansas Academy of Sciences for 1886 (pp. 84–85), and the same year Mr. John G. Jack gave a brief account of it in the

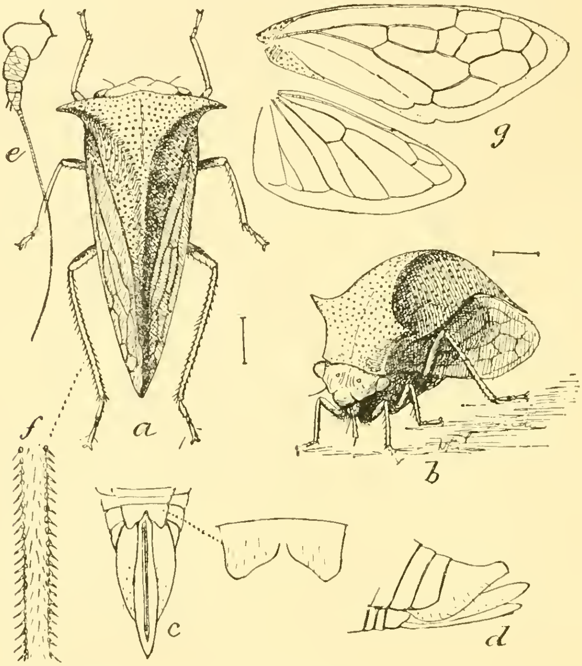

FIG. 5.—*Ceresa taurina* Fitch: *a*, adult female, dorsal view; *b*, one-half lateral view of same; *c*, ventral view of tip of female abdomen with last ventral arc still more enlarged at side; *d*, lateral view of same; *e*, antenna; *f*, portion of hind tibia—all enlarged (original).

Canadian Entomologist (vol. XVIII, p. 51). Accounts purporting to be of the habits and life-history of *Ceresa bubalus* were published by Dr. Fitch and later by Dr. Riley, but in both instances an entirely distinct insect had been studied. Dr. Fitch, in his Twelfth Annual Report (1867, p. 889), described very elaborately the eggs of the common snowy tree-cricket (*Œcanthus niveus* Serv.) as the eggs of the buffalo tree-hopper, and Dr. Riley, in his Fifth Missouri Report (1873, p. 121), takes Dr. Fitch to task for this mistake, and proceeds to describe what he supposed to be the eggs and early stages of *bubalus*, again, however, having a totally distinct insect under observation. In the latter case the error was excusable, because Dr. Riley really had under observation a closely allied species which could not, at that time, and from the literature at hand, be easily distinguished from the more common *Ceresa bubalus*. Dr. Riley has shown in a recent communication before the Entomological Society of Washington that his description, and figures of the eggs, relate to *Ceresa taurina* Fitch, a somewhat smaller and comparatively rare species. The general appearance of this latter insect is shown for purposes of comparison in the accompanying illustration (Fig. 5, *a*, *b*), and the peculiar row of little raised egg-slits in the bark, each of which contains a single oval egg, are shown at Fig. 6, *a*, *b*.

HABITS AND LIFE-HISTORY.

The habits and life-history of the true buffalo tree-hopper are as follows: The adult insect chooses as a nidus for its eggs the twigs, preferably those of two or three years' growth, of various trees, particularly the apple, willow, cottonwood, maple, etc.; confines itself in general to the upper surface of the twigs, and works more abundantly on the south side of the tree than on the north, although in this respect the prevailing winds and other conditions influence the insect. The eggs are deposited quite as readily in the new growth of old trees as in young trees, but the damage is much more noticeable in the latter case. The eggs are placed in small compound groups arranged in two nearly parallel or slightly curved slits extending in the direction of the twig about three-sixteenths of an inch in length, and separated by one-eighth inch or less of bark (Fig. 7, *b*). Facing either toward or away from the trunk, the female makes with its ovipositor

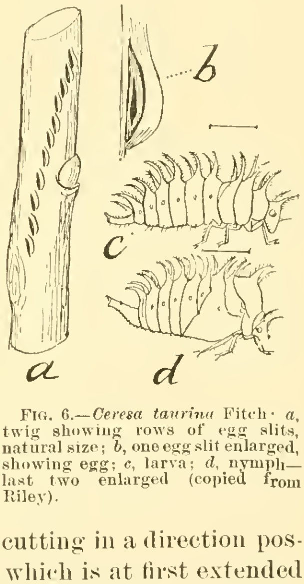

FIG. 6.—*Ceresa taurina* Fitch: *a*, twig showing rows of egg slits, natural size; *b*, one egg slit enlarged, showing egg; *c*, larva; *d*, nymph—last two enlarged (copied from Riley).

a slightly curved slit through the outer bark, cutting in a direction posterior to the insect, so that the ovipositor, which is at first extended nearly at right angles to the body, at the completion of the slit, lies almost against the abdomen. The eggs are inserted very obliquely through the bark and nearly at right angles to the twig, immediately after the completion of the preliminary incision, beginning at the end of the slit last made, and are thrust well down into the cambium layer between the bark and the wood (Fig. 7, *c*). A period of from one-half to two minutes is required for the insertion of each egg, after which the ovipositor is partly withdrawn, moved a little forward, and re-inserted, about twenty minutes being required for the cutting of the slit and filling it with eggs, which, in each slit, vary in numbers from 6 to 12. As soon as the first slit is completed a second one is made parallel to and slightly curving toward the first, without change of position by the insect. The ovipositor, however, is thrust in at a very considerable angle from that assumed in the first case, so that it crosses beneath the bark the cut first made, and the narrow intervening bark between the two incisions is cut entirely loose. This has a very important bearing on the subsequent condition of the wounds made by the insect in oviposition. The object is doubtless to cause a certain cessation of growth between the two rows of eggs, to prevent their being crushed and choked out by the rapid growth of the twig, and it is due to this peculiarity that the injury to the young limbs later assumes so serious a nature. A single incision made by the insect to contain its eggs would heal over and cause little after-damage, but with the combination of two incisions and the killing of the intervening bark, causing it to adhere to the wood, a large scar is produced, which, with each subsequent year's growth, enlarges and ultimately assumes an oval form, the dead bark of the center breaking out.

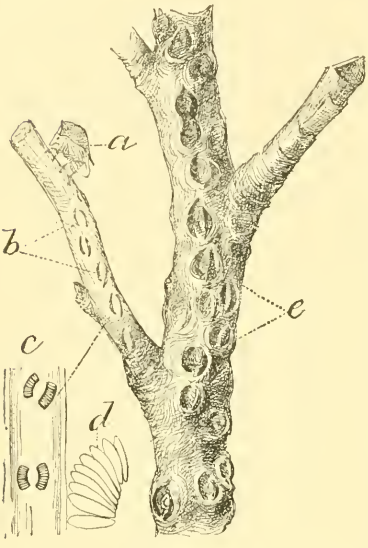

FIG. 7.—*Ceresa bubalus* Fab.: Twig of apple showing: *a*, female at work; *b*, recent egg-punctures; *c*, bark reversed with eggs in position, slightly enlarged; *d*, single row of eggs still more enlarged; *e*, wounds of two or three years' standing on older limbs (adapted from Marlatt.)

After a few years, limbs which have been thickly worked on by the insect become very scabby and rough, are easily broken off by the wind, and are very liable to attack by wood-boring insects. (See Fig. 7, *e*.) After completing the two complementary slits and filling them with eggs, the female rests a considerable time before again beginning operations. The number of eggs deposited by a single female exceeds 100, and possibly 200. Rather late in the fall a female which had just finished a pair of slits which contained some 20 eggs was found to still contain 40 eggs in her ovaries. The adults first appear about the middle of July, and become most numerous during August and September. They begin oviposition about the middle of August, or even earlier, and continue this work until they are killed by the frosts of early winter. In Kansas I have found them busily ovipositing as late as the 24th of October. The eggs remain unchanged or dormant in the twigs until the following spring, hatching in May or early in June.

The eggs of the buffalo tree-hopper are subject to the attacks of at least two minute egg-parasites. · One, an undescribed species of *Cosmocoma*, Miss Murtfeldt reports had destroyed the larger proportion of eggs sent her from various localities in Missouri. Mr. Jack probably refers to the same parasitic insect which he says he observed, September 17, to the number of twelve or fifteen on a branch of apple about four inches long and on which some five or six tree-hoppers were ovipositing. The other little parasitic fly is a Trichogramma, and has been described by Mr. William H. Ashmead as *T. ceresarum* (Canadian Entomologist, vol. xx, p. 107, 1888).

DESCRIPTION OF THE EARLIER STAGES.

The egg is about one-sixteenth of an inch long, slightly curved, tapering towards the outer end and more rounded at the inner one. It is without markings, of a dirty, whitish color, and cylindrical, except as more or less angulated by the pressure of the wood and the adjacent eggs.

The early larval and nymphal stages have never been carefully described. In general, however, the larvæ and nymphs resemble the adult, but are wingless and covered along the center dorsally with numerous forked or barbed projections, in this particular resembling the same stages in the very closely allied *taurina*, which Dr. Riley has figured. (Fig. 6, *c* and *d*.)

Mr. Jack has described what is probably the last nymphal stage as follows:

The full grown larva is about 8^{mm} in length, and light green in color, somewhat lighter than that of the mature insect. The young larvæ appeared to be of a darker green than they were at a later period of their growth. The general shape is triangular, like that of the mature insect, but the broad horn-like projections are not seen in the larva. The eyes are prominent. On the front of the elevated thorax, and behind each eye are two short, strong spines, one above the other, armed with several lateral prongs or forks; higher up, near the apex of the triangular shaped thorax, are two more, somewhat larger armed spines, and the last two visible thoracic segments are each provided with a pair of these branching spines that are still longer. There are also a pair of these spines, each armed with about 6 or 7 barbs, on each of the abdominal segments next to the terminal. These are graduated in length, the shortest being on the last segments, and the longest hardly more than a millimeter in length. The thoracic spines project forward, while those on the abdominal segments are drawn forward at the base and then curved back, strongly suggesting the dorsal fin of a fish. On the last segment, which is long and tapering, there are two short armed spines directly above the anal opening, which is terminal. The ventral surface of the abdomen is scatteringly covered with short, strong bristles or hairs. The legs are also covered with stiff hairs.

FOOD-PLANTS.

The larvæ and pupæ, as well as the adults, feed on all sorts of succulent vegetation, such as weeds and garden vegetables, and are apparently not particularly fond of the apple, much preferring the more succulent annual plants. Mr. Jack reports that he found the adults feeding on the young and tender shoots of the apple, near the ground, by which I suppose he means the water shoots, for certainly after very careful and repeated observations in an orchard which was so infested as to be nearly ruined, I failed entirely to find any indication of the feeding of larvæ or adults on apple. The injury, then, in this direction, to fruit and shade trees, is practically not worth considering. These facts give a valuable suggestion in the matter of preventives.

REMEDIES.

Remedial measures are difficult and in general impractical, because the larvæ and adults feed on all sorts of vegetation and are very widely distributed. The adults, also, are too active and quick of flight to be successfully reached by caustic washes; and spraying to destroy the early stages is ordinarily out of the question, because it would necessitate extending the treatment to all surrounding vegetation, and as the adults are strong flyers, even this would give no absolute security. We must therefore turn to preventive measures for practical results.

The limiting of the amount of foreign vegetation about and in orchards and nurseries is an excellent precaution, and little damage may be anticipated where the ground between the trees is kept clean and constantly cultivated. The larvæ and pupæ under these conditions will be starved out. The orchard in which the writer first studied this insect, and which was so thoroughly infested as to be seriously injured, was one which had been neglected for a number of years and was full of weeds and succulent undergrowth, furnishing conditions under which an unusual multiplication of the Ceresa had taken place over a number of years. Surrounding and better-kept orchards showed little, if any, damage.

Vigorous pruning in the fall or winter should be given trees which have been cut up to any extent, and this with clean culture should reduce the insect to small numbers. It is possible that something could be done by planting trap plants between the rows of trees, such as beans or other similar summer crops, which could be sprayed with the stronger mixtures of the kerosene and soap emulsion when the larvæ became numerous or about the 1st of July, but the more practical method is the cultural one already described.

SUPPLEMENTARY NOTES ON THE STRAWBERRY WEEVIL, ITS HABITS, AND REMEDIES.

By F. H. Chittenden.

The strawberry weevil (*Anthonomus signatus* Say) appeared in injurious numbers in the spring of 1893 and again in 1894 in many of the same places that were infested in 1892, as reported in a previous article by the writer in Insect Life (vol. v, pp. 168–170), and in a few new localities.

INFESTED LOCALITIES OF 1893–'94.

In Maryland the strawberry weevil was reported by Mr. Elon Behrend at Seat Pleasant, Prince George County, where it was injurious during the past two seasons. No injury had been noticed on Mr. Behrend's farm in previous years, but great damage had been done on neighboring farms, from which the insect had undoubtedly spread to his own. Wild vines of strawberry and Potentilla were growing in some abundance in the vicinity of the strawberry beds when these were visited in May of 1893, but were little troubled by the weevil, the cultivated varieties "Sharpless" and "Charles Downing" being greatly preferred. Mr. Behrend reported that a neighbor of his, Mr. W. E. Carrick, had also sustained some loss through this weevil.

The insect was again destructive in Anne Arundel County, at Arnold and at Harmans. Mr. R. S. Cole, of the latter place, wrote that there was a shortage of at least half the crop in 1892, and in 1893 about a third was destroyed. The species had been noticed there for upwards of ten years, the principal damage being to the "Sharpless," "Hoffman," "Michel's Early," and "Bidwell" varieties.

Mr. L. J. Atwater reported injuries to "Sharpless" berries in Montgomery County, near the District line. One crop was completely ruined.

In Virginia, in Alexandria County, Mr. W. T. Sprankle, of Falls Church, who was one of the heaviest losers in 1892, gathered good crops the past two years, the weevil appearing in injurious abundance in only one portion of his fields. He reported that those who had lost entire crops in 1892 did not suffer much loss in 1893. Capt. William S. Patton, West End, Fairfax County, reported complete loss of a crop of "Sharpless," and added that the fruit-growers of his vicinity had abandoned this variety on account of its susceptibility to weevil attack.

Information was also received of the presence of this insect in a number of other localities in Maryland and Virginia but no serious loss was incurred. The insect was noticed in Delaware again and reported to Mr. M. H. Beckwith, of the State Experiment Station, in strawberry fields about Clayton. It was also troublesome in a few localities in southern New Jersey during the two years past and so reported by Prof. J. B. Smith in the preceding volume (p. 191) and by letter. It did not, however, do any special injury. In fact, the insect has been much less abundant the past two years than in 1892 and appears to be on the decrease in these States.

Extensive damage was reported to the strawberry during May of the current year by a correspondent in Columbia County, Pa., and as the injury was due to the severing of the stalks there can be no doubt that the strawberry weevil was the culprit.

Accounts of similar injuries in recent years have been received from New York State, but with no report as to the extent of damage.

A number of our correspondents have complained particularly of the damage done by the destruction of the staminates used in the fertilization of pistillates, the product being dwarfed and useless fruit.

The presence of the insect in 1892, when the greatest damage known in its history was done, was reported too late in the season for experimentation with remedies, and circumstances were equally unfavorable the past two seasons. Such remedial experiments as were performed were by correspondents of the Division, and we are particularly indebted to

Mr. B. E. Behrend for assistance in this line. In response to numerous invitations from local fruit-growers, in 1893 the writer visited some of the infested farms in Maryland and Virginia and made some additional observations on the habits of the species.

NOTES ON HABITS AND LIFE HISTORY.

New Food-plants; Early Appearance of the Insect.—The strawberry weevil was first noticed abroad April 16, 1893, and on the 15th, of 1894, in great abundance, on a new food-plant, the red-bud or Judas-tree (*Cercis canadensis*), which grows in profusion along the banks of the Potomac, about Washington. This tree had not yet bloomed, but the insect had already begun its attack, as great numbers of punctured buds bore witness, showing that it had been at work for several days.

Early-flowering plants were unusually backward in blooming here the past two seasons, and this had its effect on the appearance of the insect. In earlier seasons it undoubtedly appears by the first week of April, as the red-bud is known to bloom at that time. The beetles, then, are abroad some time before strawberries bloom, and may appear on the vines before blossoming. They are doubtless attracted to the vines, however, mainly by the open flowers to which they first resort for food, although they also derive much nourishment from the pollen within the buds.

Very soon after first bloom they are to be found in great abundance. Appearing, as they often do, in great numbers almost from the outset, their injuries are severe even in such seasons as the past two, when only from 10 to 20 per cent of a crop is lost in the aggregate, because the blossoms chiefly injured are the earliest, and consequently the shortage is largely in the early fruit, or that which would have brought the highest market price.

Certain red-bud trees growing on the border of woodland, where they are protected from the wind and fully exposed to the sun, were much frequented by these insects, and of the thousands of buds which they bore a majority were attacked and severed from the stem in the characteristic manner of this weevil. Other trees in the vicinity were comparatively free from attack. One of the infested trees was visited May 13 and the ground was seen to be strewn with the discolored buds. A number were gathered and examined only to find them all empty, having been torn open by ants, of which there were two species crawling in abundance about them. This would seem to prove that the red-bud is not necessarily a factor of great importance in the economy of this insect, since only such trees as are fully exposed to the sun served to attract the weevil in great numbers and the immature offspring of these are very liable to fall a prey to ants. The two species observed among the infested buds have been identified by Mr. Th. Pergande as *Formica fusca* Linn. and *Aphænogaster fulva* Rog.

Dewberries (*Rubus canadensis*) were found to be infested in about the same proportion as blackberries, and Mr. B. E. Behrend reported injuries also to "black cap" raspberries.

Other plants which it was thought possible might be exceptionally attacked by this insect were carefully examined, but no traces of its work were apparent. The blossoms of apple, pear, peach, and cherry were searched, and of wild plants, sassafras, cherry, and locust. The last named is much frequented by ants, which might repel the weevils.

Notes on the Habits of the Adults.—As night approaches the beetles descend to the base of the strawberry plants for shelter. Here, with antennæ and legs folded tightly to their bodies, they are tolerably secure from nocturnal marauders, such as Carabidæ and other predaceous insects, until the morning sun awakes them to activity.

In the field it is doubtful if this insect ever eats the leaves of strawberry, as there is usually a supply of pollen and petals sufficient for its needs, but should this supply for any reason become exhausted the leaves would undoubtedly suffer. In our rearing cages the insects lived for some time on strawberry leaves, but when blossoms were introduced the insects found them, at once showing their preference.

Duration of the Life-Cycle.—A quantity of severed buds were gathered in the field May 8, all of which had been cut that day or the day previous. These began to disclose the imago June 5, and all had issued by the 8th. These data show that the life-cycle from egg to adult is from twenty-eight to thirty days. The weather during this period was unusually cool until the last few days, hence the average period of the life-cycle may be said to be about four weeks.

Process of Oviposition.—Previous efforts to observe oviposition in confinement having failed, the insects were watched in the field, many individuals being observed puncturing the buds, and in the act of cutting the stems. The female usually works head downward, and is sometimes alone but often accompanied by the male. The egg is laid first and after severing the stem the insect always departed. After perforating the corolla, the insect turns around and applying the tip of her abdomen to the hole deposits a single egg, then crawls to the stem, places herself firmly on the upper surface, head downward as before, and deliberately severs the bud containing the egg from the stem. The latter is sometimes only punctured, but in bright sunshiny weather a number of insects were observed, all of which cut off the stem until it hung only by a thin shred of the epidermis. The stem was cut straight across, the insect working rapidly and steadily until the stem began to droop, when she ceased operations and withdrew down the stem.

On cool, damp, or cloudy days, the insect is not active and does not, therefore, accomplish as much as in pleasant weather. A field was visited on a fair, warm day following a cool, rainy spell of two or three days' duration, and an excellent opportunity was afforded for comparison. Stems could be seen that had been attacked only a day or two before, a single black speck showing where the punctures had been made. Favorable or unfavorable weather will explain, at least in part, why some buds are cut off, while others remain attached.

The entire time consumed varies greatly, but fifteen or even ten minutes, is ample for oviposition. The process of forming a hole consists simply in perforating the corolla, although the calyx is also sometimes pierced through, the time varying from two to five or more minutes. In inserting the egg less than a minute is ordinarily consumed, and the process of severing the bud varies in time according to how completely the insect does its work.

INJURIOUS APPEARANCES.

The strawberry weevil appears to be one of the many forms, like the corn bill-bugs, for example, that are only exceptionally injurious, which appear in great abundance for one or more seasons in certain districts, and after causing a vast amount of trouble relapse into obscurity, to reappear in a new locality after a lapse of years. A review of economic literature, however, together with reports from correspondents, shows that this insect has done more or less damage in the past, year after year, since its first recorded appearance in 1871. It is more than probable that the strawberry and blackberry crops, at least of this vicinity, are annually levied upon by this little creature to the extent of from 5 to 20 per cent, a loss that would seldom be noticed.

Now that our local growers are becoming familiar with the appearance of the insect and its work, we should be better able to observe its progress, as well as to cope with it in years of abundance.

The following table shows that the insect has been more or less injurious for the past twelve years:

1871.—Maryland.[1]
1873.—Missouri.[2]
1883.—Michigan (northern).[3]
1884.—Staten Island, N. Y.[2]
1885.—Staten Island, N. Y.[2]
Prov. Ontario, Canada.[4]
Pennsylvania (Krieg).[5]
1886.—Prov. Ontario, Canada.[6]
1887.—Pennsylvania.[5]
Prov. Quebec, Canada.[6a]
1888.—Michigan (Southern).[3a]
Prov. Quebec, Canada.[6]
1889.—Maryland.
Prov. Quebec, Canada.[6]
1890.—Maryland.
Virginia.
Prov. Quebec, Canada.[6]
1891.—Maryland.
Virginia.
New Hampshire (Dimmock).[5a]
1892.—Maryland.
Virginia.
Delaware.
1893.—Maryland.
Virginia.
Delaware (Beckwith).
Southern New Jersey (Smith).[5b]
1894.—Maryland.
Virginia.
Delaware.[7]
Southern New Jersey.[7]
Pennsylvania.

[1] Glover. Monthly Rept. Dept. Agr., 1871, p. 479.

[2] Riley. Rept. Commr. Agr. for 1885, p. 276.

[3] Cook. Rept. Sec'y Hort. Soc. Mich., for 1883, p. 154; 3a Rept. Agl. Exp. St., Mich., for 1888, p. 165.

[4] Saunders. Can. Ent., XVII, p. 239.

[5] INSECT LIFE, I, p. 85; 5a do., IV, p. 76; 5b do., VI, p. 191.

[6] Fletcher. Exptl. Farms (Canada), Rept. for 1890, p. 174; 6a do., for 1887, p. 37.

[7] Present in strawberry fields, but no serious injury reported.

The remaining invasions have either been recorded in my first article, or have been reported by various correspondents since that paper was published. Some of these correspondents write that the insect and its work have been noticed in Virginia for six or seven years in the past, and in Maryland for upwards of ten years. Mr. James Fletcher writes that he has an occasional reference to it every year.

REMEDIES.

Although a difficult insect to contend with, it would not be impossible to keep it in check in some districts, if all the strawberry growers of a neighborhood could be induced to combine in the work of clearing away wild plants and destroying the insects in their fields. In other places, however, where wild blackberry, strawberry, and Potentilla, in which the insect normally breeds, grow so abundantly, as in some localities about Washington, it would seem next to useless to attempt to control it.

Burning Brush-wood in Spring.—The practice of "burning over" the underbrush and weeds in the spring so universally in vogue in parts of Maryland and Virginia is undoubtedly productive of good results in protecting the cultivated strawberry from the weevil and other insect enemies. In past years the strawberry weevil has always been abundant on the wild blackberry and strawberry that grow in the greatest profusion along the shores of the Potomac near Washington, but the past two seasons this insect was comparatively scarce, and this falling off can only be attributed to the unusually close burning over of the weeds and shrubbery of the vicinity. The blackberry bushes were very generally killed, and it is quite likely that the hibernating beetles were destroyed by the heat.

Trap Crops.—Excellent proof that the beetle may be successfully trapped by planting early-flowering varieties with other berries was afforded this year. In a field of "Sharpless" a few "Charles Downing" were growing, and although the latter bloomed only a day or two in advance of the former the greater abundance of the weevils on the "Downings" was at once apparent. By laying out our beds with the earliest blooming staminates on the sides which experience has shown to be the most likely to be first attacked, *e. g.*, toward wooded land, the beetles can be massed where they can be more profitably reached with insecticides.

By transplanting a few trees of red-bud to the vicinity of the strawberry fields, placing them between the beds and the nearest woodland, the hibernated brood of beetles could be reduced to a minimum. This tree, which blooms several days before the earliest strawberries, attracts the first arrivals. As soon as the buds appear the tree should be jarred and shaken daily, and the beetles, together with the buds in which they have laid their eggs, gathered on sheets saturated with kerosene, which will destroy them. The trees may also be profitably sprayed with Paris green, as the blossoms appear in advance of the leaves and would be easily reached by the poison.

The Sweep-net.—Capturing the beetles with a sweep-net has been suggested, but in my experience they are not readily captured, on account of the low growth of the vines and the habit of the beetles of dropping to the ground or of adhering to the plants when disturbed. It would be necessary to use the net almost daily and in the heat of the day, to produce much effect.

Dusting Plants with Lime, Ashes, etc.—Some of our correspondents tried dusting the plants with lime, ashes, and similar substances as repellants, but in the fields thus treated the insects were not present in sufficient abundance for satisfactory tests. As others will continue such experiments in the future it may be well to quote the experience of Mr. W. A. Hale, as reported by Mr. Fletcher. He says: "I tried equal parts of air-slaked lime and sifted hardwood ashes; also ammonia in the form of fermenting hen manure put on between the rows, powerful enough to wither the foliage, but with little or no effect." He also tried dissolved bone, which "checked, to a certain extent, the depredations, but left upon the hulls its pungent smell." Mr. R. S. Cole writes that he "used a mixture of tobacco dust, lime, Paris green, and coal oil" quite plentifully on the vines, but with little effect on the insects.

Other remedies were tried with negative success. Pyrethrum had little or no effect when dusted on the plants in the open field. This species, as well as the other snout-beetles, is extremely hardy, and undoubtedly revives soon after treatment. Mr. Sprankle had placed a brood of young chickens in that portion of his fields which was badly infested, and at the time of my visit the little creatures were closely watched, but though the weevils could be seen in numbers on every side they seemed to utterly escape the eyes of the chickens, which were engaged chiefly in devouring larval grasshoppers and other larger insects.

Arsenical Spraying.—The arsenites have been suggested as a remedy, but their value was considered doubtful for the reason that the adult insects do not feed on the foliage, and can only be reached when they feed on the open blossoms or cut through the corolla of the bud for oviposition. The larva can not be affected at all by this or any other spray now in use, as they are entirely protected within the buds. Then, the arsenites do not commend themselves to the average grower because of the fear of poisoning the consumer. In fact, one writer on this subject expressly disapproves of their use on this ground, but there is not the slightest possibility of poisoning the fruit, since the arsenical to have any effect on the weevil must be applied while the plants are in bud or blossom, the last application being made at least three weeks before the first berries ripen.

This is not mere theory. The matter has been recently tested at the Iowa Experiment Station. A strawberry patch infested with the green strawberry slug (*Monostegia ignota* Cr.) was thoroughly sprayed with London purple (one pound to 200 gallons of water), and within a week after this application Mr. H. A. Gossard and other employés of the station "ate very heartily of the ripened fruit" without experiencing any ill effects whatever. This matter is fully discussed in Bulletin No. 18 of the Iowa station, and in *Entomological News* (vol. III, p. 230), and the general subject of the danger of poisoning from the consumption of fruit and vegetables sprayed with arsenicals is considered in Farmer's Bulletin No. 19 of this Department.

In accordance with my suggestions, Mr. B. E. Behrend made some experiments with the kerosene emulsion and, at his own instance, with Paris green, and kindly reported results.

Experiments with Kerosene Emulsion and Paris Green.—The kerosene-soap emulsion, diluted with 10 parts of water, was sprayed on the vines May 5 and 6 (1893), an ordinary spraying syringe being used for the purpose. May 8, when I visited the field, a few beetles were still on these vines, but the difference in their numbers and of those that were at work on the check plats was quite perceptible. The application was made too late to be of substantial value, but it served to show that the emulsion was of some value as a repellant.

The present year work was begun earlier, and with better success.

The field treated was divided into five parts.

Plats 1 and 2 were of the "Charles Downing" variety, of equal size, and contained about the same number of plants. Plat 1 was sprayed with Paris green April 26 and 29, May 3 and 6. Plat 2 was treated with kerosene emulsion April 29 (threatening and rainy weather preventing earlier spraying), May 3 and 6. As a result, double the number of berries were picked from plat 1 as from plat 2.

Plats 3 and 4 of the "Sharpless" variety were treated in a similar manner to 1 and 2, but the presence of blight prevented an exact estimate of the result. Plat 5, or half of the entire field, of "Charles Downing" variety, was treated with Paris green, with the result that only a few buds were found to have been cut!

Mr. Behrend also reported that a neighbor of his applied Bordeaux mixture with some success.

It should be said that while the above experiments were of value in showing the efficacy of Paris green and its superiority to kerosene emulsion, still the fact that the emulsion was not applied until three days later than the Paris green must be taken into consideration, as this undoubtedly affected the result.

Directions for the Application of these Insecticides.—The following suggestions are substantially as given to our correspondents during the past two years. To obtain the best results it is necessary to spray the vines a day or two before blooming, and again two or three days after first bloom, at least three applications being made at intervals, the different applications being graded with a view to keeping the plants constantly covered with a thin coating of oil, or the buds and blossoms with the arsenical. For example, if the variety of berry to be treated begins to bloom April 27, it might be sprayed on the 24th or 25th, again on the 29th or 30th, and a third time, say May 5. It is doubtful if a fourth application would be profitable except in the event of rain or heavy dew fall after spraying, as the chief damage is done during the first two weeks of blooming. The finest possible mist-like spray should be obtained and applied lightly, in such a manner that it will adhere to the plants, and not form globules and roll off to the ground.

In the use of the kerosene emulsion the greatest care should be observed, first, that it be properly prepared, second; that it be not applied in too large quantity. In its preparation the usual formula is used, viz, 2 parts kerosene, or coal oil, to 1 part soap solution or milk. For use on strawberry vines a 10-per cent solution, made by diluting with 9 parts water, will probably give the best results.

Either Paris green or London purple may be used on strawberry in the same proportion as on apple, viz, 1 pound of the poison to 150 gallons of water.

The best form of apparatus for spraying garden plants is the knapsack sprayer, fitted with the finest Vermorel spray-nozzle.

In case the plants should also be affected with blight the Bordeaux mixture may be employed as a diluent, instead of lime and water, with either the emulsion or the arsenites and in the same proportion.

Full directions for the preparation and application of these remedies are given in Farmer's Bulletin No. 19 of this Department, and therefore need not be repeated here.

It should also be remembered that the arsenicals will act with good success on other injurious insects that might be present on the vines, *e. g.*, the strawberry slugs, the leaf-rollers, and the adults of the root-borers, while the emulsion would prove valuable against the strawberry plant-louse.

On Covering Beds as a Preventive.—Several conditions have operated against the adoption of a covering for the beds: A disinclination on the part of the grower to incur what seemed an extra expense—although this would be amply repaid by the protection against frost and the earlier harvesting of the crop—and a general disposition to "take the chances" of the insect being again injurious. Again, there is often great difficulty in inducing a farmer to adopt remedial measures except at the time when the damage is most apparent, and this is, of course, too late for successful treatment of a species like the one under consideration. Another reason assigned for failure to employ precautionary measures was a fear that the insect hibernated in the beds. Now, while a few individuals may do so, particularly in old beds that have become choked up with grass and weeds, the majority, in all probability, seek more sheltered retreats. In conversation on the subject in 1892 with some of our local growers I expressed the opinion that the new brood as a whole would, after feeding on such flowers as could be found at that time, fly to the nearest woods and there find protection under the leaves and other débris till the following spring, and the experience of the past seasons bears out this theory. One of the strawberry beds at Falls Church adjoins a bit of woodland, and it was along the border of these woods that the insects began their attack last year, other portions of the field, on higher ground, exposed to the wind being practically exempt from infestation.

It should be borne in mind that the few insects that might hibernate in the beds, if these are neglected until they become overrun with grass and weeds, or contrive to effect an entrance under the covering, can be killed by a few dustings with pyrethrum.

Finally, the fruit-grower should not trust entirely to staminate varieties. It will be found far better, in districts where this insect is known to be injurious, to grow pistillates as is now customary, and the spray need only be applied to the staminates used in fertilization, provided the nonfertilizing plants are perfect pistillates and hence bear no pollen.

OCCURRENCE OF THE HEN FLEA (SARCOPSYLLA GALLINACEA WESTW.) IN FLORIDA.

By A. S. Packard, *Providence, R. I.*

At the meeting of the Entomological Society of Washington, held November 12, 1886 (*see* Proc., vol. I, p. 59), a letter was read from Judge Lawrence C. Johnson relative to the damage done by a species of flea to young chickens at Gainesville, Fla. At the meeting held March 7, 1889, another communication from Judge Johnson was read, in which he gave, with some detail, the habits of the insect (*loc. cit.* pp. 203–205).

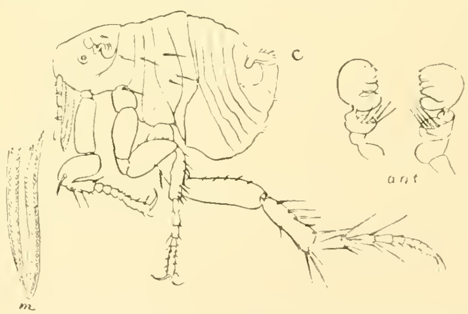

Fig. 8. *Sarcopsylla gallinacea:* male—enlarged; *ant*, antennæ; *m*, palpi—more enlarged. (From drawings by Packard.)

Wishing to further examine this case, Prof. Riley kindly sent me a number of the males and females from the U. S. National Museum. These I identified as *Sarcopsylla gallinacea* Westw., and in 1889, in the Museum at Leyden, I was kindly shown by Dr. C. Ritzema Bos specimens of this species from Ceylon, which seemed on a superficial examination to be the same as the Floridian example. The insect was first described by the late Prof. Westwood in an article in the Entomologist's Monthly Magazine (vol. XI, 1874–'75, p. 246), entitled "Description of a new Pulicideous Insect from Ceylon." To this article I have not had access.

My original identification was made from the figure and description by Dr. O. Taschenberg in his useful monographic work "Die Flöhe," which was based on type-example in Ritzema Bos's collection received from Westwood. Westwood states that the creatures fastened to the eyelids and on the neck of the domestic hen at Colombo, Ceylon, whence they were brought to England by Mr. Moseley, of the *Challenger* Expedition.

To further insure the accuracy of the identification of the Floridian examples with the Asiatic species, I sent one to Dr. Julius Wagner, of St. Petersburg, who writes me as follows: "The flea sent is *Sarcopsylla gallinacea* ♂, and quite similar to the examples of which I send you a pair (♂ and ♀)."

These specimens were from a second locality in Asia, the slide being labeled "Strix sp. Murgab, Suiran-Beir, 3, v, 1893." This locality we suppose to be in Turkestan. It is noteworthy that the host is an owl. It is possible that the wide zoographical distribution of this species is due to the fact that it is carried about from one region to another by birds.

On comparing the Turkestan specimens with those from Florida I am unable to see any difference; the proportions of the different parts of the body being the same, the joints and armature of the legs and tarsi not differing.

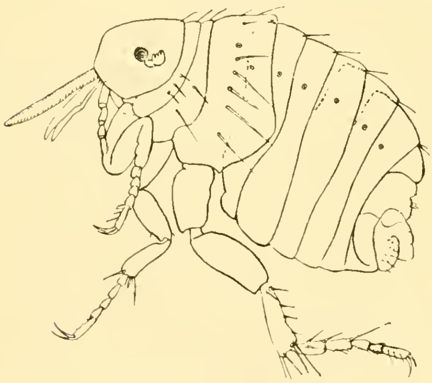

FIG. 9. *Sarcopsylla gallinacea:* Female—enlarged. (From drawings by Packard.)

I add camera sketches of the two sexes. Fig. 8, male, with the antennæ and palpi enlarged; Fig. 9, female, drawn to the same scale.

I may add that Dr. Julius Wagner, who is giving much attention to the Siphonaptera, is desirous of receiving specimens of fleas from this country. He recommends collecting them in the spring or in the beginning of summer. At that season one may find the larvæ and pupæ in the nests and holes of Mammalia, and the adult insects on the same animals, especially on the young ones. Dr. Wagner's address is the Zoölogical Laboratory of the Imperial University of St. Petersburg.

NOTES ON COTTON INSECTS FOUND IN MISSISSIPPI.

By William H. Ashmead.

Towards the latter part of July, 1893, I was instructed to proceed to Utica, Hinds county, Miss., to make some special studies on the bollworm (*Heliothis armiger* Hübn.). I reached my destination on July 23 and left August 23, my stay there extending over a period of just one month. During this brief period, as time permitted, studies were made on such other cotton insects as were brought under my observation, and I find now that many of these have never before been reported on cotton, while still others, especially among the parasitic forms, prove to be new to science.

Inasmuch as many of these are not only of scientific interest but of economic importance, it seems to me desirable that all should be placed on record, together with such brief notes on rearings and habits as have been made, for the assistance and guidance of other workers. As the most satisfactory method of presenting these brief notes, I propose to arrange the insects observed in consecutive order under the different Orders to which they belong.

ORDER ORTHOPTERA.

The Carolina Mantis or rear-horse (*Stagmomantis carolina* Burm.).—The nymph of this striking insect was alone met with, the mature insect not having put in its appearance. Its old egg-cases were found twice.

Three or four species of the genus Gryllus were common in the cotton fields. They probably feed occasionally on cotton, but no direct observations were made on their habits.

The minute three-toed cricket (*Tridactylus minutus* Scudd.) was quite common in the cotton fields and was observed feeding on the tender, newly-formed leaves. Its preference is for low, damp situations, and it was rarely met with in high, dry places.

The banded cricket (*Nemobius fasciatus* DeG.)—Not rare. Feeds occasionally on the tender leaves.

The agitating cricket (*Hapithus agitator* Uhler).—A single specimen only taken, hiding in a blossom. The petals had a hole eaten through them, possibly by it, but it was not observed feeding.

The beautiful leaf-palpus cricket (*Phyllopalpus pulchellus* Uhler) was not uncommon in the blossoms of cotton planted on low land, contiguous to a swamp or running stream. It was observed feeding upon the petals, corolla, and pollen.

Gundlach's cricket (*Cyrtoxipha gundlachi* Sauss.).—A single specimen taken in a cotton blossom. It was not observed feeding.

The banded tree-cricket (*Œcanthus fasciatus* Fitch).—This species is not uncommon, and feeds upon the leaves. It is readily distinguished from *Œ. niveus* and allied species by having a long, straight black line, and a short, more or less curved line, on basal joint of antennæ, and two short black lines on the second joint, the outer being the shorter. The eggs are deposited in double rows in long slits made by the ovipositor of the female, in the smaller lateral branches or the leaf-petioles of the cotton. Each egg is very elongate, 3^{mm} long, or over five times as long as thick, perfectly white, and with a granulated cap at the top or outer end. The duration of the egg stage is from four to five days, although it may be even shorter, as apparently fresh specimens taken in the petiole of a leaf on August 3 hatched August 6. Other specimens taken August 5 hatched August 9.

The cone-headed locust (*Conocephalus obtusus* Burm.).—Only occasionally met with on cotton. It feeds on the leaves, eating large pieces out of the sides and gnawing holes through the middle.

Two nymphs of another species, or belonging to another genus, were also taken feeding on the leaves. This species has an acute tubercle on the forehead and white rings on the antennæ.

The long-tailed cotton locust (*Orchelimum gossypii* Scudd.).—This species is in the National Museum labeled *O. longicauda* Walsh, but so far as I can find was never described by him.

Mr. Samuel H. Scudder in "Entomological Notes" (pt. IV, p. 64) described it under the name *O. gossypii*, and says: "This is the insect referred to in the Proceedings of the Boston Society of Natural History (vol. XI, p. 434) as laying its eggs in the stems of the cotton plant. The eggs were pale yellow, one-fifth of an inch long, cylindrical, bluntly pointed, and a little tapering at the end from which the larva emerges; the other extremity was rounded."

I found the species common, feeding in the blossoms, eating the corolla and petals, and preventing the formation of the boll. The species is very voracious, and a single specimen must destroy many bolls before attaining full growth.

Two other species with similar habits, *O. glaberrimum* Burm. and *O. fasciatum* Scudd., were observed.

The red-legged locust (*Melanoplus femur-rubrum* DeG.).—Taken in both nymph and imago state, feeding on the leaves.

The obscure grasshopper (*Acridium obscurum* Burm.).—Very common. Feeds in the nymph stage upon the leaves, and sometimes almost entirely defoliated some of the branches. In destructiveness it comes next to the long-tailed cotton locust.

The rugose grasshopper (*Hippiscus rugosus* Scudd.)—Although plentiful in all the fields, this species was only occasionally seen feeding on cotton leaves.

In the family Tettigidæ five distinct species were taken on cotton, as follows: *Batrichidea cristata* Scudd.; *Tettigidea lateralis* Say; *Tettix ornatus* Say; *T. femoratus* Scudd.; and *T. arenosus* Burm.

ORDER THYSANOPTERA.

Three distinct species of Thripidæ were taken on cotton. Two species, the wheat Thrips (*Thrips tritici* Fitch) and the apple Thrips (*Phlœothrips mali* Fitch) were taken in the blossoms, puncturing the stamens and corolla, but no serious injury seemed to follow their attack.

The other species is apparently predaceous and was observed feeding on the cotton Aleyrodes (*A. gossypii*). It is apparently undescribed, and may be characterized as follows:

Thrips trifasciatus n. sp.

Female.—Length 0.8 ^{mm}. Light brown; eyes strongly faceted, purplish-brown in certain lights; three basal segments of abdomen above, dark brown; segments 4, 5, and 6 white; apical segments light brown, the sutures dusky; legs, except hind femora towards tips, white; wings, linear, strongly fringed, without nerves, the ground color brown or fuscous, with three transverse white bands, i. e., the front wings have a white band at base, another at about two-thirds their length, and with the apices white.

Habitat.—Near Utica, Miss.

ORDER NEUROPTERA.

The larvæ of the lacewing flies are predaceous, feeding upon aphides, mites, minute caterpillars, and the eggs and larvæ of other insects. They are commonly called aphis lions.

In the family Hemerobiidæ only a single species was discovered feeding on the cotton aphis (*Aphis gossypii* Glover). A full-grown larva was taken July 28, while it was feeding upon aphides. The following description was made:

Body long and slender; abdomen gradually tapering to a point at the apex, and measuring 8 ^{mm} in length; head small, with long curved pointed mandibles, medium sized eyes and two antennæ extending to the middle thoracic segment; first thoracic segment much longer than wide and only about half the width of the second and third, the latter segments being the widest of all, and each with a large whitish spot at the sides; abdomen much longer than the head and thorax united, gradually produced into a point posteriorly and composed of 9 segments.

During the night it spun an extremely loosely woven cocoon, of the finest silk, 6 ^{mm} long by 3 ^{mm} in width, in which it transformed into a pupa, the pupa being whitish in color, scarcely 4 ^{mm} long, and plainly discernible through the meshes of the cocoon. On August 4 the imago appeared, being just six days in the pupa state.

It is apparently the insect described by Walker from Georgia (Brit. Mus. Cat. Neuropt., p. 286) under the name *Hemerobius humuli* Linn.; but as Hagen believes it to be distinct, and two species having the same specific name can not be retained, the specific name for this species may be changed to *gossypii* and it may be known in future as the cotton lacewing fly (*Hemerobius gossypii*).

No less than five distinct species of the beneficial Chrysopidæ were taken on the cotton, the larvæ of which feed on the cotton aphis, the eggs of various insects, and minute caterpillars. The larva of one species was seen eagerly seizing and sucking dry a minute lepidopterous leaf-miner, another the nymph of a small tree-hopper, while in confinement nearly all the species will attack voraciously almost any small insect they can seize with their curved jaws.

As no effort seems to have been made previously to identify the species of these important predaceous insects found on cotton, I give below the results of my work in this direction, believing it just as important to know the names of those insects beneficial to us as it is to know those which are noxious or injurious.

The eggs of all these species are laid in clusters on either the upper or lower side of a leaf, suspended on delicate threads, and might easily be mistaken for the spores of some fungi. All appear very much alike, and scarcely any specific difference can be detected between the eggs of the different species.

The eyed lacewing (*Chrysopa oculata* Say) is known at once by having a black ring on the second joint of the antennæ, black antennal sockets, a broad black line below the eye, four black spots on vertex, and by the prothorax having three black points on each side.

The white-horned lacewing (*Chrysopa albicornis* Fitch) agrees very closely with the previous species, but the first joint of the antennæ is annulated with sanguineous, the four spots on the crown conjoined and forming two black bands, while the prothorax has only one black point at the sides anteriorly.

The black-horned lacewing (*Chrysopa nigricornis* Burm.) resembles somewhat the preceding, but with the head without black marks or lines, except one on each side of the clypeus and sometimes a line or spot beneath the eye; the first and second joint of the antennæ are pale, not annulated with black or sanguineous, the flagellum being black at basal one-third, while the prothorax usually has a black point at the anterior angle, although sometimes wanting.

The stripe-horned lacewing (*Chrysopa lineaticornis* Fitch) is closely related to *C. nigricornis* Burm., but has the basal joint of antennæ with a black or dusky line above, the prothorax with a fuscous line along the sides, while the head is spotted with fuscous anteriorly.

The slender lacewing (*Chrysopa attenuata* Walk.) is a pale greenish-yellow species and the form most commonly met with on cotton, all the veins of the wings being pale green, more rarely with some of the veins obscured or dusky, the head with a sanguineous line below the eyes and with the palpi varied with fuscous or black.

ORDER PLATYPTERA.

The insects belonging to the family Psocidæ are more or less social in their habits, especially at the approach of cold weather, and when immature resemble the biting lice or Mallophaga. They are scavengers, feeding upon decomposing animal and vegetable matter and upon fungi.

Cæcilius mobilis Hagen.—A single specimen agreeing perfectly with the brief but imperfect description of Dr. Hagen was taken on the under surface of a cotton leaf August 5.

A second species belonging to another genus is apparently undescribed, and for this I have proposed the name *Psocus gossypii*. It is characterized as follows:

Psocus gossypii n. sp.

Female.—Length to tip of wings, 6^{mm}; expanse of wings, 10.5^{mm}. Rust-brown; ocelli, palpi, and antennæ except two basal joints, black; abdomen, except toward base above, blackish-fuscous; apical margin of the scutellum and legs (except the tibiæ and tarsi, which are fuscous or blackish), yellowish; wings, fuliginous, the large triangular pterostigma and the venation (except of the median nervure and its fork, the claval veins basally, the short vein along the hind margin just beyond the apex of the clavus, and the vein joining the hind fork of the median nervure and forming the posterior side of the closed quadrate discoidal cell, which are yellowish,) black.

This species belongs in the section with *P. venosus* Burm. and superficially resembles it; but it is relatively smaller (although specimens of *P. venosus* are occasionally found as small), the color is paler without the brassy tinge on the head, while the pterostigma is black, not yellow.

(To be continued.)

ON A LECANIUM INFESTING BLACKBERRY, CONSIDERED IDENTICAL WITH L. FITCHII, SIGN.

By T. D. A. COCKERELL, *Las Cruces, N. Mex.*

In the year 1801 (or 1804 ?) Schrank described a scale found on Rubus in Europe, naming it *Coccus rubi*. Signoret, when writing his "Essai," recognized that this was a Lecanium, but beyond this he could say nothing very definite, as Schrank's description was extremely short, and the insect had not been seen by him.

Lichtenstein, however, in 1882, proposed a new genus Tetrura, its type being *T. rubi*, which he supposed to be the *Coccus rubi* Schrank. But his insect was a form allied to Dactylopius and therefore not that of Schrank, which still remained unknown to modern authors.

Fortunately, in May, 1891, Dr. T. A. Chapman rediscovered *Lecanium rubi* (Schr.) in England, and in June of the same year the species was also found by Mr. J. W. Douglas. The latter gave an extended description of it, with figures by Mr. Newstead, in the Entomologist's Monthly Magazine (1892, pp. 105–107).

Coming now to this country, we find in Signoret's work a description of *Lecanium fitchii*, which was found on bramble by Asa Fitch. The latter had labeled it *L. rubi*, but Signoret observed that it did not seem to be the same as that of Schrank, and accordingly proposed the name *L. fitchii*.

For some time past it has been recognized that a Lecanium was to be found in the northeastern States on Rubus, but its identification has been a matter of doubt. The chief element in this doubt has arisen from Signoret's statement that *L. fitchii* was the smallest species known to him, whereas the insect commonly recognized in recent times is by no means particularly small.

In July, 1893, Mr. J. Fletcher sent me specimens of a *Lecanium* on Lawton blackberry, from St. Davids, Ontario. From these I made the following notes at the time:

Male scale 5^{mm} long, 3^{mm} wide; oblong, subcarinate, sides finely rugose, not plicate, dorsum shiny; color, dark chestnut brown; several of the scales rather subglobose than oval; sides of some more or less plicate.

Newly-hatched larvæ ocherous-white, with a very conspicuous blackish broad longitudinal band.

I did not study this species further at the time, but noted that it was allied to and possibly a variety of *L. persicæ*. June 12, 1894, Dr. J. A. Lintner sent me several specimens on a blackberry twig, the locality not being stated. Wishing to clear the matter up, I have made a microscopic examination of them, with the following result:

Female with antennæ 7-jointed; 2, 3, and 4 long and subequal (3 a little the longer); 5 and 6 very short and subequal (6 a little the longer); 7 a little longer than 6, but much shorter than 4; 5 somewhat longer than broad; 1 large and ordinary. Formula, 3 (24) 1765.

This is the normal form; one showed antenna 8-jointed, 4 longest, 3 and 2 equal, 5, 6, 7 short; 8 longer than 5, 6, or 7, but shorter than 2. Legs ordinary; tibia a little shorter than femur; tarsus decidedly shorter than tibia; tarsal knobbed hairs and digitules filiform. Anal plates extremely small; their externo-cephalad sides longer than their externo-caudad. Derm tessellate, the plates mostly hexagonal; gland-spots as in other species.

The eggs found under a female are slightly tinged with pink. As Dr. Lintner observed, the scales when removed from the twig leave a curious and pretty pattern of white secretion, consisting of an oval outline, an abdominal patch, and lines indicating the lateral incisions.

With Dr. Lintner's specimens are some male scales, which are as usual in the genus.

Now, what are we to call this Lecanium received from Mr. Fletcher and Dr. Lintner? Putting aside *persicæ*, which I am now convinced it can not be, and *fitchii*, on account of size, I turned for comparison to the European *rubi*. Mr. Douglas, in describing *rubi*, refers to the white markings of the females, which last until oviposition is completed. After that the scales become uniform nut-brown. Herein the species shows resemblance to *L. juglandis* Bouché, with its disappearing yellow marks. I have not seen the American blackberry scale in the proper condition to say whether it has the markings as described by Mr. Douglas, but certainly on Dr. Lintner's examples the dorsal band is obscurely indicated, and the transverse marks seem to have been more or less distinct. So far, therefore, the evidence is inconclusive as to the markings on immature females of the American species. The size of the American species agrees well enough with that of *L. rubi* but in the antennæ we find tangible distinctions. Mr. Douglas clearly describes and figures the first joint as very short and the second much shorter than the third. The second is about as long as the fifth. In the American species, on the other hand, I find the first not very short, the second long and always considerably longer than the fifth.

This, taken with the different locality, justifies us in considering the American scale distinct from *L. rubi*, at least so far as present information goes.

It is hardly necessary to compare it with all the various American species, but it may suffice to say that I found myself obliged to conclude it was *L. fitchii* or a new species. The legs and antennæ agree well enough with *fitchii*. It is especially to be noted that in those antennal characters by which our scale differs from *rubi* it exactly agrees with *fitchii*. *L. fitchii* was from Washington. Why is it not now known to us if the present species is not it? Is it likely that our brambles would support in the northeast United States two different species of indigenous Lecanium?

But how about the size? Signoret says, indeed, that it is the smallest species he knows; but he expressly states that his females had not yet formed eggs, and he speaks of the insect as flattened oval, with a dorsal keel. Does this not clearly show that he had to do with immature examples, dead, and shriveled? Such being assumed, there is nothing in the account of *fitchii* which will not fit the specimens now under discussion.

CONCLUSIONS.

(1) So far as at present known all the Lecania of the Northeast States and Canada found on Rubus must be referred to *L. fitchii* Sign.

(2) *L. fitchii*, so far as present evidence goes, must be held distinct from the European *L. rubi* Schr.

(3) *L. persicæ*, *L. juglandis*, *L. fitchii*, and *L. rubi* are allied species, but must be considered distinct.

INSECTS INJURING DRUGS AT THE UNIVERSITY OF KANSAS.

By Vernon L. Kellogg, *Lawrence, Kans.*

Some jars of insect-infested drugs referred to me by the department of pharmacy of the University of Kansas led me to make a superficial examination of the drugs stored in glass, tin, wooden, and paper vessels in the store-rooms and laboratories of that department which resulted in noting the following drug-attacking insects:

Sitrodrepa panicea Linn., attacking blue flag rhizome (*Iris versicolor*), comfrey root (*Symphytum officinale*), dogbane root (*Apocynum cannabi-*

num), ginger rhizome (*Zingiber officinale*), marshmallow root (*Althæa officinalis*), aniseseed (*Pimpinella anisum*), aconite tuber (*Aconitum napellus*), musk root (*Ferula sumbul*), Indian turnip rhizome (*Arum triphyllum*), belladonna root (*Atropa belladonna*), witch-hazel leaves (*Hamamelis virginica*), powdered coffee seed (*Coffea arabica*), wormwood stems, flowers, and leaves (*Absinthium* sp.), thorn-apple leaves (*Datura stramonium*), cantharides (*Cantharis vesicatoria*), and thirty other different drugs.

Lasioderma serricorne Fab., attacking powdered ergot (*Claviceps purpurea*).

Ptinus brunneus Duft., attacking musk root (*Ferula sumbul*), powdered senna leaves (*Cassia acutifolia*), and powdered Jaborandi leaves (*Pilocarpus pinnatifolius*).

Silvanus surinamensis Linn., attacking almond meal (*Amygdala dulcis*).

Silvanus advena Waltl., attacking aconite tuber (*Aconitum napellus*).

Silvanus sp., attacking aconite tuber (*Aconitum napellus*), ginseng rhizome (*Panax quinquefolium*), henbane leaves (*Hyoscyamus niger*), senega root (*Polygala senega*).

Tenebrio obscurus Fab., attacking parsley root (*Apium petroselinum*).

Paromalus sp., attacking powdered poke root (*Phytolacca decandra*).

Anthrenus varius Fab., attacking powdered cramp bark (*Viburnum prunifolium*).

Atropos divinatoria Fab.,? attacking henbane leaves (*Hyoscyamus niger*), and golden seal (*Hydrastis canadensis*).

Lepisma saccharina Linn.,? attacking powdered mezereum bark (*Daphne mezereum*), and socratine aloes (*Aloe socratina*).

The cosmopolitan and omnivorous little *Sitrodrepa panicea* was by far the most abundant and wide spread in the store-rooms. It is really a serious pest of stored drugs. In the case of the cantharides attacked by it the bodies of the cantharis beetles were completely riddled and broken. Of the thousands of bodies in the canister not one seemed to have been left unattacked. In many other instances the damage done to the drug was considerable.

The remedy, other than preventing the ingress of the insects by using tight jars and canisters, is to expose the infested drug to the vapor of carbon bisulphide. The ease with which this may be done in the case of most drugs gives the druggist a feasible, effective, and almost universally applicable remedy.

THE SENSES OF INSECTS.*

By C. V. Riley.

Having thus dealt in a summary way with some of the structures and economies of the social insects, let us now consider their psychological manifestations.†

Of the five ordinary senses recognized in ourselves and most higher animals, insects have, beyond all doubt, the sense of sight, and there can be as little question that they possess the senses of touch, taste, smell, and hearing. Yet, save, perhaps, that of touch, none of these senses, as possessed by insects, can be strictly compared with our own, while there is the best of evidence that insects possess other senses which we do not, and that they have sense organs with which we have none to compare. He who tries to comprehend the mechanism of our own senses—the manner in which the subtler sensations are conveyed to the brain—will realize how little we know thereof after all that has been written. It is not to be wondered at, therefore, that authors should differ as to the nature of many of the sense organs of insects, or that there should be little or no absolute knowledge of the manner in which the senses act upon them. The solution of psychical problems may never, indeed, be obtained, so infinitely minute are the ultimate atoms of matter; and those who have given most attention to the subject must echo the sentiment of Lubbock, that the principal impression which the more recent works on the intelligence and senses of animals leave on the mind is that we know very little, indeed, on the subject. We can but empirically observe and experiment and draw conclusions from well attested results.

Sight.—Taking first the sense of sight, much has been written as to the picture which the compound eye of insects produces upon the brain or upon the nerve centers. Most insects which undergo complete metamorphoses possess in their adolescent states simple eyes or ocelli, and sometimes groups of them of varying size and in varying situations. It is difficult, if not impossible, to demonstrate experimentally their efficiency as organs of sight; the probabilities are that they give but the faintest impressions, but otherwise act as do our own. The fact that they are possessed only by larvæ which are exposed more or less fully to the light, while those larvæ which are endophytous, or otherwise hidden from light, generally lack them, is in itself proof that they perform the ordinary functions of sight, however low in degree. In the imago state the great majority of insects have their simple eyes in addition to the compound eyes. In many cases, however, the former are more or less covered with vestiture, which is another evidence

* From an address on Social Insects, as president of the Biological Society of Washington, delivered in the hall of Columbian University, January 29, 1894.

† See article by writer in Insect Life, vol. VI, pp. 350-360.

that their function is of a low order, and lends weight to the view that they are useful chiefly for near vision and in dark places. The compound eyes are prominent and adjustable in proportion as they are of service to the species, as witness those of the common house-fly and of the Libellulidæ or dragon-flies. It is obvious from the structure of these compound eyes that impressions through them must be very different from those received through our own, and, in point of fact, the late experimental researches of Hickson, Plateau, Tocke and Lemmermann, Pankrath, Exner, and Viallanes practically established the fact that while insects are shortsighted and perceive stationary objects

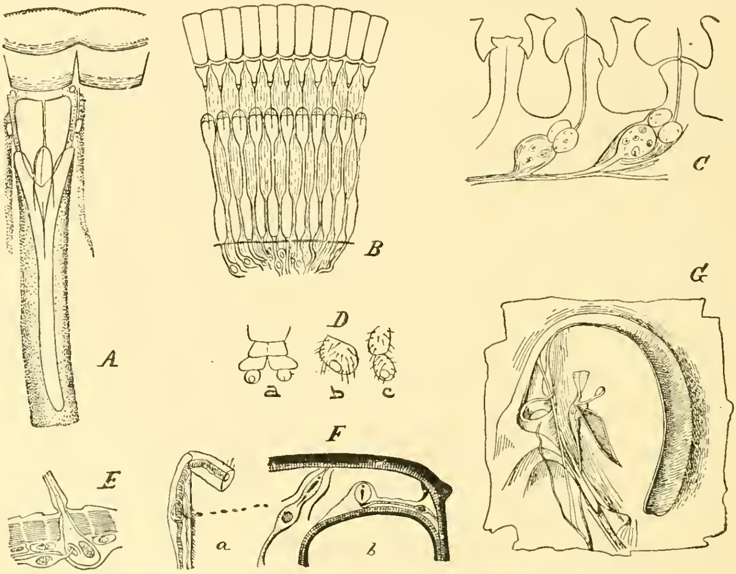

Fig. 10.—Sensory organs in insects: *A*, one element of eye of cockroach (after Grenacher); *B*, diagrammatic section of compound eye in insect (after Miall & Denny); *C*, organs of smell in Melolontha (after Kraepelin); *D*, *a*, *b*, sense organs of abdominal appendages of Chrysopila; *c*, small pit on terminal joint of palpus in Perla (after Packard); *E*, diagram of sensory ear of insect (after Miall & Denny); *F*, auditory apparatus of Meconema; *a*, fore tibia of this locust; *b*, diagrammatic section through same (after Graber); *G*, auditory apparatus of Caloptenus, seen from inner side, showing tympanum, auditory nerve, terminal ganglion, stigma, and opening and closing muscle of same, as well as muscle of tympanum membrane (after Graber).—All very greatly enlarged.

imperfectly, yet their compound eyes are better fitted than the vertebrate eye for apprehending objects set in relief or in motion, and are likewise keenly sensitive to color.

So far as experiments have gone they show that insects have a keen color sense, though here again their sensations of color are different from those produced upon us. Thus, as Lubbock has shown, ants are very sensitive to the ultra violet rays of the spectrum, which we can not perceive, though he was led to conclude that to the ant the general aspect of nature is presented in an aspect very different from that in which it appears to us. In reference to bees, the experiments of the same author prove clearly that they have this sense of color highly developed, as indeed might be expected when we consider the part they have played in the development of flowers. While these experiments seem to show that blue is the bee's favorite color, this does not accord with Albert Müller's experience in nature, nor with the general experience of apiarians, who, if asked, would very generally agree that bees show a preference for white flowers.

Touch.—The sense of touch is supposed to reside chiefly in the antennæ or feelers, though it requires but the simplest observation to show that with soft-bodied insects the sense resides in any portion of the body, very much as it does in other animals. In short, this is the one sense

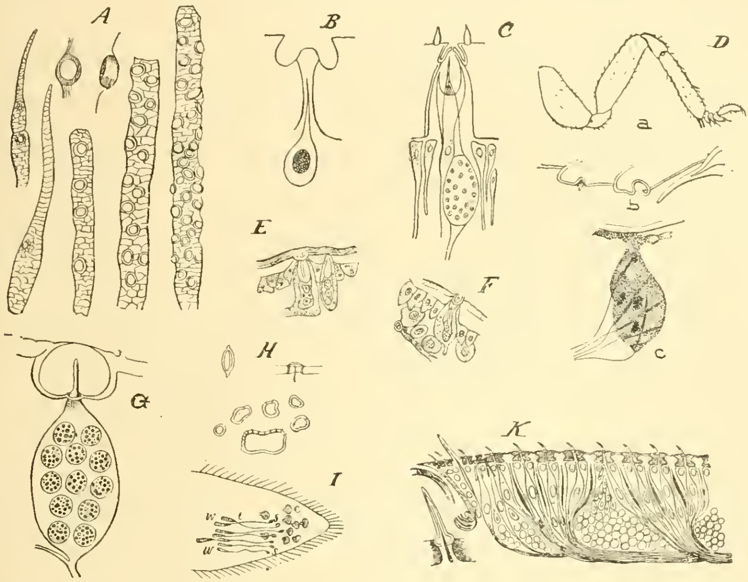

FIG. 11.—SENSORY ORGANS IN INSECTS: *A*, sensory pits on antennæ of young wingless *Aphis persicæ-niger* (after Smith); *B*, organ of smell in May beetle (after Hauser); *C*, organ of smell in Vespa (after Hauser); *D*, sensory organs of *Termes flavipes*; *a*, tibial auditory organ; *c*, enlargement of same; *b*, sensory pits of tarsus (after Stokes); *E*, organ of taste in maxillæ of *Vespa vulgaris* (after Will); *F*, organ of taste in labium of same insect (after Will); *G*, organ of smell in Caloptenus (after Hauser); *H*, sensory pilose depressions on tibia of Termes (after Stokes); *I*, terminal portion of antennæ of *Myrmica ruginodis*; *c*, cork-shaped organs; *s*, outer sac; *t*, tube; *w*, posterior chamber (after Lubbock); *K*, longitudinal section through portion of flagellum of antennæ of worker bee, showing sensory hairs and supposed olfactory organs (after Cheshire). All very greatly enlarged.

which, in its manifestations, may be conceded to resemble our own. Yet it is evidently more specialized in the maxillary and labial palpi and the tongue than in the antennæ in most insects.

Taste.—Very little can be positively proved as to the sense of taste in insects. Its existence may be confidently predicated from the acute discrimination which most monophagous species exercise in the choice of their food, and its location may be assumed to be the mouth or some of the special trophial organs which have no counterpart among vertebrates. Indeed, certain pits in the epipharynx of many mandibulate insects and in the ligula and the maxillæ of bees and wasps are conceded by the authorities to be gustatory.

Smell.—That insects possess the power of smell is a matter of common observation and has been experimentally proved. The many experiments of Lubbock upon ants left no doubt in his mind that the sense of smell is highly developed in them. Indeed, it is the acuteness of the sense of smell which attracts many insects so unerringly to given objects and which has led many persons to believe them sharp-sighted. Moreover, the innumerable glands and special organs for secreting odors furnish the strongest indirect proof of the same fact. Some of these, of which the osmaterium in Papilionid larvæ and the eversible glands in Parorgyia are conspicuous examples, are intended for protection against inimical insects or other animals; while others, possessed by one only of the sexes, are obviously intended to please or attract. A notable development of this kind is seen in the large gland on the hind legs of the males of some species of Hepialus, the gland being a modification of the tibia and sometimes involving the abortion of the tarsus, as in the European *H. hectus* L. and our own *H. behrensi* Stretch. The possession of odoriferous glands, in other words, implies the possession of olfactory organs. Yet there is among insects no one specialized olfactory organ as among vertebrates; for while there is conclusive proof that this sense rests in the antennæ with many insects, especially among Lepidoptera, there is good evidence that in some Hymenoptera it is localized in an ampulla at the base of the tongue, while Graber gives reasons for believing that in certain Orthoptera (Blattidæ) it is located in the anal cerci and the palpi.

Hearing.—In regard to the sense of hearing the most casual experimentation will show (and general experience confirms it) that most insects, while keenly alive to the slightest movements or vibrations, are for the most part deaf to the sounds which affect us. That they have a sense of sound is equally certain, but its range is very different from ours. A sensitive flame arranged for Lubbock by the late Prof. Tyndall gave no response from ants, and a sensitive microphone arranged for him by Prof. Bell gave record of no other sound than the patter of feet in walking. But the most sensitive tests we can experimentally apply may be, and doubtless are, too gross to adjust themselves to the finer sensibilities of such minute, active, and nervous creatures. There can be no question that insects not only produce sounds, but receive the impression of sounds entirely beyond our own range of perception, or, as Lubbock puts it, that "we can no more form an idea of than we should have been able to conceive red or green if the human race had been blind. The human ear is sensitive to vibrations reaching at the outside to 38,000 in a second. The sensation of red is produced when 470 millions of millions of vibrations enter the eye in a similar time; but between these two numbers vibrations produce on us only the sensation of heat. We have no especial organ of sense adapted to them." It is quite certain that ants do make sounds, and the sound-producing organs on some of the abdominal joints have been carefully described. The fact that so many insects have the power of producing sounds that are even audible to us is the best evidence that they possess auditory organs. These are, however, never vocal, but are situated upon various parts of the body or upon different members thereof.

Special Sense and Sense Organs.—While from what has preceded it is somewhat difficult to compare the more obvious senses possessed by insects with our own, except perhaps in the sense of touch, it is, I repeat, just as obvious to the careful student of insect life that they possess special senses which it is difficult for us to comprehend. The

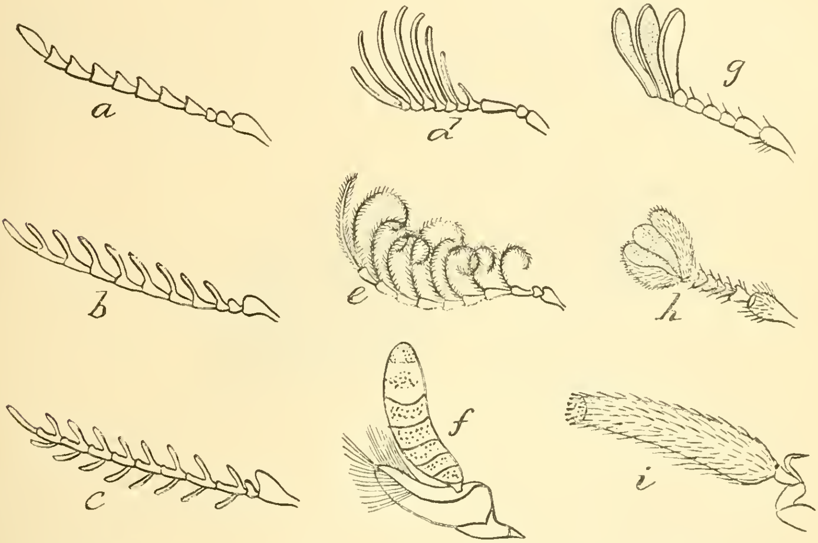

FIG. 12.—SOME ANTENNÆ OF COLEOPTERA: *a*, Ludius; *b*, Corymbites; *c*, Prionocyphon; *d*, Acneus; *e*, Dendroides; *f*, Dineutes; *g*, Lachnosterna; *h*, Bolbocerus; *i*, Adranes (after LeConte and Horn).—All greatly enlarged.

sense of direction, for instance, is very marked in the social Hymenoptera which we have been considering, and in this respect insects remind us of many of the lower vertebrates which have this sense much more strongly developed than we have. Indeed, they manifest more especially what has been referred to in man as a sixth sense, viz, a certain intuition which is essentially psychical, and which undoubtedly serves and acts to the advantage of the species as fully, perhaps, as any of the other senses. Lubbock demonstrated that an ant will recognize one of its own colony from among the individuals of another colony of the same species, and when we consider that the members of a colony number at times, not thousands, but hundreds of thousands, this remarkable power will be fully appreciated.

The neuter Termites are blind and can have no sense of light in their internal or subterranean burrowings ; yet they will undermine buildings and pulverize various parts of elaborate furniture without once gnawing through to the surface, and those species which use clay will fill up their burrowings to strengthen the supports of structures which might otherwise fall and injure the insects or betray their work. The bat in a lighted room, though blinded as to sight, will fly in all directions with such swiftness and infallible certainty of avoiding concussion or contact, that its feeling at a distance is practically incomprehensible to us.

The manner in which anything threatens its welfare thrills and agitates one of these insect communities, and causes every individual to act at once for the common good, has been noted by all observers, and is a good illustration in point. It may be likened to the manner in which the same conditions influence communities of other animals, including man. There are emergencies when intuitive feeling dispossesses reason, and every capable person seems blindly urged to definite

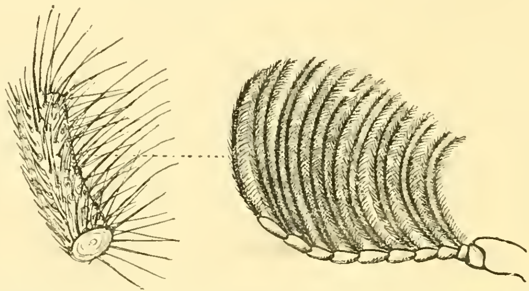

FIG. 13.—Antenna of male Phengodes with portion of ray.—Greatly enlarged (original.)

action for the protection of the community, regardless of consequence. The war cry of a nation is an example in point, and violations of otherwise just, but tedious, processes of law are under certain circumstances deemed justifiable. I shall never forget the emotion that influenced the citizens of Chicago the day following their great fire in 1871. Reason, argument, judgment, were in abeyance. The quicker, intuitive processes prevailed, and to meet lawlessness and the tendency to incendiarism, every right-minded citizen was ready to do vigilant duty, regardless of personal interest, every incendiary being hanged to the nearest lamp-post without ado or delay. It was the universal and deep-seated instinct of self-preservation.

Telepathy.—But however difficult it may be to define this intuitive sense which, while apparently combining some of the other senses, has many attributes peculiar to itself, and however difficult it may be for us to analyze the remarkable sense of direction, there can be no doubt that many insects possess the power of communicating at a distance, of which we can form some conception by what is known as telepathy in man. This power would seem to depend neither upon scent nor upon hearing in the ordinary understanding of these senses, but rather on certain subtle vibrations as difficult for us to apprehend as is the exact nature of electricity. The fact that man can telegraphically transmit sound almost instantaneously around the globe, and that his very speech may be telephonically transmitted, as quickly as uttered, for thousands of miles may suggest something of this subtle power even though it furnish no explanation thereof.

The power of sembling among certain moths, for instance, especially those of the family Bombycidæ, is well known to entomologists, and many remarkable instances are recorded. I am tempted to put on record for the first time an individual experience which very well illustrates this power, as on a number of occasions when I have narrated it most persons not familiar with the general facts have deemed it remarkable. In 1863 I obtained from the then Commissioner of Agriculture, Col. Capron, eggs of *Samia cynthia*, the Ailanthus silkworm of Japan, which had been recently introduced by him. I was living on East Madison Street, in Chicago, at the time, a part of the city subsequently swept by the great fire and since entirely transformed. In the front yard, which (so commonly the case in the old Chicago days) was below the sidewalk, there grew two Ailanthus trees which were the cause of my sending for the aforesaid eggs. I had every reason to believe that there were no other eggs of this species received in any part of the country within hundreds of miles around. It seemed a good opportunity to test the power of this sembling, and after rearing a number of larvæ I carefully watched for the appearance of the first moths from the cocoons. I kept the first moths separate and confined a virgin female in an improvised wicker cage out of doors on one of the Ailanthus trees. On the same evening I took a male to the old Catholic cemetery on the north side, which is now a part of Lincoln Park, and let him loose, having previously tied a silk thread around the base of the abdomen to insure identification. The distance between the captive female and the released male was at least a mile and a half, and yet the next morning these two individuals were together.

Now, in the moths of this family the male antennæ are elaborately pectinate, the pectinations broad and each branch minutely hairy. (See Fig. 14, *a*.) These feelers vibrate incessantly, while in the female in which the feelers are less complex there is a similar movement connected with an intense vibration of the whole body and of the wings. There is, therefore, every reason to believe that the sense is in some way a vibratory sense, as, indeed, at base is true of all senses, and no one can study the wonderfully diversified structure of the antennæ in insects, especially in males, as very well exemplified in some of the commoner gnats (see Fig. 14, *d*, *e*), without feeling that they have been developed in obedience to, and as a result of, some such subtle and intuitive power as this of telepathy. Every minute ramification of the wonderfully delicate feelers of the male mosquito, in all probability, pulsates in response to the piping sounds which the female is known to produce, and doubtless through considerable distance.

There is every justification for believing that all the subtle cosmic forces involved in the generation and development of the highest are equally involved in the production and building up of the lowest of organisms, and that the complexing and compounding and specialization of parts have gone on in every possible and conceivable direction, according to the species. The highly developed and delicate antennæ in the male Chironomus, for instance, may be likened to an external brain, its ramifying fibers corresponding to the highly complicated

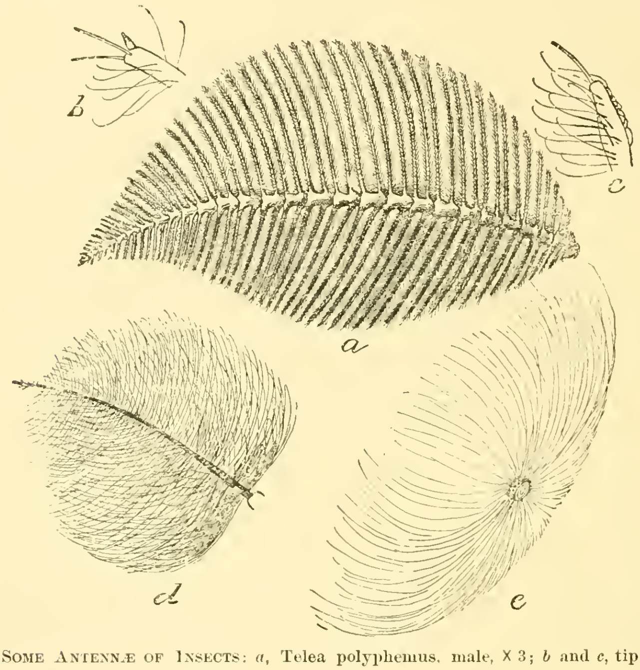

FIG. 14.—SOME ANTENNÆ OF INSECTS: *a*, Telea polyphemus, male, X 3; *b* and *c*, tip of rays of same—still more enlarged; *d*, Chironomus X 6; *e*, section of same—still more enlarged (original.)

processes that ramify from the nerve cells in the internal brains of higher animals, and responding in a somewhat similar way to external impressions. While having no sort of sympathy with the foolish notions that the spiritists proclaim, to edify or terrify the gullible and unscientific, I am just as much out of sympathy with that class of materialistic scientists who refuse to recognize that there may be and are subtle psychical phenomena beyond the reach of present experimental methods. The one class too readily assumes supernatural power to explain abnormal phenomena; the other denies the abnormal, because it, likewise, is past our limited understanding. "Even now," says William Crookes, who speaks with authority, "telegraphing without wires is possible within a radius of a few hundred yards," and, in a most interesting contribution to our present knowledge of vibratory motion and the possibilities of electricity, the same writer remarks: *

The discovery of a received sensitive to one set of wave lengths and silent to others is even now partially accomplished. The human eye is an instance supplied by nature of one which responds to the narrow range of electro-magnetic impulses between the three ten-millionths of a millimeter and the eight ten-millionths of a millimeter. It is not improbable that other sentient beings have organs of sense which do not respond to some or to any of the rays to which our eyes are sensitive, but are able to appreciate other vibrations to which we are blind. Such beings would practically be living in a different world from our own. Imagine, for instance, what idea we should form of surrounding objects were we endowed with eyes not sensitive to the ordinary rays of light, but sensitive to the vibrations concerned in electric and magnetic phenomena. Glass and crystal would be among the most opaque of bodies. Metals would be more or less transparent, and a telegraph wire through the air would look like a long, narrow hole drilled through an impervious solid body. A dynamo in active work would resemble a conflagration, while a permanent magnet would realize the dreams of mediæval mystics and become an everlasting lamp with no expenditure of energy or consumption of fuel.

In some parts of the human brain may lurk an organ capable of transmitting and receiving other electrical rays of wave lengths hitherto undetected by instrumental means. These may be instrumental in transmitting thought from one brain to another. * * *

A NEW SPECIES OF PEZOTETTIX.

By Lawrence Bruner, *Lincoln, Nebr.*

Among the locusts found most abundantly in the valley and hill-sides about Grand Junction, Colo., while on a trip to that region during the month of June, 1893, was an undescribed species of the genus Pezotettix. This locust bears some resemblance to *Melanoplus turnbulli* Thos., but unlike that species has very short and rounded tegmina. It resembles that species also in its food habits, seeming to confine its attention almost entirely to the various species of plants of the botanical family *Chenopodiaceæ*, which abound in the regions where it occurs, being particularly fond of the grease-wood (*Sarcobates vermicularis*).

In my annual report as special agent of the Division of Entomology, published in Bulletin No. 32 of the Division, I have mentioned this insect as *Pezotettix chenopodii.* The following description is given:

Pezotettix chenopodii n. sp.

A compact, short-limbed species related to and having the general appearance of the *Caloptenus turnbulli* of Thomas. General color testaceous olive-gray with markings of dark brown upon occiput, disk and sides of pronotum, sides of basal segment of abdomen and hind femora: the dark dorsal line of pronotum with a narrow paler one along its middle, as in the various species of *Hesperotettix*. Hind tibiæ varying from pink to pale glaucous, usually the latter, with pale annulus near base.

Head moderately large, eyes large but not prominent, separated above by the slightly sulcate depressed vertex, which is nearly as wide as the frontal costa;

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* Some Possibilities of Electricity.—Fortnightly Review, March, 1892.

latter of nearly equal width throughout, not prominent and but gently sulcate at the ocellus; occiput short and only gently elevated. Antennæ slender, a little shorter than head and pronotum combined, the basal joint smaller than usual, orange colored. Pronotum smooth, gradually widening behind, without well-defined carinæ, the transverse grooves all very distinct and the border rather widely margined throughout; hind margin broadly rounded. Tegmina small, lobate, their extremities reaching to the middle of second abdominal segment, and with their inner edges rather widely separated. Abdomen short, the sides but little compressed, the dorsal carina nearly obsolete, and the apex blunt, in the male gently enlarged and ending in a blunt upwardly directed point, as in *Hesperotettix viridis* Thos. Supra-anal plate of male abdomen triangular, quite broadly and deeply grooved on basal half and provided with a rather prominent carina on each side that extends from the outer basal angles to the apex of the mesial sulcus; marginal apophyses of preceding segment obliterated. Male cerci straight, rather wide and compressed at base, tapering rapidly to middle, from which point they are slender and finger like, directed slightly backward, inward, and upward. Valves of the ovipositor short, slender, their apices strongly hooked, the basal tooth of lower pair quite large and triangular. Posterior femora rather heavy, reaching the tip of abdomen in both sexes. Prosternal spine rather heavy, short, pyramidal, a little transverse.

Length of body.—♂, 16^{mm}, ♀, 20^{mm}; of antennæ, ♂, 5.5^{mm}, ♀, 6.5^{mm}; of pronotum, ♂, 4.25^{mm}, ♀, 5.5^{mm}; of tegmina, ♂, 3^{mm}, ♀, 4^{mm}; of hind femora, ♂, 9^{mm}, ♀, 10^{mm}.

Habitat: This insect was collected by me at Grand Junction, Colo., where it was present in very large numbers during the month of June. It seemed to be confined in its distribution chiefly to the grease-wood clusters, and was known by the popular name of grease-wood hopper.

According to the method employed and the characters used by Carl Brunner von Wattenwyl in his recent work entitled "Révision du Système des Orthoptères," this insect would naturally fall into the genus Hesperotettix of Scudder; but, since it has been the custom of American writers prior to this to place all short-winged acridians in the genus Pezotettix, I shall follow this custom here. It is quite evident, however, that this group will very shortly have to be revised for the entire country. This should certainly be done, because it is a very extensive one, there being fully 200 distinct species in North America alone, all more or less destructive in their food-habits. Many of them are also confined, like the present species, to special food plants.

A MARITIME SPECIES OF COCCIDÆ.

By T. D. A. Cockerell, *Las Cruces, N. Mex.*

Ripersia maritima Ckll., n. sp.

Female about $1\frac{1}{2}^{mm}$ long, plump, elongate-oval, naked, pure white, segmentation distinct, legs and antennæ slightly brownish.

When boiled in caustic soda the female turns bright yellow—a curious reaction.

Antennæ 6-jointed; 6 longest, a little longer than 4 and 5; 3 and 1 about equal; 2, 4, and 5 subequal and shortest. Formula 6 (13) (245). Each joint emits a few hairs; the sixth several. The antennæ are very small and short, and placed extremely close to one another, as in *R. rumicis.*

Derm with numerous but scattered short hairs, and round gland-spots.

Mentum apparently triarticulate, the last joint beset with 8, the penultimate with 2 short hairs.

Femur decidedly longer than tibia, but femur and trochanter decidedly shorter than tibia and tarsus. Trochanter with a long hair at its proximal end. Tibia with several bristles or spines, three on the outer side and three near the distal end on the inner aspect. Tarsus about as long as tibia, and with about four long bristles or spines. The tarsus rapidly narrows almost to a point, and on the end of it is a remarkably long, almost straight, claw.

Rostral loop not quite reaching to level of insertion of middle legs.

Anogenital ring with six large hairs. External to the insertion of the hairs is a ring of oval marks, about 18 in number.

Posterior tubercles rounded and indistinct, each bearing a bristle, not so long as one of the bristles of anogenital ring.

Habitat: Hempstead Harbor, Long Island. On roots of Spartina between tide-marks.

This is the first Ripersia described from this side of the world. The species hitherto known are *R. corynephori* Sign., *R. pulveraria* Newst., *R. subterranea* Newst., *R. fraxini* Newst., and *R. tomlinii* Newst., from Europe; *R. leptosperma* Mask., from Australia, and *R. formicicola* Mask., *R. rumicis* Mask., and *R. fagi* Mask., from New Zealand.

Of all these species none bear any very close resemblance to the present one, except *R. rumicis*, which was found amongst roots of *Rumex acetosella* in New Zealand. *R. rumicis* may be distinguished from *R. maritima* by the color and by the relative lengths of some of the antennal joints.

The idea of a maritime Coccid was a very old one, long thought to be exploded. *Coccus zosteræ* Fab. was described as living on Zostera in the Baltic. That this should be a Coccid is doubtless impossible, and either the habitat is wrong or it is something else, possibly a species of Chiton.

Much later *Coccus halophilus* Hardy was imperfectly described from British specimens. It was found at the roots of Ligusticum, Rhodiola and Statice, on rocks by the sea. Like our insect it is white, but it is not properly a maritime species.

The first genuinely maritime Coccid was described in 1883 by Prof. Comstock. This, *Chionaspis spartinæ*, was collected by Prof. W. Trelease on Spartina at Woods Holl, Mass. The plants were commonly submerged at high tide nearly up to the insects, which were themselves drenched with the salt spray.

In *Ripersia maritima* we have the most extreme case known, for the insects are entirely submerged at high tide.

The conditions under which this species exists are so peculiar and of such great interest, that I have asked Mr. Nathan Banks, who discovered the insect, to append below a full account of the facts as observed by him:

"The interesting marine Coccid described above by Prof. Cockerell is found very abundantly in some localities on the shore near Sea Cliff.

At Sea Cliff the shore is sandy and often quite stony. Here and there are patches of salt grass (*Spartina*) growing between tide-marks, but always nearer to the high than to the low water marks. In muddy places sometimes whole acres are covered by the grass. The tide here rises seven feet, and the roots of the lowest patches of salt grass are, at ordinary high-tides, covered by about three feet of water. Such a patch would be covered for about two and a half or three hours twice a day. The roots form a sod, and embedded in the sod is a common mussel (*Modiola plicatula*); *Melampus bidentatus* and species of Littorinea are common, and barnacles and seaweed grow on the stones in the sod. Fiddler crabs (*Gelasimus*) dig their holes here. Several insects and arachnids are quite common, such as *Anurida maritima*, an Anthomyiid fly, a Curculionid, a species of Bembidium, *Bdella marina*, *Chelanops tristis*, and several undescribed mites.

"The soil is thoroughly drenched with salt water, and in it are various marine worms (*Nereis*, *Halodrillus*, etc.). The Coccid was first discovered in April, 1894, on the roots of a patch of salt grass which at high tide is covered by about two feet of water. They were usually in little cavities, sometimes hundreds grouped together. They are from one to two inches below the surface, sometimes just under loose stones. An undescribed species of Trombidium preys upon them. Later I found that it occurred in some very large salt meadows near Glen Cove, near Glenwood and at Roslyn. I have examined the roots of a closely allied grass which grows sparsely above high water, but found no Coccids on them.

"The bay on which Sea Cliff, Glen Cove, Glenwood, and Roslyn are situated is known as Hempstead Harbor, and it is a branch of Long Island Sound. The bay at this point is a mile wide.

"The salt grass is used by clam diggers and fishermen to thatch outhouses, for bedding, packing clams, fish, etc." NATHAN BANKS.

AN ABNORMAL TIGER SWALLOW-TAIL.

By L. O. HOWARD.

The Division has been in correspondence during the past winter with Mr. W. A. Harshbarger, of Washburn College, Topeka, Kans., concerning an extraordinary specimen of the common tiger swallow-tail (*Papilio turnus*=*Jasoniades glaucus*) which he reared from the larva last summer, and Mr. Harshbarger was finally good enough to send us the specimen, which we have had figured both in colors and in black and white and present the illustrations herewith. The specimen was reared from a larva given to Mr. Harshbarger by some non-entomological acquaintance. It was kept for a short time in a bottle of water, but in spite of this half drowning transformed to chrysalis and eventually issued as an adult. Mr. Harshbarger states that he saw during the season of 1893 several specimens of the variety *glaucus* which were curiously splotched with yellow, and is inclined to attribute this tendency to variation to the comparative drought which characterized the summer in Kansas.

The insect most nearly resembles the black form of *glaucus*. The wings of the left side are black in general coloring. The primary of the right side is also black, while the secondary of the same side is a bright and beautiful male wing, the yellow being normal in all respects except that the four spots on the outer border are narrower than in the normal male. The three dark wings are curiously and irregularly splotched with yellow, as indicated in the figure. The tails of the two hind-wings

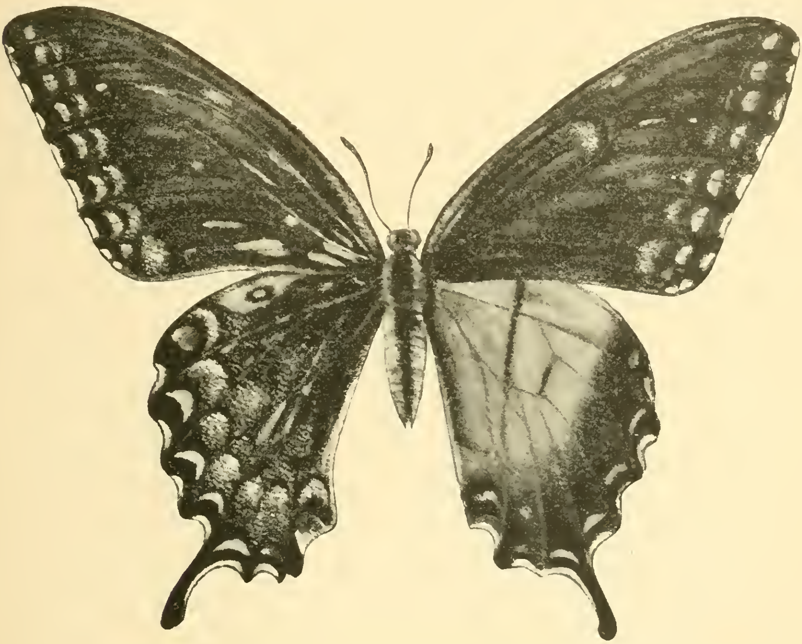

FIG. 15—*Papilio turnus* var. *glaucus*: aberrant adult, upper surface—natural size (original).

are different in shape, that of the right being the normal male tail and that of the left the normal female tail. The reëntering excision at the anal angle of the secondaries is more pronounced on the left wing than on the right, and the orange spot is larger. The orange spot on the upper and outer angle of the secondaries is present on the left wing, but is slightly smaller than the normal *glaucus* female, while on the right wing it is very minute and resembles that of the male. On the undersides of the wings the right secondary resembles the underside of the secondary of the yellow male, except that the wings are a little more deeply lined with black and above the black margin the orange is a little more conspicuous. The underside of the left secondary resembles in all respects the underside of the right, except that its yellow is not quite so bright. Both secondaries, however, would be taken from the underside for those of the male were it not for the different shape of the tails.

The coloration of the body is male throughout with the single exception that the yellow band which extends up both sides of the front at the border of the eye is lacking on the left side, although occurring as usual in the male on the right side. The genitalia are male in type, but the internal organs of the right side are much smaller than those of the left side. There is a slight difference also in the antennæ, the right antenna being a trifle smaller than the left. The structure of both, however, is female.

FIG. 16—*Papilio turnus* var. *glaucus:* aberrant adult, under surface—natural size (original).

This remarkable insect has been most carefully studied. The scale coloration is perfectly normal, so far as can be judged by any comparatively high power. Careful denuding of the base of the right secondary shows that there is no possibility of a fraud, i. e., that the insect is made up from two or more individuals.

This does not seem to us to be a case of hermaphroditism. The insect is essentially male, but it is an extremely curious sport. It is an aberrant male, imitating in some details the coloration of the female.

Under the head of "variations and aberrations," of this species, Scudder mentions the fact that he has seen a female from the White Mountains with the yellow of the upper surface, particularly of the lower half of the forewings, slightly tinged with an orange flush.

Other slight variations like these are mentioned, and he further states that he saw, many years ago, in some collection, an hermaphroditic specimen from the South, in which the wings of the left side and the left half of the body were female of the *glaucus* variety, while the right half was male and normally yellow, the valves being developed only on the right side.' This was perhaps the same individual figured by W. H. Edwards, and first described by him in the Transactions of the American Entomological Society (vol. II, p. 207).

GENERAL NOTES.

A NEW APPLE-TREE ENEMY.

We have received from Mr. Samuel E. Coleman, of Virginia, a number of specimens of a large Pentatomid bug (*Brochymena annulata* Fab.), recorded by Uhler as common to the Atlantic States, which Mr. Coleman says attacked the new growth of his apple trees in the month of

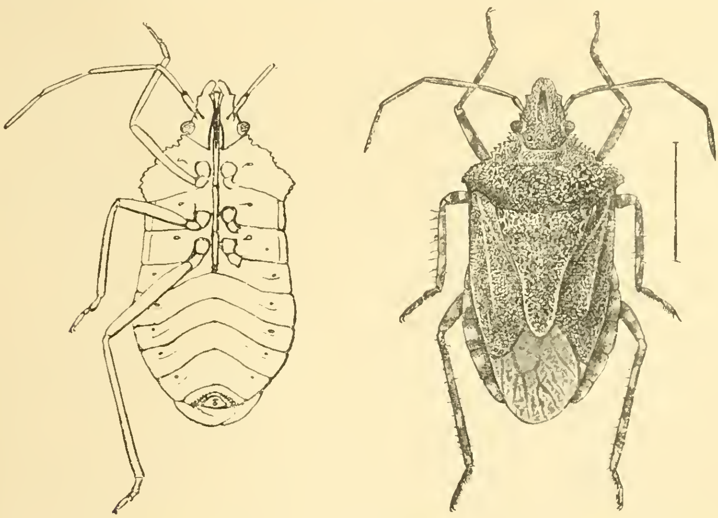

FIG. 17.—*Brochymena annulata*: adult; under surface shown at left—enlarged (original).

May, pumping up sap from the tender wood, and which is known in his locality as the "large chinch bug." Many twigs and limbs were killed. We advised the kerosene-soap emulsion spray, and while we do not anticipate any great damage from the species, the record of the habit is sufficiently interesting to justify its publication. The specimens of this insect in the U. S. National Museum collection show that it occurs in New York, District of Columbia, Virginia, North Carolina, Florida, Missouri, and Colorado. The adults have been found under old bark in midwinter, and the eggs and young larvæ have been found upon pea-vines and upon the willow. We figure the adult insect (Fig. 17) in order to enable its ready recognition should this destructive habit recur.

THE BLACK AUSTRALIAN LADYBIRD IN CALIFORNIA.

Complaints are being made in California, as we notice from the Rural Californian for May, that the black ladybird, *Rhizobius ventralis,* which was one of the late importations from Australia, from which great results were expected in the destruction of noxious orchard scale-insects, has not been doing its duty in the orchards in which colonies were placed. The phraseology of the notice is as follows: "The opinion was expressed at the meeting of the Pomological Society at Pasadena that the black ladybird was not showing up in the orchards in which colonies had been placed." From this it might be supposed that they had not been seen this spring in the orchards in question.

The Pacific Rural Press of July 21, 1894, however, quotes a statement made by Mr. T. N. Snow in the Santa Barbara *Press* as to the progress of this ladybird in the orchard of Mr. Ellwood Cooper, at Ellwood, Cal. According to this account a little more than two years ago 50 specimens of *Rhizobius ventralis* were placed in this orchard, where they multiplied so rapidly that in October, 1893, Quarantine Officer Alexander Craw was able to secure there over 500 colonies, numbering more than 10,000, for colonization in various parts of the State. On June 27, 1894, Mr. Craw, it is reported, again visited this orchard, and found not one black scale left of the army which had been there, the Rhizobius having made a perfect clearance. Mr. Craw is reported to have expressed to Mr. Snow his belief that by next November there would not be a black scale remaining in Ellwood.

THE GRAPE-VINE ROOT-WORM.

In Newspaper Bulletin No. 140 of the Ohio Experiment Station Mr. F. M. Webster calls attention to the injury done to the roots of grapevines about Cleveland by the larvæ of the grape-vine root worm (*Fidia viticida*). The larva of this insect, the adult of which has for many years been known as a leaf feeder upon the grape, has never been known with certainty. It has been suspected that it feeds upon the roots, but Mr. Webster is the first to prove this point and to rear the adult from the larva. The experiments which he has made show that the larvæ are readily killed by a very small amount of bisulphide of carbon, while the beetles may be readily destroyed with the arsenites.

AN INVASION OF THE "FEATHERED GOTHIC" MOTH IN NORTHERN FRANCE.

Dr. P. Marchal has an interesting note on the "feathered Gothic" moth (*Heliophobus popularis*) in the Bulletin of the Entomological Society of France, which he read at the meeting of June 13, 1894. Under a commission from the Ministry of Agriculture he visited the infested region, which is on the borders of the Departments of the North and the Aisne, and found that the insects occupied a plateau which had recently been cleared of trees. The larvæ marched in great hordes, very much as the army worm (*Leucania unipuncta*) does in the United States, or the antler moth (*Charæas graminis*) in northern Europe. Dr. Marchal ascribes the exceptional multiplication of the species to the unusually warm and dry season of 1893. The invasion was fought by means of ditches dug in front of the advancing army of caterpillars, large quantities of which were thus captured and carried off in sacks by the peasants, who made compost of them with liquid manure. Among the numerous insecticides tried sulphate of ammonia diluted with liquid manure and sprinkled upon the infested spots was the only one which gave satisfactory results.

TAXONOMIC VALUE OF THE SCALES OF LEPIDOPTERA.

In the Kansas University Quarterly for July, 1894, Mr. V. L. Kellogg publishes an important paper under the above title in which he gives the results of investigations announced by Prof. J. H. Comstock, in his paper on "Evolution and Taxonomy," which was reviewed in No. 3 of the present volume of INSECT LIFE. Mr. Kellogg has given us a very careful résumé of previous researches in regard to the structure and office of the scales of Lepidoptera, and concludes that the most generalized scale is the small hair without specialized insertion, while the most specialized scale is the broadened toothed form with a pedicel and a cup-shaped insertion on the surface of the wing. He applies the principle laid down by Comstock in his consideration of venation and shape of wing, and finds that his results coincide practically with the taxonomic conclusions reached by Prof. Comstock. The suborder Jugatæ is confirmed by his researches, since he finds upon the wings of Micropteryx and Hepialus, in addition to numerous specialized scales, a covering of very fine hairs differing radically from the scales in size, arrangement, and mode of attachment to the membrane, and agreeing essentially with the fixed hairs of the Trichoptera. These hairs are absent in the insects of the suborder Frenatæ. The high specialization of the true scales in the Jugatæ he considers does not indicate a high rank for these insects, but is merely corroborative of the presumption that they are the existing tips of branches whose lower members have disappeared. He believes that the stem form of Lepidoptera possessed wing-clothing much like that now exhibited by the Trichoptera and that the Jugatæ branched off before the covering of fine hairs had been lost, although the tendency to specialization had become already manifest. He discusses further the color of the scales and their peculiar differentiations, including specializations into androconia, applying his conclusions taxonomically in connection with Prof. Comstock's discoveries. The details of his examinations of the insects of several families follow. A somewhat confusing statement is made upon page 77, where

Mr. Kellogg advances the theory that when the odors can not be made out in the case of certain androconia the fact is probably due to the limitations of the human *ear!*

DEATH WEB OF YOUNG TROUT.

Many years ago one of the numbers of the American Entomologist contained an article under this caption, in which attention was called to the destruction of young trout in fish hatcheries by the larval web of Simulium (the "black fly"). Our attention has only recently been called again to this matter by the Hon. Marshall McDonald, U. S. Commissioner of Fisheries, who has sent us a report from Mr. E. M. Robinson, superintendent of the fish hatcheries at Green Lake, Me., stating that at the time when the young salmon were hatching in the troughs, the larvæ of Simulium appeared in large numbers. Any considerable number, as Mr. Robinson wrote, in a hatching trough will, in one night, fill it almost entirely full of fine web. The web sometimes gets around the neck of one of the fry and chokes it to death. The Simulium larvæ were accompanied by specimens of one of their great enemies of the genus Hydropsyche, and these Hydropsyche larvæ were reported by Mr. Robinson to feed upon dead fish, after they had been killed by the web of the Simulium. This seems to be a perversion of habit on the part of the Hydropsyche, and a most unfortunate one, as it diverted them from their normal and beneficial habit of preying upon the Simulium. Damage of this kind is only possible when the fish are just hatching, as a few weeks later the fish themselves feed upon the Simulium larvæ and practically turn the tables.

POLLINIA COSTÆ IN CALIFORNIA.

In the Annual Report of the Department for 1892, Prof. Riley announced the appearance of a peculiar olive scale, well known in south Europe, upon a few olive trees in the vicinity of Los Angeles. This scale had been described by Prof. Targioni-Tozzetti as *Pollinia costæ*, and as it is a very difficult one to destroy, its immediate eradication by burning was urged. We learn from the Rural Californian of May, 1894, that, although the insect was supposed to have been destroyed, it has recently been discovered by the State quarantine officer, Mr. Alexander Craw. Fortunately it seems to have spread but little during the past two years, and heroic measures have been taken to stamp it out. *Orcus chalybeus* was reported to have been seen devouring this scale, but it was stated later that this was a mistake.

A PREDICTION VERIFIED.

A person signing the initials "J. C. H. S." wrote from Sedgwick County, Kans., in 1882 to the Prairie Farmer in regard to rainfall and the chinch bug, showing from records which he had kept that at the end of six and seven year periods comes a severe drought with chinch bugs. He claimed that the records back to 1834 verified his theory, and the chain of drought and chinch bug years he gave as 1834, 1841, 1847, 1854, 1861, 1867, 1874, and 1881. Following this supposed law, he predicted chinch bugs in 1887, and, as the writer showed in Bulletin 17 of the Division of Entomology, his prediction was verified. The year 1894, coming at the end of the following septenary period, has also verified the supposed law of this unknown writer. He claims that the rainfall increases from each drought year up to the third or fourth year, and then decreases. The chinch bugs increase as the drought increases, reach their climax in the climax drought year, and are killed off by the heavy rainfalls of the following spring.

THE LEAF-FOOTED BUG ATTACKING PLUMS.

We are very much interested in a recent letter from Prof. R. H. Price, of the Texas Agricultural Experiment Station, which is accompanied by specimens of the leaf-footed bug (*Leptoglossus phyllopus*), and in which he states that these bugs have done considerable damage to plums during the last two years, injuring them, in fact, more than the plum curculio. The bugs puncture the buds for food, and the fruit becomes knotty. It will be remembered that Mr. Hubbard, in his "Report upon Insects Affecting the Orange," describes a similar habit on the part of this insect in the orange groves of Florida. Mr. Hubbard ascertained that the normal food-plant of the insect was a large thistle which grows commonly through the South, and he states that both young and old are frequently found in large numbers upon the head of this thistle. We have urged Prof. Price to search for this plant in the vicinity of the plum trees, and if found to destroy the bugs upon it with pure kerosene. The thistle may be used as a trap crop for this purpose.

IS ICERYA AN AUSTRALIAN GENUS?

In a paper just received from Mr. W. M. Maskell, entitled "Further Coccid Notes," from the Transactions of the New Zealand Institute for 1893, the author shows that *Icerya ægyptiacum* (Dougl.) has been received by him from Mr. Froggatt, taken in Sydney on *Goodenia ovata*, and *I. rosæ* R. & H. from the same locality on *Hakea gibbosa*. The latter he describes as "var *australis*," since it differs slightly from the typical specimens described by Professor Riley and the writer from Key West, Fla. He says, in conclusion, "the question now arises whether Australia may not be the original home of all Iceryas. There is scarcely any doubt about *I. purchasi; I. koebelei* is certainly Australian; *I. ægyptiacum* and *I. rosæ* are found there; *I. montserratensis* seems to be possibly a variety; *I. seychellarum* has as yet been reported on sugar-cane only from Mauritius, and *I. palmeri* on grape from Mexico; but even these may, after all, turn out to be Australian also." Subsequent facts may show Mr. Maskell to be right in this supposition, but in our judgment *I. montserratensis* is a very distinct species from the others, and its occurrence only on the island of Montserrat and the eastern side of the isthmus of Panama, as well as its probable occurrence, mentioned in a previous number of INSECT LIFE, in British Guiana, certainly indicate no probability that it originally inhabited Australia. *Icerya palmeri* has as yet been found only in Mexico and New Mexico, while it may be doubted whether the Australian variety of *I. rosæ* is not a distinct species. The present positive evidence places four species as Australian, one as Mauritian, and three as inhabiting tropical and subtropical America.

IS THE AZALEA SCALE INDIGENOUS?

On page 327 of the last number of INSECT LIFE we mentioned the occurrence of the azalea scale (*Eriococcus azaleæ* Comst.) upon azalea plants at the agricultural college in Michigan. We have since learned that, as we supposed at the time, the insects were found in the college greenhouses. The natural habitat of this scale has never been ascertained, but from its occurrence hitherto only upon greenhouse specimens, it was supposed to have been introduced from abroad. Prof. Comstock, however, has recently written us that this species occurs commonly upon wild Azalea (*Azalea nudiflora*) in Coy's Glen near Ithaca, N. Y., and far from any cultivated plant. This he believes indicates that the Eriococcus is a native species.

A SWARM OF WINGED ANTS.

Many large swarms of winged ants have been described in the works of travelers, but few are recorded in scientific literature. It will be interesting, therefore, to note that in a letter received about the close of August from Mr. A. H. Mackay, superintendent of education at Halifax, Nova Scotia, an authentic account is given of such a swarm, which appeared in the form of a great cloud over the valley of the East River in the county of Pictou, N. S., on August 24. Mr. Mackay waites:

> According to one account, the cloud was dense enough on some occasions to intercept the light of the sun. They did not appear to alight until dead, when a very considerable quantity of them could be gathered off some portions of the ground or pathways. Some said their bite was like that of a mosquito, but I have no other evidence of their "biting." They were visible for a whole afternoon—"until 7 o'clock," says one. Their course appeared to be moving along the valley of the river, which is not very large, quite fordable in the dry season in most places, the direction being from southwest to northeast. Nothing like it was seen in "the recollection of the oldest inhabitant." Their sudden genesis in such great numbers must be an interesting problem to the common people, as well as to the entomologist, as the sensation proves.

Mr. Mackay sent specimens of the ants, which belonged to a species of Prenolepis, apparently *parvula*.

THE COTTONWOOD LEAF-BEETLE IN NEW YORK.

The common cottonwood leaf-beetle of the western tree claims (*Lina scripta*), which has frequently done so much damage in the far West by defoliating young trees, and old ones, too, for that matter, and which was treated at length by Prof. Riley in the Annual Report of this Department for 1885, has appeared in injurious numbers in Onondaga, Oswego, and Cayuga counties, N. Y., as we learn from an interesting article by Dr. J. A. Lintner, in the New England Homestead of July 26. It has appeared in the plantations of ozier willow, which grow in the Seneca River valley, and threatens this small but important industry. Dr. Lintner shows that the insect is readily killed by an arsenical spray, which the character of the crop renders easy of application.

RESIN WASH AGAINST THE GRAPE ASPIDIOTUS.

On page 5 of the current number of INSECT LIFE we refer to the occurrence of *Aspidiotus uvæ* Comst. on grape-vines near Beltsville, Prince George County, Md. This vineyard was visited by Mr. R. S. Lull, then a member of the office force, in the late fall of 1893, who found that about two dozen vines were affected, and that two had been killed outright, while a number of the others were dead or dying. By his advice all the vines in the vineyard were sprayed once with winter resin wash, during the winter of 1893, while all those known to be affected were sprayed twice. The locality was visited by Mr. Coquillett on July 20, 1894, and after a careful examination he found that, to all appearances, the scale had been exterminated.

NOTES FROM CORRESPONDENCE.

A Scale Insect on Laurel Oak.—Mr. Louis A. Berckmans, of Augusta, Ga., sent us some time ago specimens of a Rhizococcus found upon what he called English Laurel. The tree, however, seems to be really a laurel oak, *Quercus laurifolia*, and the insect is *Rhizococcus quercus* Comst.

Anthrenus varius feeding on a Comb.—Some time ago Mr. D. W. Coquillett sent us from California a larva of *Anthrenus varius* which he had confined in a bottle with a tooth from a horn comb. He reports having actually seen this larva feeding upon the tooth. This is the first recorded instance, so far as we know, of this food-habit of Anthrenus.

Living Larvæ on Snow.—Mr. James Fletcher, Dominion Entomologist of Canada, sent us some time ago specimens of Tipulid larvæ which a correspondent of his had reported to be present in large number on the snow near Whitby, Ontario. These insects winter in the larval state, near the surface of the ground, and were probably tempted out by a warm day, when, the ground becoming hard again, they were unable to return to their winter quarters. In INSECT LIFE (vol. IV, p. 335) we have recorded other instances of living larvæ found on the surface of snow.

Mud Wasps in Deserted Paper-wasps' Nests.—Mr. C. F. Groth, a member of the New York Entomological Society, has recently sent us some interesting entomological notes, and among other things mentions the occurrence of a species of mud wasp in the deserted paper nests of *Vespa maculata*. One that he opened recently contained no less than nine mud-wasp cells, about one inch in length, in the interior.

Root Web-worm in Pennsylvania.—We have received from Mr. George C. Manle, of Gum Tree, Pa., larvæ bearing the characteristic markings of the root web-worm, *Crambus zeellus*, with the statement that it is injurious to cornfields in his vicinity. On his own farm it occurred in a field which had lain two years in clover and timothy. In a neighbor's field of the same age in rotation of crops four acres of corn were entirely destroyed. Our correspondent states that the worst affected fields are old timothy sod.

The Horn Fly attacking Horses.—It will be remembered that on page 344 of the last volume of INSECT LIFE, we mentioned an instance of the horn fly attacking a horse at Cheyenne, Colo., and inquired if other correspondents had observed similar cases. Recently Mr. W. C. Brass, of Carlisle, Ark., has sent a large number of the true *Hæmatobia serrata* which he himself took from horses. Prof. R. H. Price, of the Texas Agricultural College, also writes that he has seen the flies on horses in both Virginia and Texas, but never in any great abundance.

Flies in Seaweed.—Mr. Arthur H. Norton, of West Brook, Me., has sent us specimens of *Cœlopa frigida* Fall., a small fly of the family Phycodromidæ with the information that it occurs abundantly in windrows of seaweed left by high tides on island shores. During the warmest part of the day they may be seen flying playfully over their habitat. On being approached they crawl into the seaweed and are quick to hide "even when quite numb." Our correspondent was on an island during February, and the temperature averaged freezing during that time, the seaweed which the insects inhabited being frozen except at the surface exposed to the sun.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

Vol. VII. No. 2.

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EDITED BY

L. O. HOWARD, Entomologist,

WITH THE ASSISTANCE OF OTHER MEMBERS OF THE DIVISIONAL FORCE.

(PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.)

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Assistant Entomologists: C. L. Marlatt, Th. Pergande, F. H. Chittenden.
Investigators: E. A. Schwarz, H. G. Hubbard, W. H. Ashmead, D. W. Coquillett.
Special Agent in Apiculture: Frank Benton.
Artist: Miss L. Sullivan.

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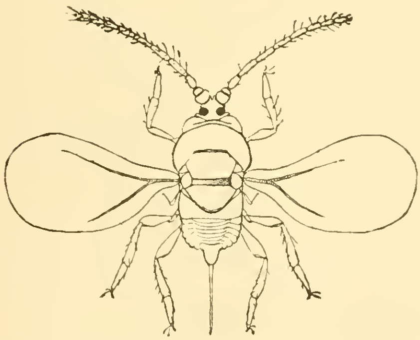

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CONTENTS.

SIXTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

MORNING SESSION, AUGUST 14, 1894.

The Association met at 10 a. m., in room 12, of the Packer Institute, Brooklyn, N. Y., August 14, 1894. The following officers and members were present:

President, L. O. Howard, Washington, D. C.; Vice-President, J. B. Smith, New Brunswick, N. J.; Acting Secretary, C. L. Marlatt, Washington, D. C. Messrs. William H. Ashmead, Washington, D. C.; Geo. F. Atkinson, Ithaca, N. Y.; Nathan Banks, Sea Cliff, N. Y.; D. W. Coquillett, Washington, D. C.; Geo. C. Davis, Agricultural College, Mich.; A. D. Hopkins, Morgantown, W. Va.; Geo. H. Hudson, Plattsburg, N. Y.; J. A. Lintner, Albany, N. Y.; V. H. Lowe, Jamaica, N. Y.; F. W. Rane, Morgantown, W. Va.; William Saunders, Ottawa, Canada; E. B. Southwick, New York City; F. A. Sirrine, Jamaica, N. Y. There were also in attendance upon the meetings visitors and members of other scientific associations, the average attendance being twenty-five persons.

The Association was called to order by the President, and in the absence of the Secretary, Mr. Gillette, on motion of Mr. Lintner, Mr. C. L. Marlatt was elected Secretary for the meeting.

The President, Mr. Howard, then delivered his annual address as follows:

A BRIEF ACCOUNT OF THE RISE AND PRESENT CONDITION OF OFFICIAL ECONOMIC ENTOMOLOGY.

By L. O. HOWARD, *Washington, D. C.*

When this Association was founded, in 1889, the name adopted was "The Association of Official Economic Entomologists," and its objects as outlined had evidently especial reference to the work of those economic entomologists who hold official positions. At the first annual meeting, held in Washington in November of the same year, Dr. Lintner, with the evident idea of broadening the scope of the Association, introduced an amendment to drop the word "official" from the title, and this amendment was adopted at the meeting at Champaign, Ill., the following year. Notwithstanding this fact, the membership of the Association is today largely official; out of 73 members 60 hold official positions, while the active work is all done by those with whom economic entomology is a means of subsistence. At the last meeting, that held in Rochester in August, 1893, every member registered belonged to the official class.

The organization meeting at Toronto on the 30th of August, 1889, presented a strange contrast to this. It was held, as may not generally be known, upon a wooded knoll at a landing called Scarborough Heights, overlooking the waters of Lake Erie. The beach below and the woods around were being scoured by industrious collectors of the old section F, of the American Association for the Advancement of Science. Professor Cook, who presided, occupied a dignified position astride a fallen log. Dr. Smith, who acted as secretary, had climbed with difficulty to the top of a tall stump and took his minutes on his knee. Dr. Bethune, Mr. Fletcher, Mr. E. Baynes Reed, Mr. H. H. Lyman, Prof. C. W. Hargitt, Mr. E. P. Thompson, and the writer reclined with more or less grace, according to their physical conformation, upon the ground or sat cross-legged upon convenient ant-hills. This group, which made the Association "official" in name, was composed of four official entomologists and five who were simply interested workers.

This brief historical paragraph is introduced for the purpose of showing the interesting paradox that this Association was originally made official by non-officials, that it was subsequently made non-official by officials, and that since it was made non-official it has become more official than before.

It is in part for this reason that I have chosen to bring together for presentation at this meeting some account of the rise and present condition of official economic entomology, but more largely for the other reasons that few of us probably have been able to take a comprehensive view of the status of our application of entomology the world over, and that a review of what has been done can not but justify our existence as a class and as an association and afford the strongest of arguments for the increase of our numbers and for increase of means and facilities.

The ravages of insects on cultivated plants were doubtless coetaneous with the beginning of the cultivation of plants. Thus a necessity for economic entomologists existed at a very early time. The condition of the ancient husbandman with reference to injurious insects is voiced by the prophet Joel, when he says:

That which the palmer-worm hath left, hath the locust eaten; and that which the locust hath left hath the canker-worm eaten; and that which the canker-worm hath left hath the caterpillar eaten. * * * He hath laid my vine waste and barked my fig tree; he hath made it clean bare and cast it away; the branches thereof are made white. * * * The field is wasted, the land mourneth. * * * Be ye ashamed, O, ye husbandmen; howl, O, ye vinedressers, for the wheat and for the barley, because the harvest of the field is perished.

In 1881, Dr. Hagen published, in the columns of the New Yorker Belletristisches Journal (August 16), an interesting article entitled "Heuschrecken-Kommissionen im Mittelalter und heute," in which he showed that grasshopper invasions have taken place since time immemorial, and that man's efforts to combat them have always ended in his discomfiture. It is not surprising, therefore, says Dr. Hagen, that the helpless multitude called on the intervention of the law and of God to deliver them from such pests; and the legislators on one side and the priests on the other were forced to carry out the will of the people. But since written laws and legislative decrees against elemental plagues would have been ridiculous without a surrounding of imposing, legally regulated forms, the development of these formalities gradually reached a high degree of perfection. Legislation for defense against injurious animals reached its highest development in the Middle Ages. Legal procedures against all sorts of noxious animals were frequent, and the famous Burgundian legal light, Bartholomæus Chassanæus, wrote a book setting forth the rules according to which a suit against grasshoppers should be entered. After a court had been called together by written request, a judge was appointed and two lawyers were elected, one to plead the cause of the people and one the cause of the accused grasshoppers. The former commenced by formulating the charge, and concluded by requesting that the grasshoppers be burned. The defendant's lawyer replied that such a request was illegal before the grasshoppers had been requested in due form to leave the country. When, however, they had not left the country after a stated term, they could be excommunicated. Many years afterward, another jurist, Hiob Ludolph, wrote a pamphlet antagonizing Chassanæus' work, setting forth the lamentable legal ignorance displayed by the latter. The accused grasshoppers, said Ludolph, must be summoned four times before the court, and if they do not appear, then they should be dragged by force before the court. Then only can the suit proceed. Other interested parties, however, shall be heard, namely, the birds that feed on the grasshoppers. Further, it would be a great injustice to banish the grasshoppers into adjacent territories. Finally, the code proposed by Chassanæus can never be brought into accordance with the laws and rules of the Church, because there is absolutely nothing in those laws about suits against grasshoppers.

Several suits against injurious insects were brought before the courts, and the rulings have been preserved. In one case (1479) a suit was brought against injurious worms, apparently cutworms, in the canton of Berne, Switzerland. The worms, although ably defended, lost the suit, and were excommunicated by the archbishop and banished. Regarding the effect of this awful punishment, the chronicler who relates the story adds, "No effect whatever resulted, evidently on account of the great depravity of the people." In various other lawsuits the chroniclers fail to mention the final outcome; but, says Hagen, it is safe to surmise that in the whole history of jurisprudence there was never a greater disregard of the rulings of the courts on the part of the guilty parties than during the time of the mediæval insect commissions.

To attempt to enumerate the different commissions which have been established, particularly by European countries, against particular outbreaks of injurious insects, and especially against locusts, which have entered Europe from the south and from the west at intervals for many hundreds of years, would be impossible, and even if possible, would extend this paper far beyond its proper length. I shall be obliged, therefore, to neglect this phase of the subject, and confine myself rather to the history of the more prominent organizations of wider scope, and these I shall treat geographically and chronologically, beginning with our own country.

THE UNITED STATES.

MASSACHUSETTS.—Dr. Thaddeus William Harris was probably the first American entomologist to receive public compensation for his labors, and in this sense he may be called the first of the official entomologists in this country. In 1831 he prepared a catalogue of insects, appended to Hitchcock's Massachusetts Geological Report. "In the condition of American science at that day," says Scudder, "it was a work of inestimable value, though his only material compensation was one copy of the report and several copies of the appendix." At a later period he was appointed by the State as one of a commission for a more thorough geological and botanical survey. In this capacity he prepared his now classic report on insects injurious to vegetation, first published in full in 1841, the portion upon beetles having appeared in 1838. He reprinted the work under the name "Treatise" instead of "Report" in 1842, and again, in revised form, in 1852. The whole sum received by him from the State for this labor was $175. After his death the work was reprinted by the State in its present beautiful form, with wood engravings which themselves marked an epoch in that art. It is largely upon this work that Harris' scientific reputation will rest, and, although prepared more than half a century ago, it is today perhaps above all other works the *vade mecum* of the working entomologist who resides in the northeastern section of the country.

From 1852 to 1870 Massachusetts did little or nothing in economic entomology. In the latter year, however, Dr. A. S. Packard, Jr., then of Salem, was appointed entomologist to the State board of agriculture—without compensation, however, as he informs me. Dr. Packard published three reports covering the years 1871, 1872, and 1873. They were short pamphlets, but were ably prepared, and were undoubtedly productive of very considerable good.

With the founding of the State Agricultural Experiment Station, under the Hatch Act, Prof. C. H. Fernald, professor of zoölogy at the Massachusetts Agricultural College at Amherst, was appointed entomologist to the station. Prof. Fernald's work has been practically like that of most other station entomologists, and he has published several important bulletins. The ones for which there has been the greatest demand are No. 5 on household pests, which was the outgrowth of original studies which Prof. Fernald had made in this direction, and No. 12 containing the work upon the bud moth, spittle insects, and several other injurious species, all based upon original observation. The most important portion of his work has not yet been published. It comprehends the scientific results of his observations as entomological adviser to the gypsy-moth committee of the State board of agriculture. That these results will prove of great value the writer is in full position to assert, as he has had the pleasure of seeing many of Prof. Fernald's experiments in the course of procedure, and has been greatly impressed by the ability and care with which they are being carried on. Prof. Fernald has also for some years held the position of entomologist to the State board of agriculture.

The work upon the gypsy moth, by the way, which has been done by the State of Massachusetts since 1889 is one of the most remarkable pieces of work, judging by results, which has yet been done in economic entomology. The operations have been carried on by a committee of the State board of agriculture and the means have been furnished by large annual appropriations by the State legislature. Three hundred and twenty-five thousand dollars have already been appropriated. A territory comprising something over 100 square miles was infested by the insect, which occurred in such extraordinary numbers as to destroy many trees and almost to threaten the ultimate extinction of living vegetation, not only within the infested territory, but in all localities to which it might spread. It is unnecessary to detail the steps by which relief was brought about. Mistakes were undoubtedly made at first, and it is to the work of the present committee that the main credit is due. The infested territory has been reduced by one-half, and within the districts in which the gypsy moth at present exists it is, practically speaking, a comparatively rare species. The future of the insect is, however, problematical. The continuance of sufficiently large appropriations from the State legislature to enable the work to be carried on on its present scale is doubtful, and yet those in charge believe that still larger appropriations are necessary to bring about extermination. They are confident, however, that with sufficient means the insect can be absolutely exterminated from the State of Massachusetts. With the legislature disinclined to continue the large appropriations, the methods of the committee at present pursued will have to be seriously altered.

Given a small appropriation of say $25,000 annually, it will become necessary to adopt some law, like that in force in California, whereby much less frequent inspection may be made, and the committee will have to rely in part upon voluntary observers for information. Moreover, they will be unable to conduct spraying operations upon a large scale, and the expense of the destruction of insects will have to be assessed upon the owners of the property upon which the insects are found, provided such owners will not themselves undertake the destruction of the insects. There will be many disadvantages from such a course, and in the case of unproductive lands the expense will be so great that the owner will prefer confiscation. Between some such course as this and the continuance of the present methods, however, there seems to be little choice, since if the appropriation were taken away the insect will not only speedily reach its former destructive height, but will spread far and wide over the country. It may be urged that it will be only a few years before the insect will take its place as a naturalized member of our fauna and will become subject to the same variations of increase and decrease as our native species, and that it will, in fact, become little more to be feared than species already existing with us, particularly if its European natural enemies are introduced. Against this view, however, it must be urged that the gypsy moth seems an exceptionally hardy species and that even in Europe it is a prime pest. The caterpillar is tough and rugged and seems little subject to disease and to climatic drawbacks and is wonderfully resistant to the action of ordinary insecticides. The gypsy moth larva will feed for days without apparent injury upon trees which have been sprayed with Paris green or London purple in a solution so strong as to somewhat burn the leaves. In fact, the committee, in the spraying which they are carrying on at present, have found it necessary to use arsenate of lead in as strong proportion as 10 pounds to 150 gallons of water. The well-known vitality of previously introduced European injurious insects is apparently increased to a striking degree with this species, while the fact that it feeds on nearly all plants renders it a much more serious pest than any of its forerunners. Under these circumstances, therefore, any course other than an energetic and well-directed effort to keep the insect within its present boundary will be shortsighted in the extreme, although it is very doubtful to my mind whether absolute extermination will or can ever be brought about.

New York.—It is rather a stretch of the facts to classify Dr. Harris as an official entomologist. The first scientific man to receive a true official commission for the investigation of injurious insects was Dr. Asa Fitch, of New York. The New York State legislature, during its session of 1853–'54, made an appropriation of $1,000 for an examination of insects, especially of those injurious to vegetation, and authorized the appointment of a suitable person to perform the work. The matter was placed in the hands of the New York State Agricultural Society, and at a meeting of the executive committee of the society, held at the Astor House, in New York City, May 4, 1854, the following resolution was passed:

Resolved, That Asa Fitch, M. D., of Washington County, be appointed to perform the work; that he be furnished with such accommodations as he may desire in the rooms appointed for the laboratory in charge of the society; and that the president and Mr. Johnson, the corresponding secretary, be a committee to prepare instructions for such entomological examinations.

Mr. William Kelly, at that time president of the New York State Agricultural Society, and Mr. B. F. Johnson, its corresponding secretary, performed their duties in the preparation of these instructions in the most admirable manner. In fact, so well were they performed that we imagine Dr. Fitch himself may have drafted the report which was signed by these gentlemen. So far as we are aware, no subsequent appointment of an official entomologist has ever been accompanied by such a full, explicit, and able paper, and for this reason we quote it in full:

As our State has had a thorough examination made of all branches of its natural history except its insects, it is of the highest importance that the remaining branch—not less in importance than the others—should receive attention. The committee feel assured that in the selection of Dr. Fitch they have secured a person every way competent to discharge the duties imposed in a manner creditable to the society and the State.

In carrying out this examination it is desirable that equal prominence be given to economical as well as to scientific entomology, that being the part of this science which is specially important to the community at large. It has been objected to the volumes of the Natural History of the State that they are too purely scientific in their character to be of special value to the great mass of our citizens, and in the work now to be performed it is obvious that it will be of very little consequence to know that a particular kind of moth or fly is an inhabitant of this State unless we are also informed of its history and habits, and whether it is a depredator upon any substance which is of value to man. The habits and instincts of our insects are a proper subject of inquiry as much as their names and the marks by which they are distinguished from each other. The whole history of every noxious species should at least be traced out as fully as circumstances will permit.

The examiner is therefore directed, in the first place, to make for the present season the insects which infest our fruit trees the leading object of examination. Those infesting our forest trees, our grain and other crops, our garden vegetables, our animals, etc., will remain to be studied hereafter. The examiner is desired in his examinations to search out every insect which is a depredator upon our apple, plum, pear, cherry, peach, and other fruit trees, and study out all the facts in the history of each species, both in its larva and in its perfect state, as far as he shall have opportunity to do it. In this way a broad foundation will be laid, to which additions can be made which future observations may show to be necessary.

Should any important insect depredator appear the present season in any other situation than upon the fruit trees, the opportunity for studying it should not be neglected, for the same species may not appear again in many years under circumstances as favorable for becoming acquainted with its real history.

Secondly, what time is not necessarily occupied in examining the insects infesting our fruit trees should be devoted to collecting and classifying the insects of the State, and to naming and describing such species as have not been described

A report to be prepared at the end of the season, to be submitted to the legislature, showing what has been accomplished during the season, to be divided into two parts. The first, upon economical entomology, giving an account of all that has been ascertained respecting the insects infesting our fruit trees, and any other injurious species that may have been obtained. The second, upon scientific entomology, giving a systematically arranged catalogue of all the insects of the State, so far as they are known, with a brief description of such new and undescribed as may be discovered.

The work should be pursued with a view of eventually securing to the State as full and complete accounts of all the insects of this State as far as to place this important science (which is at the present so greatly in the background, and so partially and imperfectly explored on this side of the Atlantic) in as perfect a position and as favorable a situation for being acquired as its nature will admit of. Should there be time, in addition to the above, to perform other labor, it is desired—

Thirdly, that a commencement should be made in writing out full descriptions of the species pertaining to some partcular order, with observations upon the time of appearing, habits, etc., with a view of future publication, so as to secure a complete account of all the insects of the State pertaining to that order.

Lastly, suits of specimens to fully illustrate both the economical and scientific entomology of the State should be gathered in connection with the other parts of this work, to be placed in the Cabinet of Natural History; and in the Agricultural Museum specimens of the wood, leaves, and fruits; and other substances depredated upon by each and every species of our noxious insects, showing the galls or other excrescences which they occasion, the holes or burrows which they excavate, the webs or other coverings for themselves which they construct, with preserved specimens of the worms, caterpillars, etc., by which each of these deformities is produced.

Such further examination as Dr. Fitch may deem necessary to carry out fully the objects desired to be accomplished, as from time to time may be deemed advisable, the committee desire may be made.

William Kelly,
B. F. Johnson,
Committee.

Dr. Fitch, while not officially designated as State entomologist of New York, was always given this title by courtesy, and continued in office until 1871 or 1872, when his fourteenth report was published, and when the infirmities of age affected him to such an extent that he could no longer continue his investigations. The reports were published in the Transactions of the State Agricultural Society from 1854 to 1870, skipping the years 1859, 1865, and 1868. The first eleven have been published separately, as well as in the transactions of the society. In 1873, through an appropriation by the State legislature, provision was made for the revision and republication of the reports, and the revision was completed by Dr. Fitch. The resolution for printing, however, failed of the concurrence of the senate, and since that time the manuscript has been lost.

The value of Dr. Fitch's labors has been very great. In his fourteen reports the great majority of the injurious insects of the State of New York received more or less detailed consideration, and in the majority of cases the life histories of the insects treated were worked out with great care and detail. The remedial measures suggested by Dr. Fitch have, however, been largely improved upon, and the practical value of these reports today rests almost entirely upon the life-history side.

From the time of the publication of Dr. Fitch's last report, in 1872, the State of New York did nothing for the encouragement of economic entomology until 1881, when the legislature, on April 14, passed an act to provide for the appointment of a State entomologist. The law reads as follows:

No. 316.] STATE OF NEW YORK,
In Senate, April 14, 1881.

Introduced by Mr. Fowler; read twice and referred to the committee on finance; reported favorably from said committee and committed to the committee of the whole.

AN ACT to provide for the appointment of a State entomologist and fixing his compensation.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. There shall be appointed by the governor a State entomologist, who shall be charged with the study of insects injurious to agriculture and of methods for controlling and preventing their depredations.

P. 2. The salary of the entomologist shall be two thousand dollars, and he shall render an annual report of his labors and investigations to the legislature and shall arrange for the State museum of natural history a collection of insects taken in the course of his investigations.

P. 3. This act shall take effect immediately.

(Senate, No. 316.) (I. 520, G. O. 391.)

(Chap. 377 of the Laws of 1881. Passed May 26, 1881, three-fifths being present.)

The movement which resulted in the passage of this law was started by the regents of the University of the State of New York at their annual meeting in 1877, and the person appointed to fill the office was Dr. J. A. Lintner, a well-known worker in entomology, who, up to that time, had been connected with the State Laboratory of Natural History. Dr. Lintner has held office continuously since 1881. He brought to bear upon his duties a ripe experience and a mind trained in scientific methods. He has published nine reports, the last one covering the year 1892, and only recently distributed. These reports are in many respects models. The great care and thoroughness of the author have hardly been equaled by any other writer upon economic entomology. The form of the reports is most admirable, and the account of each insect forms almost invariably a complete compendium of our knowledge concerning it down to the date of publication. His accounts are also arranged in the most convenient form for reference, a full bibliography precedes the consideration of each species, and the frequent subheadings enable the most practical use of the report. The reports are replete with sound and ingenious practical suggestions, and are written in a straightforward, simple style, which possesses great literary merit. They abound in illustrations, and are made available by most complete indices and tables of contents. Aside from these reports, Dr. Lintner has published a great deal in the newspapers, particularly the Country Gentleman, on the subject of economic entomology, and another valuable feature of his reports is the comprehensive list which he publishes each year of his unofficial writings.

The Cornell University Agricultural Experiment Station was established by the authorities of the university in 1879, and its first annual report contained a series of miscellaneous entomological observations by the acting professor of entomology, Dr. W. S. Barnard. The second report, issued in 1883, contained an elaborate monograph of the Diaspinæ by Prof. J. H. Comstock, and an important article on the Tineidæ infesting apple trees by Mr. A. E. Brunn, a student of the Department of Entomology. With the establishment of the agricultural experiment stations under the Hatch bill, in 1888, this experiment station became governmental in its character, and Prof. Comstock was naturally made entomologist. Since that date he, or his assistants, have published a number of very important bulletins, the first one, on A Sawfly Borer of Wheat, by Prof. Comstock; the second on Wireworms, by Prof. Comstock and his assistant, Mr. M. V. Slingerland, and the later ones mainly by Mr. Slingerland. These are among the best and most practical of the experiment station bulletins that we have. They are characterized by almost a superabundance of detail and plainly by great care. The illustrations are very nearly all original, and are excellent.

The U. S. Department of Agriculture.—Almost simultaneously with the appointment of Dr. Fitch to do entomological work for the State of New York, came the appointment of an entomological expert under the General Government. On June 14, 1854, Mr. Townend Glover was appointed by the Commissioner of Patents to collect statistics and other information on seeds, fruits, and insects in the United States, under the Bureau of Agriculture of the Patent Office. Mr. Glover was one of the most eccentric individuals who have ever done important work on North American insects. He had led a roving and eventful life as a boy in Brazil, as a clerk in a draper's shop in England, as an artist in Germany, as a roving traveler and naturalist in all parts of the United States, and finally as a landed proprietor with horticultural tastes on the banks of the Hudson in New York. Pomological interests brought him to Washington shortly before the time when he received his appointment. His first report was published in the Report of the Commissioner of Patents for 1854, was illustrated by six plates engraved on stone by the author, and comprised some consideration of the insects injurious to the cotton plant, wheat, and the grapevine, and on the plum curculio, codling moth, and peach borer, closing with some account of the more common species of beneficial insects. His second report, in 1855, continued the consideration of cotton insects, together with some account of orange insects. The reports for 1856 and 1857 contained nothing from him, but that for 1858 contains a rather full report on the insects frequenting orange trees in Florida, published over the initials D. J. B., which were those of the then chief clerk of the Bureau, with whom Mr. Glover had many serious disagreements, largely on the matter of credit, which resulted in his resignation the following year. In

1862 the Department of Agriculture was established as a separate institution, under the commissionership of the Hon. Isaac Newton, and in 1863 Mr. Glover was appointed entomologist to the Department. His annual reports follow consecutively from 1863 to 1877, and are storehouses of interesting and important facts which are too little used by the working entomologists of today. Their value for ready reference, however, is detracted from by a lack of systematic arrangement and poor paper and presswork, but many observations are to be found in the pages written by Glover which have subsequently been announced by others as original and important discoveries. There is, however, in Mr. Glover's reports a lack of consecutive and full treatment of any one topic, and the subject of remedies seems seldom to have received original treatment or thought with him. This is largely due to the fact that his reports were matters of secondary importance to him, his main energies being devoted to the building up of a museum for the Department and to the preparation of his most elaborate series of illustrations of North American insects, a work upon which he expended enormous labor, and which unfortunately, up to the present time, has added to his fame nothing but the good opinion of a few of his scientific contemporaries.

In 1877 Mr. Glover's health suddenly failed him. His report for that year was largely prepared by his able assistant, Mr. Charles Richards Dodge, who, by the way, is the author of the charmingly written account of Mr. Glover's life, published as Bulletin 18 of the Division of Entomology of the Department of Agriculture. Mr. Glover lived for several years afterwards, but was unable to do further work. He died in Baltimore in 1883, and the writer and Profs. Uhler and Riley were the only entomologists present at the funeral services of this, in many respects, remarkable man.

The year 1878 marked a new era in governmental entomological work. Prof. C. V. Riley, a comparatively young man, who had already become famous by the admirable work which he had done as entomologist of the State of Missouri, and as chief of the U. S. Entomological Commission, was that year appointed successor to Mr. Glover by the Hon. William G. Le Duc, then Commissioner of Agriculture. Prof. Riley took hold of his work with his accustomed vigor, and, during the nine months that he remained in office at that time, accomplished a great deal. His report for the year 1878, though short, is by far the most practical one which the Department had published up to that time. On account of a misunderstanding with the Commissioner, Prof. Riley resigned his commission in May, 1879, and Prof. J. H. Comstock, of Cornell University, was appointed in his stead. Prof. Comstock remained in office until May, 1881. He completed the investigation of the cotton worm, begun by Prof. Riley, and published a thoroughly practical and useful volume entitled Report upon Cotton Insects, early in 1880. In addition to this report he published extensive annual reports covering the years 1879 and 1880, which rival in thoroughness and practicality the Missouri reports of Prof. Riley and those which were issued by the Department after his resignation. The report for 1880 is marked by the publication of the results of a preliminary investigation of the insects affecting the orange, and more especially by an elaborate report upon scale insects, which formed the basis of the study of this important and very destructive group of insects in this country. Upon the change of administration in 1881, Prof. Comstock was retired, with a year's commission as investigator, and Prof. Riley resumed charge of the governmental entomological work. From that time until June, 1894, Prof. Riley remained consecutively in office. The work which he has accomplished has been of the highest order, and has been largely instrumental in placing the science of economic entomology in this country upon its present sound footing. During the course of his administration of the office he has published 12 annual reports, 31 bulletins, 2 special reports, 6 volumes of the periodical bulletin INSECT LIFE, and a large number of circulars of information. He has developed not only the scientific side of the work, but also the practical side. Under his direction advances have been made both in insecticides and insecticide machinery, which are of the most far-reaching importance. The earlier work of Prof. Riley will be mentioned in another place, but it will be appropriate to state here that no other name in the annals of North American economic entomology stands out with the same prominence as his. His work has been called epoch making, and this expression may be considered justified. His voluntary resignation at this time would be greatly to be deplored, were it not for the fact that, with the restoration of his health, which is confidently to be anticipated, he will resume his labors—in another capacity, it is true, but along entomological lines and with undiminished vigor.

Aside from the work of the Division of Entomology, the General Government has, upon one occasion only, provided for work in economic entomology, as have so many other governments, by the appointment of a special commission. The U. S. Entomological Commission was founded, by authorization of an act of Congress approved March 3, 1877, specifically to report upon the depredations of the Rocky Mountain locust in the Western States and Territories and the best practical method of preventing its recurrence, or guarding against its invasions. The commission was attached to the U. S. Geological and Geographical Survey of the Territories under the charge of Prof. F. V. Hayden, and the office of chief was filled by the appointment of Prof. C. V. Riley by the Hon. Carl Schurz, then Secretary of the Interior. The other members of the commission, also appointed by the honorable Secretary of the Interior, upon consultation with Prof. Riley, were Dr. A. S. Packard, jr., of Massachusetts, secretary, and Prof. Cyrus Thomas, of Illinois. The commission remained in existence, supported by annual appropriations by Congress of varying amounts, until 1881. It published 5 reports and 7 bulletins. The first two of the annual reports related to the Rocky Mountain locust and allied migratory locusts, and form together probably the most complete monograph of any one insect ever published. The practical end was kept constantly in view, and the reports are thoroughly practical, as well as thoroughly scientific. In the appropriations for the year 1879 the commission was instructed to report upon cotton insects, and the results of the investigation thus brought about are published in the fourth report of the commission on the cotton worm and boll worm—another elaborate volume which can not be too highly praised from all standpoints. The third report treats of a variety of topics and includes two important monographs, one upon the army worm and the other upon canker worms, while the fifth report contains a full and comparatively exhaustive treatment of the subject of the insects injurious to forest and shade trees. The first, second, and third reports are published under the joint authorship of the three commissioners, the fourth under the sole authorship of Prof. Riley, and the fifth under the sole authorship of Dr. Packard.

ILLINOIS.—During the regular session of the legislature of Illinois, in the winter of 1866–'67, a law was passed enacting that a State entomologist shall, "by and with the consent of the senate, be appointed by the governor, with a salary of $2,000 per annum, for a period of two years, or until his successor is appointed and qualified." This legislation was the result of a petition from the State Horticultural Society, and on May 21, 1867, the society passed the following resolution:

That the president of the society be authorized to engage B. D. Walsh to immediately commence entomological investigations in relation to horticulture, and be empowered to pay out for that purpose a sum not exceeding $500 from the legislative appropriation. This action is taken in case of the failure to appoint.

At a special session of the legislature held in June, 1877, the governor sent in the name of Mr. Walsh for confirmation, but the senate postponed action upon it until the next regular biennial session in the winter of 1868–'69. Hence it follows that Mr. Walsh's first and only report was published as acting State entomologist, his untimely death occurring before his second report was prepared, its preparation having been delayed by a long period of ill health which preceded the railway accident which was the immediate cause of his demise. Mr. Walsh was a retired farmer and lumber dealer of English university training, who for a number of years prior to his appointment had been industriously studying entomology and had written largely for the agricultural press upon the subject of injurious insects. Although not a naturalist by training, his work showed extraordinary powers of observation, and his published writings, as well as the statements of his contemporaries, indicate that he possessed a remarkable mind. In this connection, however, we have occasion to speak only of his official work as indicated in his one report. In this report, which is now unfortunately very rare, he treated particularly of the insects affecting the grape, the apple, and the plum, and to this added, under the head of "Insects affecting garden crops generally," a chapter on the so-called "hateful grasshopper," or migratory locust, *Caloptenus spretus*. His treatment of the other insects is very thorough and his work in large part remains standard today.

Mr. Walsh's successor, Dr. William LeBaron, a practicing physician of Geneva, Ill., well known for his writings on injurious insects in the agricultural journals of the time, and an able and conscientious entomologist, published four reports as appendices to the Transactions of the State Horticultural Society, from 1871 to 1874. The first three treated of miscellaneous insects, mainly those injurious to fruit and fruit trees, while his fourth report and part of his third consisted of the beginnings of a work entitled Outlines of Entomology, of which he completed only the order Coleoptera. This portion, however, was executed in the most scientific manner, and was fully illustrated, largely by original drawings by Prof. Riley. It has since been used to some extent in the class room, and has undoubtedly been the means of interesting many students in the subject of entomology. Dr. LeBaron's treatment of insects from the economic standpoint was careful and practical. He records in his first report the first successful experiment in the transportation of parasites of an injurious species from one locality to another, and in his second report recommended the use of Paris green against the canker worm on apple trees, the legitimate outcome from which has been the extensive use of the same substance against the codling moth, which may safely be called one of the great discoveries in economic entomology of late years.

Dr. LeBaron died in harness, I believe, and was succeeded in office by the Rev. Cyrus Thomas, of Carbondale, who published a series of six reports, extending over the years 1875 to 1880. Mr. Thomas at the time of his appointment was a well-known entomologist, who had written extensively for the Prairie Farmer and other agricultural newspapers on the subject of economic entomology, and who had published an elaborate monograph of the Acridiidæ of the United States as one of the special volumes of the Hayden survey of the Territories. He started with his first report, a manual of economic entomology for the State of Illinois, including in this report the portion relating to the Coleoptera. In his second report his assistant, Mr. G. H. French, treated of the Lepidoptera, and in his third report Mr. Thomas treated the Hemiptera, monographing the Aphididæ. His fourth report included a consideration of one family of the Orthoptera, namely, the Acridiidæ, and the fifth a paper on the larvæ of Lepidoptera, by his assistant, Mr. D. W. Coquillett, while in his sixth he was obliged, from the force of circumstances, to abandon the scheme. The manual of economic entomology of Illinois remains, therefore, unfinished. In the course of the six reports a very large number of insects are treated from the economic standpoint. Mr. Thomas was able to employ several excellent assistants, and the six reports as a whole are very creditable to the State. The last of the six reports shows rather plainly the falling off in Mr. Thomas's interest in the subject of entomology. Its publication was coincident with the close of the work of the U. S. Entomological Commission, and it consists entirely of reports by Mr. D. W. Coquillett and Prof. G. H. French. After its publication Mr. Thomas transferred his labors to the field of ethnology, in which he had long been interested, and he is at the present time one of the able workers in the U. S. Bureau of Ethnology.

Upon Mr. Thomas's withdrawal from office, Prof. S. A. Forbes, director of the State Laboratory of Natural History at Normal, Ill., was appointed State entomologist, his commission dating July 3, 1882. Prof. Forbes's attention had for some time been more or less engaged by questions relating to economic entomology. He has held office continuously since that time, and has published six reports, the first one covering the remainder of the year 1882, the second the year 1883, the third the year 1884, the fourth the years 1885 and 1886, the fifth the years 1887 and 1888, and the sixth the years 1889 and 1890. Prof. Forbes's reports are among the best which have been published. They are characterized by extreme care and by an originality of treatment which has seldom been equaled. The practical end is the one which he has kept mainly in view. His experiments with the arsenites against the codling moth and the plum curculio were the first careful, scientific experiments in this direction which were made, and his investigations of the bacterial diseases of insects have placed him in the front rank of investigators in this line. His monographic treatment of the insects affecting the strawberry plant is a model of its kind, and the same may be said of his work upon the corn bill-bugs and of his studies of the chinch bug. In fact, whatever insect or group of insects has been the subject of his investigations, he has attacked the problem in a thoroughly original and eminently scientific and practical manner. Prof. Forbes has been able to command the services of a very able corps of assistants, including Messrs. C. M. Weed, H. Garman, F. M. Webster, John Marten, and C. A. Hart.

MISSOURI.—In the session of 1867–'68 the legislature of Missouri passed an act establishing the office of State entomologist, and directed that the reports of this officer should be made to the State board of agriculture. The first and only appointee to this position was Prof. C. V. Riley, who had at that time become prominent as an entomologist through his writings in the Prairie Farmer, of Chicago, with which paper he had been for some time connected, and through his editorship, in association with Mr. B. D. Walsh, of the American Entomologist, of which one volume had then been published. He entered upon his duties April 1, 1868, and published his first annual report in December of that year. From that date there followed annually eight additional reports, the ninth being submitted March 14, 1877, and covering the year 1876.

There is no need of any comment upon these nine Missouri reports before any body of economic or scientific entomologists. They are monuments to the State of Missouri, and more especially to the man who wrote them. They are original, practical, and scientific; they cover a very great range of injurious insects, and practically all the species which were especially injurious during those nine years received full and careful treatment. They may be said to have formed the basis for the new economic entomology of the world, and they include a multitude of observations and intelligent deductions which have influenced scientific thought. Their value to the agriculturist, as well as to scientific readers, was greatly enhanced by the remarkable series of illustrations which were drawn by the author and engraved upon wood by the most skillful wood engravers of that time. Aside from a few of the illustrations to the Flint edition of Harris, they are the best wood cuts ever made of insects in this country, and as a whole the drawing far excels that of the Harris illustrations in its lifelike accuracy, artistic beauty, and closeness of detail. Prof. Riley abandoned his Missouri work on taking up the directorship of the U. S. Entomological Commission, and in pursuance of a shortsighted policy Missouri has never since had a State entomologist.

Other States and the Hatch State Agricultural Experiment Stations.—Massachusetts, New York, Illinois, and Missouri are the only States which may be said to have supported official economic entomologists. There are letters on file in the Division, dated in 1880, from Mr. J. T. Humphreys, who announces himself in his letter head as "Late naturalist and entomologist to the Georgia Department of Agriculture;" but although I have made something of an effort to learn the details of Mr. Humphreys's employment, I have so far been unsuccessful. The State of Pennsylvania has for some years handled its economic entomology by means of an officer who holds an honorary commission from the State board of agriculture. This commission was held for some years prior to his death by Dr. S. S. Rathvon. At the present time Dr. Henry Skinner, of Philadelphia, and Dr. R. C. Scheidt, of Lancaster, are entomologists to the State board.

In the spring of 1888, the State Agricultural Experiment Stations, founded under the Hatch Act, were organized. A number of entomologists were soon appointed and active work began practically in the month of February. This movement, the importance of which to American economic entomology can hardly be overestimated, is too recent to require full treatment here.

The first entomological bulletin published by any of the experiment stations was issued in April, 1888, from the Arkansas station, by Mr. S. H. Crossman, and was entitled The Peach-tree Borer and the Codling Moth. Bulletins from Hulst, in New Jersey; Morse, in California; Tracy, in Mississippi; Ashmead, in Florida; and Weed, in Ohio, followed in May. Popenoe, in Kansas, and Perkins, in Vermont, published one each in

June, and Fernald, in Massachusetts, and Lugger, in Minnesota, one each in July.

Through the kindness of Mr. A. C. True, director of the Office of Experiment Stations of the U. S. Department of Agriculture, I am in possession of a bibliographical list of the entomological publications of the agricultural experiment stations down to the present month. This was drawn up by Mr. F. C. Test, of Mr. True's office, and will be published as an appendix to this address. An analysis of its contents shows that 42 States and Territories have employed persons to do entomological work, and that the number of experiment station workers who have published entomological bulletins or reports reaches 77. Not half of these writers, however, have been officially designated as entomologists to the station. Of those so designated there are 28; 8 have held the title botanist and entomologist; 6, consulting entomologist; 4, assistant entomologist; 4, horticulturist and entomologist; 1, special entomologist; 1, entomologist and physiologist; 2, entomologist and zoologist; 1, entomologist and superintendent of farms; 1, director, entomologist, and botanist; 1, vice-director, horticulturist, entomologist, and mycologist; 1, special agent; 1, apiarist; 2, biologist. The other writers bear titles which indicate that they are not specialists in entomology. They are as follows: Agriculturist, 1; assistant agriculturist, 1; horticulturist and agriculturist, 1; horticulturist, 3; assistant horticulturist, 1; botanist and mycologist, 1; director, 2; botanist, 2; superintendent of grounds, 1; pomologist, 1; specialist, 1; veterinarian, 1; clerk and librarian, 1.

The entomological publications of these experiment stations have numbered 311, of which 88 have been annual reports, 213 bulletins, and 10 leaflets and circulars. In character the bulletins and such reports as have definite titles may be thrown into three categories: 1, those which treat only of insecticides and insecticide machinery (40); 2, those which contain compiled accounts of insects, with measures for their destruction (60); 3, those which contain the results of more or less sound original observation, with compiled matter and matter upon remedies (117). There are also two small classes: 1, apiculture (6), and 2, classificatory (4).

It would be a matter of very considerable interest if I were able at this time to give a more critical summary of the results achieved by our experiment station workers in entomology. The little analysis which precedes shows a gratifying preponderance of bulletins and reports which contain results of original work; and yet at the same time we must remember that while these papers advance our knowledge of entomological science, the compilations may frequently accomplish greater practical good. This point is illustrated by a statement which I have from Prof. Garman, of the Kentucky station. He says that Bulletin No. 40 of his station, containing condensed accounts of some of the commoner and more injurious insects of the farm and garden, is the one for which there has been the greatest demand. The original edition of 12,000 was soon exhausted, and another lot has since been printed. The bulletin was prepared by request, and naturally is not the sort of work which our station entomologists prefer to do. "Its success," writes Prof. Garman, "has been a lesson to me as to what farmers want and will use."

It occurred to me that it might be valuable to have a statement from each of the experiment station entomologists as to the piece of work he had done which seemed to have accomplished the most practical good, in the light of his own accurate information concerning the farming population of his State. I therefore addressed letters to nearly all of the station workers in entomology, but have received replies from only about half of them, so that a statement of this kind would hardly be justified. It is interesting to note, however, that experiment station workers place in very high esteem the results of their correspondence with farmers and of their lectures before farmers' institutes and other bodies. It is in these two ways that the popular sentiment among agriculturists as to the importance of economic entomology is being much more rapidly spread than, perhaps, by the publication of bulletins upon injurious insects.

CANADA.

The Rev. C. J. S. Bethune, for many years one of the most prominent writers on entomology in Canada, and a well-known contributor to the columns of the Canadian Farmer on the subject of agricultural entomology, was largely responsible for the organization of the Entomological Society of Ontario, and for the first appropriation of money made to that society with a view to the development of economic entomology among our neighbors across the border. The council of the Agricultural and Arts Association of Ontario in 1869 voted a grant of $400 to the Entomological Society of Ontario for the year 1870, on condition that the entomological society should furnish an annual report, should found a cabinet of insects, useful or prejudicial to agriculture and horticulture, to be placed at the disposal of the council, and that it should also continue to publish the Canadian Entomologist. This was the origin of the first annual report of the Ontario society, which was published in 1871 by the Agricultural and Arts Association. This association also gave the society $100 additional, and the Fruit-Growers' Association of Ontario $50 additional, to be used for the purpose of illustrating the report. During the session of the legislature of the Province of Ontario in 1870-'71, the agriculture and arts act was passed. By this act the Entomological Society of Ontario was incorporated, and a grant of $500 per annum was made to it from the provincial treasury. In 1872 the legislature made an extra grant of $200 for the purchase of woodcuts, etc., making the total appropriation $700. In 1873 an extra grant of $500 was made, and the annual grant for 1874 was increased to $750. In 1875 the grant was $750, plus $100 for illustrations; in 1876 $750, plus $500 toward the expense of an exhibit at the Centennial Exhibition at Philadelphia; in 1877, 1878, and 1879 it was $750 per annum, and in 1880 the grant was increased to $1,000, at which sum it has continued since that date. The Government also pays the expense of printing the annual report.

The society has conscientiously complied with the conditions of the grant. Its reports, published annually, have greatly increased in size and in the general interest of their contents. They have contained much matter of economic value as well as of educational interest.

In 1884 the Department of Agriculture of Canada established the office of honorary entomologist, and this office was filled by the appointment of Mr. James Fletcher, at that time an employé of the Government Library at Ottawa, and already widely known in entomological circles through his active interest in the Ontario society and his contributions to its publications. On July 1, 1887, Mr. Fletcher was transferred to the staff of the Dominion Experimental Farms at Ottawa as entomologist and botanist. Mr. Fletcher's footing since that date has been practically identical with that of an entomologist to one of our State experiment stations, except that his field is larger. He has published a report yearly in the Annual Report of the Experimental Farms, published as an appendix to the report of the Minister of Agriculture. Mr. Fletcher has shown himself to be a man of extraordinary energy, a most entertaining writer, and a most careful observer, and one who has always kept the practical part of his work foremost in view. He has paid a great deal of attention to a side of his work which is neglected by many of our own official entomologists, namely, personal intercourse with farmers, frequent talks on injurious insects at farmers' institutes, etc., and has in this way built up a very large clientage among the most intelligent agriculturists of the Dominion. In economic entomology Canada at the present day is perhaps in no way behind the United States, and this is largely due to Mr. Fletcher's individual efforts, aided and encouraged as they are by the warm support of the eminent director of the experimental farms system, Mr. William Saunders, himself a pioneer in economic entomology in Canada and the author of one of the most valuable treatises upon the subject that has ever been published in America. Canada has the man and the knowledge, but has been hampered by want of funds. The result is that while she has immediately and intelligently adopted the results of researches made in this country, she has not been able to lead us in original investigation.

European Countries.

In general it may be said that Europe has not felt the need of entomological investigation from the economic standpoint to anything like the same extent as the United States. A climate much less favorable to the undue multiplication of injurious insects than that of North America, and which, moreover, seems to act as a barrier against the importation of foreign destructive species, the actually smaller number of injurious species and the vastly greater familiarity with all phases of the life-history of these species by all classes of the people, partly resulting from the older civilization, partly from educational methods, and partly from the abundance of elementary and popular literature on questions of this character, the denser population and the resulting vastly smaller holdings in farms, the necessarily greatly diversified crops, the frequent rotation of crops, together with the clean and close cultivation necessitated by the small size of the holdings, and the cheaper and more abundant labor, have all resulted in a very different state of affairs regarding the damage which may be done by injurious insects. In summarizing these points, the Chief of the Agricultural Section of the Ministry of Agriculture of Prussia, in conversation with the writer last summer, argued that Germany does not need to employ general economic entomologists; that its experiment stations seldom receive applications for advice on entomological topics. Special insects, it is true, occasionally spring into prominence; the Phylloxera is one of these, and in an emergency like the Phylloxera outbreak, the work is handled by special commissions. European nations, therefore, can afford to let the insect problem alone to a much greater extent than the United States, for the reason that it is of infinitely less importance with them than with us. The most simple remedies, such as hand-picking, together with a rigid enforcement of the public regulations regarding hand destruction, usually suffice to keep injurious insects in check. Nevertheless insect outbreaks do occasionally occur, and there is a certain percentage of loss every year from the work of injurious species. The results obtained in the United States, where the number of native injurious species is much greater than in Europe, and where we have in addition to deal with a host of imported species—in short, where the fighting of insect foes has become an absolute necessity—have, however, acted to a certain degree as incentives, not only to other countries which labor under the same climatic disadvantages as the United States, but even to a certain degree to European countries, where more thorough investigation of injurious insects by competent persons especially appointed for the purpose is gradually becoming thought worth while.

In 1890, at the Agricultural Congress held at Vienna, resolutions were passed founding the so-called International Phytopathological Commission. The movement was an important one, particularly for European countries, and as work upon injurious insects forms a part of the object of the commission the resolutions organizing it may be given here:

1. Whereas the numerous diseases and other enemies of plants are a constant source of damage, and sometimes even occasion the greatest losses to proprietors

and the public wealth, the congress resolves that it is absolutely necessary to establish scientific stations exclusively devoted to the study of the diseases of cultivated plants among us.

2. These phytopathologic stations, which, in order to be in the closest relations with scientific and practical circles, shall be established in the center of each country that is well provided with channels of communication, ought to be State institutions, charged with aiding practice by making gratuitous analyses for, and investigating and collaborating with, it.

3. The congress recognizes that observations and experiments made in common in all cultivated countries are the best guaranty of success in the search for sure and appropriate methods of combating the diseases of plants. Great expense may be saved in overcoming future epidemics if, by means of a network of scientific observations extending over all cultivated countries, States not yet attacked by plant diseases may be warned in time to take the necessary measures.

4. The congress considers it necessary that the heads of all pathologic stations of different countries shall engage to meet once a year to discuss and pass the resolutions which shall be deemed opportune.

5. The congress elects an international commission, having the right of coöptation, which shall put itself in relation with the Society of Agriculture of Vienna and agree with it as to the measures to be taken toward founding scientific stations designed to investigate the diseases of plants, and toward organizing a service of phytopathologic inspection in all cultivated countries.

Following the general meeting at Vienna, the members of the commission held a consultation meeting at The Hague, Holland. It was plain to the members present that the first necessity was the organization of national commissions in the several countries to be represented on the international commission. The efforts of the members have, therefore, since that date, been devoted to the establishment of such national commissions. Institutions for phytopathologic service have in this way been organized in Germany, Holland, and Belgium, and are being agitated in other European countries. It is the intention of the secretary, Dr. Paul Sorauer, of Berlin, editor of the Zeitschrift für Pflanzenkrankheiten, to call the members of the commission together in 1896, at Berlin, on the occasion of the Berlin Industrial Exposition, in order to accomplish a more complete international organization, and in order to start the annual meetings provided for in the fourth section of the Vienna resolutions.

It must be remembered, moreover, in treating of European countries, that, in addition to special commissions to investigate special insect problems of temporary importance, there are other classes of official work bearing upon insects, which, however, we can hardly consider in this connection, mainly for want of space. These are, government encouragement of sericulture and apiculture, both through subsidies, and the establishment of educational institutions, and further subsidizing of learned societies, enabling them to carry on investigations and publish works of more or less importance. Very considerable good has been accomplished in this direction, but the sources of information at hand are too scanty to justify any more than a brief reference to the existence of such an element in our general subject.

GREAT BRITAIN.

There is not and never has been in Great Britain a special government appropriation for work in economic entomology. In 1885 Mr. Charles Whitehead suggested to the lords of the committee of council for agriculture that it would be valuable to publish reports upon insects injurious to various farm crops. He prepared, and the council published, a series of four reports upon insects injurious to the hop plant, corn, and leguminous plants, to turnips, cabbage, and other cultivated cruciferous plants, and to fruit crops. In 1886 Mr. Whitehead was appointed agricultural adviser and prepared a report upon insects and fungi injurious to crops of the farm, orchard, and garden for 1887–'88. In 1889 the board of agriculture was formed, and Mr. Whitehead was retained as technical adviser, especially with reference to insects and fungi injurious to crops, but also with reference to other agricultural questions. He prepared annual reports on insects and fungi for 1889, 1891, and 1892, and a number of leaflets and special bulletins on insects unusually prevalent from 1889 down to the present time. I learn from Mr. Whitehead that there is no specific law authorizing this expenditure; that his work has been continuous since 1887, and that he has received an annual sum of £250 only. The more important of the special bulletins and leaflets which have been issued have been: Special Report on an Attack of the Diamond-back Moth Caterpillar, 1892; Caterpillars on Fruit Trees; Hessian Fly; Moths on Fruit Trees, 1890; Apple Blossom Weevil, Raspberry Moth, and the Mangel-wurzel Fly, 1892; Black Currant Mite, 1893; and the Red Spider and Apple Sucker, 1894.

While Mr. Whitehead has therefore been the only governmental worker in agricultural entomology, a very considerable work has been done in a semiofficial way by an untiring and public-spirited woman, Miss Eleanor A. Ormerod, who is, or rather was, in her official capacity, honorary consulting entomologist to the Royal Agricultural Society. From 1876 to 1893 Miss Ormerod held this position; conducted the correspondence of the Royal Agricultural Society on the subject of injurious insects, and published at her own expense a series of annual reports, seventeen in number, which have contributed very largely to the diffusion of knowledge concerning injurious insects in Great Britain among the farming classes. She has had a most conservative class of people to deal with, and has encountered many obstacles. She has shown herself ingenious, careful, and receptive to a degree, and at the same time possessed of an enthusiam and an unlimited perseverance which are calculated to overcome all obstacles. She has studied many of the English crop enemies *de novo;* she has popularized the work of other English entomologists, and has made accessible to the agricultural class the work of John Curtis and Prof. Westwood, and has adopted, and strongly advocated the adoption of, measures found to be successful in other countries, particularly in America. The good which

Miss Ormerod has accomplished can hardly be estimated at the present time, but she will deserve, at the hands of posterity, canonization as the patron saint of economic entomology in England.

Aside from her annual reports Miss Ormerod has published a large work entitled Manual of Injurious Insects and Methods of Prevention, and numerous smaller works, treating of the Hessian fly, sugar-cane insects, and the injurious insects of South Africa, the last two being devoted to the agricultural interests of the English colonies.

Within the year the Royal Agricultural Society has made the office of consulting entomologist, or rather zoologist—for they have broadened the term—a salaried one, and Mr. Cecil Warburton, an able student of zoology, although not known as an entomologist, has been appointed to the position. Mr. Warburton has published one report, which is mainly compiled and devoted to extracts from the correspondence of the society, but it is too early as yet to judge of his capabilities from our standpoint.

Miss Ormerod's legitimate predecessor may be said to have been John Curtis, who, from the beginning of Dr. Lindley's Gardener's Chronicle, contributed an important series of essays upon injurious insects to its columns, under the *nom de plume* "Ruricola." Mr. Curtis's connection with this famous agricultural journal was of great advantage to him, as it enabled him to secure information and specimens from all parts of the Kingdom. He had also accumulated a large amount of information during the twenty years he was engaged in writing his great work upon British entomology. When the Royal Agricultural Society of England was founded, in 1840, the council of the society invited Mr. Curtis to prepare a series of reports upon the insects affecting various crops cultivated in Great Britain and Ireland, and in the Journal of the Royal Agricultural Society for the years 1841 to 1857 he published a series of sixteen such reports. The matter of these reports, and also of his previously published Gardener's Chronicle articles, was drawn upon largely for, and in fact forms the major portion of, his standard work upon Farm Insects, published by Blackie & Sons, London, Glasgow, and Edinburgh, in 1860. Whether Curtis was remunerated for his work for the Royal Agricultural Society or not I am unable at this time to state, although he probably received some compensation. I learn through the kindness of Miss Ormerod that, chiefly on account of the value of his writings upon economic entomology, Mr. Curtis was awarded a pension from the civil list, which was augmented about three years before his death on account of the sad loss of sight which he experienced.

In 1877 a strong effort was made to secure the appointment of a Government entomologist. A conference was held at the Society of Arts which was largely attended and was presided over by the Duke of Buccleugh, K. G. The most important paper read was by Mr. Andrew Murray, and after a long discussion the conference resolved:

That much of the loss occasioned by insects is preventable and ought to be prevented: that it properly belongs to government to provide the necessary means for protecting cultivators from this loss, as it is only by simultaneous action over considerable districts that it can be effectually done, and government alone possesses or can obtain the requisite means of indorsing such action; that the president and lords of the council and the agricultural societies of the United Kingdom be informed of the opinion of this conference and urged to take the subject at once into their consideration, with a view to providing a remedy.

While we have no doubt that this conference was of sufficient importance and attracted enough attention to induce the president, lords, etc., to take the subject into consideration, no further action resulted.

IRELAND.

Mr. George H. Carpenter was appointed in 1890 consulting entomologist to the Royal Dublin Society, and has submitted four reports, entitled Report on Economic Entomology for the Year 1890, and the same for 1891, 1892, and 1893. Reprints of these reports from the Reports of the Council of the Royal Dublin Society have been distributed. Mr. Carpenter is assistant naturalist in the Science and Art Museum in Dublin, and I am not informed as to whether he receives special compensation for his work as consulting entomologist.

GERMANY.

Except in the one department of forest insects, the official side of economic entomology has not, in Germany, reached a high plane of development. In regard to the study of forest insects, however, Germany leads the world. The work of Ratzeburg is famous, and the impulse which he gave to the study, not alone through his published writings, but through his ability as a teacher, is felt today. His labors, and those of Nitsche, Althum, and others, have resulted in a widespread knowledge of all the important forest insects, which extends even to the lowest employés in the forestry service. With regard to the other departments of economic entomology, important works have been written by Bouché and Nördlinger, Rossmäsler, Taschenberg, and others, while the number of smaller articles upon injurious insects is very large. In Germany the need of entomological information, by means of numerous well-illustrated and cheap popular works, is perhaps better supplied than in any other country. No special institutions for the investigation of the life histories of injurious animals existed, however, before 1888, when, through the influence of Prof. Kühn, in Halle, an experiment station for the extermination of sugar-beet Nematodes was founded, which Dr. Holrung, the present director, has expanded to some extent, so that other allied troubles, including injurious insects, are included in the scope of the work of the station. Dr. Holrung visited America during the summer of 1893, and expressed to the writer great interest in the work in economic entomology in this country, and examined particularly the methods in use in the insectary of the Department of Agriculture, with a view to duplicating them at his own station.

AUSTRIA-HUNGARY.

The Austro-Hungarian Empire as a whole has done little in the way of official economic entomology. Austria proper resembles Germany; general entomological education is so far advanced, semipopular works upon entomology are so abundant, and the crop conditions are such, that the necessity for official work has not been felt. Vincent Kollar, writing from 1824 to 1858, particularly after his connection with the Zoölogical Museum at Vienna, paid special attention to injurious insects, and as his museum position was an official one he may be said to have been, to a certain extent, an official entomologist. His well-known work entitled Naturgeschichte der schädlichen Insekten in Bezug auf Landwirthschaft und Forstkultur was published privately in Vienna in 1837, but its contents were based upon researches made under government pay. A translation of this work into English, by Loudon, with added notes by Westwood, published three years later in London, for many years remained a standard and accessible work upon European injurious insects. It is unfortunate that in the translation Kollar's name became Köllar. Georg Ritter von Frauenfeld, writing from 1847 to 1861, published a number of notices upon injurious insects, and other Austrian writers have done the same. Among the many semipopular works upon economic entomology may be mentioned G. Henschel's volume on Injurious Insects of Farm and Kitchen-Garden; Their Life Histories and Remedies, published in 1890, at Vienna. The department of forest insects is well cared for by forestry officials, as in Germany.

True official encouragement of economic entomology in the Austro-Hungarian Empire, is, however, confined to the kindoms of Hungary and Bohemia.

HUNGARY.—The work in economic entomology carried on under official auspices in the Kingdom of Hungary is done by the Royal State Entomological Station at Budapest, under the learned and able direction of Dr. Geza Horvath. The station was founded in 1881 by the Government as a Phylloxera experiment station, with the practical end in view of the study of the grapevine Phylloxera and the remedial measures to be used against it. The organization of the station was placed in the hands of Dr. Horvath, who had already established a firm reputation for himself in the field of economic and scientific entomology, although the Phylloxera had for some years been the main object of his investigations. As the Phylloxera question, however, became more and more elucidated, and as the means of defense against this scourge became reduced to a practical basis, the work of the station became directed more and more toward other noxious insects. In conformity with this gradual change the name of the station has been changed, and since 1890 it has been called La Station Entomologique de l'État. The establishment of the station was voted by the legislative chamber, and sanctioned by the King. It is subordinate to the Ministry of Agriculture; its offices are established in the palace of the Ministry of Agriculture at Pesth, and consist of laboratories and a library. It possesses entomological collections and a collection of insecticide apparatus. The personnel of the station is composed of the director, two assistants, and a boy, and it is supported by an annual appropriation of 8,000 florins. The station has organized in the Kingdom a special corps of reporters, who send in regular reports upon the appearance of destructive insects in their respective regions. These reports at first concerned only insects injurious to agriculture, but since 1886 the field has been extended to include insects injurious to forests. The reporters are farmers and forestry agents, who send in their reports gratuitously. The reports as they arrive at the station are immediately examined and responses are sent indicating the measures to be taken against the insect in question; or one of the employés of the station is sent into the field to study the habits of the injurious species and experiment upon the best means for its destruction. The station publishes every year a general report to the Minister of Agriculture, which is published in the comprehensive annual report addressed to the Chamber of Deputies. Since 1890 the station has also been able to publish special reports, which are issued in separate fascicles and are gratuitously distributed to the public. The leaflets which have been published up to the present time may be briefly mentioned, since they are written in the Hungarian language:

1. Spraying apparatus of use in horticulture.
2. Practical instructions concerning the destruction of locusts by the Cypriote machine.
3. Practical instructions upon the treatment of phylloxerated vines with bisulphide of carbon.
4. Migratory locusts in Hungary in the years 1888, 1889, 1890.
5. Reports upon insects injurious to forests during the years 1886–'89.
6. Practical manual upon the treatment of phylloxerated vines with bisulphide of carbon.
7. The wheat weevil (*Calandra granaria*).
8. Report upon insects injurious to agriculture, 1884–89.
9. Upon the measures to be used against injurious insects.
10. The wheat leaf-beetle (*Lema melanopus*).

BOHEMIA.—For a number of years prior to 1891, Dr. Ottokar Nickerl, principal of the seed control station of the Agricultural Council for the Kingdom of Bohemia, issued an annual report upon the principal insects injurious to the agriculture of Bohemia during the year. These reports, which were published for the years 1875, 1878, 1879, 1880, and 1882 to 1890 (thirteen in all), were published partly in the reports of the State Agricultural Council, partly by the Society for Physiokratie (at the time when Dr. Nickerl was president of the entomological section of the society), and partly privately by the author. Previous to 1875, and commencing in 1871, there were short articles on the injuries done by insects, written by Dr. Nickerl, and between the years 1850 and 1870 there were published a large number of similar reports, written by Dr. Nickerl's father, Dr. Franz A. Nickerl, who died in 1871. These reports were published by the elder Nickerl as a member of the K. K. Patriotic-Economic Society of the Kingdom of Bohemia. In 1891 the State Agricultural Council of Bohemia was reorganized, and Dr. Nickerl retired, with the effect of discontinuing the annual reports. In the last of the reports, that for 1891, Dr. Nickerl gives a complete list of the reports published by him and an index of all the insects treated from the year 1875 to date. This list includes 108 species, of which 18 occur in this country, as introductions from Europe. The reports are brief and are not illustrated.

ITALY.

The work which has been done by the Italian Government in the encouragement of economic entomology perhaps surpasses that of any other European nation. In the year 1875 the Royal Station of Agricultural Entomology was established at Florence. The director of the station was most wisely selected; Prof. Adolf Targioni-Tozzetti, a learned entomologist and a man of widespread reputation, was appointed to the position and was allowed two assistants. Since this beginning the work of the station has been continuous. Through its active and energetic labors the agriculturists of Italy have been informed concerning the vast majority of the insects of economic importance in the country. The station possesses a rich scientific library and a very large collection of economic insects. Its aims are practically identical with those of the entomological offices of the experiment stations of our own country, and with those of the Division of Entomology of the U. S. Department of Agriculture. It is a correspondence bureau; it endeavors by original research to shed new light upon the problems of general economic entomology, and to publish for the benefit of agriculturists its own researches and those of private individuals. The station has published a very large number of leaflets treating of entomological subjects, as well as general reports for the years 1877–'78 (Florence, 1881); 1879–82 (Florence, 1884); and 1883–85 (Florence, 1888). It has published also a separate work entitled Agricultural Orthoptera (Florence, 1882), and a large and useful volume entitled Animals and Insects of Growing and Dry Tobacco (Florence, 1891).

The publications of this station are too little consulted in this country. Prof. Targioni-Tozzetti has made a life-long study of the Coccidæ, and his articles upon this group of injurious insects possess the very highest value. With the assistance of Dr. Giacomo del Guercio and Dr. Antonio Berlese, he has conducted by far the most elaborate series of experiments with insecticides, used mainly against the Coccidæ, but also against injurious insects of other groups, of which there is any record in the literature of economic entomology. Some five or six years ago the mulberry trees over a large portion of Italy were attacked by a very destructive scale insect, known as *Diaspis pentagona*, a species which also attacked a number of other cultivated trees, and which instigated very largely the experimental work which we have just mentioned. The investigation resulted in the adoption of three prime insecticides, one composed of kerosene emulsion, another of an emulsion of bisulphide of carbon, and the third of an emulsion of crude tar oil. These mixtures, used in varying proportions, proved the most effective of the many scores of substances or combinations of substances tried. It is interesting to note that this great amount of admirable work has been accomplished on an annual appropriation of 11,000 lire.

Aside from the work of the station at Florence, the Ministry of Agriculture at Rome published, in 1887, an extremely important and useful work, which bears largely upon economic entomology, and which is entitled Botanical Studies upon Citrus and Allied Plants, by Dr. O. Penzig, of Genoa. The subtitle of the work is "Memoria premiata dal R. Ministero d'agricoltura" which, if I take it aright, means that it was prepared privately by the author, received a money award at the hands of the ministry, and was published as a special volume of the annals. The entomological portion of this important work is in part compiled, but it has been done in the most careful and thorough manner. The author has been familiar with the work of entomologists in all parts of the world, and has brought together a great mass of practical information. The large atlas which accompanies the work contains 20 quarto plates of a very considerable degree of excellence.

FRANCE.

The French people have done much to advance the science of entomology; they have even done a great deal in economic entomology. The agricultural conditions prevailing in France are similar to those which hold in Germany, and what we have said about the latter country will largely apply to France. The abundance of popular works upon economic entomology is the same. Beginning with Fonscolombe's Mémoires sur les Insectes Nuisibles a l'Agriculture, principalement dans le Department du Midi de France. published in 1840, a number of these works have been published, the most prominent of which was, perhaps, that of M. Charles Goureau, under the title Insectes Nuisibles, published in 1862, and of which two supplements were afterwards issued. Moreover, in 1867 a journal was established by Dr. Boisduval, entitled Insectologie Agricole, treating of useful insects and their products, noxious insects and their injuries, and the principal means of fighting them, of which six volumes appeared, comprising the years 1867 to 1872. For a number of years instruction in economic entomology has been given at the École Nationale d'Agriculture at Montpellier, largely by the able zoologist, M. Valery Mayet, who has recently published an important work upon a branch of economic entomology entitled Les Insectes de la Vigne. No nation could have attacked an insect problem with more energy than did the French the question of subduing the Phylloxera in the early seventies, by means of special commissions and the offering of large rewards to scientific investigators. The same energy was displayed when they were confronted with that disastrous disease of the silkworm known as pébrine. More recently the question of the injury to cultivated crops in Algeria by the Algerian locust has been approached with the same degree of scientific ability. But the appointment of special salaried entomological officers is a new thing in France.

In 1893 there was established at Paris an institution called Le Laboratoire de Parasitologie Vegetale de la Bourse de Commerce. This institution was created by the Société de la Bourse de Commerce of Paris in the interest of agriculture, of the commerce in grain, and of all the agricultural interests of which the Bourse de Commerce is the *centre d'affaires* in Paris. The laboratory was founded by the appointment of M. J. Danysz as director, and several bulletins have been published.

More recently Prof. Brocchi, professor of zoology at the Institut Agronomique, at Paris, has been charged with the founding of a department of agricultural entomology. The work of the department will be to identify insects sent in for that purpose by agriculturists, and to point out means of destroying insect pests or diminishing their ravages. For some time previously M. Brocchi had, in his capacity of professor of zoology, answered questions upon economic entomology referred to him by the ministry of agriculture, and, as notably in the case of *Ephestia kuehniella*, a report upon which he published in the Bulletin du Ministère de l'Agriculture, 1888, has occasionally furnished full and valuable reports.

SPAIN.

Aside from commission work upon the Phylloxera, Spain has done nothing in the way of official work in economic entomology. The shining light in entomological research in Spain, Dr. Ignacio Bolivar, for many years connected with the National Museum at Madrid, and curator of entomology in the Central University, has published many papers upon insects, some of them having an economic bearing, notably those upon injurious locusts of the Mediterranean region. Within the past few weeks an item has appeared in the newspapers stating that Spain has appropriated $100,000 to further Phylloxera investigations, but concerning the method in which the sum is to be used I have learned nothing.

THE NETHERLANDS.

Economic entomology in the Netherlands, while reasonably advanced through the private labors of Dr. J. Ritzema Bos and several other scientific men, has not reached the official stage. Dr. Ritzema Bos is professor of zoology and animal physiology in the Royal Agricultural College at Wageningen, and for more than twenty years has voluntarily given information to the Dutch agriculturists and horticulturists. Up to the present time he has received no specific indemnification from the Government. For 1894, however, he has been promised the insignificant sum of 500 florins, equal to $200. The outlook, however, is favorable, and in a reorganization of agricultural instruction which will be brought about within a year or two, it is hoped that economic entomology will gain a better place. The only active and well organized branch of the International Phytopathologic Commission exists in the Netherlands. It was organized upon the same lines as the parent society founded at the meeting of the Agricultural Congress held at Vienna in 1890. It was organized April 11, 1891, by the two Dutch members of the International Phytopathologic Committee, Dr. J. Ritzema Bos and Prof. Hugo de Vries, for a term of twenty-nine years. Roughly translated, the essential by-laws of the society read practically as follows:

Article 1 recites that the Dutch Phytopathological Society was founded in pursuance of the action of the Agricultural Congress at Vienna in 1890; that its field is limited to the Netherlands.

Article 2, that it was organized for twenty-nine years, has its official home at Amsterdam, and its year of association begins January 1.

In article 3 the object of the society is stated to be the promotion of agriculture, horticulture, and forestry in the Netherlands by the investigation of the diseases and enemies of cultivated plants and remedies therefor.

Article 4 enumerates the following specific means of attaining this end: (*a*) By making observations upon the appearance and distribution of plant diseases and injurious animals; (*b*) by the scientific investigation of the diseases of cultivated plants occurring in the Netherlands; (*c*) by testing means to prevent and combat plant diseases and injurious animals; (*d*) by disseminating information elsewhere acquired as to the different methods of combating plant diseases and injurious animals; (*e*) by the distribution of knowledge on these subjects; (*f*) by furnishing illustrations, as far as possible, free of cost, to Dutch agriculturists who desire it, in regard to the diseases or injuries of plants.

Article 5 provides for the employment, where possible, of experts, and the establishment of experimental phytopathologic stations.

Articles 6, 7, and 8 prescribe the terms of membership and provide for donations to the society from individuals or other societies.

Article 9 relates to the publications of the society, article 10 to scientific members who are willing to undertake investigations, and article 11 to the receipt of specimens from correspondents and their reference to experts for report.

Articles 12 and 13 relate to the reimbursement of members for expenses incurred in correspondence and traveling, and articles 14 to 17 to the officers of the society, the appointments of its committees, general meetings, conduct of business, etc.

NORWAY.

For the past three years Norway has been giving more and more encouragement to economic entomology. Mr. W. M. Schöyen, curator in the Royal Norske Frederike's University at Christiania, is almost solely responsible for the development of the science in that country. He had published a number of important papers relative to injurious insects, and was favorably known as a scientific entomologist through his papers on Norwegian Lepidoptera, Hemiptera, Orthoptera, and Diptera. In 1891 he was appointed by the Government "Landbrugs-entomolog" and Parliament voted an annual pay of 1,000 kroner, equivalent to $270. Correspondence with farmers and horticulturists was worked up and an annual report was published in that year, as well as the following years. In 1893 Mr. Schöyen's compensation was raised to 1,200 kroner, and in 1894 he was appointed Government entomologist and was voted a salary of 3,000 kroner ($810) with traveling expenses. He was instructed to study insects and fungi in their relations to agriculture and horticulture, as well as to forests. In his three annual reports Mr. Schöyen has treated of the insects injurious to a number of different crops, his matter consisting mainly of short notes classified according to crops. He has also published pamphlets upon the Hessian fly and several other insects. Since his appointment as Government entomologist he has resigned his curatorship in the university and in future will devote his entire time to economic work.

SWEDEN.

After one or two unsuccessful applications during the late seventies by the Royal Academy of Agriculture of Stockholm, the King of Sweden, on February 23, 1880, appropriated 1,000 kronor as an annual salary for an entomologist in the service of the academy, whose duties should be to distribute information upon injurious insects and to try to prevent the damage done by such insects. This appropriation was made annually to the academy until 1890. The Bureau of Agriculture was then founded, and the appropriation was transferred to this bureau. The compensation was increased in 1893 to 1,500 kronor. The first appointee under the appropriation of 1880 was Dr. August Emil Holmgren, a well-known writer on insects, as well as a distinguished student of the order Hymenoptera. Dr. Holmgren's position was that of lecturer on natural history at the Institute of Forestry, and he also taught practical entomology during his vacation at the agricultural school at Alnasp. If Dr. Holmgren published definite reports as the official outcome of his work I have not been able to find any reference to them. Such reports may have been filed with the Bureau of Agriculture, as has been the case in later years, without receiving official publication. He did, however, a great deal to popularize entomology in Sweden, published abstracts and translations of German works, particularly those upon forest insects, and, in fact, translated Ratzeburg's Die Forst-Insekten into Swedish. He labored under many difficulties, the text of the appropriation implying that the officer already possessed the necessary knowledge for advising farmers, and no funds were advanced to enable him to carry on experimental work—the whole amount, in fact, being ridiculously insufficient to enable the accomplishment of any good results.

Dr. Holmgren died in 1888, at the age of 69, and in 1887 Mr. Sven Lampa, a practical agriculturist and a curator in the museum at Stockholm, was appointed to carry on the work in economic entomology in his place. Mr. Lampa is an industrious and well-informed entomologist, has conducted a large correspondence, and has also published a number of valuable pamphlets upon the principal crop pests of Sweden. For four years now active efforts have been made by the Entomological Society of Sweden, by the Royal Academy of Agriculture, by the Economic Society of Ostrogothia, and by the Bureau of Agriculture, as well as by less important agricultural associations of Sweden, looking to the establishment of an entomological experiment station, which shall be well fitted out and supported by ample means. The movement was started at the tenth anniversary of the Entomological Society, on December 14, 1889, and since that time not a meeting has been held without discussion of the project in one shape or another. The movement rapidly grew, and during 1893 the Royal Agricultural Academy addressed a lengthy petition to the King to lay the project before the Legislature (Rigsdag). On receipt of this petition the King asked for a report from the representatives of the Economic Society at their last meeting in November, 1893, as well as from the Royal Bureau of Agriculture, which in its turn asked for a report from Mr. Lampa. The Entomological Society also made a special report on the subject to the Royal Bureau of Agriculture. These reports are all very instructive, and give an excellent idea of the damage done by injurious insects in Sweden. They are collected in a pamphlet which Mr. Lampa has been kind enough to send the writer recently. The appropriations asked for by the representatives of the Economic Society are 10,000 kronor for a building and 3,000 kronor for laboratory fittings, to be immediately available. They further ask annual appropriations for salary of director, 4,000 kronor; for an assistant, 1,000 kronor, and for sundry expenses, 1,800 kronor. The Bureau of Agriculture, in its recommendations, modifies the above with a proposition to rent a building instead of erecting one, and adds a pension for the director, as for the other officers of the academy. After the submittal of these various reports to the Government they were remitted to the Academy of Agriculture for further consideration, and the movement stands in this condition at present.

RUSSIA.

In Russia there is no one official charged with the work in economic entomology, although the question of how to enact effective measures for the destruction of noxious insects has for some time attracted the attention, not only of the General Government and district authorities, but also of scientific and agricultural societies, through whose combined efforts more or less aggressive measures have been made possible. At the present time a proposition is on foot to establish an organization under the Ministry of Public Lands similar to the Division of Entomology in our own Department of Agriculture. Up to the present time the authorities having the public lands in charge, both of the Central Government and the several provinces, have accomplished the result in the following way: Competent scientific men and specialists have been requested to prepare publications on injurious insects, and where these individuals have desired pecuniary aid to enable them to publish independent observations in this line the funds have been granted. As an example of this, the large three-volume work of Theo. Köppen was published in this manner during the eighties. In addition, efficient specialists have been sent out by the central department to conduct at certain points series of observations upon the life histories and habits of injurious species. These investigations have been in part at the expense of the General Government and in part at the expense of the authorities of certain sections, and at the request of the governors of provinces and scientific and agricultural societies. The reports obtained from these different sources have been published and distributed to all those interested. In this manner a large number of the most injurious insects have been successfully studied, and many unknown facts in their life histories have been brought out. Among these investigations may be especially mentioned one conducted in 1879 on the life history and habits of *Anisoplia austriaca*, by Lindeman, Portschinsky, Tarochewsky, and Metschnikoff, and incidentally to this the damage done by *Cephus pygmæus* and *Cecidomyia destructor* was studied by Portschinsky and Lindemann, and a series of special bulletins published bearing upon these two insects. In 1880 *Chlorops tæniopus* and *Plusia gamma* were studied by the same observers, and at the same time a voluminous report was prepared treating of the insects injurious to the culture of sugar beets in the districts Woronesch, Kharkow, Kursk, and Podolia. Among the more important insects studied was *Cleonus punctiventris*, the natural history of which was incompletely known at the time. In the same year two of the joint-worms, known as *Isosoma noxiale* and *I. hordei*, were studied by Portschinsky. During the years following investigations were conducted in other provinces upon *Hydræcia nictitans* and *Chætocnema hortensis* by Philipjew, while still later tobacco insects were studied in the province of Bessarabia, particular attention being paid to *Thrips solanacearum*. At the same time observations were made by Köppen upon injurious locusts and a few other insects in the country of the Don Cossacks. In 1891 an important general work treating of the insects injurious to Russian agriculture was published. Investigations relative to insects injurious to gardens were undertaken throughout the greater part of southeastern Russia, in some of the central districts, in the Caucasus, Bessarabia, and part of Turkestan. Thorough investigations have also been conducted upon insects injurious to orchards in the Crimea, which have been published in a work comprising three parts. In the first part the Pyralids and Tineids are described; in the second part *Schizoneura lanigera* and several other plant-lice by Cholodkowsky, and in the third part Coleoptera and other insects. Further publications concerning the noxious insects of the country about Khwalinsk and those of the district of Kharkow, have been issued. In the first-mentioned locality, *Rhynchites pauxillus* and *R. auratus*, and also to some degree *Anthonomus incurvus* were particularly studied, while some observations were made also upon *Psylla mali*, and in the latter locality three species of Rhynchites and a Scolytus, in addition to *Oxythyrea stictica* and *Tropinota hirta*, were special objects of study. Among insects injurious to forests observations have been made upon various kinds of Bostrichidæ, as well as several other beetles, and Lepidoptera, by Lindeman and Schewyröw. Particular attention was paid to the destruction of *Psilura monacha* (the nun moth), *Ocneria dispar* (the gypsy moth), *Bombyx pini*, *Bupalus piniarius*, and *Zeuzera pyrina* (the leopard moth), by Schewyröw.

I have entered into these details somewhat fully on account of the inaccessibility to the American worker of these papers, which are published in the Russian language, a tongue which is little known in this country. This mention will sufficiently characterize the activity of the entomologists who have been detailed by the Department of Agriculture. The department has also, in particularly important cases, called conferences and established temporary commissions. Three Phylloxera experiment stations or commissions have been established in this way—one in the Caucasus, another in the Crimea, and a third at Odessa. The expenses of these three commissions or experiment stations are paid by the Department of Agriculture. Experts are in charge and direct investigations and experiments. The results are forwarded to the central department and published.

The correspondence of the Department of Lands and Agriculture in regard to injurious insects has increased so greatly of late years that a rather peculiar feature has been introduced. A request has been sent out by the department to a number of entomologists not officially connected with it soliciting their assistance, and a contingent of so-called "correspondents on entomological questions" has been formed. Most of the correspondents are members of the Russian Entomological Society, although living in different parts of the empire. To these correspondents agriculturists and local agricultural societies look for advice as to the best means of fighting injurious insects.

In 1878 the authorities of Odessa created the Odessa Entomological Commission, which was at first almost entirely dependent upon appropriations from the provinces of Cherson, Taur, and Bessarabia. In 1887 a regular entomologist was employed, since which date the authorities of Poltaw and Jekaterinslaw have also provided funds for the support of the commission. This commission not only answers all questions directed to it, but sends out specialists to different neighboring districts to conduct investigations on demand.

The bulk of this information concerning the status of affairs in Russia I have received through the kindness of Dr. Nicolas Cholodkowsky, professor in the Forestry Institute and in the Imperial Academy of Medicine at St. Petersburg. I have also corresponded with Dr. K. Lindeman, a well-known writer on entomology, whose work has been more accessible to American and English investigators for the reason that many of his papers have been published in the German language. He writes me that while he holds no official position, he has been circulating many thousands of copies of brochures upon entomological subjects, and has given lectures upon the subject of economic entomology in various cities. He receives annually from 400 to 500 invoices of insects, and inquiries regarding the best means of fighting them. He is at present advocating the establishment of separate commissions on economic entomology at various points throughout the empire, with a central entomological commission at the Ministry of Agriculture at St. Petersburg.

FINLAND.

Finland, although an administrative province of Russia, at the last quinquennial meeting of the Diet made an independent effort to secure the establishment of an entomological experiment station. The resolution was in the form of an application to His Imperial Majesty to bring about the establishment of such a station. Three of the four chambers composing the Diet voted affirmatively on the resolution. These were the nobility, clergy, and bourgeoisie, but curiously enough the fourth chamber, the farmers or peasants, voted against it. It is likely, however, that such a station will be established in the near future, and that Mr. Enzio Reuter will be its director, as I am informed by Mr. Lampa.

SOUTH AMERICA.

The ravages of the migratory locust in South America have attracted considerable attention, and in several states fugitive commissions have been formed for the investigation of this insect. Dr. Herman Burmeister, the famous author of the Handbuch der Entomologie, and for many years resident in Buenos Ayres in the capacity of director of the National Museum, while not official entomologist to the Argentine Republic, devoting most of his time to the study of palæontology and the building up of a general museum, made large collections of insects, and in 1861, in his Reise durch die Plata Staaten, a two-volume work published in Halle, utilized his official observations to summarize previous writings upon locusts in Argentina and to give a comparatively full account of the life history of the insect and the damage which it almost annually produced. In the same way Dr. H. Weyenbergh and Dr. E. Oldendorff, also German employés of the Argentine Government, investigated and reported upon injurious locusts during the years 1874 and 1876. A later commission was established, as I am informed by Señor Enrique M. Nelson, but its publications are not accessible to me at present. Similar work of a semiofficial character has been done by Dr. Frederico Philippi, of the Botanical Gardens at Santiago, Chile, and by Dr. A. Ernst, director of the National Museum at Caracas, Venezuela, and to a lesser degree by other observers in other South American countries.

Brazil.—In November, 1870, Mr. B. Pickman Mann, a well-known entomologist, of Cambridge, Mass., went to Brazil, bearing a letter of personal introduction to the Emperor Dom Pedro II from Prof. Louis Agassiz. He arrived about the end of December and presented his letter, when the Emperor recommended him in a personal letter to the Minister of Agriculture, who, in January, 1871, gave Mr. Mann a commission to investigate the zoology, botany, and entomology of Brazil, with a salary and a free railway pass. Mr. Mann selected his own field of work, and investigated coffee and maize insects for five months, presenting a report upon each. He returned to the United States in June, 1871. So far as I know, these reports were, unfortunately, never published by the Brazilian Department of Agriculture, although Mr. Mann, after his return, published in the American Naturalist an interesting account of some of his observations upon coffee insects.

About 1885 Dr. Emil A. Goeldi, a former Phylloxera expert in Switzerland, and at that time curator of zoology in the National Museum at Rio de Janeiro, was commissioned to study coffee-tree diseases about Rio. He prepared a detailed report, which was published in the last volume of the archives of the Museum. Before the completion of this report he was sent to São Paulo to study the viticultural interests of that State, and especially to report upon the danger from the Phylloxera. Concerning this investigation he published a book entitled Vedeiras Americanos (American Vines). This work, I believe, was published privately, and in it the author showed the advantages of the culture of North American vines, especially those of the *Vitis æstivalis* group. In 1890 Dr. Goeldi left Rio, and is at present director of the Colonia Alpena of Theresopolis and also director of the Museum of Natural History at Para.

Chile.—The Chilean Government began an official investigation of injurious insects in December, 1891, and by a vote of Congress the amount of $200,000 was appropriated to be expended in exterminating the Argentine locust, which invaded Chile December 7 to 11, 1891. Less than $10,000, however, was expended, and there is now no regular appropriation beyond the salary of the entomologist, Mr. Edwyn C. Reed, an American, and formerly connected with the U. S. Naval Academy at Annapolis, Md. The reason for the expenditure of so small a sum was, primarily, the fact that the Chilean territory invaded by the locust proved to be a temporary region, and the insects died off, except in a few sheltered nooks, where they were destroyed by the local inhabitants acting under Mr. Reed's advice, chiefly by drawing thorny bushes, loaded with sufficient weight, over the young locusts before they were more than half an inch long. No separate reports upon the subject were published, Mr. Reed's reports being published in the Diario Oficial. Since the locust emergency Mr. Reed has been confining himself mainly to systematic entomology, and has published several interesting papers upon Diptera and Hymenoptera.

INDIA.

Among the English colonies the government of India stands out very prominently in the support which it has given to economic entomology. A most interesting account of the beginning and growth of this work has been transmitted to me by Mr. E. C. Cotes, from which I take, for the purposes of this paper, the following facts:

The present arrangement was the outgrowth of two reports, one on the wheat and rice weevil and the other on insecticides, which were drawn up unofficially in the early part of the year 1888 by Mr. Cotes, at the suggestion of the secretary to the government of India, in the Revenue and Agricultural Department. Mr. Cotes was at that time in charge of the entomological collections of the Indian Museum, and the reports were published by the government, with the consent of the trustees of the Museum, as the first two numbers of an official series entitled Notes on Economic Entomology. The title of this serial was subsequently changed to Indian Museum Notes, when the trustees of the Museum consented to charge themselves officially with the conduct of the investigation. The work really commenced in March, 1888, when Mr. Cotes was deputed to attend an agricultural conference at Delhi, where the part to be taken in the scheme by the various provincial governments was discussed. As a result of this conference the departments of land records and agriculture, attached to the various provincial governments, undertook to arrange for the submittal of reports and specimens from officials concerned with agriculture in all parts of India. The task of collating the results, and also of carrying on such investigations as could be conducted at headquarters, was intrusted to Mr. Cotes, aided by a staff of six office assistants, whom he was permitted to select. Circular letters were sent out to all parts of the country, and large numbers of reports and specimens soon began to come in. The results were published from time to time and freely circulated among all interested. One of the greatest of the early difficulties was the identification of species, but this was accomplished mainly through correspondence with specialists in different parts of the world. The results of six years of work are, in brief: The ascertaining of the identity of several hundred of the more important injurious species which affect crops in India, the recording of the nature of the damage occasioned by them, and the tracing out of the main facts in the life histories in a large number of cases. Information has been continuously supplied to officials and planters as to the nature of their insect pests and the more promising methods of treatment. Many experiments have been tried with a view to the adaptation of insecticides in use in other parts of the world to the requirements of special crops under cultivation in India. Fourteen numbers of the Indian Museum Notes, comprised in three volumes, have been published, and a number of special reports have also been sent out; one on the locust of northwest India and one entitled Handbook of the Silk Insects of India. Two preliminary lesson sheets for use in native schools have also been prepared by the office. A thorough investigation of the insects affecting the tea plant is now in progress. The funds appropriated for the support of entomological investigation have varied from year to year; the only special grant for the purpose is one of 5,000 rupees per annum from the government of India. This is paid to the account of the Indian Museum, and forms a part of a general fund which is distributed at the discretion of the trustees, partly for the maintenance of the institution and partly for the support of the work carried on in various departments, one of which includes economic entomology. The work was at first looked upon in many quarters as a matter of comparative insignificance, but Mr. Cotes informs me that its importance is now very generally recognized and that strong representations are being made in influential quarters, urging the desirability of extending the scope of the work, and making it, like other branches of research, an integral portion of the Agricultural Department of the government. The work which has so far been done by Mr. Cotes and his assistants has been admirable, and we know of no more interesting publication upon entomology than the Indian Museum Notes.

SOUTH AFRICA.

The Agricultural Journal, the official organ of the Department of Agriculture of the Cape Colony, has been paying a great deal of attention to economic entomology during the last four or five years. The so-called Australian bug (*Icerya purchasi*), the grape-vine Phylloxera, and the injurious locusts seemed to have roused the colonists to the necessity for more or less investigation, and the Agricultural Department has taken hold of the matter with some little energy. No distinctively official entomologist, however, was ever appointed. Privately Mr. S. D. Bairstow and one or two other colonists have made certain investigations, and their correspondence with Miss Ormerod, honorary consulting entomologist to the Royal Agricultural Society of Great Britain, resulted in the publication of Miss Ormerod's little book entitled Notes and Descriptions of a Few Injurious Farm and Fruit Insects of South Africa, with Descriptions and Identifications of the Insects by Oliver E. Jansen. Prior to the publication of this work

Miss Ormerod published a leaflet entitled Observations on the Australian Bug, treating the insect from the South African standpoint. For several years, from 1889 to 1893, Mr. Louis Peringuey, an officer of the South African Museum at Cape Town, was employed as entomological adviser to the Department of Agriculture, and drew £100 per annum for his services. His duties in the Museum, however, did not permit him to devote anything like his entire time to entomological work, and in his advisory functions he chiefly answered questions as to the names of insects and the best remedies for insect pests. Acting upon his advice, the government attempted to stamp out the Phylloxera by means of the bisulphide of carbon treatment, but without success, and he resigned his office in 1893. Since that time, and in fact for some time previously, the director of the Botanic Garden at Cape Town, Prof. P. MacOwan, a man of very wide information, although not a trained entomologist, has answered entomological questions for the government. His communications, most of them subsequently published in the Agricultural Journal, show him to be a clear-headed, practical man, and it is a pity for the interests of the colony that he is too much interested in his garden and botanical work to take up economic entomology as a study. Mr. MacOwan modestly writes, under date of April 11, 1894:

> Unfortunately, I have been in the habit of reading everything that comes in the way and indexing it, so that really they consult my indexes. It is only thus, in the rough, practical way that a garden director, in a dozen years, gets some acquaintance with injurious and beneficial insects, that I have answered questions of economic entomology. I only know what I have seen and fought against in the Botanic Garden, and anybody is welcome to such experience. * * * I only wish we could get some such man as seems to be raised easily in the States to do practical science work in the love of it.

AUSTRALIA.

The Australian colonies of Victoria, New South Wales, Queensland, South Australia, and Tasmania have all interested themselves to a very considerable extent in the subject of economic entomology. With an energy and receptivity to new ideas akin to our own, their agricultural societies and departments of agriculture have not been content to allow injurious insects full sway, but all have, in one form or another, made efforts to remedy the damage.

TASMANIA.—The earliest attempts were made in Tasmania nearly twenty years ago, when the codling-moth act was introduced in the legislative assembly. The provisions of this act were quite as wisely drawn as those of any subsequent injurious-insect legislation. It was not until 1891, however, that a definite council of agriculture was established by this colony, and not until 1892 that an official entomologist was appointed. In February, 1892, Rev. Edward H. Thompson, a clergyman of the Church of England and a naturalist of very considerable attainments, who had made himself prominent in this connection by his writings for the local press, was appointed entomologist and pathologist to the Council of Agriculture. Authority for the appointment was given in section 13, clause 1, of the Council of Agriculture act, and reads as follows:

3. To employ from time to time, with the approval of the governor in council, persons competent to give instructions of a practical character in matters pertaining to agricultural and horticultural science, and to arrange for occasional lectures on subjects of interest to cultivators of the soil.

Mr. Thompson's annual compensation was fixed at £300, which in 1894 was reduced to £270, in pursuance of a policy of general retrenchment. The entomologist has charge of no funds for expenses, and up to the present time has been allowed no assistants. Very considerable interest has been aroused, however, in the subject of economic entomology. Mr. Thompson has lectured upon insect pests throughout the colony, and during 1893 received nearly 1,500 letters of inquiry. A little volume of 100 pages, entitled Handbook to the Insect Pests of the Farm and Orchard; Their Life-History and Methods of Prevention, Part I, has been published, and will be followed by others in the same line, provided the appropriations continue.

NEW SOUTH WALES.—In New South Wales there was started in 1890 an important publication under the Bureau of Mines and Agriculture, entitled The Agricultural Gazette of New South Wales. To this periodical Mr. A. Sidney Olliff, entomologist to the Australian Museum at Sydney, has contributed many important articles on entomological subjects, which have resulted from his appointment to the charge of the entomological branch of the Department of Mines and Agriculture. Whether Mr. Olliff receives a separate compensation for his work in this direction from the Department, aside from his salary as an officer of the Museum, I have been unable to learn. The prominence given to entomological matters in the Gazette, however, is an indication of the live interest taken in the subject. In a series of "entomological bulletins," begun in 1892, Mr. Olliff's name appears on the title page as "Government entomologist, New South Wales". Another able entomologist is employed in the Technological Museum at Sydney in the person of Mr. W. W. Froggatt, who has, under the "Technical Education Series" of leaflets, published at least one important paper bearing upon economic entomology, which has reference to the damage done to boots and shoes by *Anobium* (*Sitodrepa*) *paniceum*.

QUEENSLAND.—In Queensland there is at the present time no official entomologist, although one of the best bits of printed matter relating to economic entomology which has been issued by any of the Australian colonies emanated from the Queensland Department of Agriculture. In 1889 there was published a report on insects and fungus diseases by Henry Tryon, who held, and probably still holds, the position of assistant curator of the Queensland Museum at Brisbane. This is a thoroughly practical and very able report, covering some 250 pages, and contains a great amount of important information. The report is designated as No. 1 upon this subject, but No. 2 has, unfortunately, not yet been published. The occasional bulletins issued by the Queensland Department of Agriculture, giving an account of the agricultural conferences held in different districts of the colony, show a very live interest in the warfare against insects, and this has been particularly the case since Prof. E. M. Shelton, an Englishman by birth, but since his early boyhood a resident of America, and long engaged in agricultural teaching and experimental work here, was employed by the Queensland government as instructor in agriculture in 1890. The Department has begun the publication of a series of bulletins giving the results of recent experiments made at the American agricultural experiment stations, edited by Prof. Shelton, in which late entomological information is given.

South Australia.—The first work on injurious insects in South Australia was done by Mr. Frazer S. Crawford, a practical man of wide reading, who interested himself for some years before his lamented death in the study of insects and fungus pests. He read an important paper, under the title of "Insect and fungus pests," before the first congress of agricultural bureaus of South Australia in March, 1890, illustrating the paper by careful drawings done and engraved by himself. It is likely that, had Mr. Crawford lived, he would have been appointed official entomologist to the colony of South Australia. Since his death, however, a vivid interest in the subject has been kept up, largely through the interest shown in the matter by Garden and Field, an important agricultural newspaper published at Adelaide, the editor of which, Mr. W. C. Grasby, has visited this country, and is very appreciative of the work which has been done in the United States. The government viticultural expert, Prof. A. J. Perkins, is also a man of some entomological knowledge, although his researches have mainly been connected with the subject of insects injurious to the vine.

Victoria.—In August, 1890, a conference was held at Melbourne, Victoria, with representatives from the board of viticulture, the council of agricultural education, the different horticultural societies, and wine and fruit growers' associations, for the purpose of considering means for the suppression of insect pests injurious to vegetation; and partly as a result of this conference and further agitation, Mr. Charles French was, in 1891, appointed entomologist to the government of Victoria, under the Department of Agriculture of the Colony. Mr. French's work is largely included in the two parts of an important handbook of the Destructive Insects of Victoria, the first part published in 1891 and the second in 1893. These reports are written in a popular style, and much attention is given to means of destruction. Their distinguishing feature, however, consists in their illustrations, which are colored, and many of which are very lifelike.

THE BRITISH WEST INDIES.

Injurious insects in the British West Indies have only recently received official or semiofficial attention, with the single exception that in the year 1801 a special commission composed of members of the general assembly of the Bahamas was appointed to investigate the damage done to the cotton crop by the red bug (*Dysdercus*, probably *suturellus*) and the chenille (*Aletia xylina*). Within the past two or three years, however, several of the islands have taken up the subject, with or without governmental support, and there is now a rapidly increasing spirit of investigation.

JAMAICA.—In the appointment of Mr. T. D. A. Cockerell, a well-known entomologist, to the office of curator of the Institute of Jamaica, at Kingston, it was specially desired that the appointee should conduct investigations in economic entomology and answer all correspondence in this direction which might come in from planters. Upon taking charge of his new office, in June, 1891, Mr. Cockerell was immediately struck by the extraordinary abundance of scale insects in Jamaica, and their importance as enemies to many cultivated plants. With his accustomed energy he at once undertook the study of these insects, and has since published many papers about them, which have been contributions to knowledge. He started an interesting series of stylographic notes, mainly about injurious insects, disseminated much information on this subject among the planters, and fostered an interest in the study which it is to be hoped will not die out. He was succeeded in office in June, 1893, by Mr. C. H. Tyler Townsend, formerly an assistant in the Division of Entomology, U. S. Department of Agriculture, and entomologist to the State Agricultural Experiment Station of New Mexico, who, during the short time of his residence in Jamaica, followed in the lines laid down by Mr. Cockerell, and published a number of very interesting notes, both in the journal of the Institute and in the stylographic series of notes, which he continued. Mr. Townsend resigned in May of the present year, and we have not heard that his successor has been appointed.

LEEWARD ISLANDS.—Although no officially designated entomologist is employed by the Leeward Islands, Mr. C. A. Barber, superintendent of agriculture for these islands, is a well-informed man, a trained botanist, and fully alive to the importance of entomological work. He has conducted some important investigations on the sugar-cane shot-borer and other sugar-cane insects, which have been published in the Leeward Islands Gazette.

TRINIDAD.—No official recognition of economic entomology has yet been reached in this island, but a very active organization, known as the Trinidad Field Naturalists' Club, has been established, which is well worth mention in this connection, since its president, Mr. H. Caracciolo, and its secretary, Mr. F. W. Urich, have interested themselves especially in the subject of economic entomology and are laboring to interest the government. His excellency the governor occasionally attends the meetings of the club, and by the institution of prizes for essays and by similar means a widespread interest in economic entomology is being aroused. The appointment of an official entomologist is probably a matter of only a short time. The Journal of the Field Naturalists' Club is an interesting periodical, full of entomological information, and is now in its second volume.

NEW ZEALAND.

New Zealanders have for some time been fully alive to the importance of the study of economic entomology. They have passed laws concerning the destruction of the codling moth and have made an effort to establish quarantine regulations against the introduction of infested substances from abroad. No governmental entomologist has been appointed, although the Department of Forestry and Agriculture published, in 1887, a monograph of the Coccidæ, by Mr. W. M. Maskell, registrar of the University of New Zealand, the title page of which reads: "An Account of the Insects Noxious to Agriculture and Plants in New Zealand." A second part of this account was promised in an introductory note, but has not appeared. Mr. Maskell has also written upon injurious insects in some of the New Zealand newspapers. Much credit is due to a corresponding member of this society, Mr. R. Allan Wight, of Auckland, for the public-spirited interest which he has taken in economic entomology. Nearly every number of the New Zealand Farmer for several years has contained lengthy articles from his pen, and he has traveled a great deal for the purpose of lecturing before fruit growers' associations and other farmers' organizations. The editor of the New Zealand Farmer has also helped the good work along, and has published editorially a number of articles upon the subject. New Zealanders are agitating the question of the appointment of an official entomologist, but at this date seem to have little hope of immediate success.

AWAIIAN REPUBLIC.

The newly-organized Hawaiian Republic created almost immediately a Department of Agriculture and Forestry, and one of the first acts of this Department was to secure the appointment of Mr. Albert Koebele for three years as entomological expert, at a salary of $3,000 per annum. Led by the results of Mr. Koebele's two expeditions in search of the natural enemies of injurious scale insects in California to a belief that this method of fighting injurious species is of very great importance, the Commissioner of Agriculture and Forestry has assigned to Mr. Koebele the duty of first carefully investigating the entomological situation in Hawaii and then traveling in Australia, New Zealand, and other countries for the purpose of collecting and transmitting to Hawaii insects which will prey upon native and introduced insect pests. Mr. Koebele was appointed in the summer of 1893, and is at present in Australia engaged in this work.

IN CONCLUSION.

In concluding a review of this character, an American writer may perhaps be pardoned for an exhibition of national pride. Writing in 1870, Dr. A. S. Packard, in his First Annual Report upon the Injurious and Beneficial Insects of Massachusetts, compared the attention paid to economic entomology in this country with that which it received or had received up to that time in Europe, very much to our own discredit. In the twenty-four years which have intervened the change has been vast. All of the great advances in our science have come from America, and it may justly be said that, aside from the one department of forestry insects. the whole world looks to America for instruction in economic entomology.

These great advances, we must remember, would not have been possible without legislative encouragement. Activity on the part of workers and appreciation on the part of the people and their representatives have gone hand in hand. At the present time the amount of money expended for work in economic entomology is far greater in this country than in any other. Our regular annual expenditure in the support of entomological offices amounts to about $100,000, very nearly all of which is appropriated by the General Government, $29,000 going to the Division of Entomology of the Department of Agriculture and about $60,000 to experiment-station entomologists. To this amount must be added the large sums expended annually in publishing our reports and bulletins. The sum total thus reached will probably exceed the amount expended in this direction by the entire remainder of the world. Much more is therefore to be expected from American workers than from workers in other countries. The American members of this association must bear this fact in mind, and must realize that with the present rapid increase in interest among other nations nothing but the most energetic and painstaking work will result in the retention by the United States of her present prominent position. In some respects our results have not been commensurate with our opportunities, but we have certainly justified in vast degree the money expenditure which has enabled us to prosecute our work. Not a year passes in which the sum saved to agriculture and horticulture, as the direct result of our work, does not amount to many times that which the Government appropriates, as has been often shown, and notably by our former president, Mr. James Fletcher, in his most able and interesting address at our Washington meeting in 1891.

In the good which has been accomplished in the way of remedial work against insects. the work of the official economic entomologists greatly exceeds that of all other classes of individuals. They have been investigators and teachers, students and propagandists; they have carried their researches into the fields of botany, bacteriology, chemistry, mechanics, and general zoology. Nearly all of the practical remedies in use to-day have been of their suggestion, and all great advances in recent years have come from their labors. Occasionally a practical agriculturist or horticulturist, unskilled in entomology, has discovered an important remedy, as was the case when Mr. J. S. Woodward sprayed his apple orchard with Paris green for canker-worms and found it to be a remedy for the codling moth; but Mr. Woodward would never have sprayed his trees at all but for the suggestion of Dr. LeBaron several years previously. And then, too, Prof. Cook, making the same discovery independently, was the one who, by his careful experiments, established public confidence in the remedy, and it is to him, more than to any one man, that the country today owes the great annual saving from the widespread adoption of this eminently practical remedy.

We have, then, done good work. We have accomplished results which have added greatly to the productive wealth of the world. We have justified our existence as a class. We are now better equipped for the prosecution of our work than ever before, and it may confidently be expected that the results of the closing years of the century will firmly fix the importance of economic entomology in the minds of all thinking men of all countries.

APPENDIX.

BIBLIOGRAPHICAL LIST OF ENTOMOLOGICAL PUBLICATIONS OF THE STATE AGRICULTURAL EXPERIMENT STATIONS ORGANIZED UNDER THE HATCH ACT.

Alabama College Station, Auburn, Ala.

G. F. Atkinson, entomologist. Appointed 1889; resigned 1892.

Bulletin No. 9, December, 1889: Nematode Root Gall. Bulletin No. 15, April, 1890: Kerosene Emulsion; How to Make and Apply It. Bulletin No. 17, July, 1890: Dry Application of Paris Green and London Purple for the Cotton Worm.

J. M. Stedman, biologist. Appointed 1893.

Bulletin No. 45, June, 1893: Injurious and Beneficial Insects.

Alabama Canebrake Station, Uniontown, Ala.

No entomological work.

Arizona Station, Tucson, Ariz.

J. W. Toumey, botanist and entomologist. Appointed 1891.

Bulletin No. 9, November, 1893: Notes on Insects and Insecticides.

Arkansas Station, Fayetteville, Ark.

S. H. Crossman, entomologist. Appointed 1888; died 1888.

Bulletin No. 3, April, 1888: The Peach-tree Borer and the Codling Moth.

C. W. Woodworth, entomologist. Appointed 1888, resigned 1891.

Annual Report, 1888, pp. 121-127: The Grape-leaf Roller. Bulletin No. 10, June, 1889, Part I: Kerosene as an Insecticide, and the Tarnished Plant Bug. Annual Report, 1889, pp. 141-190: Insects and Insecticides. Bulletin No. 14, September, 1890: The Effects of the Arsenites upon Plants. Annual Report, 1890, pp. 70-97: Report of the Entomologist.

Arkansas Station, Fayetteville, Ark.—Continued.

G. C. Davis, special entomologist (fall of 1890).

Bulletin No. 15, December, 1890: Some New Insecticides and Their Effects on Cotton Worms.

California Station, Berkeley, Cal.

F. W. Morse, assistant agriculturist. Appointed 1888.

Bulletin No. 79, May, 1888: Experiments on Cause and Avoidance of Injury to Foliage in the Hydrocyanic Gas Treatment of Trees. Annual Report, 1890.

E. J. Wickson, superintendent of grounds.

School Instruction in Entomology, pp. 303–307.

C. W. Woodworth, assistant entomologist.

Spray and Band Treatment for the Codling Moth, pp. 308–312. Variation in Hessian-fly Injury, pp. 312–318.

F. W. Morse, assistant agriculturist.

The Use of Gases against Scale Insects, pp. 320–326.

C. W. Woodworth, entomologist. Appointed 1892. (?)

Annual Report, 1892, pp. 211–314: Synopsis of the Families of Insects.

Colorado Station, Fort Collins, Colo.

C. M. Brose, assistant horticulturist in charge of apiary. Appointed 1888.

Annual Report, 1888: Report on the Apiary, pp. 227–235.

J. Cassiday, botanist and horticulturist. Appointed 1888; died 1889.

Bulletin No. 6, January, 1889: Notes on Insects and Insecticides.

C. M. Brose, assistant horticulturist, in charge of apiary.

Annual Report, 1889, pp. 80–87: Report on Apiary. Annual Report, 1890, pp. 55–56: Report on Apiary.

C. P. Gillette, entomologist. Appointed 1891.

Bulletin No. 15, April, 1891: The Codling Moth and the Grapevine Leaf-hopper. Annual Report, 1891, pp. 98–101: Report on Various Insects. Bulletin No. 19, May, 1892: Observations upon Injurious Insects in 1891. Bulletin No. 24, July, 1893: A Few Common Insect Pests. Annual Report, 1893, pp. 51–55: Report of Entomologist.

Connecticut State Station, New Haven, Conn.

No entomological work.

Connecticut Storrs Station, Storrs, Conn.

No entomological work.

Delaware Station, Newark, Del.

M. H. Beckwith, horticulturist and entomologist. Appointed 1888.

Bulletin No. 4, May, 1888: Injurious Insects; Their Identification and Extermination. Annual Report, 1889, pp. 103–106: Experiments with Insecticides. Bulletin No. 7, March, 1890, pp. 15–16: London Purple for the Codling Moth. Annual Report, 1890, pp. 110–129: Injurious Insects and Remedies. Bulletin No. 12, March, 1891: Reprint from Annual Report, 1890. Bulletin No. 14, December, 1891, pp. 13–15: Notes on a Corn Crambid. Annual Report, 1891, pp. 89–103: Report of Entomologist. Bulletin No. 18, September, 1882: The Strawberry Weevil. Annual Report, 1892, pp. 102–109: Report of Entomologist. Bulletin No. 21, September, 1893: Insects Injurious to Stored Grain.

Florida Station, Lake City, Fla.

William H. Ashmead, entomologist. Appointed 1888; resigned 1888.

Bulletin No. 2, May and June, 1888, pp. 14–27: Notes on Various Injurious Insects.

J. C. Neal, botanist and entomologist. Appointed 1888; resigned 1891.

Bulletin No. 4, January, 1889, pp. 13–16: Insect Enemies of the Peach Bulletin No. 9, April, 1890: Entomological Notes.

Florida Station, Lake City, Fla.—Continued.

P. H. Rolfs, biologist. Appointed 1891.

Bulletin No. 17, January, 1892, pp. 12–14: The Horn Fly. Bulletin No. 21, October, 1893, pp. 19–23: The Boll Worm.

Georgia Station, Experiment, Ga.

J. P. Campbell, entomologist. Appointed 1888; resigned 1890.

Bulletin No. 21, January, 1889, pp. 32–35: The Imported Cabbage Butterfly. Bulletin No. 3, April, 1889, pp. 45–49: A Few Noxious Insects. Bulletin No. 6, January, 1890, pp. 82–89: Cotton Caterpillar, Potato Sphinx and Twig-girdler. Bulletin No. 7, April, 1890, pp. 115: Destructive Leaf-hopper.

Idaho Station, Moscow, Idaho.

J. M. Aldrich, entomologist. Appointed 1893.

Annual Report, 1893, pp. 17–184: Report of Entomologist. Bulletin No. 7, April, 1894: Insecticides and Spraying.

Illinois Station, Champaign, Ill.

S. A. Forbes, consulting entomologist. Appointed 1888.

Bulletin No. 12, November, 1890, pp. 377–380: The Hessian Fly. Bulletin No. 15, February, 1891, pp. 469–478: The Fruit Bark-beetle. Bulletin No. 19, February, 1892, pp. 44–48: The Chinch Bug in Illinois, 1891–'92. Bulletin No. 33, June, 1894, pp. 397–399: The Chinch Bug in Southern Illinois, 1894.

Indiana Station, La Fayette, Ind.

F. M. Webster, consulting entomologist. Appointed 1888; resigned 1891.

Bulletin No. 25, June, 1889: Entomological Experiments. Bulletin No. 33, October, 1890, pp. 36–45: Entomological Notes.

Iowa Station, Ames, Iowa.

C. P. Gillette, entomologist. Appointed 1888; resigned 1891.

Bulletin No. 2, September, 1888, pp. 25–29: A Few Chinch-bug Experiments. Bulletin No. 3, November, 1888, pp. 57–62: Chinch-bug Diseases. Bulletin No. 4, February, 1889, pp. 137–140: Some Suggestions Concerning the Corn Root-worm. Bulletin No. 5, May, 1889, pp. 161–196: Important Injurious Insects and Preparations of Insecticides. Bulletin No. 7, November, 1889, pp. 270–289: Codling-moth Experiments. The Hog Louse. Bulletin No. 9, May, 1890, pp. 370–388: The Plum Curculio and the Plum Gouger. Bulletin No. 10, August, 1890, pp. 401–420: Experiments with Arsenites. Bulletin No. 11, November, 1890, pp. 490–498: Some Injurious Insects. Bulletin No. 12, February, 1891, pp. 535–549: Notes and Experiments upon Injurious Insects and Insecticides.

H. Osborn, entomologist. Appointed 1891.

Bulletin No. 14, August, 1891, pp. 166–180: Reports of Entomological Work. Bulletin No. 15, November, 1891, pp. 255–273: Reports on Injurious Insects. Bulletin No. 16, February, 1892, pp. 330–353: Lice Affecting Domestic Animals. Bulletin No. 17, May, 1892, pp. 444–452: Effects of Spraying on Plants and Fruits and Notes on Insects. Bulletin No. 18, August, 1892, pp. 506–516: Reports on Injurious Insects. Bulletin No. 19, November, 1892, pp. 566–594: Report of Experiments and Studies in Entomology.

H. Osborn, and L. H. Pammel, botanist.

Bulletin No. 20, February, 1893, pp. 706–715: Methods and Machinery for Spraying. Grass Leaf-hoppers.

H. Osborn, and F. A. Sirrine, assistant entomologist.

Bulletin No. 23, 1893, pp. 881–905: Notes on Injurious Insects.

Kansas Station, Manhattan, Kans.

E. A. Popenoe, horticulturist and entomologist. Appointed 1888.

Bulletin No. 3, June, 1888: Observations on Two Insect Pests. Annual Report, 1888, pp. 165–225: Report of Entomological Department. Annual Report, 1889, pp. 206–212: Some Insects Injurious to the Bean.

Kentucky Station, Lexington, Ky.

H. Garman, entomologist. Appointed 1889.

Bulletin No. 21, September, 1889, pp. 16–22: The Grain Louse. Annual Report, 1889, pp. 8–31, 121–127: Observations on Injurious Insects. Reprint of Bulletin No. 21. Annual Report, 1890, pp. 9–43: Observations on Farm Pests. Bulletin No. 30, August, 1890, pp. 146–150: On New Wheat Fly. Bulletin No. 31, December, 1890, pp. 150–172: Some Strawberry Pests. Circular No. 3, 1890, pp. 173–185: Means of Lessening Injuries from Insects and Fungi. Bulletin No. 40, March, 1892, pp. 43–88: Some Common Pests of the Farm and Garden. Annual Report, 1893, pp. 23–30: The Orthoptera of Kentucky. Bulletin No. 44, January, 1893, pp. 32–59: Apple Pests. Bulletin No. 47, December, 1893, pp. 88–129: The Pests of Shade and Ornamental Trees. Bulletin No. 49, March, 1894: Destructive Locusts in Kentucky. The Bud Worm of Tobacco.

Louisiana Stations, Audubon Park, Baton Rouge, La.

H. A. Morgan, entomologist. Appointed 1889.

Bulletin No. 2 (second series), 1890: Texas Screw Worm. Bulletin No. 9 (second series), 1891: Sugar-cane Borer and Its Parasite. Special Bulletin, 1893, pp. 50–110: Scale Insects of the Orange. Bulletin No. 28 (second series), 1893, pp. 982–1005: Annual Report of Entomologist.

Maine Station, Orono, Me.

F. L. Harvey, botanist and entomologist. Appointed 1888.

Annual Report, 1888, pp. 151–195: Injurious Insects. Bulletin No 2 (second series), 1889: The Apple Maggot. Annual Report, 1889, pp. 188–254: Injurious Insects and Insecticides. Annual Report, 1890, pp. 105–139: Report of Entomologist. Annual Report, 1891, pp. 187–206: Entomology. Annual Report, 1892, pp. 117–146: Entomology.

Maryland Station, College Park, Md.

E. W. Doran, consulting entomologist. Appointed 1891; resigned 1892.

Bulletin No. 16, March, 1892: Insects Injurious to the Grain of Wheat.

C. V. Riley, entomologist and physiologist. Appointed 1893.

Bulletin No. 23, December, 1893: Some Injurious Insects of Maryland.

Massachusetts State Station, Amherst, Mass.

No entomological work.

Massachusetts Hatch Station, Amherst, Mass.

C. H. Fernald, entomologist. Appointed 1888.

Bulletin No. 1, July, 1888, pp. 3–7: Report of Entomology. Bulletin No. 2, October, 1888, pp. 3–8: Report of Entomology. Annual Report, 1888, pp. 9–12 and 21–28: Reprints of Bulletins Nos. 1 and 2. Bulletin No. 5, July, 1889: Household Pests. Special Bulletin, November, 1889: A Dangerous Insect Pest in Medford. The Gypsy Moth. Bulletin No. 7, January, 1890, pp. 18–23: The Gypsy Moth (reprint of special bulletin). Bulletin No. 12, April, 1891: Report on Insects. Annual Report, 1891, pp. 5–6: Gypsy Moth and Bud Moth. Bulletin No. 19, May, 1892: Report on Insects. Bulletin No. 20, January, 1893: Report on Insects. Bulletin No. 24, April, 1894: Insecticides. The Horn Fly.

Michigan Station, Agricultural College, Mich.

A. J. Cook, entomologist. Appointed 1888; resigned 1892.

Bulletin No. 39, September, 1888: Experiments with Insecticides. Annual Report, 1888, pp. 165–170: Report of Entomological Department. Bulletin No. 50, June, 1889: The Grain Plant-louse. Bulletin No. 51, July, 1889: Enemies of the Wheat Aphis. Bulletin No. 53, August, 1889: Spraying with Arsenites. Annual Report, 1889, pp. 88–103: Report of Entomological Department. Bulletin No. 58, March, 1890: Insecticides. Bulletin No. 61, *Michigan Station, Agricultural College, Mich.*—Continued.

April, 1890: Foul Brood. Bulletin No. 65, August, 1890: Planting for Honey. Bulletin No. 66, September, 1890: The Plum Curculio. Annual Report, 1890, pp. 102–129: Report of Zoologist. Bulletin No. 73, April, 1891: Kerosene Emulsion. Some New Insects. Bulletin No. 76, October, 1891: Kerosene Emulsion. Annual Report, 1890, pp. 123–152: Report of Zoologist. Bulletin No. 96, July, 1893: Honey Analysis.

G. C. Davis, consulting entomologist. Appointed 1892.

Annual Report, 1892, pp. 215–217: Report of Consulting Entomologist. Bulletin No. 98, July, 1893: Locusts. The Horn Fly. Bulletin No. 102, December, 1893: Insects Injurious to Celery.

Minnesota Station, St. Anthony Park, Minn.

O. Lugger, entomologist. Appointed 1888.

Bulletin No. 3, July, 1888, pp. 25–34: Notes on the Rocky Mountain Locust in Otter Tail County in 1888. Bulletin No. 4, October, 1888, pp. 26–41: Fungi which Kill Insects. Annual Report, 1888, pp. 300–368: Report of Entomologist. Bulletin No. 8, July, 1889, pp. 17–36: The Rocky Mountain Locust in Otter Tail County in 1889. Bulletin No. 9, November, 1889, pp. 48–64: Insects Affecting Willows and Poplars. Annual Report, 1889, pp. 16–18: Report of Entomologist. Bulletin No. 10, March, 1890, pp. 75–84: Oak Caterpillars. Annual Report, 1890, pp. 16–18: Report of Entomologist. Bulletin No. 17, August, 1891: Migratory Locusts in Minnesota in 1891. Bulletin No. 23, September, 1892, pp. 167–170: The Frit Fly. Biennial Report, 1891–'92, pp. 20–23: Report of Entomologist. Bulletin No. 28, March, 1893: The Classification of Insects and their Relation to Agriculture.

Mississippi Station, Agricultural College, Miss.

S. M. Tracy, director. Appointed 1888.

Bulletin No. 2, May, 1888: The Cotton Worm. Bulletin No. 12, June, 1890: The Cotton Leaf-worm.

H. E. Weed, entomologist. Appointed 1890.

Bulletin No. 14, March, 1891: Injurious Insects. Bulletin No. 17, December, 1891: Insects Injurious to Stored Grain. Annual Report, 1891, pp. 32–36: Report of Entomologist. Bulletin No. 21, November, 1893: Insecticides and Their Application. Annual Report, 1893, pp. 46–47: Report of Entomologist. Bulletin No. 28, January, 1894: The Horn Fly.

Missouri Station, Columbia, Mo.

J. W. Clark, horticulturist and entomologist. Appointed 1888; resigned 1891.

Bulletin No. 6, 1889, p. 6: Pea Weevil. Bulletin No. 13, January, 1891, p. 6: Spraying Apples for the Codling Moth.

Montana Station, Bozeman, Mont.

No entomological work.

Nebraska Station, Lincoln, Nebr.

L. Bruner, entomologist. Appointed 1888.

Bulletin No. 5, January, 1889: Certain Injurious Insects of the Year 1888. Annual Report, 1889, pp. 10–12: Report of Entomologist. Bulletin No. 14, June, 1890: Insects Injurious to Young Trees on Tree Claims. Annual Report, 1890, pp. 12–14: Report of Entomologist. Bulletin No. 16, April, 1891, pp. 55–72: Insect Enemies of the Sugar Beet. Annual Report, 1891, pp. 14–15: Report of Entomologist. Bulletin No. 24, September, 1892: Notes on Certain Caterpillars Attacking Sugar Beets. Annual Report, 1892, pp. 13–14: Report of Entomologist. Annual Report, 1893, pp. 13–18; Report of Entomologist.

L. Bruner and H. G. Barber.

Bulletin No. 34, May, 1894: Experiments with Infectious Diseases for Combating the Chinch Bug.

Nevada Station, Reno, Nev.

F. H. Hillman, entomologist and botanist. Appointed 1889.

Bulletin No. 8, January, 1890: The Codling Moth. Bulletin No. 9, May, 1890: A Serious Rose Pest. Bulletin No. 10, July, 1890: The Pear and Cherry Slug. Bulletin No. 11, September, 1890: Plant Lice Infesting the Apple. Annual Report, 1890, pp. 31-32: Report of Entomologist. Annual Report, 1891, pp. 28-31: Report of Entomologist. Bulletin No. 17, July, 1892: The Woolly Aphis of the Apple. Annual Report, 1892, pp. 30-31: Report of Entomologist. Annual Report, 1893, pp. 30-32; Report of Entomologist.

New Hampshire Station, Durham, N. H.

No entomological work.

New Jersey State Station, New Brunswick, N. J.

No entomological work.

New Jersey College Station, New Brunswick, N. J.

G. D. Hulst, entomologist. Appointed 1888; resigned 1889.

Bulletin No. 46, May, 1888: Insect Pests and the Means for Destroying Them. Bulletin No. 50, 1888: Insects Injurious to the Cabbage and the Best Means for Preventing Their Ravages. Annual Report, 1888, pp. 202-212: Report of Entomologist.

J. B. Smith, entomologist. Appointed 1889.

Bulletin No. 55, March, 1889: Entomological Suggestions and Inquiries. Bulletin No. 62, November, 1889: The Horn Fly. Special Bulletin D, April, 1889: Memoranda about Cranberry Insects. Special Bulletin F, July, 1889: The Horn Fly. Annual Report, 1889, pp. 241-313: Report of Entomologist. Bulletin No. 72, October, 1890: Plant Lice and How to Deal with Them. Bulletin No. 75, November, 1890: Insecticides and How to Apply Them. Experiment Record for 1890. Special Bulletin K, February, 1890: The Insects Injuriously Affecting Cranberries. Annual Report, 1890, pp. 455-528: Report of Entomologist. Bulletin No. 82, July, 1891: The Rose Chafer. Bulletin No. 85, December, 1891: Farm Practice and Fertilizers to Control Insect Injury. Special Bulletin N, November, 1891: Insects Injurious to the Blackberry. Annual Report, 1891, pp. 341-426: Report of Entomologist. Bulletin No. 86, April, 1892, pp. 3-11: Spraying for Insect Pests of the Orchard and Vineyard. Bulletin No. 90, December, 1892: Grasshoppers, Locusts, and Crickets. Annual Report, 1892, pp. 389-512: Report of Entomologist. Bulletin No. 94, July, 1893: Insects Injurious to Cucurbs. Bulletin No. 95, September, 1893: The Periodical Cicada. Bulletin No. 99, April, 1894: The Pear Midge.

New Mexico Station, Las Cruces, N. Mex.

A. E. Blount, horticulturist and agriculturist. Appointed 1890.

Bulletin No. 2, October, 1890, pp. 5-6: Injurious Insects and Plants.

C. H. T. Townsend, entomologist and zoologist. Appointed 1891; resigned 1893.

Bulletin No. 3, June, 1891: A Preliminary Account of Some Insects Injurious to Fruits. Bulletin No. 5, March, 1892: Notices of Importance Concerning Fruit Insects. Bulletin No. 7, June, 1892: Scale Insects in New Mexico. Bulletin No. 9, December, 1892: Insecticides and Their Appliances.

T. D. A. Cockerell, entomologist and zoologist. Appointed 1893.

Bulletin No. 10, September, 1893: Insects of 1893.

New York State Station, Geneva, N. Y.

E. S. Goff, horticulturist. Appointed 1888.

Annual Report, 1888, pp. 144-152: Experiments with Insecticides.

C. E. Humm, acting horticulturist.

Annual Report, 1889, pp. 358-364: Spraying the Orchards.

New York State Station, Geneva, N. Y.—Continued.

G. W. Churchill, acting pomologist.

Annual Report, 1890, pp. 339–345: Insects and Remedies. Bulletin No 35, August, 1891, pp. 618–627: Insects and Remedies.

New York Cornell Station, Ithaca, N. Y.

J. H. Comstock, entomologist. Appointed 1888.

Bulletin No. 3, November, 1888: The Insectary of Cornell University—On Preventing the Ravages of Wireworms; On the Destruction of the Plum Curculio by Poisons. Bulletin No. 11, November, 1889: On a Sawfly Borer in Wheat. Bulletin No. 15, December, 1889, pp. 199–202; The Apple-tree Tent Caterpillar. Bulletin No. 23, December, 1890: Insects Injurious to Fruits. Annual Report, 1890, pp. 35–42: Report of Entomologist.

J. H. Comstock and M. V. Slingerland.

Bulletin No. 33, November, 1891: Wireworms.

M. V. Slingerland, assistant entomologist. Appointed 1891.

Bulletin No. 37, December, 1891, pp. 378–381: The Horn Fly. Bulletin No. 44, October, 1892: The Pear-tree Psylla. Bulletin No. 49, December, 1892, pp. 324–331: The Black Peach Aphis. Bulletin No. 50, March, 1893: The Bud Moth. Bulletin No. 58, October, 1893: The Four-lined Leaf Bug. Bulletin No. 61, December, 1893: The Pear-leaf Blister.

E. P. Felt, specialist.

Bulletin No. 64, 1894: On Certain Grass-eating Insects.

North Carolina Station, Raleigh, N. C.

G. McCarthy, botanist and entomologist. Appointed 1891.

Bulletin No. 78, July, 1891: Some Injurious Insects. Bulletin No. 80a, October, 1891, pp. 23–28: Injurious Insects. Bulletin No. 84, April, 1892: Some Enemies of Truck and Garden Crops. Annual Report, 1892, pp. 30–33: Repor: of Botanist and Entomologist. Bulletin No. 92, August, 1893, pp. 65–144. The Diseases and Insects Affecting Fruit Trees and Plants, with Remedies for Their Destruction. Bulletin No. 100, March, 1894: Our Common Insects.

North Dakota Station, Fargo, N. Dak.

No entomological work.

Ohio Station, Wooster, Ohio.

C. M. Weed, entomologist. Appointed 1888; resigned 1891.

Bulletin No. 3 (second series), May, 1888: The Spring and Summer Treatment of Apple Orchards to Prevent Insect Injuries. Experiments with Remedies for the Plum Curculio. Annual Report, 1888, pp. 128–170: Report of Entomologist. Bulletin No. 1, vol. II, March, 1889: Insects and Insecticides. Bulletin No. 6, vol. II, September, 1889: Treatment for Various Insects. Technical Series, No. 1, vol. I, October, 1889: Insect Studies. Bulletin No. 4, vol. III, April, 1890: Spraying and Various Injurious Insects. Bulletin No. 8, vol. III, September, 1890: Plum Curculio Experiments, etc. Annual Report, 1890, pp. 53–65: Report of Entomologist. Bulletin No. 2, vol. IV, February, 1891: Various Insect Investigations.

F. M. Webster, consulting entomologist. Appointed 1891; resigned 1892.

Bulletin No. 5, vol. IV, September, 1891: The Wheat Midge. Annual Report, 1891, pp. 32–33: Report of Consulting Entomologist.

Bulletin No. 4, vol. V, April, 1892: Insects which Burrow in the Stem of Wheat.

F. M. Webster, entomologist. Appointed 1892.

Bulletin No. 43, September, 1892, p. 131: Crane Flies as Food of the Robin. Bulletin No. 45, December, 1892: Insects Affecting the Blackberry and Raspberry. Bulletin No. 46, December, 1892: Underground Insect Destroyers of the Wheat Plant. Annual Report, 1892, pp. 36–38: Report of Entomologist.

Ohio Station, Wooster, Ohio—Continued.

Technical Series No. 3, vol. I, April, 1893, pp. 154–155 and 157-158: Entomological Papers. Bulletin No. 51, December, 1893: Miscellaneous Entomological Papers. Annual Report, 1893, pp. 35–37: Report of Entomologist.

Oklahoma Station, Stillwater, Okla.

J. C. Neal, director, botanist, and entomologist. Appointed 1891.

Bulletin No. 3, June, 1892: Injurious Insects and Remedies.

Oregon Station, Corvallis, Oreg.

F. L. Washburn, Entomologist. Appointed 1889.

Bulletin No. 3, October, 1889: Insects and Insecticides. Bulletin No. 5, April, 1890: Insects and Remedies. Grain Beetle. Gophers and Rabbits. Bulletin No. 6, July, 1890, pp. 10–16: Economic Zoology. Bulletin No. 10, April, 1891: Codling Moth and Hop Louse. Bulletin No. 14, December, 1891: Notes on Various Insects. Bulletin No. 18, March, 1892: Injurious Insects. Bulletin No. 25, April, 1893: Codling Moth and Hop Louse. Gophers and Moles. Bulletin No. 30, April, 1894: Progress of Entomological Work. Capons and Caponizing.

Pennsylvania Station, State College, Pa.

W. A. Buckhout, botanist. Appointed 1888.

Annual Report, 1889, pp. 182–187: The Periodical Cicada (*Cicada septendecim*) in Pennsylvania.

Rhode Island Station, Kingston, R. I.

S. Cushman, apiarist. Appointed 1889.

Bulletin No. 4, December, 1889: Bee-keeping and Notes on the Station Work. Annual Report, 1889, pp. 70–96: Reprint of Bulletin No. 4. Bulletin No. 7, June, 1890, pp. 60–63: Spring Report of the Apiarist. Bulletin No. 8, December, 1890: Experiments in Apiculture. Foul Brood. Annual Report, 1890, pp. 170–175: Report of Apiarist. Annual Report, 1891, p. 94: Report of Apiarist. Annual Report, 1892, pp. 247–248: Report of Apiarist.

South Carolina Station, Columbia, S. C.

G. F. Atkinson, botanist and entomologist. Appointed 1888; resigned 1889.

Annual Report, 1888, pp. 11–38: Report of Entomologist. Bulletin No. 4, January, 1889: Entomology.

E. A. Smythe, botanist and entomologist. Appointed 1889; resigned 1890.

Annual Report, 1889, pp. 97–107: Report of Entomologist.

I. H. Orcutt, entomologist. Appointed 1888; resigned 1892.

Bulletin No. 4, pp. 15–16: Progress of Work. Bulletin No. 13, April, 1889: Insects and Remedies. Annual Report, 1889, pp. 51–56: Report of Entomologist. Bulletin No. 18, March, 1890: The Cutworm. Annual Report, 1890, pp. 20–23: Report of Entomologist. Bulletin No. 22, March, 1891: Injurious Insects. Bulletin No. 30, March, 1892: Entomology.

T. A. Williams, botanist and entomologist. Appointed 1892.

Bulletin No. 35, May, 1893, pp. 83–87: Insect Pests.

Tennessee Station, Knoxville, Tenn.

H. E. Summers, entomologist. Appointed 1888; resigned 1890.

Annual Report, 1888, p. 17: Report of Entomologist. Annual Report, 1889, pp. 13–14: Report of Entomologist.

H. E. Summers, consulting entomologist. Appointed 1890; resigned 1891.

Special Bulletin E, July, 1890: The Cotton Worm and Hessian Fly. Annual Report, 1890, p. 14: Report of Entomologist. Bulletin No. 1, vol. IV, January, 1891, pp. 32–33: The Glassy-winged Soldier Bug. Bulletin No. 3, vol. IV, July, 1891: Heteroptera of Tennessee.

C. E. Chambliss, clerk and librarian. Appointed 1892.

Bulletin No. 1, vol. IV, January, 1893: Some Injurious Insects of the Apple.

Texas Station, College Station, Tex.

M. Francis, veterinarian. Appointed 1888.

Annual Report, 1888, pp. 45–49: The Screw Worm. Bulletin No. 12, September, 1890: The Screw Worm.

C. Curtice, special agent.

Bulletin No. 24, December, 1892: The Cattle Tick.

I. H. Connell, director. Appointed 1893.

Annual Report, 1893, pp. 364–367: Grasshoppers in Central Texas.

Utah Station, Logan, Utah.

E. S. Richman, horticulturist and entomologist. Appointed 1888.

Bulletin No. 14, June, 1892, pp. 7–11: Injurious Insects.

Vermont Station, Burlington, Vt.

G. H. Perkins, entomologist. Appointed 1888.

Bulletin No. 11, June, 1888: Tent Caterpillars. Bulletin No. 12, August, 1888, pp. 3–5: Insecticides. Annual Report, 1888, pp. 128–139: Certain Injurious Insects. Annual Report, 1889, pp. 145–163: Report of Entomologist. Annual Report, 1891, pp. 144–159: The White Grub and Insecticides.

Virginia Station, Blacksburg, Va.

W. B. Alwood, vice-director, horticulturist, entomologist, and mycologist. Appointed 1889.

Annual Report, 1889, pp. 7: Report of Entomologist. Annual Report, 1890, pp. 8–9: Report of Entomologist. Annual Report, 1892, p. 8: Report of Entomologist. Bulletin No. 24 (new series), January, 1893: Injurious Insects and Remedies.

Washington Station, Pullman, Wash.

J. O'B. Scobey, agriculturist. Appointed 1891; resigned 1892.

Bulletin No. 4, May, 1892: Wireworms.

C. V. Piper, entomologist. Appointed 1892.

Bulletin No. 7, January, 1893: Pea Weevil and Cottony Maple Scale.

West Virginia Station, Morgantown, W. Va.

A. D. Hopkins, entomologist. Appointed 1890.

Annual Report, 1890, pp. 145–180: Report of the Entomologist. Bulletin No. 14, February, 1891: Farm and Garden Insects and Remedies, and Notes of the Season. Bulletin No. 15, March, 1891: Raspberry Gouty-gall Beetle. Bulletin No. 16, April 1891: Insects of Yellow Locust. Bulletin No. 17, May, 1891: Insects of Black Spruce. Bulletin No. 21, April, 1892, pp. 151–160: Injurious Insects. Bulletin No. 31, April, 1893: Catalogue of West Virginia Scolytidæ and Their Enemies. Bulletin No. 32, May, 1893: Defects in Wood Caused by Insects. Bulletin No. 36, February, 1894: Black Holes in Wood.

Wisconsin Station, Madison, Wis.

E. S. Goff, horticulturist. Appointed 1889.

Annual Report, 1891, pp. 162–175: A New Method of Applying Kerosene for Insects. Bulletin No. 35, April, 1893, pp. 3–15: Insects Injurious to Cranberries.

Wyoming Station, Laramie, Wyo.

F. J. Niswander, entomologist and superintendent of farms. Appointed 1891.

Bulletin No. 2, August, 1891: Plant Life. Annual Report, 1891, pp. 112–114: Report of Entomologist. Bulletin No. 7, July, 1892: Insecticides. Annual Report, 1892, pp. 16–17: Report of Entomologist. Annual Report, 1893, pp. 11–13: Report of Entomologist.

On the conclusion of the reading of the address, Mr. Lintner moved that the thanks of the Association be extended to the President for the admirable review of the history and present standing of economic entomology the world over which he had presented, stating that while American entomologists were tolerably familiar with the work in economic applications of the science in this country, the foreign status was unknown to them, and hence the presentation of the condition of the science abroad was of especial importance and value. The motion was put by Mr. Lintner for the President, and carried unanimously.

Reports from officers followed. The Secretary, Mr. Gillette, announced by letter that he would not be able to be present at the meetings this year, and filed an expense account for printing circulars and programmes, amounting to $7.14.

The following active members were elected:

Proposed by Mr. Howard: F. C. Test, C. E. Chambliss, and H. G. Hubbard, all of the Department of Agriculture, Washington, D. C.

Proposed by Mr. G. C. Davis: Victor H. Lowe and F. A. Sirrine, both of Jamaica, N. Y.

Mr. Walter W. Froggatt, of the Technological Museum, Sydney, New South Wales, was proposed by Mr. Ashmead for foreign membership; and the following persons were proposed for foreign membership by Mr. Howard:

Charles Whitehead, Barming House, Maidstone, Kent, England.
George H. Carpenter, Science and Art Museum, Dublin, Ireland.
Dr. Geza Horvath, Ministry of Agriculture, Budapest, Austria.
Prof. A. Targioni-Tozzetti, R. Staz. d. Entom. Agrar., Firenze, Italy.
Prof. A. Giard, 14 Rue Stanislas, Paris, France.
M. J. Danysz, Laboratoire de Parasitologie, Bourse de Commerce, Paris.
Dr. J. Ritzema Bos, Wageningen, Netherlands.
Mr. Sven Lampa, Entomologist, Department of Agriculture, Stockholm, Sweden.
Dr. N. Cholodkowsky, Institut Forestier, St. Petersburg, Russia.
Dr. K. Lindemann, Landwirthschaftliche Akademie, Moscow, Russia.
Prof. A. Portschinsky, Bur. Entom. Ministère de l'Agric., St. Petersburg, Russia.
Mr. E. C. Reed, Baños de los Cauquenos, Chile.

On motion of Mr. Smith, the President and Secretary were constituted the programme committee for the meeting. Mr. Smith extended an invitation to the Association to visit his laboratories at New Brunswick, N. J., on the 19th instant.

The following paper by Mr. Smith was then presented:

BISULPHIDE OF CARBON AS AN INSECTICIDE

By J. B. Smith, *New Brunswick, N. J.*

Bisulphide of carbon as an insecticide of very limited range has been known for many years; but for ordinary field crops it has not been in general use. In the 1893 meeting of the Association of Economic Entomologists, Prof. Garman mentioned that he had used it in the garden, covering melon vines with a tub and allowing a quantity of the bisulphide to evaporate, destroying thereby the aphides infesting the vines. This interested me greatly, because the melon louse, *Aphis cucumeris* Forbes, is at times a most destructive pest in parts of New York and New Jersey, and one of the most difficult to deal with, owing to the fact that the leaves are close to the ground and that they curl as soon as seriously affected, making it simply impossible to reach them all, even with an underspray nozzle. A lot of pot-grown plants becoming badly infested with aphides in the botanical laboratory, I made a series of experiments, which were not recorded, but which determined that the liquid evaporated slowly, that it killed plant-lice very readily, and that it killed plants with equal facility if used in any large quantity. The appearance of the lice on cantaloupe and citron melons in New Jersey gave me an opportunity of making experiments, and Mr. Howard G. Taylor, of Riverton, N. J., kindly permitted me to kill as many hills as might be necessary to carry them on. I procured a dozen wooden bowls thirteen inches in diameter and six inches deep, inside measurement, and a series of small, graduated tumblers, in which "1 teaspoonful" and "1 dram" corresponded. To get at the rate of evaporation I poured 1 dram into a graduate and left it exposed; but placed in a shaded spot. It required fifteen minutes to disappear completely. Eleven badly infested hills were then covered by bowls, the vines being crowded under when necessary, and 1 dram in a graduate was placed under each. At the end of twenty minutes I lifted one bowl, found that less than half the material had evaporated; that all the Coccinellidæ were dead, the small lice dying, and the Diabrotica, ants, and large viviparous aphides were yet all alive. Ten minutes later there was little change. At the end of three-fourths of an hour, though scarcely more than half the liquid was gone, all save a few of the mature, wingless, viviparous females were dead. In one hour there was yet liquid in all the graduates; but all the aphides were dead, or appeared so, To test the matter, all the hills treated were marked to be examined later. Another series of infested hills was selected; but the experiment was varied by using 2 drams of bisulphide in some cases, using a shallow saucer in others, pouring the liquid on the ground in two cases, and covering other hills with large square boxes, some of them anything but tight. All coverings were left on for one hour, undisturbed. Examined first a square box covering a shallow saucer with 2 drams of bisulphide; found this all evaporated and every aphis killed. The bowls covering the saucers in which 1 dram was used showed like results. Two square boxes which were not tight, covering graduates with 2 drams of liquid, had all insects unaffected and the material scarcely half gone. The two bowls under which the bisulphide was poured on the ground were then lifted and all the aphides were found dead. All the other hills covered by bowls showed all the lice dead and not all the bisulphide evaporated. The hills first treated were again examined and there was no sign of recovered life anywhere visible. Bowls, graduates, and bisulphide were left with Mr. Taylor, and all the treated hills were marked for later examination and to note the effects of the chemical. The experiments were made in the middle of a very hot day, the thermometer 93° in the shade, little or no wind blowing, and the sand so hot that it burned through shoe soles and could scarcely be handled more than a few moments at a time. Many of the hills showed the edges of the leaves, when the covers were removed, yellowed and set with numerous drops of a clear liquid. I feared permanent injury, but instructed Mr. Taylor if he found that the plants died to continue his work before the sun was high or after it was quite low. He wrote me under date of July 19: "The hills you treated when here last started to grow nicely, except the two hills where the carbon was poured on the ground; that killed them. The treated hills showed no lice at last examination." I am quite satisfied, from the experiments above recorded and from others that were not recorded, but were simply made to settle practical questions, that in melon fields at least bisulphide of carbon can be used satisfactorily and effectively. It has the enormous advantage of reaching everything on all parts of the plant, not a specimen escaping. With a stock of from 50 to 100 light covering-boxes about 18 inches in diameter, as many shallow dishes, and a bottle of bisulphide the infested hills in a field can be treated in a comparatively short time.

Mr. Southwick coincided with the author of the paper in the importance and value of prompt preventive measures, and stated that he was especially interested in the use of bisulphide of carbon, which he had employed in his work in Central Park since 1884. He referred to a new wash, a combination of bisulphide with "polysolve," which he used in the form of an emulsion. He stated, however, that "polysolve" was no longer being manufactured, but thought its place might be taken by kerosene emulsion. In reply to a question by Mr. Lintner, Mr. Smith stated that he had made his experiments when the runners had reached a length of 5 or 6 inches, and he urged a prompt use of the insecticide on the first appearance of the lice. Mr. Lintner suggested the use of cloth coverings, in lieu of the heavier and more clumsy wooden boxes. Prof. Galloway said that the formation of globules of liquid on the leaves, referred to by Mr. Smith, was due to the reduction of temperature caused by the evaporation of the bisulphide, and that this source of possible injury might be avoided by making the applications in the early morning or late in the evening, when the surrounding temperature was much lower. He referred also to the protection cloth which is used by seedsmen, and which is treated with oil so as to be practically air-tight, and suggested its use for coverings, in lieu of wooden boxes or bowls. Mr. Smith stated that some of the boxes used by him were very loosely constructed, and in these cases the 2 ounces of bisulphide used had not been effective against the lice. Mr. Howard stated that Garman's original suggestion of the use of a washtub which would inclose a vine of considerable size by drawing in the runners was a very practical one, especially in the case of small garden patches. Mr. Smith urged the advisability of very prompt action in the case of the melon louse, instancing the comparative ease with which it could be stamped out when it first appeared on young plants having but three or four leaves. This, he said, would require a very much smaller covering and less bisulphide. He also thought it possible that paper boxes could be obtained very cheaply in nests, and could be employed to inclose the vines. Mr. Saunders said that paper caps were made for the use of farmers, to protect their haycocks, and he thought the same factories would make smaller caps for the use suggested by Mr. Smith, and probably at a very slight cost. In reply to a question by Mr. Hopkins as to the effect of bisulphide on the natural enemies of the Aphis, Mr. Smith replied that he placed no importance whatever on the action of natural enemies, and was quite indifferent as to the effect of the applications on them, believing that natural enemies were rarely, if ever, of any economic importance, or appeared in numbers sufficient to keep injurious insects in check until after the main damage had been done. Mr. Marlatt referred, in this connection, to the frequent receipt by the Department of Agriculture, during July of the present year, of samples of leaves of melon covered with aphides, which were in every instance so extensively parasitised that scarcely an unaffected louse could be found; and he urged that this seemed to be a case of very substantial benefit accruing from the presence of parasitic enemies.

Mr. Smith again stated that the parasite was, generally speaking, too late in its appearance, and that great injury was always done before any effective stay in the multiplication of the pest was brought about.

Mr. Howard said that one practical point, at least, resulted from the presence of the parasite as described on the samples referred to, and that was that it obviated the necessity of detailing any remedial treatment in reply to correspondents sending such samples, it being only necessary to state that by the time the reply was received the insect pest would have been entirely exterminated by the parasite.

Some general discussion of the relations of parasites to injurious insects followed. Mr. Howard wished Mr. Smith, in his future work, to note the exact temperature and the effect of heat on the aphides, referring to the occasional sudden destruction of these insects by the very warm July days in Washington.

Mr. Saunders suggested experimenting to determine the relative effect on plants of rapid evaporation of bisulphide on hot earth or sand, or the probably slower evaporation on cool soil, or the still slower evaporation in graduates.

Mr. Smith thought it would be advisable to make tests in the directions suggested, and also referred to the results of experiments conducted by himself against ants with bisulphide of carbon, which indicated that this substance was not necessarily injurious to vegetation; and in fact had resulted in a more healthy and vigorous growth of grass on the soil treated.

Mr. Davis reported the use of this substance to destroy woodchucks in Michigan.

Mr. Lintner made some inquiries as to the effect of bisulphide on grain when used in quantity to destroy stored grain pests.

Mr. Smith replied that the only information he had on this matter was derived from the experiments conducted by Mr. Webster; he had had no personal experience. He said that he ordinarily recommended exposing peas or beans for two hours to the vapor of bisulphide, and that in the case of stored grain, a definite amount be placed on the surface of the grain.

Mr. Saunders said that seedsmen usually exposed their stock to the vapors of bisulphide for from five to six hours.

AFTERNOON SESSION, AUGUST 14, 1894.

On motion of Mr. Smith, the reading of the minutes of the morning session was deferred.

Mr. Smith presented the following report from the committee appointed last year on cooperation among station entomologists:

REPORT OF COMMITTEE ON COÖPERATION AMONG STATION ENTOMOLOGISTS.

Your committee, to whom was intrusted the duty of preparing a plan for coöperation among the members of the Association and of proposing legislation, would report as follows:

We would recommend that certain lines of work be arranged for, to be carried on in coöperation, and that in order to facilitate the work in these lines there be three standing committees appointed, consisting of one member each: One to take charge of the subject of Life History and Geographical Distribution; the second to have charge of the subject of Insecticides and Insecticide Machinery; the third to propose Legislation and direct the efforts to secure legislative action.

DUTIES OF COMMITTEES.

The Committee on Coöperation in regard to Life Histories and Geographical Distribution shall designate such species of insects as may be determined upon for the joint investigation of entomologists of certain States, having in view the species having wide economic importance and which it is desirable to investigate in the various States, either because of their local importance or lack of knowledge concerning them; that all the entomologists located within the range of such species give as much attention to observations upon them as possible and present the results of these observations at the close of the season to the standing committee, who shall combine such reports into a symposium on the species to be published by the

Association and, if practicable, publish as a conjoint work in each of the stations where the insects have been studied, or a condensed summary of the results showing all points which have been decided by the agreement of observers at different points which are still in doubt or upon which observations still differ, and especially such points as indicate variation due to climatic or other physical conditions; that species in certain groups be selected from year to year for the purpose of obtaining their geographic range, their ability to extend their range, and especially with reference to invading species to determine the rate of progress, indicate the time at which they may occur in various portions of the country, determine their relation of distribution to food plants; such observations to be arranged for publication by the committee or some member of the Association selected by them.

That the Committee on Coöperation on Insecticides and Insecticide Machinery arrange for the joint tests of insecticides under the following regulations or such modified rules as may be deemed from time to time desirable in order to more effectually provide for thorough test of these materials.

WORK ON INSECTICIDES.

That the Association prepare and publish a list of recognized valuable insecticides, with condensed formulæ, for preparation, which may be considered as authoritative, and, if desired, can be published in the bulletins of each station. That this list be enlarged as experience warrants, any new combination or preparation proposed by official entomologists being added after trial and recommendation by at least three members.

That insecticides protected by patent or trade-mark be recognized and admitted to the list on the following conditions:

That the policy of the Association be to encourage the invention of insecticides and their sale by private individuals or corporations, inasmuch as private enterprise may often reach and help those who give little heed to official reports.

That no such proprietary insecticide be recommended or placed on the Association list until it has received sanction of the requisite committee or number of members, such sanction taking into account the effectiveness of preparation for purposes claimed by manufacturers and its cost as compared with standard preparations or the cost of its probable ingredients.

That at any time when there is reason to believe, from reports of users or otherwise, that such preparation is not kept up to its original standard, or claims are made for it that are unwarranted, it may be reexamined by use of samples secured in open market, and, if found deficient, the preparation dropped from the list with public announcement of the action and notice to all members of this Association.

That manufacturers desiring the recognition of the Association shall permit the selection of samples secured at various points in open market and their trial by a committee of three or by three separate stations, who shall send their sealed reports to the proper officer of the Association.

That the same regulations apply to testing machinery, nozzles, etc., except that in case of expensive machinery different stations may combine to share expense or, with proper care to secure the grade of apparatus regularly put on market, machinery may be received by loan from manufacturers for experiment, the results to be received by the Association.

The Committee on Legislation shall agree upon some form or act which may be considered as applicable to the majority of States and direct their efforts to secure the adoption of such laws in the various States, it being the opinion of this committee that such laws be made in such form as to apply to common destructive species for which well-known remedies can be prescribed, and that the experiment stations in each State should issue from time to time, as occasion might require, bulletins containing a copy of the State law, a list with concise description of those insects recognized as public nuisances and for which definite and effective measures of treatment are known, along with explicit directions for the application of such measures. That the enforcement of such laws be made to rest upon some local authority and a provision that no person can enforce it against another unless he can show conclusively that he has himself carried out the intent of the act upon his own premises. That said committee shall examine and report upon the desirability of introducing more instruction in entomology in public schools or means by which to secure better information among the people regarding habits and importance of insects.

HERBERT OSBORN, *Chairman.*
JOHN B. SMITH
H. GARMAN.

On motion of Mr. Southwick the report was accepted, and on motion of Mr. Smith it was ordered printed, so that an opportunity might be afforded members to examine it carefully and act on its adoption at the meeting of next year.

The President read a letter from Miss Eleanor A. Ormerod, expressing her regret that she was unable to be present at the meeting and take part in the discussions.

The following paper by Mr. J. M. Aldrich was read, in the absence of the author, by Mr. Davis:

SPRAYING WITHOUT A PUMP—PRELIMINARY NOTICE.

By J. M. ALDRICH, *Moscow, Idaho.*

We are indebted to Prof. Goff, of Wisconsin, for the demonstration of the fact that kerosene may be so mixed with water at the instant of passing through the nozzle that the making of kerosene emulsion is thereby superseded. His appliance for mixing is so arranged that the suction of the piston stroke draws on both the water and the kerosene supply, the latter being partially cut off by a stopcock to mingle the two fluids in the correct proportions. The kerosene undoubtedly remains in large globules while passing to the nozzle, in going through which it is so finely divided and mixed with the water that its action upon insects and foliage is the same as that of kerosene emulsion.

Another way of effecting the same result I would suggest, as follows: Taking the Nixon Climax nozzle as an example, the water, before striking the screen, passes with great force through a small aperture. Let a small brass tube, connecting with the kerosene supply by a rubber extension, be introduced through the base of the nozzle and continued forward into the center of the before-mentioned aperture, which would have to be somewhat enlarged to still throw the same quantity of water. Now the action of the rapidly passing water will be to draw in the kerosene, and the result, I apprehend, will be the same as in the Goff method. In this case, however, water under pressure is all that is required; the nozzle does the rest. Hence, in cities and towns having municipal water supply this nozzle attached to the ordinary lawnwatering hose will be sufficient to entirely replace the spray pump. The arsenites may be used in the same way as kerosene, using a mixture stronger than the standard and allowing it to be diluted in passing through the nozzle. A stopcock on the inlet tube will graduate the proportions, as with kerosene. Perhaps an apology is due the Association for presenting this suggestion before I have actually proved its utility. I am now having nozzles made for experiment, and will be able to give a definite report later.

Mr. Smith asked if others had had experience with the combination pump which was being put on the market by the Deming Company, and said that his experience with it had not been satisfactory.

Mr. Marlatt said that in his paper, which was to follow, some experiments with this pump were detailed which would answer the question of Mr. Smith.

Mr. Marlatt then read the following paper:

NOTES ON INSECTICIDES.

By C. L. Marlatt, *Washington, D. C.*

So much has been written about insecticides in the publications of the various experiment stations and those of our Entomological Division at Washington, and they have so frequently been a subject of discussion at the meetings of this Society, that one might infer that enough experience had been accumulated and information gained to enable us to arrive at definite conclusions in the use of the more important insecticides against the leading injurious insects. It must, however, be strongly impressed on every member of the Society who is engaged to any extent in personal experimentation and actual field operations against insects that the subject is still far from being exhausted, and that every season's experience develops a host of new facts and methods of greater or less value. It is not sufficient to know that kerosene emulsion or resin wash will destroy certain classes of insects or insects in certain stages of development, and that they are not generally injurious to foliage, but it is necessary to know also the minute particulars of time, weather conditions, and conditions of the insect which will most conduce to successful treatment. As an illustration of this, the various scale insects which have always been leading pests in subtropical regions, and are rapidly gaining importance also in the north, are, generally speaking, invulnerable to insecticide action in any strength which may be safely applied during the growing season after the covering scales are once well formed; and these insects can, therefore, only be successfully treated immediately after the young are disclosed. The farmer or fruit-grower, without the aid of a hand lens, can hardly determine this point, and ordinarily will not take the trouble to do so. It is, therefore, important to be able to give him the exact dates between which to make the application. Some species again disclose their young over a period of three or four weeks, rendering it necessary to make several applications within this period. This is the case with the San José scale, and holds generally, though perhaps not covering quite so long a period, with most other common scale insects. With some few of these the young appear almost at once, and for these a single application is sufficient. An example of this is seen in the new peach scale, *Diaspis lanatus*, which was described in a recent number of INSECT LIFE. Different insects require different strengths, and plants at different seasons of the year will show considerable variation in the strength of insecticide which may be safely applied. The effect of weather conditions, rains, hot, bright sunshine, etc., can only be determined by actual experimentation. To get at these various points requires very considerable field experience, by observers who are willing to note, and capable of noting intelligently, and properly interpreting, the reasons for any outcome.

The following notes on insecticides cover, first, some experiences in the use of old and standard mixtures, and, second, experiments with little-tried and some new combinations. In the first series the notes refer almost solely to the kerosene mixtures and resin washes and to the use of these insecticides against scale insects. The old arsenicals I have not discussed to any extent, as their use is much better understood, and has not presented the difficulties that attend the use of the various washes designed particularly for the scale insects and others of similar feeding habits. Among these I am more than ever impressed with the superiority of the emulsions of milk or soap and kerosene.

1. NOTES ON APPLICATIONS OF THE STANDARD INSECTICIDES.

Effect on trees and foliage.—The necessity of using very strong washes for most scale insects (much stronger than needed for unprotected insects, such as plant lice, plant bugs, beetles, and larvæ) makes it important to determine just how strong the application can be made without injury to the plant. About the 1st of May, when the foliage was in the vigor of its early growth, a number of plants—peach, Japan quince, elm, pine, and strawberry—were treated with the following strengths of kerosene and whale-oil soap emulsions, made after the standard formula: Diluted (1) with 2 parts of water, (2) 4 parts of water, (3) 9 parts of water, and (4) 14 parts of water, or the emulsion at $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{10}$, and $\frac{1}{15}$ strength. The application was very thorough, and the limbs and twigs were thoroughly wetted by immersion in the insecticide. The treatment was made on a very bright, warm day, in the early afternoon. No rain occurred for four days, after which there were heavy rains. No injury whatever developed in the case of the pine, strawberry, and elm with any of the strengths used. With peach the injury was trifling, a very small percentage, perhaps 1 or 2 per cent, of the early leaves turned yellow and fell to the ground, but I am inclined to believe that this was merely the normal spring shedding of the leaves, which is seen in nearly all plants, notably in the box elder; and, in fact, it was about as noticeable on trees untreated as on the treated trees. In the case of the Japan quince, however, with the two stronger mixtures, namely, those with one-third and one-fifth kerosene emulsion, a few yellow spots appeared on the leaves, and later, upon handling the limbs treated with the strongest mixture, about one-fourth of the leaves were found to fall off readily. These leaves, while looking comparatively healthy and green, had evidently been injured more than their surface appearance indicated. With number 2 this peculiarity was almost unnoticeable, and with 3 and 4 no injury whatever was shown, nor did any further injury manifest itself throughout the season in the case of any of the plants treated.

These experiments would indicate that the kerosene emulsion can be applied in much stronger dilution to tender foliage of growing plants than has hitherto been supposed. Later in the season applications were made to a large number of peach trees at the standard strength, namely, diluted with 9 parts of water, with no injury whatever resulting to the trees, and a similar result attended the midsummer application to the same trees.

Having occasion to experiment in a large pear orchard, a number of mixtures were used on July 31 on young pear trees. The foliage was for the most part well matured and hardened, but in the vigorous growth of the young trees there were more or less new and comparatively tender leaves. The mixtures used were the milk emulsion, the whale-oil soap emulsion, standard summer resin wash, and an emulsion made with the resin-wash soap and kerosene. The emulsions were all used diluted in two strengths, namely, diluted with 7 and 9 parts of water, and the kerosene and whale-oil soap emulsion, diluted also with 4½ parts of water. None of these washes resulted in any injury whatever to the pear trees, and their application was very thorough, even to the point of excess.

Some young trees on the Department grounds, presenting about the same conditions of foliage, were thoroughly sprayed with the milk emulsion diluted with Bordeaux mixture to the standard amount, namely, 1 part to 9. In this case also the plants suffered no injury whatever. The Euonymus bushes in the Department grounds were also sprayed with various strengths of the kerosene and soap mixture, the stronger mixtures being twice and four times the standard strength, or diluted respectively with 4½ and 2¼ parts of water. In neither case, however, did any injury result to the plant, and the stronger mixture of the two was the only one which was entirely satisfactory in destroying the Euonymus scale.

I have considered it important to put these various experiments on record to emphasize that little danger attends the proper application of a well-made emulsion and the possibility of using much stronger mixtures than has hitherto been advised. The necessity for such strong applications will be appreciated by anyone who has attempted to eradicate scale insects from plants.

Winter applications.—Various winter applications have been recommended for scale insects, notably the winter resin wash, formulated by Mr. Coquillett, and the lime-sulphur-salt wash which has been claimed to give very successful results in California. The occurrence of a new peach scale (*Diaspis lanatus*) in excessive numbers on some experimental peach trees in the Department grounds gave an excellent opportunity to test for our climate the winter effect of various washes. In addition to the two washes mentioned, kerosene and whale-oil soap emulsion and pure kerosene were used. The applications were made during January and February, and were very liberal, the bark of the trunks and larger branches to which the scale is confined being thoroughly wetted until the liquid ran down on the ground about the bases of the trees. The first treatments were made with the resin wash and the lime-sulphur-salt mixture. Very light rains fell after the applications were made, but not sufficient to wash the lime from the trees treated with this mixture. The lime-sulphur-salt mixture, two months after the application, had not resulted in the destruction of a single scale; the resin wash at standard strength had killed about 20 per cent, and at double strength about 50 per cent of the scales. In April, or a month after the last examination, the amount of benefit was unchanged, except that perhaps 5 per cent of the scales treated with the lime-sulphur-salt mixture were dead.

Another series of experiments was made with the kerosene mixtures, namely, kerosene emulsion diluted 5 times, diluted 2½ times, undiluted emulsion, and the pure oil. These applications were made March 10, and five days later no injury was discovered to the scales in the case of the diluted kerosene emulsion. On the tree to which pure emulsion was applied the insects had assumed a dull, unhealthy color, and the same effect, but not nearly so marked, had resulted from the use of the pure oil. Five days later, or on the 20th of March, there were still no certainly dead scales in the case of the diluted emulsions, but with the pure emulsion the scales were all dead and rapidly turning black and drying up. On the tree treated with pure kerosene the scales presented nearly the same condition as those treated with pure emulsion, perhaps 10 per cent still showing some signs of life. About the 1st of April an examination showed that the 5-times diluted emulsion had not killed a single scale. The 2½-times diluted emulsion had destroyed about 10 per cent of the scales, the rest being apparently uninjured. All the scales were dead in the case of the treatment with pure emulsion and with kerosene alone. During April all the treated trees bloomed abundantly and did not show any injury from the treatment.

These experiments, of course, are too limited to be used for general deductions, but they show in the first place the great difficulty of killing the particular scale experimented upon, and also that peach trees, in the dormant winter condition, can stand applications to the trunk and lower limbs of excessively strong mixtures, even pure kerosene oil, with no great danger. The fact that the pure emulsion was more prompt in its effect than the pure oil is explained by the fact of the emulsion being thicker and therefore longer in drying up, while the oil, which was of good illuminating quality, evaporated very rapidly. The use of applications as strong as the last two can hardly be recommended except in unusual cases of injury, where the "kill-or-cure" method is the only feasible one. Winter treatment, however, will be of value in a good many cases, notably with plants having very thick and copious leaf-growth, rendering it impossible to spray them thoroughly during the summer, and with insects the life history of which, and the nature of the plant they infest, make summer treatment impracticable or unadvisable. Winter treatment of deciduous trees has the advantage also that it requires very much less liquid to wet a tree.

Experience with particular scale insects.—Reference has already been made to winter treatment for the new peach scale, *Diaspis lanatus.* Spring or summer treatment of this scale was very satisfactory in its results. In the first place, this scale was very uniform at Washington in the period of hatching, the first young appearing April 30 and practically all emerging during the first week in May. The standard kerosene-soap emulsion was applied on the afternoon of May 7, and an examination the following morning showed that all the scales which had escaped from beneath the mother scales had been killed. Most of those beneath the scales were also destroyed, the general escape of the larvæ having loosened the old scales so that the insecticide penetrated beneath them. Following the application there was a very long period during which no rain fell, giving the insecticide a favorable opportunity to affect the plant, but no injury whatever resulted. The young scale insects were destroyed in twenty-four hours, and after this period rain would have been of advantage in freeing the plants from further action of the oil. The application was not repeated, and on the 22d of May a few living young were found beneath some masses of old scales. The habit of the young of this species seems to be to abandon the old scale and seek a new location entirely free from the protection of the mother scale; but in some few cases this had not been done, and young protected under masses of old scales had escaped the application. A few old scales were also observed at this date still living, and without any signs of the formation of eggs in their ovaries. I am of the opinion that these scales, which ultimately died before midsummer, were nonfertilized females, and this condition accounts for the prolongation of their existence.

About the 1st of July a new brood appeared in comparatively limited numbers from the few larvæ which escaped the spring treatment. The application of kerosene was repeated on July 7 as in the first instance, and a similar result followed, with the exception that it seemed to have been even more effectual, and no living scales whatever were discovered when the trees were examined on the 17th and at various later dates, even in a few instances where the young had remained under the old scales. The above experience indicates that we have in this new peach scale an insect very amenable to summer treatment.

Chionaspis euonymi Comst. has proven troublesome to the Euonymus trees on the Department grounds and in private yards in the city of Washington. Applications of kerosene emulsion have been made from time to time to eradicate the pest. When these applications were made ust at the time of hatching fairly good results followed, but the difficulty has always been that the hatching period of this scale extends over a number of weeks, and later in the season the broods become so intermingled that all stages are found on the plants together. The ordinary washes are totally ineffective on half-grown or mature insects of this species. The experiments already referred to show that it takes a strength of kerosene emulsion four times greater than that ordinarily recommended to kill the adults, and this can be applied to the plants, at least in their mature and midsummer condition, without injury. Applications made on July 18, on a scorching hot day, were not followed by rain for four days. Double ordinary strength, namely, 1 part of kerosene to 4½ of water, resulted in the death of 75 per cent of the adults. Four times ordinary strength, or diluted with 2½ parts of water, resulted in the death of 99 per cent of the adults and young. The ordinary strength, nine times diluted, killed nothing but the newly-hatched young.

Experiments were also tried on the oak scale, *Asterodiaspis quercicola* Bouché, the young of which began to appear early in May. The worst infested oak was, at the time of treatment, just expanded into full leaf, and the foliage was excessively delicate and tender. The application was therefore made only at the rate of 1 part of the emulsion to 13 parts of water. This resulted in the death of all the young which had emerged at that time. This scale, however, is one of those the hatching of which extends over a considerable time, and several applications are necessary to reach complete extermination. Similar results attended the spraying for *Chionaspis furfurus* on Japan quince. In the case of this insect, however, the emergence of the spring brood is more uniform, and one or two applications are sufficient. At Washington the young of this scale emerge during the second week in May, and the application is best made about the 15th. The abundant leafy growth of the Japan quince makes it very difficult to wet the branches with any thoroughness, and midwinter treatment for this plant will ordinarily be necessary.

2. NEW INSECTICIDES AND MODIFICATIONS OF OLD ONES.

Some opportunity has offered during the past year to experiment with one or two new insecticides, or new methods of combining old ones; also with some new combinations of insecticides and fungicides. I will not take time to refer to the host of patented articles which are constantly coming to the Department and being advertised in the agricultural journals, and which are all, so far as my experience and that of the Department goes, very much inferior to the standard mixtures, more expensive, and the best of them are merely more or less close copies of common, nonpatented insecticides.

The combination kerosene and water pump.—This apparatus, which is doubtless familiar to all of you and which was designed by Prof. E. S. Goff, of the Wisconsin station, has lately been put on the market by the Deming Company in the form of the perfected Galloway Knapsack Sprayer, with kerosene attachment. Mr. H. E. Weed has carefully described this apparatus with figures in Bulletin 30 of the Mississippi station. He reports very favorably as to the results of this means of mechanically mixing kerosene and water. Recognizing the importance of this method, should it prove to have the merit claimed for it, a number of experiments were made in the Department grounds applying the spray to the foliage of various plants. The results of this treatment were not as satisfactory as they have been reported elsewhere, and in the case of several plants very serious scalding resulted, while others sprayed at the same time, or with scarcely an interval between, presented no injury. This led to a suspicion of irregularity in the output of kerosene, and tests were made to determine this point. The apparatus was in first-class condition and the stopcocks worked satisfactorily, as shown by the fact that either pure water or pure oil could be sprayed by closing one or the other of the valves. It was early found that the relative fullness of the water and oil reservoirs had an influence on the result, and as the water became low very much more oil came out than when the water tank was half or more full. In the following tests the spray was directed into graduated jars, filling one after the other in each series, without any interval between. The oil separated practically entirely in from ten to fifteen minutes, the water retaining, however, for some hours a slight milkiness, due to the retention of a very small percentage (a fraction of 1 per cent) of oil in suspension. The separation, however, began immediately, and was rapid in proportion to the percentage of oil. When first sprayed into the jars the mixture had the appearance of an almost perfect emulsion, and the oil was undoubtedly well and thoroughly broken up, and in this respect the success of the apparatus can not be questioned. In the first two series of experiments the oil tank was practically air-tight, as shown by the fact that when the cap was removed the rush of air indicated a partial vacuum. To determine whether this had any effect on the amount of oil distributed, the cap was removed in the last four series of experiments.

Series 1.—Sprayed immediately after charging the apparatus, the stopcocks having been previously closed and the pump cleaned. Result:

	Per cent of oil.
Jar 1	13
Jar 2	5
Jar 3	3

Series 2.—Sprayed after the stopcocks had been left open ten minutes:

	Per cent of oil.
Jar 1	57
Jar 2	31
Jar 3	18
Jar 4	11

This series certainly indicates the necessity of keeping the stopcocks closed when the pump is not in use. Both these series may have been influenced somewhat by the fact, noted above, that the oil reservoir was sealed air-tight.

Series 3.—Sprayed after standing ten minutes with both stopcocks closed from the termination of the last series:

	Per cent of oil.
Jar 1	37
Jar 2	9
Jar 3	8

Series 4.—Conditions same as in Series 3.

	Per cent of oil.
Jar 1	34
Jar 2	3
Jar 3	11

Series 5.—In this series the oil was then turned off and the pump operated until the water ran clear. The oil was then turned on and pumping resumed until the milkiness of the mixture coming from the nozzle indicated that the normal mixture of oil and water was taking place.

	Per cent of oil.
Jar 1	9
Jar 2	14
Jar 3	5

Series 6.—Conditions same as in Series 5.

	Per cent of oil.
Jar 1	14
Jar 2	15
Jar 3	15

It will be noted that, with the exception of the last series, the variation was such as to render any application of the oil exceedingly dangerous to the plant, it being impossible to foretell the percentage of oil. If the results which the above series of experiments indicate are the ordinary ones in the use of this apparatus, it certainly can not be recommended, and is a most dangerous implement to put into the hands of the horticulturist. Until some more certain method of insuring uniformity in the proportion of water and oil is devised, it will be very much better to adhere to the standard emulsions, which are not difficult of preparation, and have advantages beyond the mere attenuation of the oil, namely, in giving the mixture a consistency which extends its actions, and in addition, with the soap emulsion, the insecticide value of the soap. A further objection to the water and oil mixture is that wherever the spray collects in drops, as it inevitably will, free oil will separate in sufficient amount to injure foliage. An application also which depends for its success on the perfect working of a complicated apparatus, liable at any moment to get out of order, is hardly a safe one to put into the hands of an indifferent laborer.

Arsenate of lead.—This arsenate, which originated with Mr. F. C. Moulton, of the Gypsy Moth Commission, and is reported to have such excellent insecticide qualities, both by the commission and by Mr. Fernald, who has experimented with it, is the most promising of the new mixtures which have come out during the past year. Our experiments at Washington show that this mixture has good grounds for the claims made for it. Its advantages over the other arsenicals, it will be remembered, are its qualities of adhering to the foliage and seeming to lack entirely any caustic properties. We have used it on the tender foliage of the peach and Osage orange at a strength of 1 pound to 2 gallons of water, with glucose enough added to almost make a syrup, without the slightest injury to the plants treated. The mixture adhered to the foliage through several heavy rains, and gives evidence of lasting through the summer. Its insecticide value was tested in experiments with the elm leaf-beetle, which, the present season, appeared in great numbers in the large elm grove on the Department grounds. The experiments were unsatisfactory in one respect, on account of the frequent occurrence during the spraying season of rains, which interfered with the results and rendered a number of repetitions of mixtures necessary.

On May 21 the elm trees were sprayed with the following strengths: 1 pound of arsenate of lead and 2 quarts of glucose to 120 gallons of water, to 75 gallons, and to 50 gallons, applying it in each case to eight or ten trees. The check experiment consisted in the application of Paris green, 1 pound to 150 gallons water, to neighboring trees. These applications all seemed satisfactory, with the exception of the weakest mixture of arsenate of lead, which seemed to have had very little effect on the larvæ. The two stronger applications of the arsenate of lead and the Paris green killed at least 95 per cent of the larvæ by the 26th of May. The rain seeming to have interfered with the action of the poison, and it being very desirable to exterminate the larvæ, a second application was made between the 26th and 29th of May. Arsenate of lead mixed as above and diluted at the rate of 1 pound of poison to 60 gallons of water was used, one tree being treated with Paris green at the strength employed in the first instance. Light rains immediately followed the application, and on the 31st of May the larvæ were dying, but not rapidly, the Paris green being more prompt in its action. The trees were therefore sprayed again on the 4th of June with a mixture twice as strong as the last, or 1 pound to 30 gallons of water. This last application effectually destroyed the larvæ, except some few in the top branches which were not reached by the insecticide. The larvæ, after eating a meal or two of the poisoned leaves, did not succumb immediately to the poison, but dragged out a sickly existence for several days without feeding, and more or less restlessly wandering about. Many of the nearly or quite full-grown larvæ went to the base of the trees and died before pupating, while others, which even succeeded in pupating, later succumbed to the action of the arsenical. In the case of all the applications no injury whatever was done to the foliage.

The result of these experiments on the elm leaf-beetle seem to be rather in favor of the use of Paris green, but the merit of the arsenate of lead as an insecticide was plainly shown, and the perfect safety attending its use on foliage was distinctly brought out. Its action is undoubtedly slower than Paris green, and if used at the rate of the stronger mixtures noted above, will be much more expensive than Paris green, even if secured as cheaply as it is by the Gypsy Moth Commission, namely, at 7 cents per pound.

The resin wash and resin-kerosene emulsion.—The standard California insecticide, known as resin wash, has lately been called into service by Mr. Galloway's assistants in Florida as a fungicide, to remove the smoky fungus (*Fumago salicina*) following the attacks of the various plant lice. A slight modification in the making of this insecticide has been developed in connection with this use, which consists merely in the employment of granulated caustic soda in place of the crude caustic soda recommended in Mr. Coquillett's formula. It is claimed, and the limited tests made at Washington seem to sustain the claim, that by the use of this higher grade caustic soda the resin wash may be made in very much less time, since it is necessary to bring the ingredients to a boil only long enough to dissolve the soda and the resin. Mr. Galloway tells me that he has experimented with this resin wash or soap also in making kerosene emulsion, using it in lieu of soap. I have tested this emulsion, and in a rather limited experience am satisfied that a good emulsion can be made. Whether this will be a valuable addition to the common standard emulsions remains, however, to be shown, but it would seem on the surface to be useful, because it combines two important insecticides. The emulsion made with resin has the very decided disadvantage, however, that it soon separates into the resin mixture and oil when used in the same proportions as the whale-oil soap emulsion. The proportion of resin to the oil to make a permanent mixture will have to be determined by later experiments. I found, however, that when the emulsion was immediately diluted after being made, the dilution remained uniform and without separation indefinitely, whereas in the undiluted emulsion, separation began within a very short time.

Combinations of the Bordeaux mixture with kerosene emulsions.—The idea of the combination of insecticides and fungicides to form a mixture for application to plants to correct the injuries from fungi and insects of various sorts at one treatment is not by any means new. The Cornell combination of Bordeaux mixture with kerosene-soap emulsion and Paris green is a case in point. Mr. Slingerland, who tried this combination, does not give it an altogether satisfactory indorsement. That the Bordeaux mixture and the kerosene emulsion may be easily combined is to be expected, from the fact that lime is a well-known emulsifying agent for oils; and Mr. Slingerland's experience and my own have shown that the combination results in a certain improvement of the Bordeaux mixture in holding the lime in suspension, and that there is no separation of oil even when the lime is used in very excessive quantity. In conjunction with Mr. Waite, of the Division of Vegetable Pathology in the Department of Agriculture, a number of pear trees were treated with a combination mixture of Bordeaux and milk emulsion. The treatment was made July 25, and the trees at the present time are still covered with the Bordeaux, in spite of the fact that several very hard rains have washed them since the application. This seems to show that this mixture, at any rate, adheres almost as well as the Bordeaux alone, though perhaps not having quite the same tenacity. Experiments were made in combining both the whale-oil soap emulsion and milk emulsion with (1) Bordeaux, to which just enough lime had been added to neutralize the copper, and (2) in which a slight excess of lime had been used, and (3) to which a very great excess of lime had been added. The mixture was equally satisfactory with the emulsions of both milk and soap in all three of the Bordeaux mixtures. With the soap emulsion mixtures, after over a week's standing, a very slight trace of free oil appeared on the top of the jars strongest in lime.

In view of the fact that ordinary hard waters, or those containing much lime or magnesia, will, when used in making emulsions, liberate the free oil on account of the combination of soap with the lime, it would seem that the soap emulsion could not be satisfactorily used with the Bordeaux mixture, but experiments have shown that this is not the case. This is easily explained when it is remembered that it is the lime in solution in the water which is the liberating agent, whereas in the Bordeaux mixture the lime in suspension is really an emulsifier, and counteracts the effects of the dissolved lime in the liquid. The use of Paris green or London purple in a mixture of this sort has no effect upon the stability of the combination. It seems to me, therefore, perfectly feasible to apply a combination of Bordeaux mixture and emulsion to plants, and there are a number of cases where such applications would be desirable. The pear-tree Psylla may be effectively treated with kerosene emulsion in early spring, just after the leaves have unfolded and the eggs have hatched, and at the same period the application of Bordeaux mixture is customarily made to guard against the blight. The combined mixture could be applied with scarcely any addition of trouble or expense. The same holds true for a combination of Bordeaux mixture with an arsenical for the apple scab and the codling moth, and many other illustrations will at once suggest themselves.

Mr. Smith asked if the effect of combining ammoniacal salts with arsenate of lead had been tried, and was informed that no such experiments had been conducted.

The subject of insecticides was continued in the following paper by Mr. Galloway:

SOME OBSERVATIONS ON NEW AND OLD INSECTICIDES AND THEIR COMBINATION WITH FUNGICIDES.

By B. T. Galloway, *Washington, D. C.*

In the course of sundry investigations made during the past six to eight years I have prepared and used a number of compounds with a view of testing them as insecticides and fungicides. As yet but few of the preparations have been made public, owing to the fact that many points in connection with them still remain unsettled. I should prefer to allow the matter to rest until more definite information is obtained in regard to some of the preparations, but as it is questionable when time will be found to continue the work, I have, at the suggestion of a member of your Association, decided to present the accumulated facts at this meeting. In doing this I hope it will be understood that what is said is more in the line of suggestion than anything else. If the statements are received in this light and are found of sufficient interest to be worthy of adoption by you in further experimental work, the remarks made shall have served the purpose for which they are intended. The subject may properly be treated under eight heads, as follows:

(1) Bordeaux mixture.
(2) Lime-kerosene emulsion.
(3) Bordeaux-mixture-kerosene emulsion.
(4) Bordeaux-mixture-kerosene emulsion and Paris green.
(5) Resin wash.
(6) Resin-wash-kerosene emulsion.
(7) Resin soap for Bordeaux mixture and for resin wash.
(8) Sulphur compounds.

It must be admitted that some of the names for the preparations are cumbersome, but they are indicative, and for the present purpose this is perhaps all that is necessary.

(1) Bordeaux mixture.—Although not a new thing by any means, it seems best, in view of what follows, to describe briefly some recent improvements in making this preparation, which is rapidly superseding all other fungicides and is also coming into use as an insecticide

alone and as a suitable medium for the application of the arsenites. I wish to dispel the impression which seems to generally prevail, that Bordeaux mixture is a very simple preparation, requiring no great amount of care to properly manufacture it. There are many little points that have been discovered from time to time in connection with the preparation of this fungicide, and these taken collectively are of great value in simplifying and cheapening the work of spraying.

It is found that much time is saved by preparing what may be called stock solutions of both copper sulphate and lime milk. A stock solution of copper sulphate may be made by dissolving copper sulphate in water at the rate of 2 pounds to a gallon. The most convenient way to dissolve the copper sulphate is to tie it in a coarse sack and then suspend the same in a barrel in such a way that it will be as near the top as possible. The barrel is then filled with water, and the copper sulphate within the sack quickly dissolves, the solution sinking at once to the bottom and the fresh water coming to the top to take its place. If the copper sulphate is placed at the bottom of the barrel at once the surrounding water soon becomes saturated with the chemical in solution, and in this condition, being heavier than water alone, it remains at the bottom, and in consequence prevents the further action of the liquid above.

If it is desired to make up a 50-gallon barrel of stock copper solution, 100 pounds of copper sulphate is weighed out, suspended in the sack within the barrel as already described, and the barrel is then filled to a 50-gallon mark previously made. As soon as the copper sulphate is dissolved the sack should be removed and sufficient water added to bring the solution up to the desired quantity. A stock solution prepared in this way will last indefinitely, providing too much of the water is not allowed to evaporate.

In preparing a stock milk of lime, slake 100 pounds of fresh lime after the fashion practiced by masons. When slaked place the paste in a 50-gallon barrel and then fill the latter with water.

In preparing Bordeaux mixture from such stock solutions it is only necessary to take a given quantity of each and mix them together. Thus if the 50-gallon formula for Bordeaux mixture is adopted it will be necessary to use 3 gallons of the stock solution of copper sulphate and approximately 2 gallons of the stock lime preparation. The copper sulphate solution should first be placed in a barrel and then nearly enough water added to fill the latter. The lime milk should then be added and the whole thoroughly stirred. Before using, the mixture should be tested by the potassium ferrocyanide test; that is, a few drops of the solution of the chemical in question should be added, and if no change in color is noted the fungicide may be considered perfectly safe. In case a reddish precipitate forms when the potassium ferrocyanide is added lime milk should be stirred in until no reaction takes place.

(2) Lime-kerosene emulsion.—In the course of some investigations made three or four years ago in the treatment of rust and plant lice affecting oats, it was found that kerosene and lime when shaken together cold would make an emulsion that would stand fairly well. This emulsion has been prepared in various ways, but has never been thoroughly tested by me as an insecticide. The usual method of preparation has been to first prepare a milk of lime having about the consistency of thick cream. The kerosene may then be added to the lime milk at the rate of 1 to 5, 1 to 10, 1 to 15, 1 to 20, 1 to 25, or 1 to 30. After adding the kerosene it is only necessary to thoroughly churn the mixture by pumping it back into itself by means of a small force pump. The emulsions of the strengths mentioned have been used without injurious results on a number of plants, such as grape, rose, cherry, raspberry, etc. It does not seem to spread as readily as the soap emulsion nor is it as stable when diluted. It may prove useful, however, as a medium for the combination of the arsenites with kerosene.

(3) Bordeaux-mixture-kerosene emulsion.—Having used kerosene in emulsion with lime milk, the thought suggested itself that the kerosene might be added to Bordeaux mixture and thus produce a combined insecticide and fungicide. It was found upon experimenting that the kerosene would readily emulsify with the Bordeaux mixture, forming a compound more stable than the mixture alone. The insecticide and fungicide properties of the combination have not been thoroughly tested in the field. Some trials, made with a view of testing the mixture as regards its wetting power, adhesiveness, and injurious effect on foliage, have shown that in most cases the preparation wets the parts almost as readily as Bordeaux mixture alone, but it does not seem to adhere quite so well. The strength used in these trials range from 1 to 5 to 1 to 25, the 1 in each case representing the kerosene. No injury resulted to any of the plants excepting peach, which had its foliage removed by the 1 to 5 and 1 to 10 formulas. It seems to me that this is a very promising combination, and I hope it may be thoroughly tested in the field.

About a year ago Prof. Slingerland, of the Cornell Experiment Station, described a similar mixture,* which, upon field trial, did not prove satisfactory. Prof. Slingerland's mixture differs from the one under consideration in that he made up his kerosene emulsion in the regular way with soap and then added it to Bordeaux mixture. I am under the impression that such a combination would not be as stable as the kerosene alone, as the lime would have a tendency to separate the soap from the kerosene.

(4) Bordeaux-mixture-kerosene emulsion and Paris green.—Paris green may be added to this combination in any amount desired, thus

* Slingerland, M. V., The Cornell Mixture, Science, August 25, 1893, pp. 105, 106.

producing a fungicide and also an insecticide for both sucking and biting insects.

(5) Resin wash.—Within the past few years the resin washes have come into quite general use, especially on the Pacific coast. The interest in them has been largely due to the efforts of the U. S. Entomological Division, whose agents were the first to bring the compounds prominently before the public. During the past year Mr. H. J. Webber, an assistant in the Division of Vegetable Pathology, engaged upon work in Florida, has used the resin washes with success in combating sooty mold of the orange and other citrus fruits. The sooty mold is a fungus which usually accompanies the attacks of certain insects. It is especially common in Florida, following the ravages of the white fly (*Aleyrodes citri*), and although not strictly speaking a parasite, it injures the host by interfering with transpiration and possibly also in other ways.

Mr. Webber, in the course of his investigations in Florida, found that the wash could be very quickly prepared by certain modifications of the formula now generally recommended. The formula most generally used by the U. S. Entomological Division contains 20 pounds of resin, 5 pounds of caustic soda (70 per cent), 2½ pints of fish oil, and 100 gallons of water. The resin and soda are broken up and, together with the fish oil are placed in a large kettle, sufficient water being added to cover them. The whole is then boiled for several hours, or "until the compound will mix properly in water without breaking up into yellowish flakes." Mr. Webber uses 98 per cent granulated caustic soda and by this means is enabled to avoid the long-continued boiling.

I have experimented with Mr. Webber's formula, and for a time was puzzled at the results obtained. It was found that by using the amount of caustic soda recommended by him a perfect compound was not obtained. That it was imperfect was shown by the flaky, soap-like masses floating in the clear solution. After considerable experimenting it was found that success in making the wash was dependent upon having just enough water and just enough caustic soda. By varying the amounts of either of these ingredients the preparation would show the undesirable flaky masses, which would not dissolve in cold water. However, if the full amount of water was added during the heating process there was no difficulty, but this is not desirable, as it is of considerable practical importance to have the wash as concentrated as possible. The perfect wash, although concentrated, should assimilate readily with cold water, forming a clear, brown solution when ready to apply to the plants. Without going into further details it may be said that as now worked out the formula for the stock or concentrated wash is as follows:

Resin	20 parts = 20 pounds.
Caustic soda (98 per cent)	3 parts = 3 pounds.
Fish oil	3 parts = 3 pints.
Water	120 parts = 15 gallons.

The resin, caustic soda, and fish oil are placed in a suitable vessel and the 15 gallons of water is added all at one time. The heat is then applied, and just as soon as the mixture comes to a boil, which will in a measure depend upon the strength of the fire, the preparation becomes clear brown, indicating that it is ready to be removed from the fire. When allowed to cool this mixture is of a yellowish color and somewhat opaque. As already indicated, however, it readily mixes with cold water, forming a brownish, clear solution entirely free from flaky masses of soap.

For use in the greenhouse in combating red spider on violets, climbing asparagus, and roses, we dilute the stock preparation at the rate of 1 to 3, that is, 1 part of stock solution to 3 parts of water. This is rather strong, and perhaps for all ordinary purposes 1 to 4 will have sufficient strength. The concentrated wash made up in accordance with the foregoing formula will cost approximately 4¾ cents per gallon, not counting the labor, which will not exceed 10 cents for the 15 gallons of wash, making the total cost of the stock preparation approximately 5⅓ cents per gallon. Prepared by the old formula the total cost will be not less than 6½ cents a gallon for the concentrated wash, estimating the cost of labor at 30 cents. These figures are valuable only in a comparative way, as the actual cost of the washes could probably be reduced one-third by making them in large quantities and buying the ingredients at wholesale prices. As a matter of fact, the 98 per cent caustic soda can be obtained in 400-pound barrels for 6½ cents per pound, or in broken lots for 8½ cents per pound. The 70 per cent caustic soda costs about 4½ cents in 600-pound drums and 7 cents per pound in small quantities. The granulated soda is much more convenient to handle than the other form, and furthermore, it requires no preliminary treatment, such as breaking up, dissolving in water, etc.

As already indicated, we have used the resin wash in combating red spider on violets and have found it very efficient. It seems to me that the compound is worthy of trial in greenhouses as a remedy for sooty mold, red spider, and plant lice.

(6) Resin-wash-kerosene emulsion.—It has been found that a thick emulsion can be made by churning together while cold equal parts of the imperfect resin wash made with an excess of caustic soda and kerosene. This emulsion, however, is not stable, probably owing to the fact that the proper proportions have not been worked out. The emulsion may be diluted to almost any strength and in this condition is more stable than when not diluted. A more stable and in fact a better emulsion may be made by using the kerosene and the diluted resin wash in strengths ranging from 1 to 5 to 1 to 20. These emulsions are milky white and show upon standing very little free oil. Not enough experiments have been made, however, to warrant any definite statements in regard to the preparation. The emulsions were suggested to Mr. Marlatt, who has already given his experience with them in treating the pear-tree Psylla.

(7) Resin soap for Bordeaux mixture and for resin wash.—In the course of work in Florida, Mr. W. T. Swingle, one of my assistants, has found that a clear resinous solution may be very quickly made as follows:

> Resin, 2 parts.
> Crystallized sal soda, 1 part.
> Melt together and add 4 parts of water.

This forms a stock solution of a beautiful clear brown color. I have used it, at Mr. Swingle's suggestion, in connection with Bordeaux mixture to increase the wetting power of the latter, and find it just as effective and much cheaper than ivory soap or whale-oil soap. The compound costs about 1½ cents per pound, while ivory soap can not be bought for less than 16 cents and whale-oil soap for less than 8 cents per pound. It is probable that this preparation might prove equally as valuable as the ordinary resin washes as an insecticide, and its use as such is therefore suggested.

(8) Sulphur compounds.—A number of the sulphur compounds have proved of value as insecticides and fungicides. They are among the oldest preparations in use, especially as fungicides. Among those generally recommended are potassium sulphide, eau grison, and the sulphur, lime, and salt mixture. Potassium sulphide is not now generally used, as it is likely to injure the plants. The sulphur, lime, and salt compound is extensively used on the Pacific coast for the San José scale. Mr. Pierce, our agent in California, has also found that this preparation will largely prevent peach curl, if properly applied. The eau grison and the sulphur, lime, and salt mixture are both troublesome to make, as it is necessary to boil together the ingredients of each for several hours. Messrs. Swingle and Webber, in the course of their investigations upon the diseases of citrus fruits, have experimented with a number of sulphur compounds, in the hope of obtaining one that can be made cheaply and without the long tedious boiling process. It is believed that this has been accomplished, but as there are some points in connection with the work that yet remain to be settled, it is thought best not to give the formulas in full. Suffice it to say that compounds which appear to be as valuable as any of the old ones, and which can be prepared in a few minutes, have been obtained at a cost not exceeding one-fourth of a cent per gallon.

Mr. Galloway's paper was accompanied by the exhibition of a large series of vials, illustrating the various insecticide mixtures and combinations described by the author. Some of the mixtures were experimentally made on a small scale, to illustrate the characteristic reactions which accompany the combining of the different elements. In the course of the examination of the specimens and the discussion which followed, it was pointed out that the kerosene mixtures were not as stable as the old standard ones of soap and milk, and Mr. Galloway explained that while this was generally true, many of the mixtures were sufficiently stable for practical, immediate use, and that the whole matter had been worked out provisionally by him with the idea of merely bringing it before the Association so that others having more time could take up the matter, make more careful experiments, and devise methods and formulas which would bring about the best results.

In the absence of the author the following paper by Mr. Webster was read by the Secretary:

SPRAYING WITH ARSENITES VS. BEES.

By F. M. WEBSTER, *Wooster, Ohio.*

At the Rochester, N. Y., meeting of this Association, I gave the results of some experiments looking toward a solution of the problem, Will spraying fruit trees while in bloom affect the bees which afterwards visit these trees for the purpose of securing either honey or any other substance carried to the hives, and if such be the case, what is the effect upon the inmates of such hives? The results of my first attempt at settling this question will be found on record in INSECT LIFE, vol. V, pp. 121–123, and it will, therefore, not be necessary for me to repeat them here. On account of the meteorological conditions under which the experiments were carried on they have never been deemed conclusive in point of definite results, even by myself, and I have only been waiting a favorable season in order to finish the work. This year the time appeared to have arrived in which I might hope to solve the problem.

On May 2 two apple trees in full bloom—and the blossoms were abundant—were thoroughly sprayed with a mixture of 1 ounce of Paris green to each 12 gallons of water. After the water had evaporated the poison could be clearly observed both on bloom and foliage. The application was made during the forenoon, the day being warm and clear, and during the afternoon quite a number of bees were caught while visiting the bloom and marked with carmine ink. The hives were located but a few yards distant from the trees, and both being situated at a considerable distance from any other trees at that time in bloom. None of these marked bees were afterwards found dead about the hives. During the night following the application there was a rainfall of 0.20 inch. On the following day bees were caught and killed by being dropped into a cyanide bottle where the cyanide was embedded in plaster of Paris, after the usual custom. As soon as the bees were dead they were dissected as follows: The posterior legs with pollen attached were severed from the bodies and placed in a small glass vial and securely corked. The contents of the abdomens, including the honey sacs, were next dissected out and placed in a separate vial, and the same mode of procedure was followed with the whole inside of the thorax, this giving me the entire bee except the head, anterior and middle legs, wings, and chitinous walls of the thorax and abdomen. Besides these a number of the bees were kept intact. The whole series was submitted to the assistant professor of chemistry of the Ohio State University, L. M. Bloomfield, to be tested for arsenic by the Marsh method. Mr. Bloomfield found the weight of material submitted in each case to be as follows: Posterior legs, with pollen attached, 0.3498 gram; contents of abdomens and honey sacs, 0.0990 gram; ditto thorax, 0.0710 gram. After the usual tests to prove the absence of arsenic in the reagents it was found that no arsenic was associated with the posterior legs or the pollen with which they were loaded, none had been left in the thoracic matter, but the material from the abdomens gave unmistakable proof of the presence of arsenic. The entire bodies of a number of the bees, taken at the same time from the same tree, were then washed with diluted ammonia water, three washings failing to give a trace of arsenic, but the bodies, after being thus treated, and being boiled in water slightly acidulated, gave distinct traces of the poison, thus eliminating any possibility of the poison having been introduced into the abdominal matter at the time of dissection and from the exterior. May 15 a crab apple tree (*Cratægus*) was sprayed with a mixture of the same ratio of Paris green as before, but in this case only the contents of the abdomens were retained. This matter, to the weight of 0.1463 gram, treated as in the preceding, gave unmistakable proof of the presence of arsenic.

Just at this stage of my investigations, chance, if such a thing there be, threw in my way still more conclusive proof. A few days prior to my last experiment, probably about May 10, a small apple orchard on the experiment farm was sprayed with Bordeaux mixture, to which had been added Paris green at the rate of 4 ounces to each 50 gallons of the mixture. The bloom had at this time nearly all fallen from the trees the exceptions being an occasional belated cluster. Three colonies of bees, recently brought on to the premises, were located near by, to all appearances in a perfectly healthy condition. A few days after the application of the poisoned Bordeaux mixture one colony suddenly became extinct and a second greatly reduced in numbers, dead bees being abundant about both hives. From these colonies I was able to secure dead bees, and both honey from uncapped cells and dead brood from the hive that had been so mysteriously depopulated. When tested for arsenic by Mr. Bloomfield, precisely as with the other matter, contents of abdomens of the dead bees to the amount of 0.2334 gram revealed the presence of arsenic; 3.7061 grams of honey gave no trace of poison, while 1.8481 grams dead brood showed it to be present, and the entire bodies of the dead bees, thrice washed in ammonia water, as before explained, gave traces of arsenic. In regard to the honey I can only say that it was from uncapped cells, which might and probably did contain last year's honey that was still being used for a partial food supply by the bees.

Briefly recapitulated, arsenic was found present in the contents of the abdomens of bees frequenting recently sprayed blossoms, and we are at least free to assume that more or less of it was contained in the honey sacs. The dead bees, three times washed in ammonia water, the latter not revealing the presence of arsenic externally, when tested showed its presence internally. Brood from uncapped cells (larvæ) of a colony suddenly dying without other apparent cause gave evidence of having died from the effect of arsenic which could have been introduced only from without.

In summing up the matter, then, I can see no other conclusion that can be drawn from the results of my experiments than that bees are liable to be poisoned by spraying the bloom of fruit trees, the liability increasing in proportion as the weather is favorable for the activity of the bees, and that all bloom must have fallen from the trees before the danger will have ceased.

Finally, I believe we now have the first conclusive proof of the effect on bees by the use of arsenical poisons in the orchard while the trees are in bloom. Heretofore all has been uncertainty, the statements made being based on either pure assumption, or, as in once instance, on the result of penning up the bees and feeding them on poisoned sweetened water. It is certainly to the credit of the entomological fraternity of America that among their number but few could be found willing to risk a positive assertion based on such slender and unreliable information, and I feel that I am fully justified in pointing out the fact that in the case of two of our fellow members, Dr. Lintner and Mr. Fletcher, in the face of the legislative bodies of their respective States, both refused to commit themselves to the extent of making positive statements either one way or the other.

Mr. Lintner said that his position hitherto had been that laws ought not to be passed on the subject unless it was amply proved that harm did result to bees; and even in that event, the relative interests of the bee-keepers and fruit-growers should be carefully weighed, since it has been showed by him that many harmful insects also visited the blossoms, and they would stand an equal chance with the bees of being poisoned by the arsenical mixtures.

Mr. Smith said that the bee-keepers would always have an advantage when it came to securing legislative action, because, while they represented a comparatively small number of individuals, they are well organized, and can secure action where the much larger body of fruit-growers would be powerless.

Mr. Southwick read the following paper:

ECONOMIC ENTOMOLOGICAL WORK IN THE PARKS OF NEW YORK CITY.

By E. B. SOUTHWICK, *New York City.*

The work of the entomologist of the Department of Public Parks in New York City is the care of trees, shrubs, and plants in an entomological sense, and is under the direction of the Commissioners.

The ground to be covered is about 4,000 acres more or less, but most of the work is confined to the Central and other parks of the city proper. Two men, with the entomologist, constitute the working force, save when the Orgyia cocoons become very abundant. then laborers assist in their removal.

The work is continued the year round every day save Sundays and an occasional holiday. A one-horse spraying machine carrying 2½ barrels of liquid is used for the ordinary work of spraying, and a one-horse machine with a powerful force pump for knocking off plant-lice, cottony scale, etc. Various other tools and appliances are used for the removal of egg masses, webs, bag worm cases, larvæ, etc. The poisons used are those that are now quite commonly accepted to be the best, viz, London purple, Paris green, kerosene, crude petroleum, crude carbolic acid, bisulphuret of carbon, hellebore, pyrethrum, and others. The insect that requires the most attention the year round is *Orgyia leucostigma.* This species is reduced in several ways.

(1) By hand-picking, by which means barrels of the cocoons and egg masses are removed each year. This work is carried on through the entire winter, when all the parks have to be gone over and the trees put in as good condition as possible.

(2) By jarring the larvæ down with a pole so arranged that a blow from a mallet on a projection placed at the larger end of the pole will jar down any that may be on the limb.

(3) By poisoning the foliage with London purple, which is quite effective, and used especially on very large trees that can not be treated otherwise.

(4) By spraying the trunks of large trees that are covered with cocoons with an emulsion of petroleum and carbolic acid. This spray put on with force will penetrate most of the cocoons and destroy the pupæ or larvæ within and many of the eggs that may have been deposited on the outside. This last method is only resorted to when we are unable to subdue them in other ways. Large quantities of the cocoons of this insect are collected each year and taken to the arsenal, where the parasites when bred are allowed to escape from the windows of the building to continue their work of parasitism.

The bag-worm, that at one time defoliated whole sections of the park, has been so subdued that it no longer gives us much trouble. Barrels of their cases have been removed from the trees, and each year we remove all that appear in devastating numbers as far as it is possible to do so.

The European leopard moth (*Zeuzera pyrina*) is one of the worst insects we have to contend with. It works in secret, and not until the damage is done can we locate it. Last season we spent two months on this insect alone, collecting and destroying the larvæ and pupæ. All the affected limbs were collected, the insects removed, and then the limbs were taken to the dump and destroyed by fire, in this way making the work complete. A great many wagon-loads were so collected and destroyed, and this work manifested itself this year in the lesser number of trees affected. This year we continued the work of collecting, but were only able to give two weeks to it, but with the aid of the gardeners we were able to destroy a great many. I believe the work we have done with this insect alone has saved thousands of trees in our parks that would otherwise have been either destroyed or deformed. This question is a serious one when we are considering such valuable representations of our Silva as are collected in our city parks, for when a limb is amputated by this insect the stub is most sure to die, and if the fungus does not immediately take possession of it, it will be amputated by a so-called gardener, who does not see the advisability of protecting the scar from fungi and insects; and here is offered a field for the greedy fungi, whose ever-present spores are ready to grow when the proper field offers itself, and they hardly ever fail to take possession and all over our fine elms can be seen with groups of *Agaricus ulmarius* in all stages of growth. This close pruning, without proper protection from insects and fungi, is one of the most important questions of our times, for every year great numbers of trees are destroyed for want of proper protection and a knowledge of seasonable pruning.

Right here the sap-fly, which I take to be *Mycetobia pallipes*,* finds congenial habitat, and hundreds of trees are weakened by the flow of sap they cause, besides being unsightly from the slimy frass running down their sides. Those we treat with a crude carbolic-acid emulsion sprayed over them; after a time, however, they again show themselves, and have to be treated again.

The elm leaf-beetle is another pest that we have to fight, but with the force of two men, and miles of ground to cover, it is very difficult to keep this insect in subjection. Our success has been in preventive measures rather than otherwise. However, we do successfully destroy them when they have spread over the entire tree. As soon as the first eggs are discovered on the leaves, about the 1st of June, we immediately poison the foliage and keep them from spreading. When the larvæ come down to pupate and collect at the base of the tree, we treat them by spraying with an emulsion of kerosene and crude carbolic acid. In this way we destroy bushels of them, and with the spraying are able to keep them in check in our city parks.

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*Mr. A. D. Hopkins says it is probably a species of Sciara.—E. B. S.

The pine Chermes (*Chermes pinicorticis*) is another insect that is giving us a great deal of trouble, but we can subdue it most effectually with a stiff spray. The tree is then treated with the kerosene emulsion, and also those insects collected or washed down around the base of the tree. This has to be done at least three times a year. For the past seven years I have been using the stiff spray for different work, and it is one of the best means I know of for cleaning maples of Pulvinaria. Three years ago *Pulvinaria innumerabilis* was very abundant on a great number of trees in our parks, and I treated them with the hose and emulsion until I had them in fair subjection. The Chermes and Pulvinaria were at one time taken off with corn brooms, but the spray is much more effectual, and gets in among the small twigs without breaking them.

Scale insects are treated with washes and taken off with steel brushes, and are also sprayed with an emulsion, which covers the smaller branches. *Eriosoma rileyi* is common on our young elms, and these are treated with the kerosene and carbolic emulsion.

The larvæ of the larger silk producers are collected and destroyed, as well as the cocoons. Datanas are collected by hand, as they are assembled in masses, and destroyed. The web-worm, always abundant in our parks, is collected either by taking down the twigs or, if the tree is a valuable one, by twisting them out and crushing the larvæ.

Alypia octomaculata is abundant where Ampelopsis is grown. These are effectually destroyed with the London purple solution.

The catalpa trees have been affected by a species of Cecidomyia, which causes the ends of the branches to turn black and break off. These are collected every year and destroyed before the larvæ leave the twigs. Leaf-skeletonizers are always abundant on many of our trees, and the Platanus and Liquidambar species have suffered most. These insects are cut off as soon as they can be seen working and destroyed. If left for any length of time they make the tree very unsightly.

Aphis species are treated with the kerosene emulsion after the colonies have been broken up with the stiff spray. I have found it impossible to get an emulsion to act upon many of the plant-lice on account of the secretion; but let me play the hose on them a short time and they are disintegrated and demoralized, and many are killed outright by the shock; then a fine spray of emulsion will reach them more effectually than otherwise. The more I have occasion to use a force of water the more I see the benefits that will accrue from it, especially in economic entomological work, for larvæ of many kinds can be knocked down by it, and my men have brought me birds that they have knocked out of a tree and captured.

Other insects that are working on the foliage and in the stems of our plants we have in great numbers, but enough has been said to give an idea of some of the work we try to accomplish. Could we have sufficient force to do the work at the proper time there seems to be no reason why our parks could not be kept in the best condition, but with a force of but two men, with the entomologist, the wonder is that even a respectable showing can be made and the vegetation kept in as good condition as we now find it.

Mr. Howard said that he was very much interested in Mr. Southwick's account of the use of water as an insecticide and referred to some experiments in the same line which he had conducted, in which he showed a strong stream of water to be an effective agent against the rose slug and certain other insects.

Some discussion followed on the nature of the work and the probable species of the sap worm described by Mr. Southwick, which was thought by Mr. Lintner to be probably a species of Sciara.

Mr. Southwick then read the following paper:

THE WOOD-LEOPARD MOTH IN THE PARKS OF NEW YORK CITY.

By E. B. Southwick, *New York City.*

This very destructive insect is now thoroughly established in the parks and places of New York City, and is yearly doing an immense amount of damage.

This Zeuzera was first noticed by me in Central Park in the year 1884,* when the gardeners brought me a large larva, which they had taken from an elm limb. At the time I did not know what insect it was. It resembled somewhat the larva of *Xyleutes robiniæ*, and I thought it might possibly be that species which had taken to a new food plant, as it was known to bore into the trunks of willow, oak, locust, poplar, and chestnut.

Although numbers of the moths had been taken at electric lights, and the larvæ had become more abundant, yet it was not until 1889 that the real species was found out. Mr. Angelmann, of Newark, N. J., was the first to obtain the imago from the larva, and these were identified as *Zeuzera pyrina*, or *Z. æsculi*, as some authors have it. This fact was noticed in an article by Prof. John B. Smith, published in Garden and Forest.

This insect has now become one of the worst pests we have to deal with, and already the trees and shrubs are becoming deformed from the effects of their disastrous workings.

They are already affecting more than 20 species of trees and shrubs, and none seem to be exempt save the evergreens, and possibly a few others.

Even quite small shrubs are affected by them, which no doubt occurs from the fact that the gravid female is blown from the trees, and being

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* Published in the New York Independent, October 1, 1891.

unable to fly very far or high, deposits her eggs in the first suitable place that offers. I have but little doubt that the larva, when getting too large for the branch in which it is feeding, migrates to a larger branch, as affording sufficient room for its development, for in my insect room, where the specimens are kept for breeding, they often do migrate from a small branch and eat their way into a larger one, and they have even eaten into the yellow pine flooring and covered themselves with their frass; one migrated nearly 30 feet and went into the white pine window-casing, where it remained until it pupated, and emerged as a moth. Experience has shown in a great many cases that they are amply able to take care of themselves, and when in their burrow and drawn up the thoracic and anal shields form perfect opercula impervious to all external enemies.

The family of Zeuzeridæ are very remarkable from the fact that the females have a long and quite hard ovipositor, by means of which they, probably, are able to introduce their eggs into the soft tissue between the bud and the node on which it is situated so that the young larvæ when hatched can without much difficulty enter the twig to feed upon its interior. In Europe it is recorded as feeding upon six species of trees, and an English writer has made the statement that fruit trees pierced by this insect bear even more abundantly than do those untouched by it. However this may be, most of the limbs affected break off entirely with us, provided the larva attains its full growth, for it then, in many cases girdles the limb, when a storm is most sure to break it off. After every storm great quantities of limbs can be seen either entirely broken off or still hanging on the trees. In 1893 we spent two months in fighting this insect alone in our city parks, collecting wagon loads of limbs and branches, and destroying the larvæ or pupæ, as the case might be.

This is one of the most difficult insects we have to keep in check, for it works in secret and does not disclose its whereabouts until the damage is done, disfiguring and destroying many of our most valuable shade and ornamental trees, and particularly our beautiful American white elm, which, if not killed outright, is thrown out of character by severing its leading branches. In many cases the entire head of the tree is severed from the trunk, and it may have attained a diameter of six or more inches.

Again we find as many as six larvæ in a single tree but three inches in diameter, any one of which is able to destroy the tree if not removed. These are cut out as soon as detected, and all the young elms undergo a rigid examination three or four times a year. A system of lights has been projected for use in the Central Park, but as yet the means to the end desired has not been given. The light would attract many males of this species and some females, but most of the females are too heavy to fly far, or at least seem to be unable to when in captivity, but the lights would attract other noxious moths which could be easily taken in traps. This insect, working in secret, can only be destroyed by cutting down the limb affected; or, where the tree is small and very rare and we can locate it, I have put in bisulphuret of carbon and puttied up the hole, thus killing it in the burrow without severing the branch. This remedy can be used in the trunks of small trees, and is very effective. With an oil can the carbon can be introduced without difficulty.

Mr. Smith remarked that the habits of the larvæ in wandering or migrating into old burrows, mentioned by Mr. Southwick, is paralleled in his experience by certain Cossid larvæ, with which he had observed at various times an exactly similar habit.

Mr. Howard inquired if anyone could give the present distribution of the European leopard moth in the vicinity of New York.

Mr. Smith said he was confident it had not yet reached New Brunswick, but possibly had extended as far as Elizabeth, N. J. He said it had been reported by Col. Nicolas Pike as occurring in Connecticut.

In the absence of Prof. F. H. Snow, of Lawrence, Kans., the following paper was read by Mr. Lowe:

WORK IN ECONOMIC ENTOMOLOGY AT THE UNIVERSITY OF KANSAS FOR THE SEASON OF 1894.

By Francis H. Snow, *Lawrence, Kans.*

WORK WITH CHINCH-BUG INFECTION.

The principal work in economic entomology conducted by this University during the present season has consisted of a continuation of the laboratory and field experiments for the destruction of chinch bugs by *Sporotrichum globuliferum*. At the date of the present writing upward of 6,000 individual farmers have been supplied with Sporotrichum from our laboratory since April 15, 1894. In addition to the supply of individual farmers, thirty-six substations have been supplied with the material for the starting of the work of infection in as many different counties in the States of Kansas, Missouri, and Oklahoma Territory. The material necessary for supplying the large number of orders has been manufactured in thirty infection boxes, kept constantly in operation since the opening of the season, about the middle of April. Live, healthy bugs from the fields have been killed by Sporotrichum in these infection boxes, and their mummified bodies have been distributed to the farmers with instructions to each individual to establish a separate infection box for himself similar to the boxes in use at the University laboratory. An improvement adopted the present season in the infection boxes has been the spreading over the bottom of each box a layer of moist soil about an inch in depth. This seems to afford conditions for the propagation of the Sporotrichum more in accordance with the natural conditions which prevail in the field. We have included in every package of infection sent out from the laboratory at least six or eight dead bugs with the full external growth of the Sporotrichum. The attacked area in the State of Kansas has moved northward from the area most destructively infested last year. The southern counties of the State, where the bugs were quite destructive in 1893, and where large quantities of Sporotrichum were sent from our laboratory, seem to be comparatively free from chinch bugs in 1894. Our station is located in about the center of the eastern fourth of the State, and for the first time since the beginning of our experiments the chinch bugs have attacked fields in the immediate vicinity of our laboratory. This gave us the first opportunity of conducting an experiment which could be under our own personal daily supervision from beginning to end. Inasmuch as this may be taken as a standard example of the manner in which the Sporotrichum works in the field, I will append the following notes:

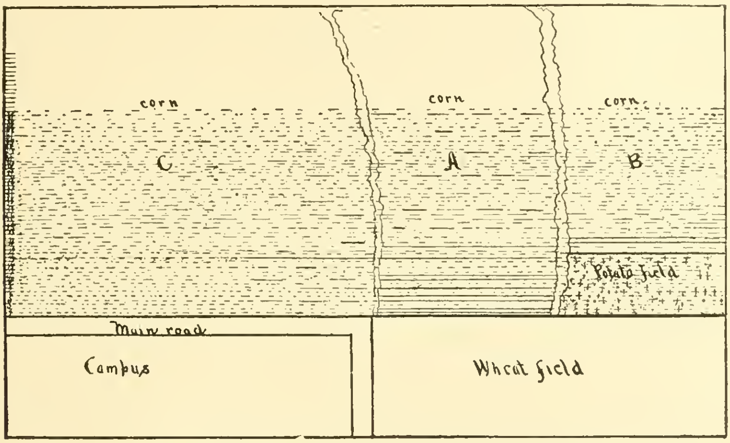

FIG. 18.—Diagram of field infested with chinch bug (from sketch by F. H. Snow).

The field experimented upon was a corn field 100 rods in length, a portion of which joined the University campus, and the remainder a wheat field from which the wheat was cut on June 20. The above diagram will give the relative position of the fields and will illustrate the accompanying explanation:

When the wheat was cut it was noticed for the first time that chinch bugs were abundant in the wheat. They moved immediately from the wheat field into the adjacent corn field belonging to another owner. The bugs were first noticed by him in the corn in large force, in both A and B, blackening the stalks, on Saturday, June 23. The bugs were in about 20 rows in A and about 10 rows in B. The strip of potatoes between corn in B and wheat field had hindered the bugs in their progress into B. The contents of one of the laboratory boxes of the 24 by 36 by 6 inches dimensions was taken out, earth and all, and used for the infection of these fields on the morning of Saturday, June 23. In field A the infection was put in the axils of the leaves and at the bases of the stalks of every hill of rows 4 and 5, and 7 and 9. In field B the same was done for rows 2 and 3.

Search was made before distributing the infection for possible Sporotrichum bugs, already spontaneously in the field, but none were found. Previously to June 23 there had been frequent rains, so that the ground was moist at this time. On the night of June 23, heavy rain fell, and again on the afternoon and night of June 24. The afternoon rain was accompanied with heavy hail. Some of the stones were an inch in diameter. The night rain of the 24th was driven by a strong west wind, so that the corn was laid flat in places. The field was visited on the afternoon of the 25th and the bugs were found in as good condition and as numerous as when first noticed on the 23d. It was the intention to scatter more infection on the 25th, but a rain storm came and further infecting was deferred. On the morning of June 26 a bucket of soil was taken from the infection box and scattered in each hill of rows 9 and 10 and row 15 of field A. At this time the bugs appeared in good condition, and no signs of the spread of the infection were apparent. The bugs had advanced somewhat into field C, and infection was scattered down row 15 of this field for the few rods the bugs extended, and also in different places in row 15. The morning of June 26 was warm and clear.

On the morning of June 28 a bucket of earth from the infection box was scattered at every alternate hill through row 18 of field A, and at intervals of every two or three hills through rows 1 and 2. Only a few Sporo bugs could be found. The bugs were working in great force. Under clods and fallen stalks and leaves large numbers of the bugs were gathered for molting. Most of the bugs on the standing corn were black larvæ and pupæ, but there were a few red larvæ and a few old winged and newly-molted winged individuals. The morning clear and warm. A slight shower on the night of the 27th. Earth moist in the field.

July 2: Bugs from the infection boxes sufficient to infect each hill for two rows were scattered in field A where the bugs were thickest out to the fifty-second row, the bugs having extended to that distance. A few white fungous bugs could be found at nearly every hill. The bugs were apparently not more than half as numerous as when the field was first infected, but they had scattered as far as the fifty-second row, and this may account for the apparent decrease. Bugs are continually hatching and molting at this time.

July 5: There was a heavy rain on the morning of the 4th. Bugs covered with Sporotrichum can be found in great quantity under fallen cornstalks and clods. One and one-half gross of pill boxes were filled from the field today. The victims are chiefly old bugs, but not all.

July 9: More Sporo bugs were scattered along the advance line of the chinch bugs. The bugs had made very little headway since the 2d of July. From 2 to 3 gross of infection boxes are filled with Sporo from this field daily. The bugs, both old and young, seem to be but sparingly present in the field. Here and there a very few live bugs may be found in the axils of the leaves and under clods.

July 13: The Sporo is continually increasing in the field, but there is a larger number of live bugs on the corn in places than could be seen on the 9th.

July 16: There was a heavy rain on the 15th. There are plenty of Sporo bugs for picking, and pickers are still at work and have not ceased since they began on the 5th.

July 18: Sporo is increasing over the field, but the bugs are numerous in occasional spots throughout the field. These bugs are of all ages, but adults greatly predominate. The dead bugs or mummies gathered by the pickers now include large numbers of little red bugs as well as the pupæ and the adults.

July 22: A visit to the field shows the live bugs reduced to a satisfactory minimum; probably not more than 1 to 2 per cent of the number which blackened the stalks for from 2 to 3 feet above the ground for 20 rows when the infection was first introduced. The entire field promises an abundant crop of corn and even the outer rows where the attack was most severe are well eared and luxuriant in foliage.

From this field the pickers have already gathered 7,000 boxes of Sporotrichum-covered bugs as a reserve stock for early distribution to the farmers for use in the wheat fields in the spring of 1895. If in every township in the State of Kansas infested with chinch bugs a similar gathering should be made by the township trustees and distributed to the farmers early in the spring the chinch bug, in my opinion, would soon be reduced to an uninjurious minimum.

A NEW ALFALFA AND WHEAT PEST.

On March 24, 1894, Mr. Ezra Main, of Jewell City, Kans., forwarded me a box of cutworms, stating that these worms were destroying the wheat in his neighborhood, taking it clean as they went.

On March 31, Mr. William H. Chance, of Linda, in extreme western Kansas, forwarded me a box of the same species of cutworm, stating that they were in his wheat by the million and destroying it rapidly. I sent my son, Mr. W. A. Snow, to examine the situation, and append his notes as follows:

March 30: Visited field of wheat about 3 miles southeast of Jewell City, with Mr. Ezra Main, the correspondent. Hot winds had prevailed for several days prior to my visit, and the frost and wind had injured the wheat in that part of the State. Wheat was only 3 or 4 inches high and much of it lying flat. The field attacked by the cutworms belonged to Mr. John Lamon. His wheat had been taken clean for several rods into the field. The day of the visit was warm and sunshiny. The worms were not visible on the surface of the ground, but burrowing a couple of inches deep I found them in some places very thick, in other places scarce. Mr. Lamon stated that a few days before they were observed in great numbers crawling on the surface. The worms entered the field from an alfalfa field on the south line of the wheat field. In this field the alfalfa maintained a very poor, thin growth, and the same cutworms were found working in it. Went to next farm south, where there was a large field of alfalfa about 1 mile from the first field. Here the worms were much thicker in the alfalfa than in the first field mentioned. Here, also, they were to be found just below the surface of the ground at the base of the alfalfa stems. Found many worms under cattle chips and other refuse. The worms evidently originated in the alfalfa and proceeded to the wheat. Visited four or five alfalfa fields around Jewell City, east and north, and found the cutworms in every field.

My son brought a large number of the worms to our laboratory, and in due time an Agrotis moth, which proved upon comparison with specimens in the Agricultural Department at Washington to be *Agrotis introferens* Gr. I was informed by Mr. Theo. Pergande that specimens of this moth had been received by him in 1893 from Stillwater, Okla., and from Lucerne, Kans., but no information had been received with reference to the habits of the larvæ. Making several trips to different points in central and western Kansas during the month of May I found the moths of this Agrotis exceedingly abundant, gathering about the electric and other lights at night and almost darkening the windows of barns and other outhouses. This invasion of central and western Kansas by an Agrotis, which, during twenty years of diligent collecting in Kansas, had never obtained an entrance into my cabinet, was certainly rather remarkable.

Mr. Smith reported that the noctuid larva referred to by Mr. Snow had been, on the authority of Mr. Gillette, very abundant in Colorado; and Mr. Howard referred also to its occurrence in enormous numbers in Nebraska, where the alarm created by it had not been due to the larvæ, but to the presence of enormous swarms of the moths.

On motion, the following committee was appointed by the President to nominate officers for the ensuing year: Messrs. Lintner, Ashmead, and Hopkins.

Mr. F. W. Rane, of Morgantown, W. Va., was proposed for active membership by Mr. Hopkins, and duly elected.

MORNING SESSION, AUGUST 15, 1894.

The first paper was by Mr. Hopkins, as follows:

NOTES ON SOME DISCOVERIES AND OBSERVATIONS OF THE YEAR IN WEST VIRGINIA.

By A. D. Hopkins, *Morgantown, W. Va.*

In this paper I shall endeavor to give a brief summary of some observations of the year in West Virginia, which may be of interest to economic entomologists. As the year is meant to include the time between the Madison meeting and the present, I will also add some observations made at Madison and at other points out of the State.

A Buprestid borer affecting oak trees.—Quite a serious trouble, affecting different species of oak in and around Madison, was observed, which caused the death of isolated and groups of trees of different ages. Upon examination, I found the larva of *Agrilus bilineatus* quite common in the bark of most of those that were just commencing to die. I also observed what appeared to be this same trouble at different points through Ohio, Wisconsin, and Indiana; and upon my return to West Virginia I noticed a number of trees dying in the same manner; one of which I examined, September 10, and found the larva of the same Agrilus mining through the inner living bark and outer sapwood. From what I have observed up to the present date with reference to the habits of this insect, it is very evident to me that it is capable of attacking and killing healthy oak and chestnut trees, and should the conditions at any time be especially favorable for its increase I anticipate that serious trouble will result from its attack.

On the habits of Corthylus punctatissimus.—While on the excursion to the Dells of the Wisconsin, on August 18, I observed numerous hazel, sassafras, and a species of dogwood that had been killed or were dying from the attack of *Corthylus punctatissimus.* All stages of the Scolytid were found in their galleries in the base of the infested plants. On September 6 the same species was observed near Evansville, Ind., where young sugar maple, water beeches, ironwood, and black gum were being killed by it. On September 24 dead examples of this insect were found in the base of living sassafras saplings over two inches in diameter near Morgantown, W. Va. Two annual growths had formed over the entrance to the galleries, thus proving that the species does not necessarily kill the plants in which they breed.

A Buprestid borer affecting oak twigs.—September 4 to 6, different species of oak, were observed around Evansville, Ind., to be affected with a rather serious trouble, resembling twig blight. The unusual appearance of the affected trees was attracting considerable attention. I found that the trouble was caused by a minute Buprestid, evidently an Agrilus larva. Numerous infested twigs were collected, but I failed to breed an adult. The same thing was subsequently found killing the twigs on oaks in Wood and Monongalia counties, W. Va.

A Lima-bean borer.—September 8, a Lepidopterous larva was found causing considerable damage to Lima-bean vines in Wood County, W. Va. The larva was about one inch long, the body uniform purple above and light blue beneath. It occupied about two inches of the vine, causing a swelling or kind of gall, in this respect resembling the habits of the common stalk-borer (*Gortyna nitela*). When more than one larva occurred in a plant it died from the injury. I also failed to rear the adult of this insect.

Indications that Cyllene picta emerges in the fall.—September 24, a hickory log was observed that had been cut in the spring of 1893 which was infested with great numbers of the larvæ and pupæ of *Cyllene picta*. Numerous holes in the bark indicated that adults had emerged. None could be found in the wood, however; but fully matured pupæ were found. If the imago of this species does emerge in the fall the fact is probably unrecorded.

The Columbian bark-beetle.—October 7, I discovered the Scolytid which I subsequently described under the name of *Corthylus columbianus*. This insect and its work was the subject of a special investigation, which led to the determination of numerous heretofore unknown facts with reference to defects in wood caused by insects and other agencies, some of which are mentioned in Bulletins 35 and 36 of our station, and others will be mentioned in this and other papers to be read during the present session of the American Association.

The investigation led to the discovery that what has been considered a serious defect in lumber, causing an immense loss to lumber manufacturers, is not, in fact, a detriment in material for certain uses, but, on the contrary, may be desirable. Considerable interest has already been manifested by manufacturers, house and furniture builders, regarding the statement of this fact in Bulletin 36 of the West Virginia station, and the indications are that a demand will thus be created for oak, "yellow poplar," and other woods containing the natural stains resulting from the attack of this insect. If so, the amount saved to the lumber manufacturers and owners of timber in our State will be inestimable.

Injury to wood by woodpeckers.—While studying the work of the Columbian timber-beetle I discovered that woodpeckers cause an injury to the outer sapwood of living trees which results in certain characteristic defects which reduces the value of the lumber and causes considerable loss. While examining the work of the birds I found that the punctures made by them in the bark of growing tulip trees caused a wrinkled or knotty condition in the surface of the wood beneath the bark. This led to my discovering, in a few days after, that an unnatural and much admired condition of the wood, known as "curly" or "birds-eye" poplar, was the result of the injury in the bark by woodpeckers.

The potato-scab gnat.—During November I obtained a fresh supply of material for the continuation of an investigation, commenced in September, 1891, to determine the relation of certain dipterous larvæ to the so-called potato scab and to certain other injuries to the potato tuber. This investigation has resulted in the determination of some interesting facts, among which I may mention in this connection the following:

First. That two species of so-called fungous gnats Mycetophylidæ, one a Sciara, the other an Epidapus, will attack and feed upon healthy vegetable tissue; a fact regarding the habits of the Mycetophilid which, I believe, has never before been demonstrated. It was also determined that the latter species, which I have described under the name of *Epidapus scabies*, will develop from eggs to imago in the healthy or sound substance of potato tubers.

Second. That the larva of *Epidapus scabies* will cause injuries in the outer portion of potato tubers which would be recognized as so-called potato scab, and that under favorable conditions they will feed upon the tubers until all but the epidermis is consumed.

Third. That the presence of stable manure and decomposing vegetable matter in the soil, together with moisture, are the most favorable conditions for the presence of these insects, and that under such conditions serious loss is caused by them to potato growers.

It may be of interest to note that the male of *Epidapus scabies* is the first male of the genus ever recorded, although the genus has been known in Europe for over fifty years. Some of the results of the investigation were presented to the newly-formed State Horticultural Society on April 6, and in a paper read before the Washington Entomological Society on May 3, 1894. In the latter a full description, with illustrations of all stages of the species, was presented, and will be published in the Proceedings. The former will be published in the Proceedings of the State Horticultural Society.

The following observations not noted in the above papers may be mentioned here: On February 3, a Proctotrypid, determined by Mr. Ashmead as *Ceraphron basalis* Ashm., was observed to be quite common in company with the Epidapus in the mushroom beds and on the floor in the greenhouse. It was also reared from manure infested by the scab gnat. It is, therefore, probably a parasite of this species.

Several species of Staphylinidæ were also common in the beds infested by the Epidapus, and as they increased in numbers the gnats decreased, and finally became so rare that it was scarcely possible to find an example. *Philonthus longicornis* Steph., *P. nigritulus* Grav., *Xantholinus cephalus* Say., and *Homalota lividipennis* Mann., all determined for me by Mr. Schwarz, were among the species met with in the manure, *X. cephalus* and *H. lividipennis* being especially common.

A Cerambycid in walnut wood.—January 18, an undetermined Cerambycid larva was found inhabiting the sound heart wood of living black walnut. This, together with large species of black ants which enlarged the mines of the wood-boring larva, cause serious damage in this valuable wood.

Pin-holes in poplar wood.—January 20, I received from Pickens, W. Va., a piece of sound yellow-poplar wood containing an example of *Xyleborus pubescens* Zimm., which served to explain the cause of a serious trouble complained of in poplar lumber, sometimes causing the loss of thousands of dollars to poplar manufacturers. It appears that the beetle is either in the log when the lumber is sawn or it enters the lumber directly after it comes from the saw. It continues to work in it for some time after, boring it full of minute pin holes, thus reducing the value of the lumber. *Xyleborus pubescens* is a remarkable insect in its habits and distribution. It appears that it will infest the wood of all kinds of trees, and that it is widely distributed over the world. It is probably the same species as the one which is so destructive to sugar-cane and wine casks. It is my belief that Zimmerman's name and a number of other names given to slightly varying forms of the genus must give way to Wollaston's name applied to the species he described in 1857, now known as *Xyleborus perforans* Wall.

On February 3, Prof. Rane called my attention to swarms of small "gnats" in the station greenhouse. Upon examination I found that they were Braconid parasites of *Aphis brassicæ*, which was very abundant on the radish and lettuce leaves. I also found that the method the gardener was using to destroy the lice, i. e. smudging with sulphur and tobacco, was killing the parasites as well. Realizing the opportunity offered for an experiment to determine the value of the parasites as a natural check against the Aphides, I requested that the smudge treatment be discontinued. The experiment proved to be a complete success. Within a few days we could see that the parasites were gaining on the Aphides, and within two weeks the numbers of the latter were greatly diminished and had ceased to be particularly injurious, and they were kept under control by the Braconids until all the vegetables were removed from the house. Specimens of the Braconid were sent to Mr. Ashmead, who pronounced it a new species and named it *Aphidius lactucæ* n. sp. If this insect makes its appearance next winter in the greenhouse, we will attempt its introduction into other greenhouses as a method of combatting this serious hothouse pest.

The clover-leaf weevil.—On April 18, we received specimens of the larva of the clover-leaf weevil (*Phytonomus punctatus*) from Berkeley and later from Hampshire counties, W. Va., with the statements that the clover in that section of the State was being destroyed by the insect. Upon investigation, on May 4, I found the fungus epidemic had struck them a few days previous to my arrival, and the leaves of the clover, the dead weeds, etc., were covered with the dead and blackened bodies of the larvæ. Scarcely a living example of the insect could be found.

A Lepidopteron feeding on scale insects.—May 7, a Lecanium scale insect was observed on the twigs of scrub pine in Hampshire County, and a lepidopterous larva was found feeding upon the scales, after covering a number of them with its web. Several examples of the imago of this larva were reared and the species was determined by Messrs. Schwarz and Pergande as probably Comstock's *Dakruma coccidivora.* Subsequently, I observed apparently the larvæ of the same species feeding upon a similar scale on tulip tree twigs in Wood County.

Insect injurious to tan bark.—May 15, I received a piece of chestnut-oak tan bark from Mr. G. Paunall, of Hampshire County, which had been eaten by a bark-boring larva. Mr. Paunall, who is a dealer in tan bark, informs me that this injury is of common occurrence in bark three or more years old. Upon examining some old bark at a tannery in Morgantown, I found that the larva, which is evidently a Cerambycid, is indeed a destructive pest. No living examples could be found at work, but from the number of elytra present, evidently of *Phymatodes variabilis,* I am led to believe that this species is to blame for the trouble.

The chestnut timber-worm.—On June 3, I discovered the pupa of the chestnut timber worm in chestnut trees and stumps near Morgantown, from which the imagos emerged June 12 to 15, and proved to be the rare beetle, *Lymexylon sericeum*, and on June 20 I cut male and female examples of the same thing from a chestnut tree in Wood County. This result will be of interest to Coleopterists from the fact that it explains the mystery regarding a larva first described by Harris (Injurious Insects, p. 68) as that of *Eupsalis minuta*, subsequently figured by Riley, Sixth Missouri Report, as an undetermined Tenebrionid and correcting Harris' mistake. The same larva was figured and mentioned by me in "Hardwood," of February 25, 1893, as an undetermined, and probably a new Lymexylid. Also in my catalogue of West Virginia Forest and Shade Tree Insects (p. 190) as a "Lymexylid larva sp. a.;" and in a paper read before the Washington Entomological Society, October 5, 1893, I referred to the larva as a Lymexylid, basing my conclusions upon a microscopic study of the mouth parts and other external characters in comparison with the larva of *Hylecœtus lugubris.* In the discussion, Messrs. Riley and Schwarz thought that it must be a Tenebrionid, and that it would probably prove to be the larva of Strongylium. This, together with Prof. Riley's subsequent statement in a letter November 23, 1893, that he had tentatively referred the species to Strongylium led me to mention it in the index to Insects, Bulletin 35, as "Strongylium sp. (?) Riley, family Tenebrionidæ." That it should prove to be the larva of *Lymexylon sericeum* was a surprise to us all, and is of especial interest in being another example like *Corthylus columbianus* of an extremely rare insect in collections being the cause of one of the commonest defects in wood, and among the worst timber pests known. It is also of interest in showing Harris's error in concluding that the larvæ of American Lymexylids were the same as those of European species, an opinion which some European writers have interpreted as a fact. I agree with Mr. Schwarz in his opinion expressed in a recent letter that *L. sericeum* of this country and *L. navale* of Europe will show, upon comparison, different generic characters.

With reference to our *Hylecœtus lugubris* and the European *Lymexylon dermestoides*, I am confident that they belong to the same genus, since I have collected the larvæ and observed the character of the galleries of the latter species in the white spruce forests of the Jura Mountains in Germany.

My observations with reference to the habits of the chestnut timber-worm (a popular name which I prefer to retain on account of its especial injury to chestnut wood) leads me to believe that it remains in the wood a number of years before it attains maturity.

A Ptinid injurious to seasoned and old lumber.—On June 19 different stages of a Ptinid beetle, *Xyletinus peltatus* Harr., were found in a seasoned yellow-poplar board where they had done considerable damage. Subsequently I found that this insect does serious damage to siding, flooring, and timbers in barns and outbuildings, converting the seasoned wood, especially the sapwood, into a fine powder, thus materially weakening the timbers, and resulting in promoting decay when exposed to moisture. A Clerid larva and a Proctotrypid (*Scleroderma macrogaster* Ashm.) were found in the mines of the Xyletinus, but as two or three species of small Hymenopterous insects build their nests in the vacated mines of this insect, it is uncertain what the Clerid and Proctotrypid prey upon.

A Cerambycid injurious in tulip wood.—June 20 a large Cerambycid larva was discovered in yellow-poplar wood, which is to blame for serious damage to the heart wood of living as well as dead trees. It extends its irregular galleries in every direction through the solid wood, packing them as it goes with its finely powdered borings. The eggs from which this larva hatched are evidently deposited in some wound in the bark or wood, and they probably remain in the wood several years before developing.

Gas affecting shade trees.—June 28 I investigated a trouble among the shade trees in Parkersburg, W. Va., which was causing the death of a number of trees along the streets. No evidence could be found of a primary attack by insects, but the trouble appeared to be due to escaping natural or artificial gas.

The melon plant-louse.—On July 27 complaint was received with specimens from Mr. S. A. Gallaher, of Pleasants County, that the melon plant-louse, *Aphis cucumeris* Forbes, was destroying the melon vines in that section, where melons are one of the principal crops grown. On the leaf inclosed in the letter four pupæ and one larva of *Hippodamia convergens* were found, which indicated that this Coccinellid was common on the vines. Mr. Gallaher said in his letter that he had tried Paris green to kill the lice, but it did no good. Evidently he killed more friends than foes.

Study of sexual characters in Scolytidæ.—During the latter part of July and the first of this month I have been engaged in a systematic study of the sexual characters of species in the family Scolytidæ, which has resulted in the discovery of some new and interesting facts that I will refer to in a paper before Section F.

Conclusion.—In conclusion, I may say that at the close of this year I realize more than ever the importance of confining my energies as far as possible to one or two restricted lines of research. Owing to the fact that the products of the forests of West Virginia are among her principal natural resources, and that forestry, under some organized system of management, will become necessary in the future, I have felt that the study of forest and shade tree insects is the line demanding especial attention in our State.

I realize that I have a difficult and endless task before me in the study of this class of insects, and that considerable preliminary work on the obscure habits of many of the species must be done before the best results can be obtained, but at the same time it is a line rich in opportunities for original work, and in possibilities for doing present and future good in promoting the interests of forestry.

Mr. Smith referred to the melon aphis which had been abundant and destructive in New Jersey during the season. He has found Coccinellidæ in great numbers, but helpless as against the rapid increase of the lice. He has seen them, however, where there were half a dozen or more species at work cleaning them out completely. This was later in the season and the damage was done. Behind the ladybirds the vines were clear of aphides, but curled, withered, dry, and blackened, the fruit sparse, undersized, and dirty—unsalable, in short. Way in advance were the aphides attacking new vines. He had noticed that the Coccinellids and their larvæ exercised a nice discrimination, feeding on healthy lice only and leaving those that were parasitized or killed by fungus disease.

Concerning *Phymatodes variabilis*, he had made a number of observations in Ocean County early in the season, examining piles of cord wood. It is extremely abundant in wood that has been cut one entire year, and the larvæ work between bark and sap wood in such numbers as to loosen it, from which the woodmen call them "bark slippers." Sometimes the larvæ bore into the solid wood quite deeply and the pupa forms wherever the larva has been feeding. He has never found them in the bark, but this may be because there was not enough of it.

Mr. Hopkins said that in bark of two or three inches thickness pupæ were occasionally found entirely within the bark and not between the bark and the wood.

Mr. Smith further discussed the Sciara mentioned by Mr. Hopkins as breeding in mushroom beds and manure, stating that he had found a species very common in mushroom houses, and that it was particularly destructive to the bricks of spawn. The first brood of the insect breeds in these bricks and in the compost in which the mushrooms are grown, and the second and later broods take the mushrooms themselves. So serious were the attacks of this fly that only one crop, the first, can be successfully grown, the later crops being destroyed by the Sciara. The insect breeds in any decaying vegetable material, and the species had not been determined.

In reply to a question by Mr. Hopkins, Mr. Smith stated that both sexes are winged in the case of his species.

In reply to a question by Mr. Smith, Mr. Hopkins stated that he did not mean to assert that all the scab was caused by the Mycetophilid, but that it caused one kind of scab. Mr. Smith added that there were plenty of scabby potatoes in some fields in New Jersey, but though, after hearing of Mr. Hopkins's discovery, he had examined a great many, he had never found an insect associated with it.

The interrelations of Cerambycid larvæ and the woodpecker, and the nature of the injury produced by the bird in its attacks upon the larvæ, were discussed by Mr. Hopkins in answer to questions. Mr. Hopkins's paper was accompanied by the exhibition of many specimens of wood, showing the markings and work of the insects and birds described.

Dr. Lintner, after expressing his very great interest in the paper, said that the assertion that the Mycetophilidæ never attack healthy vegetation was somewhat erroneous, as, in the case of the mushrooms, they certainly did, and hence the difficulty, or impossibility, of growing this crop late in the season. He said also that the case of Aphidid parasitism mentioned contradicted Mr. Smith's stand in the matter of parasites, and he thought Mr. Smith might be more nearly right if he limited his conclusions to field insects; for certainly, in the case of indoor insects, parasites are frequently, as in the present instance, of exceptional and undoubted value. He asked also if the larvæ of the clover-leaf weevil, when affected by fungus, are not white in appearance.

Mr. Smith replied that the diseased larvæ are first gray and become black as they shrivel and dry up.

With reference to the twenty-seven-year life-period for the chestnut timber worm, Mr. Lintner expressed himself as regretting any possible competitor with the seventeen-year Cicada for the place of the longest-lived insect, because we have been so long in the habit of ascribing to this interesting species the longest period of insect development. He suggested that the Lymexylon case is very likely analogous to many others on record, of mere arrested development, in which the larva, removed from normal conditions, sometimes remains for years without transforming to the adult, as in the case of wood-boring insects emerging from furniture.

Mr. Hopkins suggested the deposit of eggs year after year in the same wounds as a possible explanation of the apparent long life-cycle of the insect. He also said that Mr. Walsh had reached conclusions similar to his own in the matter of the potato-scab larvæ, many years ago.

Mr. Kane, referring to the subject of parasitism, and to the particular case noticed by Mr. Hopkins, said that we had here an undoubted instance of the great value of parasites in the case of this lettuce crop, injury to which by the aphis was limited to the first crop, and in all the later croppings the louse was kept in almost complete check by parasites, so that no difficulty whatever was experienced.

The President read a letter from Mr. F. M. Webster, stating that he would be unable to attend the meeting on account of his active operations in attempting to stamp out the Fidia larvæ about the roots of grapes by the use of bisulphide of carbon.

Mr. Howard then read the following paper:

THE EASTERN OCCURRENCES OF THE SAN JOSÉ SCALE.

By L. O. HOWARD, *Washington, D. C.*

During the first week in August, 1893, Mr. B. T. Galloway, chief of the Division of Vegetable Pathology of the Department of Agriculture, brought me a pear which had been sent him by Dr. C. H. Hedges, of Charlottesville, Va., on account of what the sender supposed to be a fungus disease. I nearly jumped out of my seat at the first glance at this pear, for I immediately recognized that scourge of western orchards, the San José scale (*Aspidiotus perniciosus* Comst.), with which Eastern entomologists had, up to that time, been made familiar only through publications of the California State Board of Horticulture, and the writings of Prof. Comstock and Mr. D. W. Coquillett. As soon as possible, I informed Prof. Riley of the fact, and he wrote to the owner of the affected trees warning him of the serious nature of the insect, and also to the State Board of Agriculture of Virginia, announcing the appearance of the scale in their State. Two weeks later he presented a note on the insect at the Madison meeting of this association. Meeting Prof. W. B. Alwood, entomologist and botanist to the Virginia State Experiment Station, in Chicago, on the 20th of August, I also informed him of the occurrence of the insect at Charlottesville, in order that he might take steps looking towards its extermination. Two assistants in the Division of Entomology, Messrs. E. A. Schwarz and D. W. Coquillett, were sent by Prof. Riley to Charlottesville at different times in the autumn to examine into the exact conditions, and to report upon the number of infested trees and the means by which the insect probably became introduced. The reports of these two gentlemen were published in INSECT LIFE, that of Mr. Schwarz in volume VI, p. 247, and that of Mr. Coquillett in the same number, beginning on p. 253. It appeared from their examinations that the insect was very limited in its extent; that the few spraying experiments which had been instituted by Mr. Hedges had been unsuccessful; that the insect affected pear, peach, plum, apple, currant, rose, quince, gooseberry and raspberry, and that it must have been introduced several years previously, presumably upon nursery stock, and probably (in the light of what we have more recently ascertained) upon currants purchased from a New Jersey firm.

Inasmuch as the insect was found to be so limited, and to occur upon such a comparatively small number of trees, and they of small size, it was decided to postpone treatment until the early spring of 1894. In order to make a single treatment absolutely effective, tents for fumigating were constructed, and Mr. Coquillett, who was already experienced in the application of the gas process, was sent to Charlottesville early in March to conduct the operation. In the meantime Prof. Riley had consulted personally with the board of agriculture of the State, and an arrangement had been made to conduct the operation conjointly, as to the expense, the State Board furnishing the labor, and the Department of Agriculture furnishing the apparatus and Mr. Coquillett's services as overseer. The tents were constructed of eight-ounce duck, and were made in the form of an octagonal sheet. Two of them measured 44 feet in diameter, and two 28 feet. They were oiled with boiled linseed oil. On trees of six feet and under the tents were placed over by hand; on larger trees they were hauled over by means of a single upright post with a pulley arrangement. The operation was unique in the fact that, for the first time, the tents were to be put over leafless trees, and it was expected that some trouble would result from the breakage of the limbs; but with the exception of a few large pear trees, the branches of which were somewhat rigid and brittle, very little trouble was experienced. Each tree was fumigated for half an hour with hydrocyanic acid gas, made in the usual way. The trees were in a semidormant state, although some of them had put forth a few leaves, and a few peach trees were in full blossom, but none of the trees were injured by the gas. So far as I am at present informed, all the scale insects were destroyed.

During March, 1894, the proprietor of a large peach orchard at Riverside, Charles County, Md., brought to the office peach twigs covered with the pernicious scale. Prof. Riley was in the West Indies at the time, and I immediately sent an assistant, Mr. Marlatt, to visit the orchard. It was found that the farm is situated on the river front, and comprises about 288 acres, of which 20 are planted to orchard. In the orchard are 2,000 peach trees, with 250 apple trees intermixed with them. The older portion of the orchard was planted in 1882, in a strip along the river front. In the fall of 1887, 500 peach trees were planted on the western side of this strip, separated from it only by a low hedge. This stock was obtained from a New Jersey nursery, and it is believed that upon it the scale was introduced. Later (1891) a younger orchard was planted still farther on the west and adjoining the 1887 orchard.

The latter portion was originally free and in fine condition, and much of it is still uninjured by the scale, which has, however, spread from the northern older trees over the central portion of the newer orchard, many trees being so badly infested as to be killed outright. The New Jersey stock planted in the spring of 1888 is all thoroughly incrusted with the scale, and much of it has died, and at the time of the examination had been removed and destroyed. In the old orchard on the riverside more or less of the New Jersey stock of 1887 was used in replanting trees which had failed, and most of this orchard was found to be thoroughly infested with the scales, which examination showed had spread from the later replantings. In much of the central part of the older orchard the trees were found to be dead, having succumbed to the severe winter from the weakening resulting from the attacks of the scale.

Within a radius of two miles three other orchards were found on the river front, one of them on the farm immediately adjoining that containing the infested orchard. The trees in all three of these orchards were obtained, as were the 1891 trees in the infested orchard, from Redding & Ninde, of King George County, Va., and were found to be perfectly healthy and absolutely free from scale.

Some experiments had been made during the late winter and early spring with winter washes for scale insects, mainly against *Diaspis lanatus* and *Chionaspis furfurus*, from which it appeared that of the three principal winter washes (viz, strong kerosene emulsion; lime, salt and sulphur; and resin wash) the strong kerosene emulsion was most effective. The Riverside fruit-grower was therefore advised, more to relieve his great anxiety and keep him occupied than with any explicit idea that he would be able to exterminate the scale, to apply strong kerosene emulsion to a number of his dormant trees and report results. This he was unable to do until the trees were beginning to spring into life. Some trunk washings, however, which were conducted during April, showed that by the application of this remedy about 90 per cent of the scales could be killed without injury to the vitality of the tree, the standard emulsion being diluted with 4½ parts of water. It was then decided to delay further insecticide operations until the hatching of the young. The first young were noticed on May 19, and upon May 27 a portion of the infested trees were sprayed with a bucket pump. This spraying, however, was very carelessly done, as subsequent observation and examination showed. Not even all of the newly hatched young were killed, owing to the fact that the spray did not reach all parts of the tree. The females, viviparous in habit, gave birth to their young over quite an extended space of time; the young were continuously hatching for a full month. Ten days after the first spraying badly infested trees were swarming with newly hatched young and covered with others recently settled. A second spraying over another portion of the orchard was performed June 7. This was done a little more carefully, and destroyed the majority of the young larvæ. By the 19th of June all the fruit trees had been sprayed. The emulsion used was made by emulsifying 1 gallon of kerosene and half a gallon of hot water in which one-fourth of a pound of soap had been dissolved, after which a sufficient quantity of cold water was added to make 15 gallons in all. This dilution was insisted upon, owing to the susceptibility of the peach foliage to strong mixtures. The cost of the emulsion so made amounted to half a cent per gallon. On June 19 Mr. Coquillett was sent to Riverside to ascertain the reason for the poor success of the previous sprayings. It was found that a Climax bucket pump and a knapsack sprayer had been used, and that the workman who operated the knapsack sprayer could not be induced to pull down the handle of the sprayer hard enough to make a good spray, since to do this it would be necessary to pull down with considerable force upon his own shoulders. With the bucket pump he did better work, but even here one side of the tree was usually slighted. The experiments showed that 1 gallon of diluted emulsion was sufficient to treat 5 peach trees averaging 6 feet in height, and that one man could treat about 250 trees per day. On the 20th of June Mr. Coquillett had 26 trees sprayed with a resin wash composed of 20 pounds of resin, 5 pounds of 70 per cent caustic soda, 2½ pounds of fish oil, and water to make 100 gallons. This mixture was sprayed during the sunny part of the day upon trees treated with kerosene emulsion ten days previously, and resulted in the almost complete extermination of the insect. The resin wash was found to destroy the scales in a more advanced stage of development than the very dilute kerosene emulsion, while its work was more rapid. The rapidity of the work is of importance, since where a full-grown female is sprayed with kerosene emulsion she may live for three or four days, during which time she brings young; whereas, if sprayed with resin wash, fewer young scales are produced. The resin wash, however, is readily washed off by the rains, while the kerosene is more resistant. On the 28th of June Mr. Coquillett was again sent to Riverside and found that on the 26 trees treated with resin wash following kerosene emulsion absolutely all the scales were dead. In the meantime the owner of the orchard had sprayed all the remaining fruit trees a second time with kerosene emulsion, an interval of ten days or more having elapsed between the two sprayings. Examination showed that very few of the older scales were still living, while more recently hatched individuals were almost as scarce as the traditional hen's teeth. On July 22 a final examination was made. No living insects could be found upon the trees treated with resin wash, and so few upon those treated with kerosene emulsion that a third spraying would have undoubtedly freed the trees from the insects. The owner, however, was unwilling to go to the expense of a third spraying, but promised to thoroughly apply a strong wash in the early winter. The owner of this orchard is a very busy man, with many other interests, and all the operations were undertaken at his expense. He deserves much credit for the energetic way in which he attacked the difficulty, and it may be safely said that the orchard is at present practically innocuous as a center of dissemination, and that the insect will be completely stamped out by the close of the year.

During March further specimens of the San José scale were received from De Funiak Springs, Fla., through the entomologist to the Florida experiment station, Mr. P. H. Rolfs. Information concerning remedial measures was immediately sent both to the director of the station, Prof. O. Clute, and to the Fruit Growers' Association, Mr. G. W. Mellish, secretary, at De Funiak Springs. Recognizing the fact that this outbreak could probably be handled by the State experiment station, in coöperation with the Fruit Growers' Association, the Department was loath to undertake any other than advisory functions, and both organizations were so informed. The entomologist to the station, Prof. Rolfs, was sent by the director, Prof. Clute, to De Funiak Springs, and prepared a resin wash, which was used with some effect. The most badly infested trees in certain orchards were burned. In the meantime the fruit-growers, alarmed by the finding of the insect over a much larger area than was at first suspected, petitioned the Department of Agriculture at Washington to send an expert to the spot, to assist and advise with Prof. Rolfs. As one of my assistants, Mr. H. G. Hubbard, was at the time in Florida, conducting investigations upon the insects affecting the orange, he was instructed to proceed to Walton County and report the results of his examination. From a report which Mr. Hubbard submitted July 4, it appears that the scales are practically confined to the peach and plum, occurring, however, in small numbers upon Kieffer pears and also upon pecan and persimmon. The prevalence of persimmon shoots through the orchards constitutes a serious difficulty in clearing orchards of the scale, as they form thickets in waste places and fence corners, providing lurking places from which the pest will spread again to the peach trees. Mr. Rolfs had visited the locality and taken copious notes as to the extent of territory infested. According to Mr. Hubbard, he found many thousands of trees infested, and nearly every orchard within a radius of five or six miles more or less attacked. The efforts which had been made to keep it down were desultory and ineffectual. After an examination of the effect of the resin wash, which had been applied in varying proportions, even at the rate of equal parts of water and resin wash, many living scales were found in all cases. Mr. Hubbard recommended the standard kerosene emulsion, 1 to 9, and visited one grove where this was said to have been used in the course of spraying. He found it had been very effective, quite as much so as in the case of the purple scale on orange. A second application, however, had not been made during the month of June, and the scale was again increasing. It was further learned that the experiment station had arranged that Prof. Rolfs should go to De Funiak Springs with an entire outfit of pumps and spraying nozzles of the most approved pattern, and a skilled man was also to be sent there, who should remain in Walton County as long as his services are needed. The fruit-growers are to furnish materials and men, and a concerted effort will be made to go over all the infested trees in the district and make five or six applications of resin wash at intervals of about ten days. If these sprayings are carried out by an expert as promised, and if the operative is fortunate enough to hit upon a period of dry weather, there is every reason to suppose that the nuisance will have been abated by the close of the season in Florida, although extermination may not be found possible. If, however, the spraying is done during a comparatively rainy season there will be reason to regret that the kerosene emulsion was not used. Mr. Hubbard made further arrangements with Mr. Mellish to forward specimens to Washington at intervals of a week, so that the rate of development in Florida may be compared with the rate of development at the North, and details of this character I hope to publish at the close of the year.

In March, immediately upon the determination of the insects from Riverside, Md., as the San José scale, upon the receipt of the same species from Florida, and upon learning that, in the former case at least, the stock was in all probability purchased from a large Eastern nursery as long ago as 1887, I prepared a circular of warning and distributed it the first week in April to all Eastern agricultural newspapers and to nearly 12,000 Eastern fruit-growers, whose addresses I obtained through the kindness of Mr. S. B. Heiges, pomologist of the Department. The circular gave carefully drawn illustrations of the insect in its different stages, described its appearance, explained how it spreads, gave the known remedies, and urged upon fruit-growers the great importance of examining their orchards at once and sending specimens of suspected scales to the Department.

As the result of this widespread distribution and the wide dissemination of the warning by the newspapers, the division was for some weeks almost overwhelmed with packages containing scale insects of all kinds, from all sorts of plants, and from all parts of the country. Not only were scale insects received, but species belonging to many other groups, all the senders wishing to know if these were not the San José scale. The bark lice most abundantly received were the scurfy bark-louse, *Chionaspis furfurus*, and the common oyster-shell bark louse of the apple, *Mytilaspis pomorum*. I had previously supposed that every apple-grower knew this latter species, but this experience indicated a greater lack of familarity with the commonest forms than I had suspected.

As a result of issuing the circular, the following new localities for the scale were ascertained:

Neavitt, Talbot County, Md.; Chestertown, Kent County, Md.; Bartle, Washington County, Ind.; many points in New Jersey; Atglen, Chester County, Pa.; Lewisburg, Union County, Pa. Farther west the scale was received from Middleton, Canyon County, Idaho, and, through Mr. James Fletcher, from British Columbia.

The New Jersey investigation of the insect the Department of Agriculture has not touched. It is in the safe hands of Dr. Smith, who has promised a paper upon the subject for this meeting. He has also visited the locality at Atglen, Pa., and found that in an orchard of over 7,000 trees all of certain varieties and a few of others were infested by the scale. As a result of his recommendations, kerosene emulsion has been applied three times to most of the trees, at intervals of ten days, up to the first week in June. The treatment has been absolutely successful.

The other Pennsylvania occurrence was at Lewisburg, Union County. Dr. G. G. Groff, of the board of health, in 1890 bought one dozen Buffum pear trees from a New Jersey nurseryman. One after another died, until but one remained. Six months later he bought one dozen Lawsons from the same firm. Several of these were infested and afterwards died. The insects hatched prior to the time of writing spread slowly among the trees. The remedial measure adopted prior to writing to the Division was the dampening of a cloth with kerosene and wiping all the affected parts of the tree by hand. The orchard in this case was small, and the owner was able to destroy the majority of the insects by hand-rubbing. We advised him to spray with kerosene emulsion during June, but have not learned whether he considered it necessary to adopt this course. He seemed fully alive to the importance of the matter, and on account of his intelligence and scientific ability we have no doubt that he has exterminated the insect on his trees.

The Indiana occurrence was, as above stated, at Bartle, Washington County. Two young apple trees were found affected by the scale, and the owner burned them, previously cutting off twigs, which he sent me May 8. On the 26th of June he wrote that he had made a most careful examination and could find no more of the insects. These trees were bought and planted in the spring of 1891, and were purchased from a firm of New Jersey nurserymen.

The occurrence at Neavitt, Talbot County, Md., is in an equally satisfactory condition. The orchard is located on one of the inlets of the Chesapeake Bay, and contains about 14 acres. Specimens were first received May 19, and full directions as to remedies were sent. As a result the trees most badly infested were destroyed, and spraying operations were begun. During July we sent Mr. Coquillett to visit the orchard. He found that 10 acres were set out to peach trees eight years ago, that nearly all these trees are now affected by the San José scale and are in a languishing condition. At the time of setting out about two dozen were left over, and these were disposed of to a neighbor, who planted them in one corner of his orchard a short distance away. The remaining 4 acres of the first orchard are set out to peach, apple, plum, cherry, and pear, and range in age from 1 to 6 years. Almost every tree of these 4 acres is infested with San José scale, some of the youngest being very thickly infested. The place was in charge of a tenant, and accurate information as to the purchase of the several lots of trees was not obtained by Mr. Coquillett. The advice given was to dig up and burn all the trees on the ten acres and to spray the remainder three times at intervals of ten days with dilute kerosene emulsion as used at Riverside. The owner of the orchard has promised me in correspondence to carry out this plan. The oldest peach trees have never been productive, and many of them have already died, while the balance have suffered so severely from the attacks of the scale that it seems doubtful whether they will ever recover, even if rid of the pest. Careful examinations were made in the surrounding yards and orchards by Mr. Coquillett, but the scale was found to be confined to this one orchard. I visited this orchard on the 28th of July and found matters exactly as represented by Mr. Coquillett. In this orchard the originally infested trees do not seem to have come from either of the two New Jersey firms, who are, with little doubt, responsible for all the other cases mentioned, excepting, possibly, the Florida one; but it is interesting to note that the first affected trees introduced, as I am informed by the owner, are supposed to have been received from a Missouri nurseryman.

In the third infested locality in Maryland, namely, Chestertown, Kent County, comparatively few trees are affected. It was discovered in this orchard by Mr. Marlatt, whom I had sent to investigate the pear-tree Psylla. He tells me that the owner of the orchard, in 1890, purchased between 200 and 300 trees from a New Jersey nurseryman. They were poor trees, considered by the dealer as the best of his second-rate trees. They were planted after pruning, and about half of them died before spring. The dead ones were replaced by trees in excellent condition, purchased from Ellwanger & Barry, of Rochester, N. Y. Across the road he put in later a younger orchard, also from Ellwanger & Barry. At the present time about half a dozen of the trees in this younger orchard are affected. The year following the planting of the New Jersey trees the owner had an emyloyé go over the ones most affected with a thick whale-oil soap of the consistency of molasses. This treatment was perfectly effectual. Mr. Marlatt examined one of these trees and found it perfectly clean nearly three years after treatment, although standing in the middle of the affected orchard. Upon certain of these older trees, curiously enough, the scale seems dying out. The trees themselves are in an enfeebled condition, but have put out some new growth, and upon this new growth there are no scales, while the great majority of the old scales on the older growth are dead. The original specimens, which he brought from this orchard, contained no living scales. The owner of the orchard is rather prejudiced in favor his whale-oil soap treatment, and promises next fall to treat most carefully every affected tree. The probabilities are strong, therefore, that the insect will be exterminated at this point before the close of the year.

To sum up, east of the Mississippi River the San José scale is now known to occur in one rather widely extended point in Florida, at one point in Virginia, at three points in Maryland, at one point in Indiana, at two points in Pennsylvania, and at many in New Jersey. In Indiana and Virginia it has been exterminated. At the three points in Maryland the probabilities are strong that it will be exterminated before the close of the year. In Florida active and energetic work is going on, and, while Mr. Hubbard is doubtful of the possibility of actually exterminating the insect, it is being carefully and intelligently handled. There is little danger of the insect spreading to any degree from this point. In the two Pennsylvania localities the outlook is equally good, although Prof. Smith may have ascertained other facts of which I know nothing. With the exception of the Neavitt orchard, into which the scale was introduced from Missouri, and the Florida orchards, into which it was introduced from some point as yet unknown, all the occurrences above mentioned have originated from two prominent nursery firms in the State of New Jersey. An investigation of the circumstances connected with the introduction of the insect into these two nurseries, and its subsequent distribution throughout the State of New Jersey, as well as to other localities (many of which, I imagine, are as yet unknown to us), has been in the hands of Prof. Smith, who informs me that the insect came to New Jersey direct from California upon Japan plums.

Remedial work against this insect is onerous, but our experience has shown that three sprayings, at intervals of ten days during the latter part of May and June, will practically destroy the insect, whether the spraying be conducted with very considerably diluted kerosene emulsion or with a resin wash, while during the winter a single application of either of the three winter washes, mentioned in an opening paragraph, will greatly reduce the numbers of the insect. Among the winter washes our experience leads us to give the preference to strong kerosene emulsion; next, to the winter resin wash; and finally, to the lime, salt, and sulphur mixture.

After the publication of the warning circular, the president of the California State Horticultural Society, who also holds the responsible position of secretary to the State Board of Horticulture, Mr. B. M. Lelong, is reported to have said at the April meeting of the society that he had been somewhat amused, but more chagrined, to see an official bulletin giving remedies which had been discarded in California fifteen years ago. He recalled how himself and others had tinkered round with kerosene emulsion and the like, to the waste of time and money, and he hated to see others go through the same wasteful experience. The sovereign remedy for this insect he stated to be the lime, salt, and sulphur compound generally used in California. It had saved our orchardists millions of dollars, and it would do for the infected orchardists East what it had done in the West.

As a matter of fact, our recommendations in Circular No. 3 were based upon the results of winter experiments upon allied scales at Washington, and it is pleasing to be able to quote in support of our circular, and as opposed to Mr. Lelong's statements, the testimony of so practical a man as Mr. H. B. Muscott, chairman of the county board of horticultural commissioners of San Bernardino County, Cal., who writes (April 12, 1894) that five years ago his commission was organized and started a vigorous crusade to eradicate the scale, and that the work has been so successfully accomplished that, from the reports of inspectors received in April, there was not at that time so much of the scale in the entire county as could be found in individual orchards five years ago. When carefully prepared and thoroughly applied, the choice of the commission which has accomplished this effective work is, first, kerosene emulsion; and, second, lime, salt, and sulphur as a dormant wash. The San Bernardino County method of preparing kerosene emulsion is as follows: Take 5 pounds of whale-oil soap, 5 gallons of kerosene; dissolve the soap in 10 gallons of boiling water; then remove from the fire and add the kerosene slowly, thoroughly churning the mixture in the meantime; then add enough hot water slowly to make the whole mixture 50 gallons, continuing the churning while adding the hot water. Apply milk warm for the best results. This will not make a thoroughly satisfactory emulsion; that is to say, an emulsion which will stand for any great length of time. It amounts, in fact, to one part of standard emulsion to a little over three parts of water.

An interesting phase of this investigation is the use that has been made of the fact that the San José scale was first discovered in Virginia, by an Ohio nursery firm through one of its agents in the State of Kentucky to build up business for his firm by discrediting nursery stock coming from Virginia. It was quite to be expected that tree agents, who are proverbially almost as sharp as lightning-rod men, should use such a fact as this, and we have been to some trouble to assure Virginia nurserymen that in no case have they been proved to be responsible for the introduction of this insect. As above stated, the onus rests entirely upon the two New Jersey dealers and the one in Missouri.

There can be no doubt that great harm has been done by the lamentable carelessness of these two New Jersey firms and the firm in Missouri. But, from the present outlook, so far as my own information goes (and it must be remembered that I know nothing of the state of affairs in New Jersey) the damage done has not been irremediable. In fact, it is an open question whether the ultimate result will not be a good rather than a bad one. One, at least, of the New Jersey firms has shown such a desire to make amends that it has burned up thousands of valuable trees and has madeevery effort not only to repair the damage done but to prevent any similar future occurrences. I have not learned that the other firm has taken any such measures, but I do know that a lawsuit has been instituted against this second firm, and the probabilities are that this action will accomplish what mere qualms of conscience might fail to bring about. The result of the whole experience, it seems to me, can not fail to make all nurserymen extremely careful in future; and care in regard to injurious insects is a quality in which some of them have been greatly lacking in the past.

In this paper I have given simply the results of the investigation of infested localities and of the remedial measures carried on. Careful investigations of all of the other points necessary to a complete monograph of the species from the economic standpoint are under way, and it is hoped that the material will be in such shape by the close of the season that a special bulletin of considerable length may be published. One other interesting point may be mentioned before closing, and that is, that a little Scymnid beetle, *Pentilia misella*, which was found by Mr. Schwarz last September in such numbers at Charlottesville feeding upon the scale, has also been found in other eastern localities, and that an attempt has been made to introduce it into California, since it does not normally occur in the west coast fauna. A considerable number of living and healthy specimens were sent in the latter part of May to Prof. C. W. Woodworth at Berkeley, who wrote that the insects were received in good condition and had been placed upon a well-infested peach tree at Oakland, where they would be kept under observation.

The next paper on the program being on the same subject, discussion was deferred. Mr. Smith then read the following:

THE SAN JOSÉ SCALE IN NEW JERSEY.

By John B. Smith, *New Brunswick, N. J.*

In March, 1892, the agriculturist of the station received from a nursery in our State a pear twig, with a card inquiring whether the insect on it was an aphis, a scale, or the pear "Scilla." It was in due time shown me and I said it was a scale, and that kerosene emulsion should be used. I presume that this message reached the sender and was considered satisfactory, for I heard nothing more concerning it. The twig was labeled, placed away, and forgotten; recently it turned up again and proves to be infested by the *Aspidiotus perniciosus*. My lack of familiarity with scale insects prevented my recognizing the species at the time, and the lack of further complaint or inquiry disposed me to believe that it did not amount to anything. Had I been familiar enough with scales to recognize the importance of the specimens then in my hands, a portion of its spread could have been prevented. In

1893 Dr. Riley spoke of the appearance of the insect in Virginia at the meeting of this association; but California and Virginia are both quite remote from New Jersey, and I failed to make myself acquainted with the appearance of the creature. In the autumn of 1893 I investigated the appearance of the pear psylla in a Delaware River nursery and incidentally noticed that some of the trees were very scaly. I recommended that they be scrubbed; but again failed to suspect their identity. It is a matter of some consolation that another station entomologist had visited this selfsame nursery only a few days previously and had as completely failed to identify the species. I do not feel called upon to apologize for failing to identify the scale, because no one man (unless he lives in Washington) can know everything, and scale insects had not theretofore come under my notice to any extent. My only fault lay in that I did not seek to have the insect determined at once; but at the time the matter seemed unimportant. Early in 1894 a special circular on the San José scale was issued from the U. S. Department of Agriculture, and on reading it I at once thought of the appearance noticed in the "Psylla" nurseries and wrote for specimens. These, when received, left me in doubt and were forwarded to Washington, whence Dr. Riley soon wrote me that, while they were much dried up and undersized, there was no doubt as to their identity. I at once took measures to discover how far the trouble had spread in New Jersey, and the owners of the nursery seconded my efforts by every means within their power. In a panic, when they were first assured that they had the scale and before I called on them, they tore out several blocks of young stock valued at over $1,000 and burned them—a very unnecessary proceeding as I believe. I soon found that while many bearing trees were badly infested, the nursery stock was quite free and that it was mainly old stock and preferably French stocks upon which the new varieties were budded that were infested, and that very few scales were to be found on the new wood. At my request the owners furnished me with a list of the persons to whom suspected or suspicious stock had been sold during a period of five or six years, and meanwhile I visited nurseries in all parts of the State and wrote to leading growers everywhere. Several trips were also made to leading fruit centers, and this resulted in discovering the scale in another large nursery at quite the other side of the State—on the Atlantic coast. Here the scale was much more restricted in the territory covered; there were only a few bearing trees, and the young stock, while almost uniformly was yet so sparsely infested that when sold in small lots the chances were all against the propagation of the insects. The source of supply was discovered in a row of old Bartlett pear trees which were completely incrusted. This lot of trees was at once taken out and burned and arrangements were to be made to clean all stock to be sent out from the infested block. A huge list of names was now at hand, and by the courtesy of the United States Entomologist a supply of the circulars sent out by them was secured. Nearly 1,000 letters were mailed, each inclosing a circular, each separately written on the typewriter, and signed by myself, in order to avoid any "circular" look. A large number of replies was received, and guided by them I visited nearly 100 orchards, spending twenty-one days in the field, and examined many thousands of trees, covering very completely all the central and southern portion of the State.

It is worthy of note that in not a single point north of New Brunswick has the scale spread, though I believe scaly trees have been set out; in fact, so far as I have been able to ascertain, it has propagated only south of the red shale which extends diagonally across the State from a point a little north of Perth Amboy in the east to Trenton in the west. That it will maintain itself north of this point, for a time at least, is proved by the fact that an orchard in Columbia County, N. Y., is very thoroughly infested. Throughout New Jersey, south of the red shale, the scale is distributed here and there, but nowhere in sufficient numbers to spread from the orchard into which they were originally introduced. In fact, in many cases the trees are yet so small and the scales are comparatively so few that extermination will be an easy task. On the other hand, a considerable number of trees were found so badly infested that they were decidedly dangerous, and they were in all cases cut out and burned at my suggestion.

I feel positive that no spread has yet been made in New Jersey except by means of nursery stock. I feel safe in saying that no further infested stock will be sent out from our nurseries. I am reasonably sure that all the growers that I have seen will adopt any measures suggested by me, and will get rid of the scales—in fact, I will make it my business to follow them up until they do it—and, finally, I see no reason why it can not with us be completely stamped out.

The history of the importation of the scale into New Jersey is the same for the two nurseries from which it has been distributed. In either 1886 or 1887, in their search for a Curculio-proof plum, their owners were advised that the "Kelsey," an improved Japanese variety, grown in California, filled all requirements, and a lot of Kelsey trees was ordered from the San José district. In both cases the trees looked bad, grew very little, and after remaining in the ground for two years were, most of them, taken out and burned. Other trees had been grafted and budded from them, however, and from the appearance of the few remaining trees it is certain that this importation brought in the infection. Idaho pears have also been imported from the Pacific coast for several years past, and it is certain that many of them were also infested. At all events, a start was soon made, and in 1891 and 1892 several blocks of young apple trees were badly infested—so badly, indeed, that many were not considered up to the standard, and were destroyed. Since that time few apples have been grown at these nurseries, and no distribution of the scale has been made on them.

Plums are not grown to any great extent in New Jersey, owing to the attacks of the Curculio, and few scales were distributed on such stock in our State. It is on pears principally that the distribution has been made, and on a few varieties chiefly. The Idaho has been the most dangerous because it came infested whenever imported direct, and after it came in close order Madame von Siebold, Garber, Lawson, Seckel, Lawrence, and Bartlett. Other varieties are also infested, but less frequently, and the scales do not do so well. Kieffers alone are absolutely exempt, and closely following comes the Leconte, which is rarely infested in the nursery, and never in the orchard, in my experience. One tree grafted with Lawson and Kieffer had the Lawson branch and fruit covered with scales, while the Kieffer branch was entirely free. In not a single case have I found scales in a Kieffer orchard, though in the nursery a larva will occasionally get upon a fruit and fix, only to be forced out before it is half grown. As the Kieffer is the favorite variety in southern New Jersey and hundreds of it are set out to one of any other, the danger of serious or very rapid spread is much lessened. Currants, black and red, became rapidly infested, and the scales were certainly distributed on these plants, mostly outside of New Jersey, however. The Japanese quince is extremely susceptible to scale attack, and the fruit particularly becomes entirely covered. Within a few days I have received a branch of an elm badly infested.

It was for a time a matter of surprise to me that so comparatively few orchards were infested by the scale; but I soon found that this was due in great part to the care given the orchards by the majority of growers. In one case I found Idaho trees that had certainly been infested and yet showed the marks where numerous scales had been. Inquiry showed that the owner treated all his trees to a winter washing of crude potash dissolved in water sufficient to take it all up, and in Spring gave them all a dose of poisoned whitewash. He believes in clean trees and tries to keep them so. As a result he cleaned out the scale, and others I am quite sure have been similarly successful.

Whitewashing alone, over the scales, will not kill them; but repeated washings during the season hits a vast proportion of larvæ before they are fixed and materially checks spread. In one orchard infested apple trees were introduced in 1890 and they were reported clean by the owner. I had the opportunity to call on him and found the trunk and larger branches all clean; but on some of the fruit and at the tips of the branches were a very few scales; they were barely maintaining themselves, and certainly had not increased in number in four years. The owner sprays regularly with both insecticides and fungicides, and always makes a practice of covering trunk and branches completely with the combination of Bordeaux mixture and Paris green every time he sprays. Thus he hits the larvæ when uncovered, or when just fixed, and the result has been practically clean trees.

Very little has been done in the way of experimenting with insecticides. Kerosene emulsion diluted 9 times has been used successfully in one case on the mature scales, just before the young larvæ emerged. Diluted from 11 to 15 times it has proved ineffective on half-grown forms; but diluted not more than 5 times it has proved effective against all the scales on the trunks.

I see no reason why during the coming winter the San José scale should not be practically exterminated in New Jersey.

It is too early to speak of the life history of the species in New Jersey. Young larvæ appeared early in June, and again early in August.

Dr. Lintner expressed himself as greatly interested in the preceding papers, and queried if there were not a possibility of the dissemination of the scale from California or other infested districts on fruit. He concluded, however, upon a general survey of the possibilities, that the chances of the scale carried about on fruit reaching a tree on which it would successfully establish itself were so slight as to be practically not worth consideration.

Mr. Marlatt, referring to the discussion of the methods taken by nurserymen to rid their trees of the scale, and the statement by Mr. Smith of the completeness of this work, suggested that there was some danger in placing too much confidence in the work or the statements of nurserymen in this particular. Mr. Marlatt pointed out the great ease with which one or two scales on a tree could be overlooked, even by an experienced entomologist, as illustrated by the case referred to by the author of the paper, in which he had concluded that certain trees which had been infested were entirely free from the scale, until later he happened to examine the fruit and found the scale was quite abundant on it; and he then also discovered that it occurred on the tips of the smaller twigs.

Mr. Smith stated that in the case of the large trees referred to, on which he had at first failed to find the scale, he was misled by the fact that the scale had been entirely exterminated on the twigs and larger branches, and had not taken the trouble to examine the smaller twigs, knowing that the scale habitually confined itself to the older parts of the tree; but in the case of nursery stock examination was much more easy, and he thought it quite possible to determine whether the scale had been completely eradicated or not; he stated further that the practice of nurserymen was to cut their stock back so vigorously before sending it out, that examination was much simplified.

With reference to the localities in New York where this scale had appeared, mentioned by Mr. Smith, Mr. Banks said that he had seen notices in the New York Times, three or four weeks since, of the occurrence of the scale in three distinct localities, with the accompanying statement that active and thorough measures had been taken to exterminate it.

AFTERNOON SESSION—AUGUST 15, 1894.

Mr. Smith, in continuation of the discussion on the morning's papers on the San José scale, exhibited half a dozen California pears, obtained at a fruit stand in Brooklyn, on which the scale in question occurred in all stages, from the young active larva to the full-grown gravid female.

Mr. Lintner, in the same connection, exhibited an apple covered with the scales of *Mytilaspis pomorum*. This specimen had been handed him by Mr. Saunders, who had obtained it from near Ottawa, and it illustrated the extreme abundance of the scale in that locality.

The following paper was then read by Mr. Davis:

MEALY BUGS AND THEIR ALLIES.

By G. C. Davis, *Agricultural College, Michigan.*

As a greenhouse pest mealy bugs are well known to entomologists and are much too common for the wish and welfare of the florist. Individually they are easily recognized from other insects, as they are distinctly different. Economically they are well known as general feeders on tender plants in the house and conservatory and to a less extent on plants and trees outside. They are much dreaded, because they multiply so rapidly, and as surely weaken a plant by extracting much of the sap from its tissues. Scientifically they are quite well known since Prof. Comstock described the different species and gave illustrations of them in the Annual Report of the U. S. Entomologist for 1880. The descriptions include the egg, larva, and the adult male and female of the two species, *Dactylopius destructor* and *D. longifilis*, along with descriptions of many other Coccidæ. Prof. Comstock has also given them brief recognition in his Introduction to Entomology.

Aside from these few facts given above, American literature is almost silent on the subject. A careful search, about a year ago, of the literature at my command, gave me no light as to the habits or life history of the species, or those closely related to them. This was quite a surprise, since mealy bugs are such common and noxious insects. When literature will not afford one the desired information, the next best recourse is to search it out for himself, which I have attempted to do, and the few notes will be from observation and rearings made in the past year and a half. No attempt will be made at this time to redescribe the various stages of the different species where descriptions are already accessible. When the notes are more complete, they can then, perhaps, be put in suitable form.

The female of our commonest mealy bug, *Dactylopius destructor*, is very prolific, laying usually not far from 400 eggs, but may vary in number from 300 to 600. Each egg is slightly oblong and about 0.25^{mm} in length. The color is a light straw yellow, with small particles of the white waxy secretion covering each one. Over the whole egg mass is a white flocculose network of waxy threads which cover the eggs and quite effectually protect them from attack by other insects. The female commences secreting these threads some hours before egg laying begins, and continues secreting as long as the mass of eggs increases. A female before laying her eggs will be about 2.5^{mm} wide and 4^{mm} long, but when through there is nothing left of her but a little dry wrinkled piece of lifeless skin and a mass of eggs back of her that will measure two or three times as much as she did a short time before. The female feeds all the time she is depositing her eggs, and no doubt lays far fewer eggs when forced to do so with no food accessible. The eggs first laid will remain farthest from the female and beneath, she moving ahead as the mass grows. The mass also raises her until, toward the last her position is often nearer vertical than horizontal.

Quite a number of females of various sizes were placed in a jar to see how long they would live with no food. There was moisture enough for their needs, and the temperature was a little above what it would be in a comfortable dwelling house. The smaller ones, which were not over a quarter grown, molted on the second day and on the third were mostly dead. Many of the larger ones molted the day the smaller ones died. Some of the smaller of them lived a few days longer and then died, but the most of the larger ones began very soon to deposit eggs. One of the largest of the number was carefully watched, and it was found that the eggs increased at the rate of about 36 every twenty-four hours. Egg laying lasted only four or five days, instead of ten days or two weeks as usual, when the female shriveled and died, leaving from 100 to 150 eggs in each mass. The most of these eggs were fertile and hatched in about a week after they were placed there. None of the females were full grown, and the experiment shows that the mealy bug will still strenuously endeavor to propagate its kind from immature specimens when food is wanting. Another lot of specimens were placed in a cold room under otherwise similar conditions and all sizes remained dormant for a long period with no apparent injury.

It requires from one to two weeks for the eggs to hatch, according to the temperature. As a usual thing the young mealy bugs from the eggs first laid will hatch some days before the female has finished laying. They are very active and, like other young bugs, appear to be mostly antennæ and feet. They do not venture out from under the flocculent covering for several days, and before they do they have assumed a partial mealy coat resembling considerably the parent. The attennæ are 6-jointed in the female and 7-jointed in the male larvæ.

On the 14th of April a single gravid female was placed in the laboratory on a Coleus plant. Since that time two generations have been reared from the one specimen. This would make about two months for each generation, but, where the temperature is like that maintained in a conservatory, this period is shortened two weeks. We may say then that in general the time required for development is from six to eight weeks.

The young grow very slowly for the first two or three weeks and the growth is very uneven. Should one look at them for the first time when three or four weeks old he would declare they could not all belong to the same brood, as there is such a great difference in their size. The difference is maintained from this on, so that it is impossible to tell where one generation begins and the other ends. There will be all sizes, from the ones just hatching to the female forming a woolly mass. About half of the brood are regular enough, however, so that one can, with a little care, trace the generation through its development.

When the mealy bugs become about a third grown, perhaps one out of every eight or ten will be seen to travel off a little apart from the rest and begin to construct a light fluffy cocoon around itself. It is the young male preparing for his transformation to the winged state. The material of which the cocoon is constructed is similar to that used by the female in covering her eggs, except that the thread is finer and more downy. The cocoon is oblong in shape, being from 1 to 2^{mm} in length and half as thick. The construction is alike throughout, with no hard portion except the cast-off skin which is left behind. The transformation is very rapid, taking, as nearly as I can ascertain, only three or four days, or a week at most, when the 2-winged male comes forth with quite a different appearance from what it possessed before. The males are very delicate and slender, measuring less than a millimeter in length and with an expanss of wings from 2 to 3^{mm}. The flight is slow and steady, and although they are so very minute, when one has become acquainted with their appearance on the wing, he will readily recognize them and can easily catch them by a quick thrust of the open hand. The body is an olive brown and is more or less flecked with the mealy covering. At the extremity of the abdomen are the two white anal filaments nearly as long as the body itself. The wings are milky white, extremely fragile, and with only the two customary veins. There are now 10 segments to the antennæ instead of 7. The mouth parts are either wanting or are very rudimentary. Perhaps the most interesting change is in the placing of the eyes. On the top is a pair of large dark red eyes with a lighter ring of red around them. On the under side of the head, separated nearly as far as they can be from the ones above, is another similar pair. On the sides of the head are the two dark eyes, the same as seen in the immature stage.

Mating with the half-grown females occurs soon after the males issue. Some one has said that the anal filaments are used for mating, but observation in several cases has not shown such to be the case, the filaments merely extending backward out of the way.

Dactylopius longifilis differs structurally in quite a number of minor details from *destructor*. Perhaps the most evident character is in the long posterior filaments of the female, which gives the species its name.

In life history there is one decided difference: *Longifilis* is viviparous, while *destructor* is oviparous. *Longifilis* is larger but not nearly as prolific as *destructor*, and rarely becomes numerous enough to do much harm. The species is almost as general a feeder as *destructor*.

On the 27th of April, while in the clover fields studying the clover root-borer, an occasional nest of *Lasius niger* was disturbed or dug into, and the little ants were noticed to be carrying away some oval, plump, mealy-covered, egg-like objects for a safer location. Some specimens of them were obtained and placed in a box with a few ants and later were examined in the laboratory. They were 1.5^{mm} long and 1^{mm} wide and to the unaided eye looked like oval eggs with a mealy covering. When placed under the microscope, it revealed no head, but a set of almost transparent legs, antennæ, and a short rostrum on the plump body close to the front legs. The legs were small, not capable of dragging the body any distance, but could move it a few millimeters at a time. The tarsal claw and 4 tarsal digitules were present, though the latter were shorter than in the common mealy bug. The antennæ were from 6 to 8 jointed according to the number of joints made in the terminal segment. The color was a reddish brown, which appeared much lighter because of the white covering.

The specimens with the ants were placed by a potted clover plant and every few days were examined. On the 15th of May some of them had commenced giving birth to young. These young gathered under the mother bug, or else collected in the flocculent mass back of her that she had secreted while producing them. They were of a light translucent flesh color and much flatter than the mother. They had the same mealy covering in a short time after birth that she possessed. The legs and antennæ were dirty yellow and almost as large as those possessed by the adult. The antennæ were 6-jointed, the basal and terminal joints being the largest and longest; the others globular and subequal; eyes red.

To put in as brief a form as possible a long and careful watching from that time on to the present, we will say that the young mealy bugs grew, and they have since been carried through two generations on the roots of the common red clover, *Trifolium pratense*. After about the 1st of June the mealy bugs were found quite common on the clover roots in the vicinity of the Michigan Agricultural College wherever clover was found. They are more regular and even in development than *destructor* and the number of broods can be easily followed. They are nearly as prolific through the summer as *destructor*, though the winter interferes, as they do not breed through the cold weather and must start from the winter form in the spring. From 1 to 2 inches below the surface is about the usual depth on the root at which they will be found, but they often go 5 or 6 inches out on a lateral root that does not run too deep. They prefer cavities made in the roots by the clover root-borer, *Hylastes trifolii*, which is very common with us, but

I have often found them on thrifty roots uninjured by the little root borer. They always remain below the surface of the ground, except the male, which often comes above to pupate on the green stems and leaves. Instead of producing the young alive, as the winter form of this species did, the summer females deposit eggs with the floccose covering the same as *D. destructor* does.

As this species appears to be without a name, it perhaps would be well to term it *Dactylopius trifolii** for convenience in comparing the forms with those of the other species given. The female of *trifolii* in general appearance and structure resembles that of *destructor.* She is smaller and the seventeen waxy filaments around the margin are longer, particularly the anal ones, which are sometimes more than half as long as the body. With her mealy covering dissolved by chloroform she is of a deep brownish red color with dirty yellowish legs; the other two species are a brownish yellow. The anal cavity is also deeper than in either of the others, being the least so in *longifilis.* In the quite large series of specimens of the different species studied, the form and length of the antennal segments and the comparative length of the tibiæ and tarsi seem to be stable characters of considerable value. In *trifolii* the tarsus is nearly as long as the tibia and the claw well developed; in *longifilis* the tibia is slightly longer and the tarsal claw is shorter; in *destructor* the tibia is twice the length of the tarsus and the claw is small. The four digitules are about the same in all three species. The antennæ of *trifolii* are distinct from the other two in that the first two segments are thicker than any of the others, which is even more characteristic in the male, where they are nearly as broad as long. Segments 7 and 8 of the female are also slightly thickened; 3, 4, 5, and 6 narrowest and of equal thickness. In *destructor* the basal and terminal segments are of equal width and broader than the others. *Longifilis* has the eighth segment the broadest, the others subequal. The following table will show the relative length of the different segments, beginning at the base. The measurements are made by using the micrometer.

Number of segment.	Length of segment.			
	D. trifolii.	D. trifolii (winter form).	D. destructor.	D. longifilis.
1	3.25	2	3.5	3
2	3.5	2.5	5	7
3	4.75	3	5	5.75
4	2.5	2	3	4
5	3	3	4.25	5.5
6	2.5	2	3.25	4.25
7	3.5	2	4.5	4.75
8	7	4	10	11.5
Total	30	20.5	38.5	45.75

In *trifolii* the terminal segments at the tip are quite truncate, in *destructor* considerably less so, and in *longifilis* tapering to a point.

* Under date of October 10, Mr. Davis writes that he has found this insect to be synonymous with *Coccus trifolii* Forbes.—L. O. H.

The male resembles that of *longifilis* in appearance, though the anal filaments are not as long. The head, thorax, and two basal segments of the antennæ are nearly as deep a red as those of the female; the abdomen, legs, and remainder of the antennæ are much paler. The eyes are not ringed with bright red, as in the other two species, but are a dark reddish brown. The immature male has 7-jointed antennæ, and shortly before pupating a mass of waxy secretion posteriorly is quite noticeable.

In the allies of the mealy bugs there are several common injurious species where study becomes quite as satisfactory and interesting as in the species of Dactylopius. *Eriococcus azaleæ*, which has been on our azaleas in such numbers the past season, is one of them. This species has received considerable attention, but only a brief notice will be given it here. It is a close ally to the mealy bug and might be very easily mistaken for one unless structurally studied. Since the note on this species published in INSECT LIFE (vol. VI, p. 327), where it says, "The insect has not yet been found out of doors, and it will be interesting to know its natural habitat," the query with me has been, Is the species not exclusively a greenhouse pest with us and perhaps imported with the azalea plants? To partially answer this question a badly infested plant was placed out of doors about the 1st of May, subject to Michigan's climatic changes. About a month later most of the eggs hatched, but not a young Eriococcus has survived.

A full-grown female of this species lays about 250 eggs in the winter and they remain under the sack until they hatch in the spring. At the present time the females are nearly half grown and the males are still in the pupa state. If I am not mistaken, there is only one annual brood, so that the species does not increase with the rapidity of the mealy bug. We have never found a species on any plant except the azaleas, and as these plants are all imported from Belgium and France at least once in every two years, it is very probable that the Eriococcus is also imported with the plants.

Another close ally of the mealy bug is found on our greenhouse palms. Specimens sent to the Department of Agriculture at Washington bring back the word from Mr. Howard that he feels sure the species is not described and that it apparently belongs to a new genus. The bug is quite common on the three species of palm—*Areca lutescens* from eastern Asia, *Ptychosperma cunninghamiana* from Queensland, and *Rhapis humilis*, the dwarf rattan palm, from Japan. The species is apparently quite restricted in the number of food plants, as an effort was made to rear specimens on some other species of dwarf palm, but the bugs refused to remain on the plants and soon starved. The mealy covering is thick and heavy with a broad margin and large pyramidal elevations of dirty-yellowish white over the dorsum. The females are viviparous and about as prolific as *Dactylopius longifilis*. The young remain under the mother for several days until there are so many that she can brood them no longer. They resemble the mealy bugs closely when young, but can be recognized by a few structural differences. The older bugs move but very little. The male has not been reared and the species carefully enough studied at present to speak further of it.

A much more distant ally is Aleyrodes, which Prof. Comstock classifies under the succeeding family by having two-jointed tarsi and four wings. The species that has been the most troublesome in the greenhouse the past year is what Dr. Packard determines for us as probably *Aleyrodes vaporarium* Westwood. Specimens have bred the most extensively on *Ageratum mexicanum* and *Abutilon marmarophyllum*, but a little later also bred quite as well on potted roses, geraniums, and Coleus. Our florist says that a few years ago they made the green foliage of the roses quite white after the plants had been set out in beds for the summer. A lady who lives near Detroit sent me the same insect on Salvia leaves, and Dr. Packard, in his report for 1870, speaks of them on fuchsias and as occurring in great abundance on the tomato in September. The species in the greenhouse is much the most common through the last of the winter months and through the spring until the plants are taken out of doors for the summer.

The eggs of this species are glued to the under side of the leaves. They are only about .25^{mm} in length, and when seen by the lens look like oblong cone-shaped galls. They are fastened perpendicularly to the leaf, and resemble a long, slender, pointed bird's egg fastened at the large end. On the Ageratum the leaves are so hairy that the female usually leaves only one egg in a place, but on Abutilon and rose leaves I have counted as high as 17 deposited in rapid succession inside of an area not greater than 1.5^{mm} in diameter and still none of them touching each other. The eggs when first deposited are green like the leaf, but in three days they turn a metallic blue-black. Eight days later the shining shell is burst and the young larvæ scatter over the leaf and begin to feed. They were seldom seen traveling after the first few days of their larval life, unless a leaf on which they are located became wilted and no longer yielded a supply of food. They became permanently located and passed through the pupa stage with few perceptible external changes. About three weeks is required to pass through the larval stage and about one week in the pupa stage. When we add the eleven days in the egg to this, we have from four to five weeks as the period for the development of each brood. They breed so fast and become so abundant at times that they would do great harm were they not so exceedingly minute. Last spring they nearly killed our Ageratum plants by puncturing the leaves so thoroughly that the leaves which glazed with sap and this started a soot fungus, *Fumago vagans*, which always follows such work.

In conclusion, we must acknowledge that there is still much to be learned regarding the species treated of in this paper. The vision, seen in the study of these few, reveals that there is a large and interesting field for study and observation before any one who will make a thorough study of the two families that include these species. Let us see if more may not be known of the families before many seasons have passed.

Mr. Sirrine remarked that Prof. Forbes has found a Coccus on white clover which may be the same as the one mentioned by Mr. Davis.

Mr. Ashmead exhibited specimens of a mealy-bug—probably *Dactylopius destructor*—which he found occurring abundantly on a plant (*Cyperus alvernifolius*) growing in the room in which the meetings were held. He thought it possible that the species described by Mr. Davis would prove to be the one characterized by Prof. Forbes as *Coccus trifolii.*

Mr. Howard said that the theory hazarded by the author, viz, that *Eriococcus azaleæ* Comst. was introduced from Belgium on Azalea, was almost certainly incorrect, since the species is not known in Europe, while Prof. Comstock has recently found it on wild plants near Ithaca, indicating, with almost equal certainty, that it is a native species. He said also that the two old species of Dactylopius referred to by Mr. Davis have been shown by Berlese to be both synonymous with European species, and that the latter author has worked out their life history with great detail.

Mr. Marlatt read the following paper:

THE PEAR-TREE PSYLLA IN MARYLAND.

By C. L. Marlatt, *Washington, D. C.*

THE PSYLLA IN THE ORCHARD OF CAPT. ROBT. S. EMORY.

About the middle of July of the present year the Department received information of an overwhelming invasion of the Pear-tree Psylla (*Psylla pyricola*) in one of the largest pear orchards in Maryland, if not in the United States. The orchard in question belongs to Capt. Robt. S. Emory, is located near Chestertown, Kent County, on Kent River, in the very heart of the famous "Eastern Shore" fruit district, and contains over 20,000 pear trees. The success of Capt. Emory as a pear grower during the last thirty years has made him an authority on the subject, and he has manifested great intelligence and promptness in combatting all former attacks of disease and insect enemies. The present invasion, which is perhaps the worst which has occurred in his experience, he is preparing to combat with his customary energy, and, we hope, with his usual success.

The pear-tree Psylla has not hitherto been reported south of New York, although extending westward as far as Michigan, and occurring generally in the New England States. Its sudden appearance in such enormous numbers so far south was therefore a matter of considerable surprise, and at the instance of Mr. Howard, I visited the orchard twice, made careful examinations of the work of the insect, and conducted some experiments with remedies.

The pear-tree Psylla is by no means a common insect, and most entomologists are unfamiliar with the interesting conditions accompanying an excessive invasion of the pest. As described by Mr. Slingerland in the case of the New York invasions of 1891 and 1892, and as witnessed by myself at Capt. Emory's place, the indications of the presence of the insect in its effects upon the trees are in the falling of the leaves and fruit, the latter before it is half grown, but chiefly in the enormous secretion of honeydew by the larvæ and nymphs. One who has not witnessed this sight gives credence with difficulty to the reports as to the amounts of this liquid constantly being secreted. In the present case the water-like fluid or honeydew not only covered the leaves and twigs, but, to quote from an interesting account in the Chestertown Transcript, "fairly rained from the trees, and ran down the trunks to the ground; and even now a discolored circle, extending for from 6 to 8 inches around the trees, attests the extent of the presence of this liquid. Heavy and protracted rains kept the honeydew washed from the trees for several weeks, so that it was not at first noticed, but after the rainy season, when the trees were being worked, the horses used became so drenched with the sticky substance that it became necessary to wash it off with sponges, the currycomb being useless. The trees became weakened and lost much of their fruit, the leaves became blackened and fell in great numbers, and the bodies of the trees look to-day as if they had been smoked. The scene presented was certainly one never before witnessed in Kent County. Twenty thousand beautiful trees, many of them nearly stripped of their foliage, the remaining leaves blackened and the trunks blackened by the honeydew, is a sight well calculated to strike consternation and despair to the heart of the average fruit-grower."

When I visited the orchard on July 20 the transformation from the last nymphal stage to the adult had taken place and the trees were covered with adult insects only, and these had only just begun depositing eggs for what was probably the second summer brood. The secretion of honeydew had of course ceased, the excretion of the adults being wax like and crystalline, but the trees still bore marked evidences of the secretion of a few weeks earlier. The leaves, limbs, and trunks were blackened by the growth in the sweetish liquid of the smoky fungus, *Fumago salicina*, and in the falling of the foliage and the diseased and smoky-looking fruit a picture of disaster was presented which was rather startling in its effects. Mr. Slingerland has described the appearance of the leaves of a tree severely attacked by this insect as small, yellow, and easily falling. In Mr. Emory's orchard the leaves were scarcely at all yellowed, but were covered with dead and dry patches or spots, sometimes including almost the entire leaf, which seemed to be not due directly to the extraction of the plant juices by the insects, but rather to the sun-scalding resulting from the collection on the leaves, in large drops or in masses, of the liquid honeydew. This gave an appearance which might easily be mistaken for the result of some fungus attack, and in fact Mr. Emory supposed at first that this was the nature of the trouble, and had had the matter investigated by Mr. Waite, of the Division of Vegetable Pathology. The orchard was for the most part of dwarf trees and was arranged in plots, rather thickly planted, and covering an area of upward of 100 acres. The Psylla was distributed over this entire tract, but was much more abundant in the plots of older trees. The young orchard, perhaps amounting to one-third of the entire tract, was in vigorous condition and had not been seriously affected. The old Duchess orchard seemed to have suffered the most. On these trees the adults were very numerous, frequently 15 or 20 resting along the midrib of a single leaf. They were depositing their eggs along the midrib on the upper surface, and also thickly along the serrated margin of the leaf. I saw no eggs in any amount on any other part of the leaf. At the time of my second visit, July 31 to August 3, the eggs were much more numerous and had been frequently deposited in small clusters, 5 to 8 together, along the midrib and at the margin of the leaves. Scarcely any of the eggs at this time had hatched, at least not more than 2 or 3 per cent, and the adults were still almost as numerous as ever and busily ovipositing.

THE PSYLLA IN THE ORCHARD OF C. C. BROWN.

The presence of this pest in the orchard of Capt. Emory is not the first instance of its occurrence in Maryland. The pear orchard of Mr. C. C. Brown, of Pomona, Md., about eight miles south of Capt. Emory's place, was also very badly infested, over a limited tract, in the summer of 1891. The insect appeared during that year on pear trees next to and in the vicinity of the house, and its presence was first noticed from the fact that clothing put out to dry near the pear trees was covered with the honeydew secretion. Examination showed that it was confined to an area of 3 or 4 acres, which, however, was so thickly infested that the leaves and fruit fell and the trees were so stunted and injured that they have not since been in bearing condition until the present year, when they have set a fairly good crop. Curiously enough, however, in this instance the Psylla disappeared entirely after the first year and has not again put in an appearance in this orchard. I visited the orchard on August 1 and examined it very carefully, but failed to find the least trace of the insect. Thorough search in other pear orchards between and in the neighborhood of the two referred to failed to show any indication of the Psylla in any of them.

HOW THE PSYLLA WAS INTRODUCED.

The suddenness and severity of the appearance of the Psylla in Maryland makes the question of its introduction one of considerable interest. Upon inquiry it was developed that both Mr. Emory and Mr. Brown had procured pear trees from a nursery in New York State in 1890 or 1891, and it is unquestionably from this source that the Psylla was introduced. It will be remembered that this was just at the time when the Psylla put in an appearance in such extraordinary numbers in New York State, as reported by Mr. Slingerland. Mr. Brown told me that he had heeled in a lot of young pear trees procured in the fall, near his house, for spring planting. These young trees were undoubtedly infested with hibernating Psyllas, and it was in the immediate vicinity of the point where these trees were heeled in that the outbreak occurred in this orchard. Mr. Emory about the same time procured a lot of young stock from the same nursery, and undoubtedly introduced the Psylla into his orchard with these trees, coming as they did from a New York nursery at a time when the Psylla outbreak was at its height in that State. In further confirmation of this, Mr. Emory is confident, he tells me, that the present year is not the first one in which the Psylla has been present in his orchard, and that he has observed indications for the last year or two which he has now no doubt were evidences of the presence of the insect. The multiplication of the insect in the orchard of Mr. Brown was very rapid at the start, and its entire disappearance after the first year is probably to be explained on the ground of some peculiar climatic conditions which obtained in his neighborhood, but did not extend northward to the orchard of Mr. Emory. Such conditions are not unusual in the peach belt of Maryland, as illustrated by the fact that orchards separated by only a few miles and in the same conditions as regards soil and variety of fruit will seemingly be affected by cold waves or storms, so that one will be barren while the other will be full of fruit.

THE FUTURE OUTLOOK.

When suddenly confronted with an injury as unusual as this and as startling in its effects, one is naturally led to overestimate the immediate damage and to take a too despairing view of the probable future. In the case of the pear-tree Psylla, however, I incline to the belief that while the seriousness of the present damage can not be questioned, the injury will be very much less in future, even if there is not an entire cessation of the trouble and a disappearance of the pest. The fact that this insect was imported into the United States with pear trees over sixty years ago, and was long since widely distributed throughout the pear districts of the northern States, and westward to the Mississippi, and has yet, during all this time, rarely been reported as injuriously abundant, argues that the conditions favorable to its increase are seldom met with. Its complete disappearance in the orchard of Mr. Brown after one year of excessive abundance is a case in point; and the excessive multiplication in New York State in 1891 was followed the next year, according to Mr. Slingerland, by scarcely any injury in comparison; while the fact that this particular invasion was the first one of any importance of which we have a report further emphasizes the view taken. The reasons for the sudden multiplication and quite as sudden disappearance of this pest are difficult to give. A succession of two or three winters favorable to hibernation probably leads to the unusual multiplication, and this results in a condition of plants which is probably prejudicial to the further increase of the insect. Mr. Slingerland has pointed out that in the later summer broods the condition of the leaves which have been seriously attacked by the earlier broods becomes such that the insect can not thrive on them, and it is a common experience that the insect becomes markedly less abundant in the later summer broods. The green succulent foliage of the young spring growth is especially favorable and when the leaves become hardened and mature, and especially dry and innutritious, from having been already sapped of their vitality, they are distasteful and unsuited to the development of the later broods. In Mr. Emory's orchard the eggs were being placed most numerously on the few young shoots and water sprouts which were manifestly not numerous enough to sustain even a small percentage of the coming brood. It is of course possible that some insect disease worked the complete extermination noted in the case of Mr. Brown's orchard.

The influence of parasitic and predaceous insects should be considered in this connection, and a very interesting experience was had in the case of the Maryland invasion, which will be noted later.

LIFE HISTORY.

As a basis for the discussion of parasitic enemies and remedial measures I have briefly summarized the life history of this insect, more particularly from the careful account given by Mr. Slingerland. The adults hibernate in crevices in the bark of pear trees, and emerge with the first warm spring days, copulate, and begin the deposition of eggs before the leaves have expanded, placing them singly or in rows or bunches in creases of the bark of the twigs, on old leaf scars, about terminal buds, and later, after the leaves begin to unfold, on the leaves themselves, as already described. The egg-laying goes on during April, probably later in the north than as far south as Maryland. The larvæ hatch in from ten to seventeen days, from ten to twelve days probably being the ordinary summer period, station themselves on the axils of the leaf-petioles, on the stems of the leaves, on the fruit, and over the surface of the leaves. The moment they begin feeding the secretion of honeydew takes place, and in a very short while the bulk of liquid will be several times that of the insect, rapidly increasing until it forms a good-sized drop. This, when there are millions to aid in the work, soon becomes abundant enough to fall as a shower from the tree whenever it is shaken by the wind or other means. Mr. Slingerland shows that there are 5 molts, including the last change from the pupa to the adult insect, and the life from the laying of the egg to the adult covers a period of about thirty days, the periods between molts varying from three to seven days. In Maryland, the second brood, as indicated, had already entirely transformed to the adult stage by the 21st of July, and allowing a month for a generation to include the egg period, we ought to expect a third brood of adults about the first of September, which will probably be the hibernating brood.[1]

NATURAL ENEMIES.

No enemy for this insect among the parasitic and predaceous species has hitherto been recorded. On my first visit to the orchard of Mr. Emory I was shown what was taken to be the egg of the Psylla, which proved, however, to be the egg of a common lace-winged fly, *Chrysopa oculata* Say. The mistake was a very natural one, because the eggs occurred in such extraordinary numbers throughout the orchard. On some trees nearly every leaf would have one or two eggs of the Chrysopa attached to it. I immediately inferred that the abundance of the Chrysopa was an incident of the extraordinary multiplication of the Psyllas, and recognized that the latter had a very important enemy in the larva of the lace-winged fly. At this visit I did not have time to investigate the matter further, but on the second visit nearly full-grown larvæ of the Chrysopa were found on the pear trees attacking and devouring the adult Psylla in a very vigorous manner. I collected a large quantity of the Chrysopa eggs and bred a number of young larvæ, and found that they would feed with great readiness on both the eggs and the young larval Psyllas.[2] I think it a safe estimate to say that one lace-wing fly larva will easily destroy several hundred eggs and larvæ of the Psylla in addition to the adults which it will destroy in its later larval growth. From the great numbers of the Chrysopa eggs on the pear trees it is not at all improbable that the lace-winged fly alone will bring the Psylla pretty well into subjection.

Two or three species of ladybirds were also observed running about over the pear trees, the commonest one being *Adalia bipunctata* L., a little red species with two black spots on its elytra. One of these latter species was seen in the orchard with an adult Psylla in its mandibles, and in my breeding cage at Washington one or two adults cleaned the

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[1] Numerous belated species of the July brood were caged on potted pear trees Aug. 3 and produced a new brood of adults by Aug. 30 and these still another by Oct. 1. None of these, even of the last brood, showed any variation from the summer form.

[2] On some trees that were infested with a *Phytoptus* sp., allied to the pear-leaf blister-mite, but living exposed on the lower surface of the leaves, the Chrysopa larvæ were observed also to devour the mites of this species with great avidity.

eggs from the leaves of a young pear tree about as fast as upward of 50 to 75 Psyllas laid them. The larvæ of the ladybirds are equally active and beneficial, and I had no difficulty in rearing a brood from the eggs in my breeding cages on the eggs and larvæ of the Psylla.

It is possible that the disappearance of the Psylla in the orchard of Mr. Brown may have been in part due to the attacks of these two predaceous enemies, but while the great value of these two insects, particularly of the lace-winged fly larvæ, in this direction can not be questioned, they could hardly have caused complete extermination which has probably been more correctly accounted for above.

LIFE HISTORY OF THE LACE-WING FLY.

The predaceous habits of the lace-wing fly larvæ are of common record, and their beneficial character is well known, but in view of the important role played by this insect in the economy of the Psylla it is of interest to describe more minutely its life history and habits. The eggs, instead of being deposited in rather numerously placed clusters or groups, as is the case with some other species, are distributed almost invariably singly on the leaves, rarely two together on the same stalk. The stalk is also not half the usual length, not much exceeding three times the length of the egg proper. Judging from examinations made on my first and second visits, I should say that the egg period ranged from seven to ten days. The young larva cuts off the upper end of the egg on emerging and is surprisingly large in comparison with the egg from which it emerges. It is light ash-gray in color, the head abnormally large, and the body armed with immense curved hairs or spines which give it rather a ferocious appearance and makes it seem to the young Psylla undoubtedly as a veritable dragon. The body is long and tapers very considerably toward the tip, and the head is notable for what appear to be two large curved mandibles. It crawls down along the egg-stalk and begins immediately its active search for food. On approaching the egg or young larval Psylla it immediately grasps it between its long curved mandibles. These are really compound organs, being deeply grooved to inclose the maxillæ, which nearly equal in size, are of similar form, and play in the grooves of the mandibles. These organs form two sucking tubes, between the tips of which the egg or the young larva is held and rolled one way and the other, as between a thumb and finger, the juicy contents being in the meanwhile rapidly extracted. It is a most interesting sight to watch this little larva at work and to note with what celerity it grasps the young Psylla, quickly extracts the juices, and casts aside the dry shell, the whole operation taking frequently less than a minute. The larva is an extremely hungry one, is always feeding, and its rapidity in growth is limited only by the abundance of the food supply. It eats anything that comes in its way, is totally fearless, and is also, unfortunately, cannibalistic, eating its own kind with as great readiness as any other larvæ, as I found to my cost in the case of jars containing several Chrysopa larvæ.

The larval life covered about two weeks in confinement, and with limited food supply; but from the rapidity of the growth when supplied with abundance of food I think under very favorable conditions the period would not much exceed one week. The adult larva attains a length of nearly three-eighths of an inch and is more robust than the newly-hatched larva. In general structure there is very little change, except that the hairy vestiture becomes less prominent. In color the adult larva is brownish purple, darker along the dorsal margin, and with the lateral projecting angles of segments yellowish white. The venter is greenish hyaline centrally including the basal joints of the legs. The femora and tibia and feet are resinous, inclined to brownish. The head is marked dorsally with two slightly divaricating black bands, and with a purplish band extending backward onto the first thoracic segment from the black eye spot. The foot consists of 2 small curved claws and a rather long, projecting finger, with disk to enable the larva to better adhere to the smooth foliage. The tip of the abdomen has a retractile quadrituberculate process which is used as a sort of anal proleg in running or bracing itself. The larva, when full grown, spins up in the curl of a leaf or in any partial protection, constructing a delicate, slightly oval, but nearly spherical, silken cocoon, which is attached to the leaf by silken threads. This cocoon is very small in comparison both with the larva which spins it and the adult which emerges from it, and is less than one-eighth of an inch in longest diameter. The adult emerges in from ten to fourteen days cutting off the upper end of the cocoon in a neat cap. The fly is pea-green in color with, in life, bronzy eyes with greenish reflections. The characteristic markings of the species are the black second joint of the antennæ, a black ring around the antennal sockets, a broad black line below the eye, 4 black spots on top of the head and 3 similiar spots on either side of the first segment of the thorax. The transparent, gauzy, greenish, iridescent wings are very broad and long and very finely netted or veined in a very neat pattern, the normal greenish-yellow color of the veins being varied with dusky crossbars. The adult is a very helpless insect, does not feed at all, and remains concealed in low grass during the day, becoming more active in the evening and depositing its eggs, so far as observed, only at this time, though perhaps also during the night. Its sole reason for existing is to deposit eggs, and having accomplished this it dies. It is a very fragile insect and can not be handled without being crushed, but is withal rather active and difficult to catch. When taken it emits a most disgusting and disagreeable odor, which seems to be its chief means of protection from enemies. While the species *Chrysopa oculata* referred to above was the common one in the orchard in question, another species also occurred there, and perhaps also still others. The differences between these species are so slight, however, that no one but a specialist would detect them, and the habits are practically the same for all.

EXPERIMENTS WITH REMEDIES.

Judging from the results obtained by Mr. Slingerland, the period of my two examinations of Mr. Emory's orchard was not favorable for the application of remedies, the trees being covered with adults and the leaves being rapidly stocked with eggs. Nevertheless, to satisfy myself as to the effects of various washes on the eggs, a variety of careful tests were made. Young trees were selected, the leaves of which were well covered with eggs, and were very carefully and thoroughly sprayed with the mixtures. The applications were all made on the 31st of July, on a very hot, scorching afternoon, and the following days were of a similar character, no rain of any importance falling for nearly a week. The insecticides experimented with were milk and whale-oil soap kerosene emulsions diluted with 9 and 7 parts of water, and the soap emulsion also with $4\frac{1}{2}$ parts of water; the resin wash; and an emulsion made by using the resin wash in lieu of soap, with kerosene, this being also diluted with 9 and 7 parts of water. Notes taken on the day following, and the two or three subsequent days, indicate that with the stronger mixtures of each of the three emulsions mentioned there was a slight change in the appearance of various percentages of the eggs on the leaves. This change consisted in their assuming a reddish orange color, quite unlike the normal tint of the newly deposited egg, and also much darker and more uniform than the color assumed by the egg just before hatching. The young larvæ disclosed at the time of the application were destroyed in every case. Examination of the leaves ten days after treatment indicated that this yellowing of the eggs really had resulted from the action of the insecticides, the eggs so colored having failed to hatch, and were, for the most part, shrivelled and dead. From 75 to 95 per cent of the eggs were killed with the 7-times diluted emulsions, and more than half as many with the emulsions 9-times diluted. The results for each mixture may be more accurately summarized as follows:

Milk emulsion diluted 9 times: From 3 to 5 per cent of the eggs dead; one-half hatched; balance apparently uninjured.

Milk emulsion diluted 7 times: 25 per cent of the eggs hatched; balance shrivelled, showing effect of wash.

Whale-oil soap emulsion diluted 9 times: 25 per cent of eggs hatched; condition of remainder doubtful.

Whale-oil soap emulsion diluted 7 times: 75 per cent killed; 5 per cent hatched; condition of the rest doubtful.

Whale-oil soap emulsion diluted $4\frac{1}{2}$ times: 3 to 5 per cent hatched; balance dead; discolored or affected by the wash.

Resin-wash kerosene emulsion diluted 9 times: 25 per cent of eggs hatched; 25 per cent killed; 50 per cent not certainly injured.

Resin-wash kerosene emulsion diluted 7 times: About 2 per cent of the eggs hatched, the others dead or shriveled and changed in color, and will undoubtedly die.

Resin-wash was applied to an old tree blackened with smoky fungus to test whether it would free the tree of this discoloration and at the same time act on the eggs of the Psylla. The effect in the latter direction was unimportant, most of the eggs hatching, and are now developing uninjured. The smoky fungus also does not seem, at this date, to have been materially lessened, although it is showing some little indications of breaking off and peeling where it was most abundant.

The above series of sprayings supports, to some extent, the results obtained by Mr. Slingerland, but are more satisfactory. It is possible that Mr. Slingerland's observations were not continued long enough to determine the actual facts as to the effect on the eggs, the results of these experiments only reaching any definiteness after eight or ten days. The results obtained with the stronger washes mentioned are the only ones of any value, and as none of the applications harmed the trees in the least, it will be feasible to spray with the emulsions diluted as little as with 7 parts of water. In every case, however, a number of eggs escaped destruction, while even with the weakest washes the larvæ were invariably killed. Spraying has, of course, no value against the adults during their active summer existence, because they are comparatively shy and at the first disturbance fly to other trees.

REMEDIAL TREATMENTS ADVISED.

In view of the experience gained by Mr. Slingerland, and the above series of experiments, it seems to me that the larval periods in the life-cycle of the Psylla are particularly vulnerable, and the first of these especially so, occurring as it does at a time when spraying can be most economically and efficiently pr cticed. Spraying to reach the mid-summer broods of larvæ when the trees are in full fruit is more or less impractical, but may sometimes be advisable, particularly with young orchards. The following treatments are therefore recommended: The first is a spring application which should be made immediately after the leaves are well unfolded and the eggs, deposited by the hibernating individuals, are hatched. A thorough spraying at this time with kerosene emulsion diluted to the normal strength with 9 parts of water, or, if applied earlier, before the eggs are all hatched, with 7 parts of water, will, it seems to me, effect the destruction of practically all the eggs and larvæ. Treatment at this time is especially recommended on account of the fact that it coincides with the periods for first or perhaps the second application for the leaf blight of the pear, and the kerosene emulsion and Bordeaux mixture may be combined in one application with little additional trouble or expense. The experiments already conducted show the complete feasibility of this combination, which, briefly, consists in using Bordeaux mixture in lieu of water as a diluent for the emulsion.

A second treatment which promises well is the winter spraying for the hibernating adults. A thorough wetting of the trunk and limbs at any time during the winter with kerosene emulsion diluted from 7 to 9 times will, it is believed, reach and destroy many of the insects, and will be more effective if the loose bark be scraped from the trunk and larger limbs before the application be made.

Mr. Davis wanted to know the authority for the occurrence of the species in Michigan, and was informed that it was reported by Mr. Schwarz.

Mr. Southwick reported a case of extraordinary abundance near New Baltimore, N. Y., in 1893, which was followed by almost total disappearance the present season.

Dr. Lintner referred to a case reported by him of a similar excessive abundance with total disappearance the year following in the Hudson River valley; but said that the insect had again appeared this year. He referred to the experiments by Mr. Slingerland, indicating that pure kerosene was effective in destroying the eggs of the Psylla, and stated in the same connection that he had applied undiluted kerosene to plum and rose in full leaf without material injury.

Mr. Marlatt said that from his experience it seemed probable that the reports of failure to destroy the eggs with very strong mixtures had been due to the fact that the observations had not been continued long enough; and by referring to his experiments he showed that the eggs retained for a long time after treatment every appearance of life, but eventually, with the strongest washes, shriveled and died in large percentage. In answer to questions by Mr. Ashmead, he also stated that no true parasites had been reared from any stages of the Psylla.

Mr. Smith said he would defer his discussion of this paper until his own, which included the same subject, was read. This paper followed.

NOTES OF THE YEAR IN NEW JERSEY.

By John B. Smith, *New Brunswick, N. J.*

Although it is early in the season for a review of its insects, yet my experience has been that practically most of the damage to crops in our State is done before the middle of August; and that after that time insect life, or at least that portion of it which preys upon cultivated plants, is on the decline. In our State the season has been an extremely interesting one from the insect standpoint, and it has been at the same time the most destructive within my experience. So many troubles made their appearance that I found it desirable to spend in actual field work between forty and fifty days between April 30 and August 10.

In the first place, the San José scale forced itself upon my attention, and it occupied a large portion of my time in following out its distribution and studying its habits. In another paper I have given in some detail a record of my observations in this matter, and I need not do more than mention the subject here. Incidentally I found that the most abundant scale in the orchards generally was the *Chionaspis furfurus*, which attacked pear trees of all varieties and more rarely apples. In one case I found it completely incrusting currant twigs and branches, giving by its great numbers such peculiar appearance to the twigs that I failed to recognize the scale until assured of its identity by Mr. Howard.

In the season of 1893 I found an orchard on the Delaware infested by the pear Psylla, which had been introduced apparently on young stock brought in considerable number from New York State. The insects appeared to be confined to one section of the plantation, and I recommended a winter treatment with whale oil soap, to be thoroughly applied to all trunks and branches, and especially forced into crevices; rough trees to be scraped in order to destroy the hiding places, and consequently the insects themselves. This practice seems to have been remarkably successful, and I failed to find during the present year more than a single specimen of the insect where last fall there was no difficulty in finding any number. On the other hand, I found at quite the opposite side of the State, in the vicinity of Newark, an orchard very much worse infested than anything I have before seen. Quite early in the year—the latter part of May, I think, or early in June—I found any number of adults on the leaves and an abundance of eggs. I have not had an opportunity cf getting into this orchard since that time, because the proprietor is an extremely old and crusty individual, who keeps dogs and has the orchard defended from the road by a hedge of Osage orange. I got into it in the spring at a time when he had cut down this hedge almost to the ground, so as to make it possible for me to step over it, the appearance of the trees having attracted my attention. From another orchard in the southern central portion of the state I received some twigs that appeared, according to the owner, to be unhealthy and to have a blackish coating which was not due to fire blight. The specimens came while I was absent from the office for a day or two, but enough remained on my return to show that the twigs had been clustered pretty thoroughly with pupæ of the pear Psylla. The insect therefore has probably obtained a foothold in different parts of our State, and is one that must be dealt with.

The pear blister mite has been exceedingly abundant in some localities; but it is rather strange how the distribution has been localized. One orchard may be badly infested, another next to it may be almost entirely exempt. A few places that were badly troubled last year were very little troubled during the present season, and I have not been able to discover any satisfactory reason for the difference. It can scarcely be said that any real injury has been caused by this insect anywhere, and at all events not sufficient to make it worth while to suggest the treatment of the trees during the winter for this insect alone.

The pear midge has continued its spread in our State in every direction. It has reached the extreme northern boundary, and along that boundary extends to the Delaware River. Its spread westward from New Brunswick I have had no means of ascertaining during the present season, and it may not have been great because there is a stretch of territory in which not much fruit is grown, immediately west and southwest of New Brunswick, and until the Trenton region is reached there is little opportunity for the midge to show itself in any force. I fully expect, however, that next spring I will hear of the insect in that vicinity. Southward the insect has reached Monmouth County, not far from the shore, but considerably south of the point where I noticed it in 1893. In all localities the injury by the midge was greater than ever before, and has resulted in the loss of almost all the Lawrence pears grown in the Newark district, and of a large proportion of the Bartletts. So serious has been the attack that many growers are becoming discouraged and speak of abandoning pear culture. In the immediate vicinity of New Brunswick every orchard known to me is infested at the present time. It will be remembered that in one of the orchards near the city I carried on a series of field experiments, testing the use of kainit for its killing power on this insect. In the summer of 1892 a very heavy dressing had been applied, and in 1893 there was a practical exemption from injury by the midge in this orchard—an infested pear here and there, and in all not half a dozen, being found. Immediately adjoining this place almost every pear was infested, and not a Lawrence and not 10 per cent of the Bartletts, ever reached maturity. Seckel pears escaped in larger proportion, but even they were very badly infested. No special application of kainit or other fertilizer was made in 1893 in the experiment orchard, and either from the few insects that came to maturity in that year, or from some that had come over across the fence, a considerable number of the Lawrence were infested in 1894. The specimens were thinned out as much as possible, and again a very heavy dressing of kainit was applied after the larvæ had matured. I expect that in 1895 this orchard will again be practically exempt. It is interesting to note the point that, whereas everywhere else injury has increased each year, in this orchard there has been no spread. Only the Lawrence, and even here only a very small percentage of the fruit, has been touched. I attribute this entirely to the use of the kainit. for I can see no other reason why the insect should not have spread here as well as elsewhere but for the application of this material. However, to test the matter in quite another locality and under different circumstances, on quite a different soil, I induced a grower near Newark to apply the fertilizer at the rate of a ton to an acre, the kainit being furnished by the German Kali Works for the purposes of the experiment. This orchard was very badly infested this year, and a very large percentage of the pears of all varieties, except the Kieffers, were attacked. It is an interesting fact and one of a great deal of practical importance, perhaps, that thus far I have not found a Kieffer pear infested. This may not be due entirely to any peculiarity in the fruit itself, but to the fact that so far as the midge has extended at present the Kieffer blossoms first and perhaps gets a little ahead of the adult insect. I had an opportunity this year of watching the oviposition of the insects and find that Schmidberger's account, as quoted by Dr. Lintner and subsequently in my Bulletin No. 99 of the New Jersey Experiment Station, is correct in all essential features. I find that the eggs are deposited in little masses in the buds long before they are opened. There is no one point that seems to be more favored than others in oviposition. Usually the point where the bud is most easily penetrated is the place selected, but sometimes it is pierced through the side by the female close to the base, or at any point. More usually, perhaps, no trace of a puncture is to be discovered, but the ovipositor has been apparently inserted at the point where the petals of the future flower were slightly separated. The eggs themselves were not attached in all cases to any part of the flower, but seem to be connected with each other either by a very frail tissue or by a gummy excretion. I have not been able to watch the actual oviposition itself, but from the mounted specimens it almost appears as if the eggs were laid in little masses rather than singly. I am not certain that this is possible, and the appearance may be due to a spread of the gummy material surrounding the eggs. I had no difficulty whatever in finding the eggs in the buds, and usually in those that might be considered as normally developed. Very early buds, very far advanced, usually contained no eggs, and those that were very late, crippled, or retarded were also usually bare of them. The very fact that only normal buds were infested would seem to indicate that the insects were thus given a somewhat better chance, because either very early or very late flowers would stand less chance of being pollenized and thus furnishing food for the young larvæ. I am inclined to believe that in many cases, at all events where the bud had been punctured, its opening was slightly retarded, and possibly this may be an advantage to the insect, giving the egg a little longer time to hatch and make its way into the ovary of the flower before the bud actually opens. So far as I examined I found it to be invariable that the young larvæ made their way into the ovary before the flower opened. While there is not much difficulty in finding the eggs in the unopened bud, I did find a very great difficulty in seeing the very young larvæ in the open flower. And those specimens that I did find showed so little differentiation from the egg that it seemed almost in some cases as if the egg itself had the power of motion, enabling it to get into the plant tissue before the opening of the flower. None of the stains that I attempted to use gave me any clear differentiation of the parts of the very young larvæ. I found that while there was no trace of distortion in the bud, and it was impossible to distinguish with any degree of certainty the infested from the sound bud, yet almost immediately after the young pears had set, or almost immediately after the flower had become pollenized, a change in appearance took place. As soon as the blossoms had dropped there was no difficulty whatever in recognizing the infested fruit, and here another peculiarity was noticed. While almost all the infested pears stuck fast and started growing, most of the apparently sound pears dropped almost as soon as growth began; when growth of the fruit had fairly started and it was larger than a pea, only infested pears remained upon the tree.

As if this was not sufficient, an entirely new pest on pears was brought to my attention this spring. In the vicinity of Hilton and Irvington, localities not far from Newark and lying between Newark and Elizabeth, a borer has made its appearance that threatens to kill all the pear trees in that region within a very few years. The insect has been known for several years, but not until this season was it brought to my attention. There was no difficulty in finding the larvæ in trees of all ages, and there was no difficulty in recognizing it at once as that of an Agrilus. The larvæ when full grown measured nearly an inch and a half in length, and a single larva in the course of its life made a burrow which, when measured, ranged between 6 and 8 feet in length; not in a straight line of course, but in the winding and sinuous line which is peculiar to many Buprestid larvæ. From this enormous larva, making such a wonderfully long burrow, I obtained two specimens of an Agrilus scarcely more than one-fourth of an inch in length, and which Dr. Horn pronounced as probably *acutipennis*. The determination was made from females only, and may have to be changed to *anxius*, in which the females are nearly alike, and the specific characters are marked in the males alone. Before pupating the larva makes a short burrow into the solid wood, preparing a chamber in which it undertakes its transformations. The pupa state must be extremely short, because, although I visited the infested orchards weekly, and found the larvæ during the early part of the season in the pupal chambers, yet I never found the pupa, and always found either a larva just entered into the burrow, or a recently vacated burrow, a little round hole being bored through the bark. I never found a specimen of the beetle upon the trees, either on the leaves or on the trunks; but about the middle of July I began to find young larvæ. The larva bores between bark and sap wood, its channels being distinctly visible in both. Where a number of them are at work in the tree it becomes completely girdled sooner or later, and dies. Every portion of the trunk is infested, and all the larger branches are attacked. But it is not only large trees that the insect attacks; even young trees just set out becomes its prey, and from a little sapling set the year previous, I took out three full grown larvæ, and found that it had been bored from the top down to the root, killing it of course. All sorts of trees are attacked by the insect, but not all trees succumb with equal readiness. Vigorous varieties like the Kieffers resist for a long time, and the burrows of the larvæ become filled up with new tissue nearly as fast as they are made. Bartletts and Seckels do not seem to have the same amount of vitality, and the wood and bark immediately around the burrows dries and dies off, the bark cracking on the outside and indicating, by its appearance, the presence of the larva and the course of the burrow. Trees 40 years old, and which have yielded annually large crops of fruit, are now dying off in great numbers, and will probably be entirely gone in a very brief period. The insect requires living tissue for its nourishment, and never under any circumstances works in dead or dry wood. In two or three instances I carried infested wood with me to the laboratory, but in all cases the larvæ died just as soon as the wood lost sap, and no specimens came to maturity. I was equally unfortunate where I had an entire tree sent me, most of the larvæ dying, although here I obtained one mature insect, a pupa having evidently been already formed. This is really the most serious threat to pear culture in the district where the insect has thus far made its appearance. Fortunately it has not yet spread over any very large extent of territory, and there is no indication at present of any very rapid extension of its injury. It seems to be confined, so far as I can make out, to a territory not exceeding 10 or 15 miles in diameter; but within that point it is extremely destructive. It was an extremely discouraging feature this spring to visit orchard after orchard where there were numerous trees well kept and cared for, carefully fertilized, and where in previous seasons good crops had been raised, and to find that on sound trees the midge infested a very large percentage of the fruit, and that where the midge did not attack everything, the borers were working in the trunks, and that the trees were losing vitality and were on their way to the grave. There certainly was no encouragement to the farmers, and unfortunately I had very little consolation to offer. Borers of this description are among the most difficult insects to deal with, and apparently preventive measures only are indicated. Even they are difficult in this case, because the beetle lays its eggs anywhere on the tree, and is not confined to the trunk or to the larger branches. I have found shoots less than half an inch in diameter infested by larvæ, and they work down from that point toward the trunk, and in the trunk work down toward the ground in every instance. I presume that mechanical coatings to the trees might offer some benefit, but it is a practical impossibility to cover not only the trunk but all the branches in such a way as to prevent the entrance of some larvæ, and once under the bark, the work will go on without danger from any application that we can make, or even without discovery until the damage has been done. It is interesting to note that prior to this year the insect itself had never been taken by any collector in New Jersey, and it is not only new as an injurious insect, but is new to the New Jersey fauna, and had heretofore been considered as rather a rare insect. Thus much for pear trees, which, up to a few years ago, were rather free from insect attack.

I find that in some localities growers have become tired of washes and paints applied to the base of quince and apple trees to prevent the entrance of the borer, and instead, use fine wire netting, enveloping not less than twice and closely tied, extending below ground and upward along the trunk for the distance of at least a foot or eighteen inches. This has the advantage of affording complete protection, of yielding to the growth of the tree, and of allowing the bark to perform its functions with absolute freedom. It is effective, certainly, because none of the trees that were so protected showed signs of the borer, though all others in that vicinity were more or less infested.

There were no other orchard pests that made themselves especially obnoxious, and in fact, in view of the extreme prevalence of the blight on both pear and apple trees, insect injury sank almost to insignificance.

Cutworms have been particularly abundant in New Jersey during the present season. All sorts of planted crops have been affected and everywhere complaint was made that replanting was made necessary, sometimes twice or even three times, and in a few cases crops were abandoned and others put in, simply because the supply of plants was not sufficient to obtain a stand after feeding the cutworms. Acres upon acres of sweet potatoes were cut; early cabbage was ruined in some sections; melons were cut off as fast as they came above ground; so was corn, and, in fact, there was a universal wail asking for a remedy. The poison-bait trap was used with great success in many instances; but for some reason the farmers seem to have an objection to using it at the proper time. One of the sweet-potato growers near Beverly, N. J., made some experiments on his own account, and among other things prepared a mixture of bran and Paris green, using no definite proportion, but adding Paris green enough to the bran to give it a greenish tinge when thoroughly mixed. This mixing was done dry, and then water enough was added so that the mixture would stick together and form a rather dry mush. Of this mixture about a spoonful was applied to every hill of sweet potatoes at the base of the plants, and in every instance this mixture was preferred to the plants themselves and served as an absolute protection to the crop. Mr. Oliver Parry, who was the originator of this material, gave me the information at the time, and I immediately published it in the Weather Crop Bulletin. Many of the farmers tried it at once and I have responses from a number who found it to be absolutely successful. There seems to be a peculiar attraction in moist bran to the cutworms, and they will eat it in preference to the vegetation. That it actually killed the insects and that there was not a mere cessation of attack, was proved by the positive statements of the farmers, made in answer to questions, that they found the dead larvæ near the plants. For some reason farmers seem more inclined to adopt this measure rather than the poisoned vegetation trap, and as it has proved successful in so many hands, perhaps we have at last something that will protect planted crops from the cutworms.

The appearance of the periodical Cicada, or the "seventeen-year locust," as it is usually termed, was, of course, in one respect the most striking occurrence of the year. This is one of the broods that is supposed to appear all over New Jersey, but principally in the northern portion, and perhaps that is about as good a description as it is possible to give, and yet there are more places where the insect does not appear than where it does make its appearance. The fact that the insect was abundant in those counties about Jersey City, containing the most dense population, gave the insects an undue prominence in the newspapers, and there were numerous references and notices concerning them, the great majority more or less erroneous. It was curious what a lot of injury was attributed to the locusts. They were said to have destroyed all the rye and wheat fields in certain localities, and in som New York papers they were credited with destroying the grass crop. It is really surprising what an enormous amount of misinformation seems to be generally distributed concerning this insect, but it is hardly necessary for me, in this Association, to call attention to facts like this. The interesting point to me was the spotty distribution of the insects. There were very few large tracts infested, and, with perhaps two exceptions, no entire county was covered in all its portions by the insects. Union and Essex counties alone seem to have been covered in all parts. Hudson County consists of so much lowland and marshy ground that it afforded no opportunities for the insects; but along the Hudson, as soon as the ground became sufficiently high, the insects made their appearance, and they covered a considerable proportion of Bergen County. Passaic County was invaded in its southeastern portion about Paterson, but I had no reports from the northern and western parts concerning the presence of the insect. A small portion of Sussex County was invaded at points remote from the Delaware River, and possibly it may be in place to say here that nowhere in New Jersey does this brood of Cicadas approach within 15 or 20 miles of the Delaware River. Warren County had one little spot in the extreme eastern corner from which the insects were recorded, and in the vicinity of Boonton they were reported for Morris County also. At the most northern point of Somerset County, where it joins Hunterdon, the insects made their appearance; but, except perhaps just across the border at this point, no portion of Hunterdon seems to have been troubled. Middlesex in its northern portion was pretty well covered by the insects, and they extended up the Raritan River for some distance above Bound Brook and down the river toward Perth Amboy, but far from equally. They would occur in great numbers in certain patches of woods, skip others completely, and reappear a mile or more farther along in immense numbers, leaving then another blank patch of greater or less extent. The western and southwestern portion of Middlesex and all of Mercer County were free from the insects. A small region in the northern part of Monmouth County was invaded, and a very few points in Ocean County reported the presence of the insect. In fact, it was only along the course of Toms River and its upper branches that I had any reports from Ocean County at all. In Burlington County they were reported from a single point only, and that near the center of the county. In Camden County they appeared along the line of the Atlantic City roads about fifteen or more miles from Camden, and extended for a short distance on each side of the railroad to Hammonton. There a considerable patch of country was skipped and then they reappeared, not again becoming abundant, however, until the Egg Harbor City region was reached. From Egg Harbor City a streak extended southward and a small spur also north of that point, and Atlantic County was crossed to the Tuckahoe River. Along the Tuckahoe River through the central portion of its course they were extremely abundant, and from this river they extended southward for some distance into Cape May County, becoming perhaps most numerous near Woodbine, where there is a large settlement of Hebrews. This settlement suffered perhaps most of any other in the State from the injuries caused by the insects in ovipositing. They had set out young shade trees, as well as orchard trees, in very great abundance. Soft maples, three and four years old, lined out the streets and all the roads, while to every allotment of land there were a certain number of fruit trees of all descriptions. This seems to have been just exactly what these insects were looking for, and they simply wrought havoc with everything, because they oviposited not only in all the branches, but in the trunks clear down to the base and on all sides of the tree trunks, so that there was in some cases scarcely a clear space of an inch square to be found anywhere on the tree. I have in my laboratory now several trees in which there must be several hundred egg slits made by the Cicadas. This is the only portion of the State in which a real permanent injury was caused by the insects; because here many young trees were killed and others were set back so far that they were rendered practically useless for some time to come. Cumberland County reported the insects from several points along the Maurice River, extending from Franklinville almost to Delaware Bay, and at Franklinville entering Gloucester County for some little distance. At this point also there was the only extension into Salem County that was reported, and at Bridgeton, on the Cohansey Creek, there was a small area of a few miles in extent in which the insects appeared. One of the interesting features was the abnormally early appearance of the insects in certain localities. In one spot, a short distance south of New Brunswick, specimens were collected which reached my hands on the 5th or 6th of May, far in advance of anything else reported from any other part of the State. In Cumberland County they made their appearance about the middle of the month, and here first the Philadelphia papers got hold of the matter from the fact that a physician of that locality driving through a burned district discovered acres of the woods covered by the "chimneys" that these insects sometimes build. According to his description, every square foot of sod showed dozens of these chimneys, and in each was to be found a Cicada pupa. He sent me, at my request, two sods showing the average number of exit holes, and sent me also the chimneys taken from them. None of the ground covered by me, where the insects were appearing, showed any trace of these peculiar chimneys and nowhere else in the State were they recorded, except at one point in the vicinity of Newark, where Mr. E. Bischoff reports finding them near an old stone quarry. A considerable proportion of the State has therefore been covered by the insects during the present year, and I have marked on a map of the State all the points from which I have been able to receive authentic reports of the presence of the insects, but even in the territory covered there were many points in which the insects did not appear. In riding along the line of the Cape May Railroad from Camden the insects were noticed for the first time a short distance north of Vineland; nothing more was seen of them until Millville was reached, and a little north of that point the insects were again seen. Then came a considerable stretch of territory where there was no appearance of the presence of these insects, until some ten miles north of Woodbine they again made their appearance, sometimes on one side of the railroad and sometimes on the other; sometimes skipping a mile, then appearing over a territory as far as the eye could reach, causing the oak shrubbery that covers the ground to appear as if a fire had passed over the tops. Woodbine seems to have been the center for this aggregation, and from there to Cape May Court-House, near the middle of the Cape May Peninsula, they were noticed in gradually decreasing abundance in all the high wood lots. It was the same way in riding along the line of the Atlantic City road. At Atco, and a little north and south of that point on the Camden and Amboy Railroad, and near Clementon, on the Reading road, the insects were noticed on both sides of the railroad in the woods. Towards Hammonton nothing was seen of them and very little was noticed until within a short distance of Egg Harbor City. Then a colony made its appearance on both sides of the railroad, and they were visible for a short distance southeast of Egg Harbor City, but petered out long before the low lands near the shore were reached. Seventeen years ago the insects, it was said, were abundant within the limits of the city of New Brunswick. This year not a specimen was found in the city, or close to it, and it is certain that the sparrows are responsible for this fact. On one occasion I brought in about a dozen specimens and put them on the piazza for the children to play with. It delighted them for a time, but one after the other made its escape and flew for the trees in front of the house; not a specimen ever got beyond the first or second tree. Most of them were captured by the sparrows before reaching the first tree and were torn to pieces. One or two of the specimens were brought to me in a fragmentary condition by my next-door neighbor, and if any unfortunate creature did actually emerge anywhere within the city limits it lived so short a time as to be unnoticed. This is rather a curious fact, too, because the ordinary harvest fly (*Cicada tibicen*) occurs within the city limits in any number and does not seem to be in the least disturbed by the sparrows.

In many places the melon lice were very destructive during the present season, and acres of vines were plowed up because of the injury caused by them. The appearace of these insects was expected by me, when the last week of June and the first days of July passed without a cold storm. For two years we have had, in New Jersey, either in the last days of June or the first days of July, very heavy storms, generally accompanied by heavy winds and by cold rain, and as these occurred just at the time at which the aphides migrate from their winter and spring food plant, which I regret to say I have not yet been able to discover, they have been so much reduced in numbers that no injury was caused by them and only a few plants here and there became infested. During the present season there was no rain in the central and southern part of New Jersey from the first days of June to the last days of July, and in some localities there has been only a trace of rain up to the present time. This was ideal weather for the aphides, and they took advantage of it. The presence of the insects gave me an opportunity of making some tests of bisulphide of carbon, first suggested for this purpose, as far as I am aware, by Prof. Garman, and from these experiments, of which I will speak more at length elsewhere, it appears that this material can be practically used in the field as against these insects early in the season.

Sweet potatoes were much retarded by the dry weather and this prevented them from growing away from their ordinary insect pests, the Cassidæ. They were so long in starting that in many cases the beetles and their larvæ destroyed the entire shoots, and the ground was then so dry that it was simply impossible to set out new plants. Much damage was therefore done, which, although directly attributable to the insects, was yet indirectly chargeable to the dry weather; because with an ordinary amount of moisture the plants would have grown away from the insects. The most satisfactory method of dealing with these creatures, up to the present time, is to let chickens run in the fields, and many of the growers, nowadays, set their chicken coops in the field and keep anywhere from a dozen to twenty chickens picking up their living among the sweet potatoes. The practice is said to be effective, and that is all that can be asked. Few of the farmers raise their own chickens; but just when they need them they buy them in the Philadelphia market and keep them running in the sweet potato field until the insects have been cleared up; then they either fatten and kill them for their own use or ship them to market again.

Truckers, of whom there are a very great number in southern New Jersey, have lost heavily on their tomato crops, chiefly from meteorological conditions, but largely also by the corn worm (*Heliothis armiger*). Early tomatoes were scarce, owing to the heavy rains at the time that the plants set the first blossoms. These were blighted and the plants recovered slowly from the setback received, and almost all of the second set proved to be infested by worms. One source of profit, therefore, for our farmers was practically cut off entirely, because early tomatoes are usually counted on as a money crop.

The onion maggot appeared in Cumberland County early in the season and showed itself in large numbers on the plantations. The same measures that were so successful last year were again adopted; that is, the earth was turned back from the onion rows, kainit was applied in a heavy dressing in the furrow, the earth was turned back again, and in three days thereafter not a maggot could be found in the fields. This is the second season in succession when this practice has proved entirely successful. It has checked injury by killing the larvæ, and it has stimulated the plants to such an extent that they overcame the injury that had been already done, and matured the fruit. I think I am justified in claiming value for this method of treatment; the more so, as in several other cases, farmers who used heavy dressing of this material in spring have been at a great advantage as compared with their neighbors, so far as insect injury to corn was concerned.

The remarkable invasion by the larva of the clover-leaf weevil, which I have now observed for four years in succession, started again during the present season, and as in all the previous seasons the larvæ have been swept away before maturity by the fungous disease. This disease appears to act irrespective of weather. It seems to make no difference whether the season is wet or dry, and possibly this might be a good subject to experiment with on some of the other insect pests.

Blister-beetles have again made their appearance in considerable numbers in some few localities and have attacked quite a variety of plants. Beets seem to have been rather the favorites during the present year, and after them egg-plants and potatoes have been injured.

A trouble which was brought to my attention for the first time this year, but has probably existed to some extent for several years past, is the potato stalk-borer, the larva of *Trichobaris trinotatus*. I found them early in the present month in Mercer County, and in the fields that I examined there was scarcely a vine that was not infested by anywhere from one to five of the larvæ. They were pupating just at this time, and I found among the material gathered one adult, although very immature. It is somewhat questionable whether any very great damage would have been done by the insects, numerous as they were, if the dry weather had not stunted the vines and prevented them from growing as vigorously as they would do under ordinary circumstances. Certain it is that in those fields that were most heavily fertilized, and in which the vines were rank, the insects seem to have done little damage, and the tubers that were set were of good size and in fair numbers. The insect has not been heretofore reported from New Jersey by collectors and I have no means of knowing just yet how far it is distributed and what measures should be adopted to check it. It will certainly be impracticable to follow the recommendation that has been given, to pull out the infested vines and burn them, because that would mean, in the fields that I examined, that the entire stand would have to be pulled out and destroyed. It is likely that early planting of early varieties, early harvesting, and then destroying the vines by fire will in time reduce the numbers of the pest.

Altogether the farmers in New Jersey have had an extremely hard time of it during the seasen of 1894; all kinds of crops have suffered to some extent, and in many cases insects which usually do no damage have been troublesome during the present year from the fact that the plants have been reduced in vigor by the dry weather. Of this character is the injury caused during the present season by the Hessian fly, which seems to have damaged wheat to a considerable extent in some of our northen counties.

Following the reading of his paper Mr. Smith said that the conditions of the tree and the insect which he found in New Jersey corresponded exactly with the conditions described by Mr. Marlatt as prevailing in Maryland. This held in the matter of the spotting of the leaves, in the blackening of the twigs and limbs, and also as to the source of the infestation.

Mr. Southwick said that he had found at Fort Lee and also at Short Hills, N. J., the towers of the Cicada very abundant. He also said that in his experience the *tibicen* species was vigorously attacked by the English sparrow, without, however, being killed; the birds merely cut off various parts of the insect's body.

Mr. Davis said that the clover-weevil fungus is not confined to this insect, but will develop in other species, as shown by the studies of various mycologists. He reported that in Michigan it was very effective in destroying the clover-weevil larva. He stated also that the clover weevil had only recently been noted in Michigan, but was increasing rapidly.

Mr. Hopkins, referring to the Agrilus attack on pear trees mentioned by Mr. Smith, said that he had observed two distinct species, one attacking beech and the other *Cornus florida*. He also exhibited examples of Agrilus injury to *Populus quadridentata*, which had been grown over by healthy wood, indicating that the larvæ undoubtedly bore in the living wood. This fact, he said, was also evidenced in the work of the raspberry Agrilus, and the evident intention of these insects in working, as they almost invariably did, in such a manner as either to completely surround and girdle the plant, or, in the case of larger trees, to zigzag across it, was to effect the partial disease or death of the plant.

In reply to a query by Mr. Smith, Mr. Hopkins said that the burrows in beech and Cornus were similar to the ones exhibited in Populus. Mr. Smith said that the peculiarity of the burrows of the pear species was their extraordinary length. Mr. Lintner said that he had hitherto supposed that the poplar Agrilus attacked only cut timber, and that he had taken great numbers of them about such wood, but had failed to notice any of them in the act of ovipositing.

Mr. Howard suggested, in reference to the use of arsenated bran as an insecticide, that perhaps Mr. Parry, whom Mr. Smith had named as the originator of this insecticide, had been reading some California literature on the subject. He called attention to the fact that this mixture had long been used in California as a means against locusts and cutworms, and reports on its use have been printed in the publications of the Division of Entomology and elsewhere. Mr. Smith, however, was of the opinion that the use of this mixture was original with Mr. Parry, who was unaware of its prior use elsewhere.

Mr. Marlatt, referring to the pear blister mite discussed in Mr. Smith's paper, said that a new Phytoptus affecting pear leaves had been brought to his notice by Mr. Waite, of the Division of Vegetable Pathology. This species differed from the blister mite in that it lived exposed on the under surface of the leaf, causing a slight granular appearance of the leaf surface, with a reddish or brownish tinge, and the curling of the leaves. He said that in Maryland this mite was quite abundant, whereas the blister mite was rarely met with. The injury from this mite seemed to be comparatively slight.

Mr. Smith said that he had also seen the condition of the foliage described by Mr. Marlatt.

Mr. Davis then read the following paper:

SPECIAL ECONOMIC INSECTS OF THE SEASON.

By G. C. Davis, *Agricultural College, Mich.*

One can hardly fail, in a year's correspondence, to learn some new facts in an economic line regarding insects. This year I have obtained much information in this way, which I have endeavored to bring together in this brief paper. While the work of the various insects is generally understood, many of their habits are not known, are indeed entirely new to me, and, so far as my researches in enconomic literature have gone, are as yet unknown to others.

DIPLOTAXIS HARPERI AS A STRAWBERRY PEST.

Specimens of this Scarabæid came to me May 24 from Campbellsburg, Ind., through the Practical Farmer and Fruit Grower of Grand Rapids, Mich. The accompanying letter from Mr. Brown stated that they were injuring his strawberries and had already done some injury to his wheat; that they attacked the smaller and weaker plants over his 2½-acre field of berry plants and very quickly destroyed them. A subsequent letter explained that the beetles remained about three weeks. They fed at night and in the daytime buried themselves an inch or two below the surface of the ground. As high as two dozen specimens were found at a time on a single plant. The beetles appeared on the wheat first, but as it became too tough they migrated to the newly set strawberry field near by. An old strawberry patch adjoining this one was not harmed. The soil is a light clay loam and the beetles were not noticed to appear in any one place, but appeared to be equally distributed over the whole piece. Paris green was tried, but with no evident effect.

The species is closely allied to *Lachnosterna fusca*, and its nocturnal habits appear to be the same. The form is that of Lachnosterna, but the beetles are not much larger than the rose-chafer. Our college collection contains specimens from Michigan, Illinois, and the District of Columbia.

A DIPTERON RASPBERRY GIRDLER.

Early in May a letter from a Lansing fruit-grower reached me, from which the following is taken:

> A few days ago I noticed that some of the young shoots of my raspberry canes were withering. On examination I found the cause to be a small worm or grub about an eighth of an inch long and as large as a small needle. It seems to enter the shoot at the tip and works its way downward for several inches and then makes a complete circle near the outside of the shoot so close to the bark that it can be distinguished by close inspection without breaking the shoot. Here the worm is found, and of course the shoot dies.

The next day the berry patch was visited, and I found that about half of the young shoots had already been destroyed by the maggot. The keeper had guarded the field closely, and as soon as a shoot wilted had broken the stems off and burned them. In fact, he had been so vigilant in the work that I was unable to secure but few specimens for myself. At this time the maggots were about 5^{mm} long, white, with black jaws, truncated posteriorly, and sloping gradually to the pointed head. In general appearance they resemble very closely the larvæ of Anthomyiidæ. They work only on the young shoots of the black varieties of raspberries. Entrance is made near the top of the shoot in a leaf axil, which was probably in the top bud at the time the egg was laid, and from this entrance the larva works its way in an irregular course down through the pith until it comes within a few inches of the ground, when it girdles the canes as represented in the extract. As soon as the top wilts the maggot continues its course downward through the pith.

Careful search was made in neighboring berry patches and in our own at the college, but nothing more of the kind was found. Not so much would have been thought of this one local injury had not there come a letter from Costello, Pa., about two weeks later, describing the work and maggot exactly at that place. It was stated that the injury was considerable in the locality. This made me think that perhaps the species is more widespread than thought at first. Every effort was made to rear the maggots which I had, and I was successful for some time by transferring them every few days to fresh shoots. The last maggot reached a length of 11^{mm}, when it died.

ADIMONIA CAVICOLLIS ON CHERRY FOLIAGE.

A correspondent at Bellaire, Mich., sent me specimens of this Chrysomelid the latter part of May, saying that they were causing damage to cherry trees of that locality. On investigating the life history of the species I find that it is reported by Packard in Forest Insects under *Galeruca sanguinea* as found abundant in New Hampshire on wild cherry.

Like so many insects that we find each year, the Adimonia has in some way found that a cultivated plant closely related to its old food plant is preferable, and is making the most of the newly found plant. The beetle is spoken of by Mr. Schwarz (INSECT LIFE, vol. VI, p. 94) as being a common northern species, and we may possibly yet find it quite a serious pest.

In response to my inquiry my correspondent wrote that there were wild cherry trees not far away, with a few of the beetles on them. Larvæ received July 10 were about 5^{mm} long, not very broad, and tapering posteriorly. Head, legs, pronotum, and terminal plate black in all the specimens, except one which was larger, and these parts in that one are reddish brown. On the dorsum of each segment are two transverse rectangular parallel dark spots, with two or more smaller ones on the sides at the end of the large ones, and beneath these is a longitudinal block on each segment. The venter of each abdominal segment is marked with five dark-brown spots, the central one being largest.

NOTOXUS ANCHORA EATING CHERRIES.

In connection with the Adimonia this species of Notoxus might be mentioned. It was reported from northern Michigan as collecting in large numbers on nearly ripe cherries and eating the contents from them. It is quite probable that the species was not the direct cause of the injury, but ate the fruit after it was punctured in some other way.

MONONYCHUS VULPECULUS DESTROYING IRIS FLOWERS.

This Curculionid destroyed the flowers in a bed of Iris plants at Flint, Mich. The beetles ate little holes over each corolla as soon as it appeared and quickly killed it. The beetles showed a preference for the white and lavender varieties of the Iris. No other species of flowers around the bed was molested. The beetles remained for some time, but nothing more has been learned as to their work or habits.

Mr. Hopkins said that in 1890–'91 he had observed what was evidently the raspberry-cane maggot described by Mr. Davis, but had failed to rear the adult. He was of the opinion that it would prove to be an Anthomyiid. He had also found the cherry beetle mentioned to occur very abundantly in the Alleghany Mountains in 1892.

In the absence of the author, the following paper by Mr. Chittenden was read by Mr. Southwick:

ADDITIONAL NOTES ON THE STRAWBERRY WEEVIL, ITS HABITS AND REMEDIES.

By F. H. CHITTENDEN, *Washington, D. C.*

[Published in INSECT LIFE, vol. VII, pp. 14–23.]

Mr. Smith said that this year he had anticipated very considerable damage from this insect on account of its distribution and abundance last season, but that so far as he had observed it had not manifested itself to any extent in New Jersey.

In view of the lateness of the hour, the President suggested that the remaining papers be read by title only. This suggestion was approved by the Association, and on motion of Mr. Ashmead the President and Secretary were constituted a committee to examine these papers and pass upon the question of their publication.

The following papers were then read by title, and their publication was subsequently approved by the committee:

NOTES ON THE INSECTS OF NORTH IDAHO.

By J. M. ALDRICH, *Moscow, Idaho.*

The introduction of new insect pests is an important and interesting process which is now going on in all the newer Rocky Mountain region. From a year's experience in the southern part of the Idaho "panhandle," I select a few notes on the principal pests. The region varies in altitude, in the farming portion, from 700 to 3,500 feet above sea level, with a corresponding change in climate. Wheat and fruit are the principal crops.

The wheat aphis (*Siphonophora avenæ*) has been almost universally present this year in northern Idaho and eastern Washington. The Syrphus flies, lace-wing flies, and ladybirds have pretty well checked it at the present writing (July 30). I have seen no internal parasites, though Mr. Howard reported some in a shipment sent to him from a point in Washington. The aphis must have been in this section for a number of years, otherwise it could not have appeared so widely this season. Accurate observation on this point is lacking, but some farmers say the same outbreak occurred ten or twelve years ago.

The codling moth (*Carpocapsa pomonella*) has been abundant for some years in the old fruit-growing region about Lewiston. It is now gradually spreading into the newer orchards. Doubtless the spread is very largely due to bringing apples from old orchards into the vicinity of the newer.

The bud moth (*Tmetocera ocellana*) was introduced about Genesee last winter on shipments of apple trees from New York. It attracted considerable attention, and appears to find the climate favorable to its increase.

The woolly aphis (*Schizoneura lanigera*) and the apple aphis (*Aphis mali*) are both present, the former in restricted areas and the latter quite generally. Both were doubtless introduced on young fruit trees.

The pear-leaf blister-mite (*Phytoptus pyri*), which from an economic point of view belongs to the entomologist, is quite generally distributed through the State. It was, of course, introduced in the buds of young trees.

The San José scale (*Aspidiotus perniciosus*) is known as yet only in a limited area about Lewiston, where the oldest orchards are. It was introduced on trees. It is the most dreaded of all the insect pests, and a considerable effort is made to prevent its getting a foothold in new localities. The laws of Idaho permit each county to appoint a "horticultural commissioner," whose duty is to inspect orchards, fruit stock, etc., with ample powers to compel spraying or destruction of property infested. Only three counties have taken advantage of the statute at present, the fruit interests of the others being but little developed.

INSECTS OF THE YEAR.

By F. M. Webster, *Wooster, Ohio.*

To me, in Ohio, the present year has been unusually prolific in those unexpected occurrences and outbreaks which happen to a greater or less extent every year, and of which we may truthfully say that we know not one day what the next will bring forth. In early spring I have not unfrequently wondered what species it would be that would come to the front, and what heretofore uncommon species would show itself in numbers sufficiently great to cause trouble among the agricultural and horticultural interests of the country; and it is the unexpected that always occurs. Foremost in this year's surprises came the discovery of the larvæ of *Fidia viticida* Walsh in the extensive vineyards along the shores of Lake Erie. But, as this subject will form the basis of a separate paper, I will not discuss it here.

Early in January there came a complaint from the vicinity of Cincinnati regarding a serious injury to the Lucretia dewberry, which had been extensively grown in that section of the State, the industry being now in a precarious condition, however, owing to what had been supposed to be the effect of winter killing of the previous year's growth, but now believed to be due to the attacks of some insect unknown to the growers. My first visit made to the locality revealed the destroyer in the shape of the well-known depredator, the red-necked Agrilus (*A. ruficollis* Fab.). The attack was generally made near or just above the surface of the ground, and while the plants remained alive during the summer and fall, very few survived the winter and produced fruit the following year. In the latitude of Cincinnati adults appear quite early in the season, and I found them quite numerous on May 18, fully a month earlier than they are to be found in the northern part of the State. A very few of the beetles were to be found abroad in this locality on June 27, thus showing that the adult period lasts about six weeks. In the matter of preventives, I think we have settled the problem, at least so far as the dewberry is concerned. From a number of accidental cases and some experiments made by Kentucky growers, it seems every way probable that young growth in which the eggs have been deposited can be cut out about the 25th of June, and the second growth, now necessarily free from attacks, will furnish sufficient wood to produce a full crop of fruit the following year.

Late in April it became evident that we were to have trouble from the clover-leaf weevil (*Phytonomus punctatus* Fab.). This insect has for the last three or four years been gradually making its way across the State, both along the lake and the Ohio River. This year it passed over the western line, in the northern section, far over into Indiana, if not indeed to Illinois. Cocoons were received from Monroe County, Ohio, April 25, and for a short time every mail brought complaints of the depredations of the larvæ. One report of injury came from West Virginia. The clover fields about Wooster were being literally eaten to the ground, when suddenly, as it seemed, the fungoid disease (*Entomophthora sphærosperma* Fres.) appeared, and the result was simply astounding. A farmer came to me on a Saturday to say that his field was literally swarming with the larvæ and the clover being fast destroyed, but on the following Wednesday, he came again to tell me that the rain or something had killed them off so that it was then difficult to find a living worm, though there were an abundance of dead ones. This simply coincides with my own observations, and notwithstanding what has been said in regard to the value of parasites to the farmer, this one has this year saved the farmers of Ohio several hundred thousand dollars, and though I expect to see this clover pest reach, if not cross, the Mississippi River next year, there is little doubt but that this fungoid enemy will not only overcome it on its first appearance in any locality, but keep it under control in the future. I observed adult Phytonomus, about Wooster, up to May 3, and again on June 21, while they were quite abundant near Cleveland, June 23, on the heads of timothy.

An invasion of the pear-tree blister-beetle (*Pomphopœa ænea* Say) occurred in central eastern Ohio, the pest appearing suddenly on pear trees in great numbers, eating off the bloom and very young fruit. In a few days they disappeared as suddenly as they came. Mr. Dury, of Cincinnati, tells me that he secured his only specimens, one from the crop and the other from the bill of a bird shot in the high top of a maple tree, where it was evidently feeding on the beetles when death suddenly ended the repast.

The joint worm (*Isosoma hordei* Harris) must have been excessively abundant in the northern portion of the State last year, as I found the adults in myriads in a field, in Huron County, on May 11, apparently just issuing from last year's straw, left in the field.

The bean leaf-beetle (*Cerotoma caminea* Fab.), which I have elsewhere* recorded as feeding on the foliage of the bean in Indiana, and both this and the cowpea in Louisiana, was found working a similar mischief in the southern part of Ohio, in May, while a few days later they were observed in the woods in Licking County, feeding on the foliage of a species of Desmodium which, in the north at least, is probably their natural food plant.

The well-known raspberry fruit-beetle (*Byturus unicolor* Say) was also in Licking County, eating out the blossom buds of a species of *Geum*, either *rivale* L. or *album* Gmel., usually two beetles being found on each plant.

No serious ravages of the four-lined plant-bug (*Pœcilocapsus lineatus* Fab.) on the currant have been reported this year, though they were working to some extent in Ashtabula County, where they last year exhibited a partiality for the grape varieties, while this season no such selection was apparent. Adults and young were observed here on June 9. Just a week earlier, in Licking County, the pest was literally swarming, not only in the woods but in the fields and along the roadsides, seemingly almost omnivorous, so far as food plants were concerned, catnip, dock, sweet clover, and numbers of other plants and shrubs exhibiting the marks of their depredations.

Once or twice only have I read of a dipterous enemy of growing beans, and had supposed that the single species, *Anthomyia angusti-*

*Report U. S. Comm. Agr., 1887 (p. 152).

frons Meig., the only one known to attack growing beans in this country, would content itself in restricting this source of food supply for our Canadian cousins. June 1 a lot of injured bean plants with a large number of maggots were received from Tippecanoe County, Ind., while on the following day another lot came from Van Wert County, in western Ohio, where it was accused of working serious injuries in the fields. Having never before received it or known of its occurrence, this second lot was a good deal of the nature of a surprise. Adult flies were reared from both consignments, appearing June 10 to 18. Some of the plants seemed to have hardly gotten above the surface of the ground, while others indicated by their size that the attack had not begun until they had acquired several leaves.

A threatened outbreak of the grain aphis (*Siphonophora avenæ* Fab.) failed to materialize, except in a few localities. As in the past, when this insect has been overabundant, the weather during May and early June was cold and wet, far less favorable for the parasitic enemies of the pest than for the latter, thus giving it the advantage of a more or less unrestricted multiplication. This I believe to be the secret of the occasional outbreaks of *Siphonophora avenæ*. I was wholly unable to keep them on young wheat plants growing in the insectary, after the kernels began to harden in the wheat heads in the fields outside. They simply will not stay on wheat during midsummer.

Until this year I had supposed that, in the Northern States at least, we need have no fears of depredations from mole crickets (*Gryllotalpa borealis* Burm.). But twice this season specimens have been sent me from widely distant localities in Ohio, in one case accused of destroying growing vegetables and flowers, and in the other destroying potatoes in the field by gnawing the tubers, the former in Portage and the latter in Delaware County.

July of this year brought me another of several reminders that the economic entomologist, or any others who delight in solving the morphological problems connected with the insect fauna of our Western swamp lands, will find ample material and no lack of opportunity for enriching science, at least during the next two or three decades. From the Alleghany Mountains to the Mississippi River, north of the Ohio, a greater or less area of swamp land is each year underdrained and brought into cultivation, and as the natural flora is exterminated, the insects which fed thereon, and notably the Rhynchophora, for the first year at least, transfer their attention to the crops of the husbandman. The swamp bill-bug (*Sphenophorus ochreus* Lec.), which Prof. Forbes has studied in Illinois and I in Indiana, is a good illustration.* In Wayne County, Ohio, a field of this swamp land was underdrained last year, and last January was plowed; no further cultivation being given it until quite late spring, when it was prepared and planted to cabbage, about

*Sixteenth Report State Entomologist of Illinois, pp. 58–71, Pls. I, II, III. INSECT LIFE, vol. II, pp. 132–134, figs. 20, 21.

50,000 in number, set late in June. These have been attacked and many of them destroyed by the adults of two species of Rhynchophora (*Listronotus appendiculatus* Boh. and *Erycus puncticollis* Lec.). The former is supposed to be the chief depredator, though I myself saw the latter attacking the plants. First, great cavities are gouged out of the stems of the young plants, and later the bases of the larger leaves are attacked from beneath. Both secrete themselves in the ground about the plants, and I took ten individuals of the Listronotus from about a single plant. It is not unlikely that one and perhaps both of these species breed in Sagittaria, though I have some reasons for suspecting that the Erycus may breed in the common *Typha latifolia* or cat-tail.

A minute Thrips, in all probability *Limothrips tritici* Pack., as determined by Mr. Th. Pergande, through the courtesy of Mr. Howard, U. S. Entomologist, has caused serious injury to the onion crop, seeming to be very generally distributed over the State. This little pest appears to breed in enormous numbers among the tops of the onions, well down toward the crown of the plant, where the close proximity of the young, tender growth renders destructive measures well nigh impractical, and, besides, places the young Thrips beyond the reach of the majority of its natural enemies. Still, continual reproduction compels the little pests to sooner or later leave their coverts, especially after reaching maturity, and they are then devoured by the swarms of little red and black ladybirds (*Megilla maculata* De G.), which, judging from the number of them present in the onion fields, must exert a powerful influence in holding the pest in check during ordinary years. The most useful parasite, however, is the larva of a small Syrphus fly belonging to a species not yet determined. These maggots are to be found down among the younger portions of the tops, near the crown, and right in the midst of the young Thrips, which they devour precisely as aphides. We have found that applications of a strong decoction of tobacco water, or a mixture of 1 part crude carbolic acid to 100 parts water killed all that were in reach, but so many are so entirely protected in their secluded nooks in the crown of the plant that repeated applications are necessary. For some reason the injury has been more emphatic on the higher lands. In the vicinity of Lodi, Ohio, there are several hundreds of acres of onions, cultivated for the most part on redeemed swamp lands where the soil is of a peaty nature, but with an occasional knoll of clay. Comparatively little injury has been done on the low, wet, peaty soil, while on the clay the destruction is almost total.

A number of years ago, while living in Indiana, I observed adults of *Ligyrus gibbosus* De G. depredating on carrots in the fields. This year the same insect came to me likewise from Indiana, accused of destroying sunflowers by eating the roots, going from hill to hill to continue their depredations. This character has been recorded of the species west of the Mississippi River, but not, I believe, farther east.

Even households have yielded me some uniques in the way of new pests. *Ips fasciatus* Oliv. and *Nitidula bipustulata* Linn. have both been received as infesting cupboards and pantries, where they depredated on bread, cakes, and other sweets. The larvæ of *Attagenus megatoma* Fab. (*piceus*), as shown by the adults afterwards reared, came to me as literally swarming under carpets, eating out the woolen portions of the fabric and rendering it worthless, doing a greater injury than the clothes moth.

Finally, and going slightly beyond the bounds of entomology, according to a strict interpretation of the term, you will pardon me, perhaps, for directing attention to an invasion of a species of Myriopod (*Fontaria castanea* McNeill), as determined for me by Mr. Howard. In Vinton County these worms became so abundant about springs and wells as to temporarily ruin the water supply on some farms, gallons of dead worms accumulating about a single spring, the odor arising from their bodies resembling that of wild cherry.

These are some of the surprises that have come to me during the year, and while we term them surprises, as indeed the like may not again occur in years, yet each is an oasis in the desert of inquiries in regard to how best to kill the squash bug, how to protect cucumbers from the striped beetles, etc. I am heartily in favor of placing such scraps on record, of course not as finished work, but we all understand how we, when we stumble upon any new thing, rummage our bookshelves for any clue to information previously gained, and how jealously we glean a point here and another there, knowing that every word is just so much light upon our obscure pathway. One little observation, carefully made, will often prove to some other investigator a veritable search light and save him no end of time and perplexity, not to say patience, that virtue of which entomologists must of all others possess an ample supply.

NOTES FROM NEW MEXICO.

By T. D. A. COCKERELL, *Las Cruces, N. Mex.*

At the present time it is not possible to describe in any adequate manner the injurious insects of New Mexico, but notwithstanding the small advance which has been made towards a full knowledge of the subject a few informal notes may have enough interest to be worth communicating.

The writer has examined only two localities in the Territory, namely:

1. *The Mesilla Valley*, in the southern portion of New Mexico, watered by the Rio Grande River, and about 3,800 feet above sea level. Here the summer temperature exceeds that which I experienced in Jamaica, but in the winter hard frosts are common, owing no doubt largely to the almost cloudless skies and the paucity of vegetation, which permit rapid radiation of heat during the night. The snowfall is very slight.

The ordinary deciduous fruit trees are cultivated, of course with irrigation, very successfully, and the climate is sufficiently warm for the grapevine and sweet-potato to flourish. Cotton, however, though grown experimentally on the college farm at Las Cruces (and there attacked by Aletia), will not do sufficiently well to be worth cultivating for profit.

Thus, though the region is a warm one for the temperate zone, it can not by any means be described as subtropical or approaching thereto. All that can be said is that there are certain suggestions of the tropical region further south, e. g., the abundant presence of the neotropical butterfly (*Synchloë lacinia*) and the presence of some genera of Coccidæ, such as Ceroplastes, Tachardia, and Prosopophora, which are rather neotropical than nearctic.

2. *Santa Fé*, in the northern part of the Territory, watered by mountain streams (usually almost dry), about 7,000 feet above sea level. The comparatively cool summer forms a pleasant contrast to the Mesilla Valley, while the winter, although cold, is mild for a place of such altitude, owing to the protection afforded by surrounding forest-covered mountains and the general southwest slope.

As in the Mesilla Valley, the apple, peach, pear, plum, and apricot are successfully grown, though sometimes injured by late frosts. It is, perhaps, the only place in the United States where these fruits are grown at and above 7,000 feet, though I speak here without certain information of what may be done in Arizona and southern California. Some small fruits, such as raspberries, succeed excellently. The fig and the sweet-potato, which grow well in the Mesilla Valley, will not do in Santa Fé, and it is too high even for grapes, excepting one or two hardy varieties.

Santa Fé, judged by its fauna and flora, is distinctly in what I have called the sub-alpine zone, but it is near the upper limit. In Colorado I had considered the mid alpine to go down to about 6,500 feet, though from lack of positive information this was only supposed to be an approximation to the truth. Probably it was very nearly correct for Custer County, Colo., since we find at Santa Fé (7,000 feet), the upper limit of the sub-alpine, the more southern latitude and the southwestern exposure accounting for the extra 500 feet.

At such an altitude one would expect at least some mid-alpine features, and on the whole I have been surprised that they are not more prominent than observation has shown them to be. At the same time, one sees at once strong differences from the fauna and flora of the Mesilla Valley, which will necessitate further subdivision of the sub-alpine zone, doubtless on such lines as have been already indicated by Dr. Merriam and Mr. Coville for points farther west. Thus, what may be termed the region of *Solanum elæagnifolium* extends up the Rio Grande Valley from El Paso to Albuquerque, but at Santa Fé this conspicuous roadside Solanum is wanting. Here, in its place, one meets various Solanaceæ, one of which, *S. rostratum*, is characteristic of the sub-alpine of Colorado, but is wanting in the mid-alpine

Further details of this sort need not be now given, as I hope to be able to describe the Santa Fé insect fauna at greater length hereafter, in comparison with that of other localities.

The more noteworthy insect pests which have so far come under observation may now be briefly mentioned.

(A) IMPORTED SPECIES.

These are mentioned first, being the most troublesome.

(1) OF BOTH MESILLA VALLEY AND SANTA FÉ.

The codling moth (*Carpocapsa pomonella*), though unknown in either locality ten years ago, is now extremely injurious, being altogether the worst insect pest in the Territory. Mr. Boyle, of Santa Fé, informs me that he has seen the native jays in his garden eating the larvæ, finding them in places where they had gone to pupate. Mr. H. Casad, of Mesilla, remarked to me that in that locality many of the larvæ entered the fruit at the side. This statement was confirmed by an examination of his orchard in company with him.

In the Mesilla Valley apples injured by the codling moth are attacked by *Drosophila ampelophila;* but this fly has not yet been detected at Santa Fé.

The house fly (*Musca domestica*). There does not seem to be any reason for supposing that this insect is a true native of New Mexico, though it is now of course everywhere established. In the Mesilla Valley and at Albuquerque it is extremely numerous, but much less so at Santa Fé. At Las Cruces I found *Eucoila impatiens* Say (identified by Mr. Ashmead) on horse dung in a corral, and suspected it might have been parasitic on house-fly larvæ breeding in the dung. So long as the town is full of corrals, cleaned out at not very frequent intervals, the fly plague seems inevitable.

The common cockroach, apparently true *Blatta orientalis*, is found abundantly in Las Cruces, and more rarely in Santa Fé. In my house in Las Cruces I caught an apparently undescribed Evania, which is probably parasitic, on the eggs of the Blatta. The large *Periplaneta americana* has not been observed.

The cabbage aphis (*Aphis brassicæ*) is sufficiently plentiful in both localities. At Las Cruces it is parasitized by *Allotria brassicæ* Ashm.

The woolly aphis (*Schizoneura lanigera*) is fairly common.

(2) OF MESILLA VALLEY ONLY.

The San José scale (*Aspidiotus perniciosus*) is well established at Las Cruces, but has only just reached the neighboring town of Mesilla. It has also been detected at Chamberino.

The sesiid peach-borer (*S. exitiosa*) no doubt has been imported, and I have myself seen it in peach trees only just received from Missouri, and not yet planted.

The peach shield-scale (*Lecanium persicæ*) is found at Las Cruces, but so far has done no serious damage.

The cottony scale of the Osage orange (*Pulvinaria macluræ*) has been introduced, and is found on a tree in Las Cruces, and also in a hedge between Las Cruces and Mesilla. The Osage orange hedges in Mesilla, raised from seed by Mr. Bull, of that place, appear to be free from the scale.

There is also a large Lecanium (a new species or a variety of *L. robiniarum* Dougl.) on Osage orange in Las Cruces.

Stored grain suffers from the attacks of *Tribolium confusum* and *Calandra granaria.*

(3) OF SANTA FÉ ONLY.

The pear and cherry slug (*Eriocampa cerasi* Peck) is well established in at least two Santa Fé orchards, and doing serious damage.

The box-elder trees planted in the streets are doing very well, but some are affected by *Aspidiotus ancylus* Putnam. There is also on these trees an apparently new species of *Lecanium*, allied to *L. persicæ*. *L. persicæ* is above given for Mesilla Valley only, but what may be the same has just been found in Santa Fé on peach. One can not pronounce very certainly as to these scales without a more careful examination than I have yet found opportunity to make.

Lecanium hesperidum has been found badly injuring oleander, and also infesting other plants in pots. It may here be mentioned, also, that in hothouses one finds *Dactylopius citri*, *Aspidiotus ficus*, and *Lecanium oleæ*—the first two troublesome.

Roses are affected by a *Lecanium* which, superficially at any rate, looks like *L. rosarum* Snell., of Europe. I am informed that roses have been imported to Santa Fé direct from France, and this may well have come with them.

(B) NATIVE SPECIES.

(1) OF BOTH MESILLA VALLEY AND SANTA FÉ.

A *Phlœotribus*, which Capt. Casey thinks best referred as a variety to *P. liminaris*, attacks various fruit trees, viz, apple in Mesilla, plum and cherry in Santa Fé. It appears only to injure trees which are failing in health from other causes, and is thus not a very pernicious insect.

Lygus pratensis is common enough on alfalfa and elsewhere.

The bean ladybird (*Epilachna corrupta*) seems equally injurious in both localities.

The corn worm (*Heliothis armiger*) is similarly troublesome in both places.

Pieris protodice is likewise distributed; the same may doubtless be said of *Plusia brassicæ*.

The Corneo (*Cimex inodorus*) of Las Cruces I have not seen at Santa Fe, though I saw more than enough of *C. lectularius*. However, Mr. Boyle describes to me the occurrence in numbers at Santa Fé of what could only be *C. inodorus*.

Hyphantria cunea, so excessively abundant on the cottonwoods at Las Cruces, is rather uncommon at Santa Fé, according to my observation.

The screw-worm fly (*Compsomyia macellaria*) is common in both localities.

(2) OF MESILLA VALLEY ONLY.

The western June beetle (*Allorhina mutabilis*) is very common and rather variable; so far as known, its habits resemble those of the eastern representative of the genus.

The tornillo bag-worm (*Oiketicus townsendi*), which occurs on the wild tornillo (*Prosopis pubescens*), has taken to the cultivated locust, and more especially to the apple. So far, it has not become sufficiently numerous to do very much harm.

The Prionus borer in fruit trees is said to cause the loss of many trees, although it can not yet be said that we fully understand this pest. At Santa Fé there is also a Prionus which very likely will prove injurious.

The twelve-spotted cucumber-beetle (*Diabrotica 12-punctata*) is excessively abundant, and must be held responsible for a fair amount of damage. At Santa Fé this species has been taken by one of the Boyle family about two years ago; but I have not myself met with it there, so it must be too scarce to be injurious. Hence I put it with the injurious insects "of Mesilla Valley only."

The squash bug (*Anasa tristis*) is abundant and troublesome.

The army worm (*Leucania unipuncta*) did considerable damage last year.

A mite (*Bryobia pratensis*), identified by Mr. Howard, abounds on apple and pear trees, causing the leaves to turn yellow. I place it with doubt as a native species; very likely it was imported from the Eastern States.

A gray bug (*Brochymena obscura*, according to Mr. Howard) is common on fruit-trees, and is believed to puncture the young fruit of the peach. Its eggs are parasitized by a species of Trissolcus. This, apparently the first Proctotrypid recorded from New Mexico, is stated by Mr. Ashmead to be new.

The grapevine hopper (*Typhlocyba*) is common, and at times destructive to the crop.

A small buffalo gnat (*Simulium occidentale* Twns.) is abundant in the early summer and very annoying.

(3) OF SANTA FÉ ONLY.

The grubs of Polyphylla abound and are much complained of as injuring the roots of trees and other plants.

Rhynchites bicolor is very troublesome, eating holes in the buds and bud stalks of roses, also eating the expanded petals.

Euphoria is sometimes found on fruits, but I think does no serious harm.

A very variable *Cacœcia* (probably *C. argyrospila*) infests cherry, pear, box-elder, and plum; sometimes eating into the fruit of plum and pear. It was noticed in seriously injurious numbers on a plum tree. This may very well be an imported insect.

Many other insects might be mentioned, if one were to attempt a complete list, but the present notes, made from memory without any attempt to compile the records, may serve to give a general impression of the condition of affairs. The time is not ripe for anything very elaborate, but those who desire further information will find much that is interesting in Prof. Townsend's various papers, based on the work done by him as Territorial entomologist.

To sum up, even from our fragmentary information, I think the following facts may be held self-evident:

(1) New Mexico is not at present very much harassed by insect pests, but probably the injury due to insects has at least doubled per acre of cultivated ground during the last ten years.

(2) This increase of injury is due almost entirely to imported species, especially to the codling moth.

(3) While not many of the native species are greatly to be feared, there are numerous Eastern and Western insects which will certainly be imported if due measures are not taken to examine trees and plants received into the Territory. Such, for instance, are the mussel scale of the apple (*Mytilaspis pomorum*), the rose saw-flies, the pear-tree Psylla, etc.

(4) Several pests found now in the Mesilla Valley are not to be seen at Santa Fé, and *vice versa*. It may here be noted that I am informed that the plum curculio has reached Santa Fé, though I have not seen specimens. It has not reached the Mesilla Valley.

One insect, omitted above, should perhaps be mentioned. It is the *Aspidiotus juglans-regiæ* var. *albus*. It occurs on ash in Las Cruces and Mesilla, and on pear and apricot, quite locally, in Mesilla. So far it has not done enough harm to attract attention, but it may become a serious pest. Its occurence on the ash trees in the streets suggests that it may be a native of New Mexico, since these trees were brought from the mountains not very far distant.

SOME EXPERIENCE WITH MOSQUITOES.

By Howard Evarts Weed, *Agricultural College, Miss.*

While it has been known for some time that a small amount of kerosene placed upon water containing the larvæ of the mosquito will kill the larvæ and thus to some extent lessen the number of mosquitoes in a locality, it was not until Mr. Howard gave his experience with the remedy that we realized how easy it was to rid a locality of the mosquito pest. In the French quarter of New Orleans it has been a common practice for many years to place kerosene in the water tanks to lessen the number of mosquitoes in that locality; but I know of nothing that has been written showing that such is the case, and in this age of advancement we can no longer go by hearsay evidence. Everything must be founded upon known facts, and these facts can only be ascertained by experiment. Thinking that some experience with the kerosene remedy for mosquitoes which I have had this season might be of interest, I wish to state the following as corroborative of what Mr. Howard has shown in regard to the simplicity of the remedy.

On the college campus are eleven large water tanks, two of which are used for drinking water and the others for irrigation and fire protection Not far from the limits of the campus are also four pools of standing water, three of which are used for watering stock and the other for irrigation in the horticultural department. These pools, however, are well stocked with fish, and as I have never foun d any mosquito larvæ in the pools, I am under the impression that the fish keep the pools clear of them.

Before the water tanks were built the college campus had been quite free from mosquitoes, but the evil has been constantly upon the increase, reaching its climax early the present season. I have often advised that a small amount of kerosene be placed in each of the water tanks, and the college proctor several times informed me that he "had a nigger put kerosene in the tanks every week, but it did no good." The college physician also stated that he had placed some kerosene in a jar of water containing some of the wiggletails, but that the kerosene had not killed them, thus regarding the remedy recommended as ineffective.

By the 20th of June of the present year mosquitoes had become so numerous on the college campus as to make life a burden, and sleeping without a mosquito bar was out of the question. Wishing to demonstrate the effectiveness of the remedy which I had recommended, I took a large glass jar and filled it nearly full with water from one of the tanks, which was fairly alive with the mosquito larvæ. The jar contained several hundred of the larvæ and I took it to the college physician, poured a little kerosene in the jar, and asked him to please watch the effect. This was as expected, for within fifteen minutes all the larvæ were dead. Upon visiting the various tanks I found that four of them contained the mosquito larvæ in very large numbers, as I had expected to find. The other tanks, with one exception, are within closed buildings in which the mosquitoes are not apt to breed, as they are situated in dark garrets and used for fire protection. The exception noted was a tank used for general household purposes, and the gentleman owning it assured me that he placed a cup of kerosene in the tank every Monday morning. June 26, I placed in each tank a gallon of kerosene with the result that ten days later the mosquitoes had almost entirely disappeared from the campus, and we were able to sleep without mosquito bars. The amount of kerosene used was much more than would have been necessary, and I am sure the same work would have been accomplished had only five of the tanks been treated, these being the only ones that are outdoors and not protected much. All the outdoor tanks are covered, but there are many cracks where the mosquitoes can get in and out. An examination of the tanks has been made about once a week since the kerosene was put on, and on July 18 more kerosene was put in two of the tanks. Upon all the outdoor tanks a thin film of kerosene has remained since the kerosene was put in. The campus is now nearly free from mosquitoes and has been so since ten days after the kerosene treatment. Hereafter during the summer kerosene will be put in the outdoor tanks, putting in enough to keep a thin film over the top of the water.

I have also found that kerosene is also a good article to use to prevent mosquitoes from annoying one when the mosquitoes are numerous. To use it for this purpose a little is smeared on the back of the hands and also upon the face. At first thought this would seem to be a disagreeable operation, but a trial of it will prove that it is not disagreeable in the least. It is quite effective in keeping the mosquitoes away and is much better than the Florida method, which I have been told is to remain secreted under a large iron kettle and with a hammer clinch the bills of the mosquitoes as they are thrust through the kettle.

The report of the committee on nominations was presented by the chairman, Mr. Lintner, as follows:

President, John B. Smith;
Vice-President, C. H. Fernald;
Secretary, C. L. Marlatt.

The report of the committee was unanimously adopted, and the officers named duly elected. [Inadvertently no second vice-president was nominated or elected.]

Mr. Smith moved that the usual custom be followed as to the time and place of meeting next year, namely, that it should be on the two days immediately preceding the meeting of the American Association for the Advancement of Science and at the place decided upon for the next meeting of that Association.

On motion of Mr. Smith also, it was requested that the proceedings of the Association be printed in full in INSECT LIFE.

The minutes of the entire session were then read by the Secretary, and approved.

Mr. Southwick moved that the hearty thanks of the Association be tendered to the President and Secretary for the able and satisfactory manner in which they had discharged their respective duties.

The meeting was then declared adjourned.

C. L. MARLATT,
Acting Secretary.

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U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

Vol. VII. No. 3.

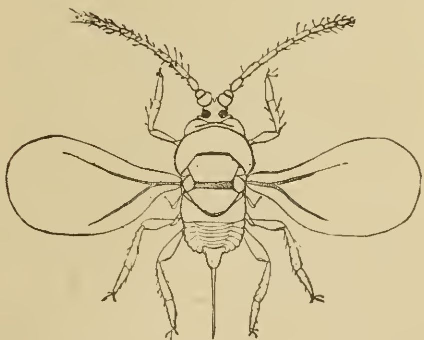
INSECT LIFE.

DEVOTED TO THE ECONOMY AND LIFE-HABITS OF INSECTS, ESPECIALLY IN THEIR RELATIONS TO AGRICULTURE.

EDITED BY

L. O. HOWARD, Entomologist,

WITH THE ASSISTANCE OF OTHER MEMBERS OF THE DIVISIONAL FORCE.



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WASHINGTON:
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1894.

DIVISION OF ENTOMOLOGY.

Entomologist: L. O. Howard.
Assistant Entomologists: C. L. Marlatt, Th. Pergande, F. H. Chittenden.
Investigators: E. A. Schwarz, H. G. Hubbard, W. H. Ashmead, D. W. Coquillett.
Special Agent in Apiculture: Frank Benton.
Artist: Miss L. Sullivan.

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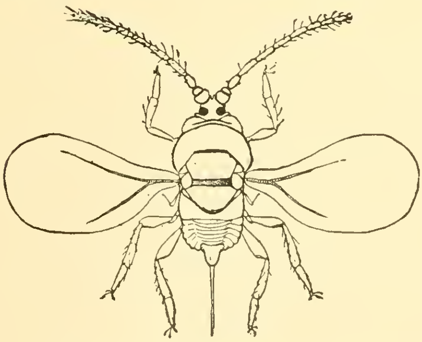

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CONTENTS.

SPECIAL NOTES.

The Need of Quarantine Laws in the East.—Readers of INSECT LIFE are aware, from items which have been published from time to time, of the fact that the State of California has in force a quarantine law which operates against the importation of nursery stock affected by injurious insects or plant diseases new to California. Similar regulations are in force in New Zealand and some of the Australian colonies. In Idaho a law was enacted at a recent session of the legislature which, while it is primarily an inspection law, authorizes the entrance of horticultural commissioners into packing houses, storerooms, and salesrooms, in addition to orchards and nurseries, and thus operates to a certain extent as a quarantine regulation. The necessity for similar regulations in our Eastern States has never been greater than it is today, and is every year emphasized by the importation of new insect enemies from abroad, while destructive species from the west and south are encroaching upon and entering northern and eastern territory. The importation into eastern orchards of the San José scale, to which we have referred in Nos. 1 and 2 of this volume, and the introduction of the pear Agrilus from Europe into New Jersey orchards, as pointed out in the present number, are cases in point. The State legislatures should take this matter in hand. They will do it at the instance of State horticultural societies and other societies of agriculturists or horticulturists. The excellent California and Idaho laws will serve as models upon which to frame laws for other States.

The Double-broodedness of the Codling Moth.—Prof. J. B. Smith's observations, which show the codling moth to be apparently single-brooded at New Brunswick, N. J., surprised us and will be also a surprise to those entomologists who were not familiar with an important article by Mr. C. A. Atkins in Agriculture of Maine, for 1883. The whole question as to the number of broods of this important insect in the Northeast is once more opened up, and entomologists favorably located will do well to conduct careful experiments the following season. The facts on record concerning the number of broods in this and other parts of the country have been brought together by Mr. Marlatt, who has also added his own personal experience in an article which is published in this number.

The Chinch Bug in 1894.—We publish in this number the conclusions reached by Prof. Herbert Osborn on this subject, after a trip through Iowa during the month of July, undertaken at our instance. Prof. Forbes early in the season foresaw the possibility of very considerable damage by chinch bugs this year, and wrote to this office suggesting coöperative study throughout the threatened states, for the purpose of making a broad investigation of conditions and surroundings—a broader one, in fact, than has heretofore been made or could well be undertaken by any one state officer. Prof. Forbes engaged to do the work for Illinois; Chancellor Snow for Kansas; Director Porter for Missouri; and we were asked to send agents into Iowa and Nebraska. After correspondence with Prof. Bruner we ascertained that investigation of Nebraska reports showed that nearly all were unfounded, and therefore no work was done in that state. Prof. Osborn, however, undertook a commission for a month, and the material which we publish consists of his conclusions from his investigations in Iowa. We learn from Prof. Forbes that he has been so fully occupied in studying the one phase of the subject regarding the practical use of contagious diseases that he has not been able to carry out the proposed work as thoroughly as he desired. The general coöperative series has, then, been partially a failure. Prof. Osborn's observations, however, are valuable, and his full report will be digested and published, together with the incidental observations which have been made in Illinois and other states. His inferences regarding the question of hibernation are significant, and will bear comparative reading with Mr. Marlatt's paper in this number on the same subject.

Reviews of Entomological Publications.—One of the features of the previous volumes of INSECT LIFE was the publication of many reviews of experiment station reports and bulletins and other papers bearing upon economic entomology, under the head of "Special Notes," and the insertion under "General Notes" of other reviews of papers for the most part not of especial economic bearing, but of general interest either popularly or to the special class of readers interested in scientific work in entomology. At the same time another division of the Department of Agriculture, the Office of Experiment Stations, has been issuing a most useful publication entitled Experiment St tion Record, which has been devoted entirely to abstracts of the publications of the different experiment stations in this country, and to short notes derived from foreign publications of a similar character. This Experiment Station

Record is published in sufficiently large edition to reach all American workers in scientific branches as applied to agriculture, and it seems unnecessary that any duplication of labor should occur with two divisions of the same Department. It has, therefore, been decided that in the future INSECT LIFE will contain no abstracts or reviews of publications bearing upon agricultural entomology. Persons desiring to see abstracts of such publications should apply to the Department to be placed upon the mailing list of the Experiment Station Record. We are aware that perhaps this move will detract from the general readability of INSECT LIFE, but it is necessary to thoroughly systematize publications in so large a Department as the Department of Agriculture has grown to be.

DAMAGE BY THE AMERICAN LOCUST.

By L. O. Howard.

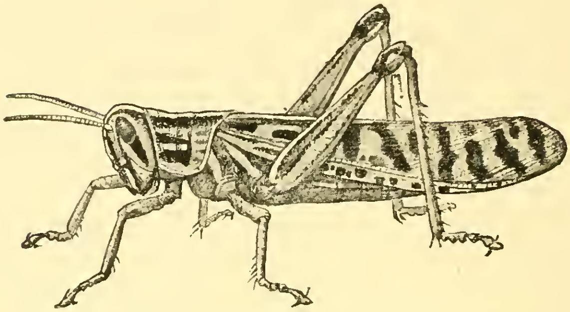

Fig. 19.—*Schistocerca americana*, adult—natural size (original).

The large "American Acridium," as it was formerly called (*Schistocerca americana* Drury), the popular name of which has been changed to the "American Locust," in view of the change of the generic name, has been figured and described in many works on economic entomology, and has always been considered a more or less destructive insect. It occurs throughout the southern States, from the District of Columbia to Texas, and south through Mexico into Yucatan and Central America. It is also found as far north as Illinois and Indiana, and is doubtfully reported from New York, while Prof. J. B. Smith tells me that he has taken specimens at Newark and New Brunswick, N. J. Since 1876, when the insect did very considerable damage in Missouri, Tennessee, Indiana, Ohio, North Carolina, Georgia, and southern Virginia, it has not been reported as having occurred in especially large numbers.

The present year, however, there has been a local outbreak of a severity possibly unprecedented in the history of this insect. This locality comprises the country about Roanoke, Va., and the outbreak was first called to our attention early in August by Mr. E. C. Moomaw, of Roanoke, who wrote that the locusts made their appearance on July 1, and at the time of writing covered a territory of 30,000 acres, destroying everything green. Realizing that with this insect we have a somewhat different life history from the majority of injurious locusts, which renders it, on the whole, a more difficult insect to fight, we deemed the outbreak worthy of careful investigation, and therefore sent Mr. Coquillett to look the ground over and to consult with the individuals owning damaged property and that liable to future damage. His report is full and interesting, and is appended. The variation in life history referred to above consists in the fact that the insect hibernates as an adult, and lays its eggs in May and June. Most other injurious species, it will be remembered, lay their eggs in the autumn, and these eggs hibernate. Late fall and winter plowing, therefore, usually affords a good remedy in the case of other species. With the American locust other means have to be adopted, and these are found in the use of hopper-dozers while the insects are yet unfledged, and in the use of the bran-arsenic mash for both unfledged and winged individuals. Experiments tried by Mr. Coquillett, and which are detailed in his report, show that the poisoned mash seems very attractive to this species, and indicate that by its use at the proper time much damage may be predented.

The cause of this extraordinary local abundance of the insect is difficult to ascertain. Mr. Coquillett is inclined to follow the popular local opinion in attributing it to a successful hibernation on account of the mildness of the winter of 1893–'94. As a general rule, however, we

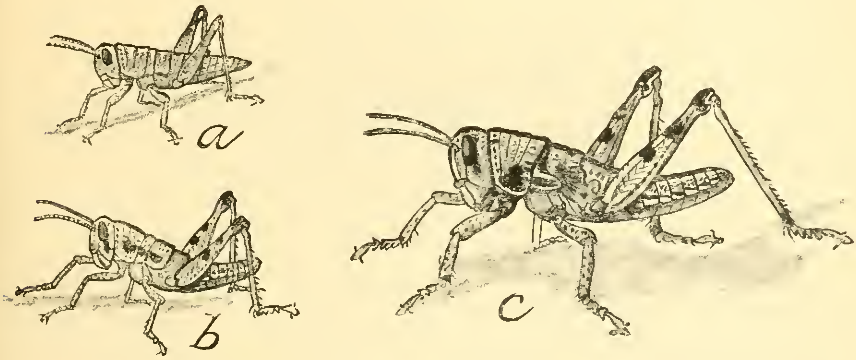

FIG. 20.—*Schistocerca americana*: *a*, first stage; *b*, second stage; *c*, third stage—enlarged twice (original).

believe that mild winters, particularly when followed by late and severe spring frosts, as was the case in the spring of 1894, are not so favorable to successful hibernation as uniformly severe winters, and we are inclined to think that we must look further for the cause of this outbreak. Last year extensive forest fires in the region about Roanoke may have had some influence. The comparative drought of the present summer may have been favorable to the development of the insect in greater numbers than usual. Other and unknown causes, appearing to produce a smaller number of natural enemies than customary, may also have been immediate factors. Such speculations, however, are of little practical account, and the important fact is that the insect was present in great numbers and may increase and spread another year.

Curiously enough, although the species is everywhere common throughout the South, its early stages have not been figured, and, so far as we know, have not been described. We therefore take the opportunity of presenting careful drawings of the five different stages and present colorational details. The species appears to be quite as handsome in immaturity as is the adult form.

Prof. Riley seems to have studied this species in captivity and to have observed the laying of eggs and hatching, since he gives certain details concerning these processes in the First Report of the U. S. Entomological Commission. For instance, he says (p. 221) that from mature insects captured June 14 the eggs were deposited June 24, and (p. 226) that the eggs are irregularly arranged, as is the case with *Caloptenus differentialis* and *Œdipoda phanœcoptera*, and that in this species the cement which binds the eggs together is more copious than in the others. The number of eggs he states (p. 228) to be about 120, and (p. 232) that they hatch in rather more than a month, while it is said (p. 237) that the average period between hatching and maturity is 70 days. This would bring the adults out at St. Louis about September 1.

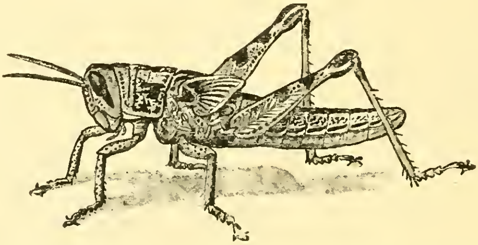

FIG. 21.—*Schistocerca americana*, fourth stage—natural size (original).

The different stages collected by Mr. Coquillett and sent in by Mr. Moomaw may be described briefly as follows:

First stage.—No trace of wing-pads; antennæ thirteen-jointed, the eighth joint noticeably longer than either of the others; color, nearly a uniform wine red. Length, 10 mm.

Second stage.—Wing-pads are indicated, but the posterior pair scarcely encroach on the following segment of the body; antennæ seventeen-jointed, the third joint slightly longer than any of the others; colors, yellowish-gray, mottled with blackish, a black streak beneath each eye, a black dorsal stripe extending the entire length of the head and body, an indefinite black spot on each side of the thorax, including the wing-pads, also two black spots on each hind femur, the apex of the latter, base of each hind tibia and the antennæ, black. Length, 12 mm.

Third stage.—Wing-pads distinct, projecting obliquely *downward* and backward, the posterior pair encroaching upon but not attaining the middle of the segment back of them; antennæ from twenty to twenty-two jointed; colors and markings as in the preceding stage, except that the ground color is extremely variable in the different individuals, ranging all the way from a yellowish-gray through grayish-yellow, bright yellow, greenish-yellow to bright green; those of a green color usually have the black markings very faint. Length, 18 mm.

Fourth stage.—Wing-pads of a considerable size, projecting obliquely *upward* and backward, the tips of the posterior pair nearly reaching the hind margin of the succeeding segment; antennæ twenty-five-jointed; color and markings as in the preceding stage. Length, 28 mm.

Fifth stage.—Wing-pads large, projecting backward, their tips attaining the hind edge of the segment back of the one to which they are attached; antennæ twenty-six-jointed; color and markings as in the third stage. Length, 38 mm.

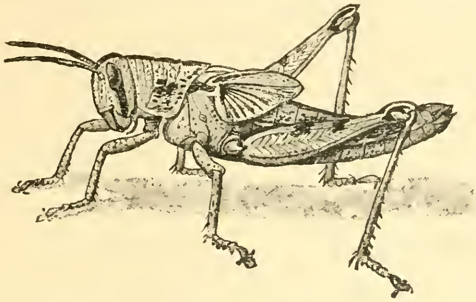

FIG. 22.—*Schistocerca americana*, fifth stage—natural size (original).

At the next casting of the skin, full wings appear.

Mr. Coquillett's report of the observations which he made from August 27 to 31 follows:

MR. COQUILLETT'S REPORT.

The infested district.—The region in which this grasshopper (*Schistocerca americana* Drury) occurred in destructive numbers, is situated in Roanoke county, in the southwestern part of Virginia, at the base, or rather among the foothills, of the Blue Ridge Mountains. The topography of the country is very irregular, consisting of hills of greater or less elevation, with intervening valleys. The soil is a rich, clayey loam.

The area in which they occurred in the greatest numbers contains about four square miles. Within this area twenty-five acres of oats and seventy-five acres of clover had been entirely ruined by them; two fields of corn containing one hundred acres each had been almost stripped of their leaves, and several other fields of less extent had been treated in a similar manner. It was a curious but repeatedly demonstrated fact that the grasshoppers manifested a decided preference for the leaves of the older and nearly matured corn, while the younger corn plants almost entirely escaped their ravages. In a few instances the silk and husks at the ends of the ears of corn had been devoured, and in rare instances they had fed upon the nearly ripened kernels of corn. Where the husks had thus been eaten away, the ears were exposed to the rains and fogs, and frequently molded from this cause.

In this infested area various kinds of fruit trees had been almost completely defoliated by the grasshoppers, which had gnawed the bark from the smaller twigs and also eaten large cavities in the apples still hanging on the trees. It was very noticeable that the leaves at the top of the trees had first been attacked, while those lowest down on the trees were the last to be attacked. They showed an evident preference for the leaves of apple and cherry trees, while those of pear trees although eaten, were less to their liking; mulberry trees growing in the midst of other trees that had been defoliated entirely escaped their ravages. Peach and walnut trees had been completely defoliated. Locust trees (*Pseudacacia robinia*) were great favorites, and wherever one of these trees grew in the infested district it bore, almost without exception, evidences of having been visited by the grasshoppers. which not only devoured the leaves, but also the bark on the smaller twigs. The leaves of hickory and oak trees growing along or in the cultivated fields were also eaten, but the insects did not occur in the more central portion of the woodlands, showing an evident preference for the open fields.

The leaves of the cultivated sunflower had been considerably eaten; also the strap-leaves of the flowers, but the seeds had not been touched. The leaves of cotton plants had also been eaten, but not to any great extent; the smaller twigs in several instances had been completely girdled. The leaves of sumac trees and those of the Virginia creeper had been considerably eaten.

It was repeatedly noticed that the low-growing cultivated plants had almost completely escaped their ravages. Melon and pumpkin vines, sweet and Irish potatoes, as well as garden truck of all kinds, were remarkably exempt. The same is also true of the weeds growing in and around the cultivated fields, with the single exception of the rag-weed (*Ambrosia trifida*), which was somewhat eaten by them. The other. kinds, such as Spanish-needles (*Bidens frondosa*), knot-weed (*Polygonum aviculare*), smartweed (*Polygonum pennsylvanicum*), Jamestown weed (*Datura stramonium*), and sand-briar (*Solanum carolinense*), were scarcely at all eaten. The grasshoppers in all stages sometimes congregated in large numbers in low places in wheat stubble overgrown with weeds; still the latter showed no traces of having been eaten. In such places the only plants which gave evidences of having been eaten to any extent were the young plants of volunteer wheat, and these had been gnawed down until scarcely a vestige of them remained. Even the grass growing in such places had not been molested.

Millet had been somewhat eaten, but where this grew by the side of a field of corn it was plainly to be seen that the leaves of the latter were preferred to those of the millet. The grasshoppers did not appear to attack the heads of the millet, confining their attention solely to the leaves; and, so far as observed, they had not succeeded in completely destroying a single field, although the yield of several fields had been considerably reduced as a result of their attacks. Nor had they, so far as observed, completely destroyed a single field of corn. In the majority of instances the corn in the ear was too far advanced to be seriously injured by the loss of the leaves. The greatest loss, therefore, will be in the fodder, since in this section the farmers depend largely on their corn as food for the cattle during the winter season, and this will have lost much of its value from having been stripped of its leaves.

Just what this loss will amount to it would be difficult to ascertain. It has been variously estimated at from one-third to one-half the value of the corn crop for fodder, and doubtless the first figure represents approximately the loss. In addition to this there will be a greater or less shrinking of the corn in the ear from the loss, or partial loss, of its leaves, but in most cases this will be slight, since, as stated above, the corn was far advanced before the leaves had been injured to any great extent.

Outside of the locality above mentioned these insects also occurred in destructive numbers, but in much more restricted areas, and the injury occasioned by them was principally confined to the outer rows of corn in fields adjoining clover or grain fields after these had been cut. Later in the season, as soon as the grasshoppers had acquired wings, they dispersed over the cornfields, and the injury occasioned by them was therefore not so noticeable as at an earlier period, when they fed from day to day in nearly the same spot. This area in which they occurred in more or less restricted localities is comprised in a stretch of country about ten miles east and west by twelve miles north and south. As stated above, this entire territory was not overrun, but within it they occurred in destructive numbers in several more or less restricted localities. It could not be learned that they occurred in such numbers at any point outside of this territory.

Breeding grounds.—All indications point to the fact that these grasshoppers issued from eggs deposited the present season in grain and clover fields within the infested districts. It was the universal testimony of the farmers in the infested localities that at the time of cutting their wheat, about the middle of June, the young insects were present in the wheat fields in large numbers, and even as late as the last week in August the young, recently-hatched individuals were still to be found even in the more central portions of these fields. On the other hand, none of them could be found in the central portions of the larger cornfields. When occurring at all in such fields they were always most abundant along the outer edges, indicating that they had originated in an adjoining field. It was also the testimony of the farmers that they had not observed any of the wingless ones in the more central portions of their cornfields.

In the clover fields the conditions were the same as in the wheat fields, the recently-hatched specimens being present even in the central portions of the largest fields, some of which were twenty-five acres in extent.

In the woodlands no recently-hatched larvæ were observed, except along the outer edges adjoining grain and clover fields. Even the winged individuals did not penetrate far into the woods, but contented themselves with "roosting" in the trees along the outer edges at night, where they would be within easy reach of the cultivated fields upon which to depredate the following day.

Development and habits of the insect.—Mr. W. P. Moomaw, who owns a large farm in the locality where the grasshoppers were the most abundant, and to whom the writer is indebted for much valuable information, informed me that he noticed them pairing in the month of May of the present year, and that he observed the recently-hatched ones early in June, while the first winged ones appeared early in the month of August. This would indicate only one annual brood, the individuals of which attain their wings late in summer or in the autumn, and pass the winter in some sheltered place, pairing, and afterwards, depositing their eggs early in the following summer. The eggs, as is the case with those of other members of this family, are deposited in masses in holes made in the ground by the female grasshopper, the upper end of the egg-mass being nearly on a level with the surface of the earth. There is great irregularity in the time of hatching of the eggs, since, as stated above, recently-hatched larvæ belonging to the species under consideration were observed early in June and as late as the last week in August, while by the date last given fully two-thirds of them had already acquired wings.

After issuing from the eggs, the young cast their skins five times before attaining wings. The habits of the winged forms are very interesting. Toward sunset numbers of them may be seen flying into the tops of neighboring trees, sometimes, in the case of a tall oak or hickory tree, alighting in the tops of these from twenty to thirty or more feet from the ground. Here they remain during the night, and early on the following day they again fly to the ground, usually not going any great distance from the trees in which they had passed the night. In the early part of the day they were fond of frequenting bare ground, especially the middle of roads and paths, while, if there were any boards lying on the ground in that vicinity, these formed favorite resting-places. Here they could be found congregated in large numbers, lying partially upon one side, apparently enjoying to the utmost the rays of the morning sun. Later in the day they could frequently be found in large numbers upon the droppings of horses in the roads, and they appeared to be feeding upon these droppings. Even in the orchards and corn-fields the winged individuals were frequently found upon the ground, although their favorite situations were on the taller weeds, stalks of corn, or in trees.

In the afternoon of August 28, the writer witnessed a partial migration of the winged ones. This began at about one o'clock and lasted until half past three, there being a light breeze from the southeast at the time. All of the grasshoppers did not rise on the wing at once, but a few would start up in one place, some in another, and so on, until several thousand would be upon the wing at the same time. All of them took a northerly direction, and continued upon the wing until lost to view. The majority flew obliquely upward until attaining a height of from fifty to eighty feet from the ground, after which they would continue at about this height until lost to view. The migration was not continuous, there being intervals of from ten to twenty minutes, during which time scarcely a grasshopper would be seen on the wing. They would then start up again, and in a comparatively short time thousands of them could be seen upon the wing in every direction. This migration ceased at about half past three o'clock in the afternoon. Scarcely a single winged specimen remained where there had been thousands of them before the migration began. It was feared that the migration was only temporary, and that they would return again at the changing of the wind, but this had not happened at the time of leaving this district about three days later. This migration occurred in the locality where these grasshoppers were the most numerous. It was reported that a similar migration, but on a much smaller scale, had also taken place in one or two of the other infested districts.

Other kinds of grasshoppers occurring in this district.—Associated with the destructive species were five other kinds of grasshoppers, none of which were at all abundant. The species most frequently met with was the small, red-legged species, *Melanoplus femur-rubrum* DeG.; this was observed in all stages excepting the egg, but there was scarcely one specimen of this species to one thousand of the *americana*. The four other species observed in the infested district were the following: *Dissosteira carolina* Linn.; *Chimerocephala viridifasciata* DeG.; *Encoptolophus sordidus* Burm.; and *Hippiscus tuberculatus* Beauv. The first of these was only occasionally met with, while the others were rarely seen.

Cause of the undue increase.—Mr. W. P. Moomaw informed the writer that the species which occasioned so much damage the present season has infested that district as long as he can remember. He has been familiar with its appearance from boyhood, but it had never appeared in destructive numbers in that locality prior to last autumn, at which time it was present in unusual numbers in his orchard, attacking the leaves of his apple trees as well as gnawing large cavities in the growing fruit. At the same time it also occurred in a neighboring cornfield, which, in a comparatively short time, became almost completely defoliated. It was the almost universal opinion of persons living in the infested district that the past winter was the mildest one they had experienced within the recollection of the proverbial "oldest inhabitant;" and this, taken in conjunction with something unusually favorable to the rapid increase of the grasshoppers last season, is doubtless responsible for their appearing in such large numbers the present season. It has already been stated above that, in all probability, none of the individuals of this species deposit eggs the same season that they acquire wings, but pass the winter in some sheltered place and deposit their eggs early in the following summer; it therefore follows that any condition of the weather during the winter season that is favorable to them in their winter quarters will result in a corresponding increase in their ranks during the succeeding summer. That such conditions existed in an exaggerated degree during the past winter has already been stated above, and the unusual increase in numbers the present season was therefore only what might have been expected under the circumstances. With a return to the normal conditions of weather the coming winter, we may reasonably expect that they will again be reduced to their usual, not particularly destructive, numbers.

Natural enemies.—The absence of insect-eating birds within the infested district was very noticeable. During the four days spent in that district not a single bird of any kind was observed to feed upon the grasshoppers. Barnyard fowls fed sparingly upon them, but whenever one of the red-legged species appeared upon the scene, the fowls at once ceased pursuing the larger ones and went in search of the former. Turkeys were reported to feed greedily upon them, and when the latter did not appear in excessive numbers the turkeys succeeded in preventing them from injuring the corn-fields to any great extent. Ducks also fed upon them, and several cases were reported where ducks had died, apparently from having partaken too freely of them. The only insect observed feeding upon the grass hoppers was a large black beetle, *Harpalus caliginosus* Fab., which was caught in the act of feeding upon a half-grown specimen. These beetles were quite numerous in the infested district, and doubtless destroy large numbers of the unfledged individuals. A medium-sized black wasp, *Prionony.x atrata* St. Farg., which was also rather common, confined its attention solely to the red-legged species, which she would render helpless with her sting, then get astride of it, sieze it by the antennæ and drag it to her nest in the ground. It was somewhat curious that, although other kinds of grasshoppers were present, this wasp always selected a red-legged specimen for her victim. This same kind of wasp also occurs in California, and there it also confines its attacks to one kind of grasshopper, the *Melanoplus devastator* Scud., which is very similar, both in size and color, to the red-legged species.

Remedies employed.—A short time after the wheat had been cut, the young grasshoppers which had hatched out in these fields began to migrate into the adjacent fields of corn, where their presence was soon made manifest by the large holes which they gnawed in the corn leaves. When this was first observed many of the farmers spread dry straw along the side of the infested corn-fields and drove the grasshoppers upon it, then set fire to the straw; in this way many thousands of the young were destroyed, and in cases where they did not occur in too great numbers the corn-fields were protected by an occasional repetition of this method. In the worst infested districts, however, this means was found to be wholly inadequate, owing not only to the excessive numbers of the grasshoppers but also to the fact that their coming was prolonged over such a long period of time, making it necessary to repeat the burning operation almost every day for a period of several weeks. The expense of such repeated burnings would in most cases amount to more than the corn crop was worth.

At my suggestion Mr. W. P. Moomaw made a test of the mixture of bran, arsenic, and sugar, which had been used in California with such success against various kinds of grasshoppers, but which had not, to my knowledge, ever been tried against the present species. It consists of six parts by weight of bran, to one each of arsenic and sugar. The bran is placed in a barrel or other convenient receptacle and the arsenic added and thoroughly stirred through the bran; the sugar is next dissolved in cold water and added to the mixture and the whole thoroughly stirred; water is then added until the mixture is wet in every part, after which it is taken to the field and distributed in heaps containing a tablespoonful each, or it may be sown broadcast, care being taken not to put it out where any livestock or barnyard fowls have access to it. In the present instance it was placed in clover and corn-fields and in an apple orchard, where both the winged and wingless grasshoppers were present in large numbers. It was distributed rather early in the morning, and shortly after it was placed upon the ground numbers of the grasshoppers were attracted to and greedily fed upon it. Not only were the wingless ones attracted, but the winged ones as well, and these were observed coming from a distance of several feet direct to the mixture, as if attracted to it by the sense of smell. The arsenic is very slow in its effect. A wingless individual lived for about eight hours after having partaken of the mixture, while a winged one lived several hours longer than this. It will thus happen that only a comparatively small proportion of those killed by the mixture will be found in its immediate neighborhood. Even the wingless ones will sometimes manage to travel a distance of seventy-five or eighty feet before being overcome by the poison. The favorite resting place of the grasshoppers was in or beneath the tall weeds, and under one of these sometimes as many as thirty dead ones could be counted the day after the mixture was distributed.

The best time for using this mixture would have been shortly after the wheat was harvested. By placing the mixture along the sides of the wheat-fields adjoining the growing crops, the grasshoppers, in migrating to the latter, would have found and been destroyed by the poisoned mixture. The latter is comparatively inexpensive, and after it has once been distributed in the fields requires no further attention, as it will retain its poisonous quality and still be attractive to the grasshoppers several weeks after being put out.

CHINCH BUG OBSERVATIONS IN IOWA IN 1894.

By Herbert Osborn, *Ames, Iowa.*

Acting under a commission from the Department of Agriculture received from Mr. Howard late in June, I took an extended trip through the State, making careful observations in all localities in which the chinch bug had appeared. I have submitted a full report, giving my field notes in detail. The following matter is extracted from the closing pages of the report:

To sum up the results of these investigations in as compact form as possible it may be said that the crop first attacked this season was in about 45 per cent of the cases wheat, in about 30 per cent barley, about 18 per cent rye, about 20 per cent oats, and 2 per cent corn. The attacks in oats were in most cases where oats had been grown on corn land or were adjacent to shelter for the bugs and where no other grain crop was present, and also it would seem in most cases where oats were planted early so that the bugs were able to commence work in the fields as early as they would have in other grain crops. With regard to the crop which had been on the ground a year before, it was, in the majority of cases, corn where the preceding crop could be determined, about 55 per cent corn, about 35 per cent oats, about 7 per cent wheat, and about 2 per cent rye. This would indicate that if there is any importance to be placed upon the sequence of crops that the bugs are more likely to infest fields which have been previously in corn stalks. It seems probable, however, that this sequence is simply a result of the ordinary sequence of farm crops, wheat very commonly following corn. It would seem by the records in some cases that there was a strong probability that bugs hibernate in corn stalks, and it would seem wise to consider these a probable source of danger. In regard to the method of hibernation the record shows that practically in every instance there was some kind of shelter within a very short distance of the infested fields, and the evidence all points toward the movement of the bugs directly from such shelter into adjacent fields, and in many cases without even necessitating the taking to flight. In a great majority of cases, 90 per cent or more, the fields were directly adjacent to hedges or thickets or timber belts, and in 75 per cent Osage orange hedges were the most available shelter. In about 13 per cent of the cases the evidence showed hibernation in grass or weeds, and in some of these cases there could scarcely be a doubt that the hibernating bugs were protected in a heavy growth of grass or weeds, and that they moved from these directly into the adjacent grain fields. These observations, while of course simply duplicating what has been recognized before, seem to show very forcibly the importance of destroying the rubbish alongside of the fields, where chinch bugs have been present, as a means of protection for the following season. If new in any respect it is in that they indicate so clearly the hibernation of bugs directly adjacent to the fields they infest later. The fact that certain fields almost identical in conditions where stubble, corn stalks, and other rubbish were burned, were very free from bugs, while others not burned were badly infested this season, is strong confirmation of this view.

In about 90 per cent of the infested fields examined the ground was high and in all cases had been extremely dry during the preceding fall and spring. In about 80 per cent the fields were hilly and ridged, and in most cases the damage was first apparent upon the higher portions of the fields, the exceptions to this rule being in the case of fields which had evidently become infested from bugs hibernating in slough grass or weeds occurring in lower places, and it must be noted here that even these places were comparatively dry during the twelve months preceding the damage of the present season. The character of the soil does not seem to have been of so much importance in determining the distribution, as we find a nearly equal distribution of cases between black loam, clay loam, and sandy soils; but on the whole the soils most infested were rather light and friable soils, even the clay soils, where abundant, being of a rather light and in some cases sandy character. As to the distribution in the State with reference to crop distribution, the counties most infested are those in which there has been a pretty continuous growth of small grains—wheat, rye, and barley—but, as will be seen by comparing the chinch-bug distribution with crops by the annexed tables, the distribution, instead of being for those counties where spring wheat was the special crop, are those in which fall wheat or rye constitutes the special grain crops.

The infested area runs across various geological formations from Silurian to Carboniferous, and clearly bears no reference to soils in this regard; but from the fact that this area is in large part covered with glacial deposit the geological horizon is of little consequence.

It may be noted that the principal centers of injury are the divides and bluffy sections adjacent to the river valleys of the Des Moines, Skunk, Iowa, Cedar, and Wapsipinicon rivers and also along the Mississippi.

It will be noticed that practically all the damage occurring in the southeast quarter of the State and reference to the table of crop statistics will show that the counties Decatur, Wayne, Appanoose, Monroe, Mahaska, Keokuk, Jefferson, Henry, Des Moines, Van Buren, Lee, Louisa, and Muscatine are the most important fall-wheat districts, while for spring wheat and barley the northwest counties of the State, especially Kossuth, Emmet, Dickinson, Osceola, Lyon, Sioux, O'Brien, Clay, Palo Alto, Plymouth, Cherokee, Buena Vista, and some others are the important spring-wheat districts, and in none of these were chinch bugs present in sufficient numbers so that they were reported. It would seem, therefore, that the popular idea that chinch bugs affect spring wheat rather than fall wheat is due to the fact that their injuries are more apparent because of the earlier ripening of the fall wheat and in reality the growing of fall wheat has a greater tendency to favor their increase.

Finally, the most important factors in the chinch-bug outbreak this season seems to have been the extended dry period of preceding autumn and spring, shown by precipitation charts, the cultivation of fall wheat, rye, and in some cases barley, and the abundant Osage-orange hedges as convenient places of hibernation.

It seems safe to conclude that for Iowa, with the present system of agriculture, chinch-bug outbreaks over the State at large are not likely to be of very frequent occurrence, but that in sections where wheat, rye, and barley are grown extensively and for a series of years in succession chinch-bug outbreaks must be expected and prepared for.

I am satisfied that the chinch bug can be controlled, but that farmers should not depend upon any one method of treatment, and especially not upon any that is to be adopted only where serious damage is actually occurring, though even then prompt and vigorous measures may save a large part of the crops.

THE HIBERNATION OF THE CHINCH BUG.

By C. L. Marlatt.

In nearly every account of the chinch bug which I have seen, stress has been placed on the hibernation of the adult in rubbish of any sort, such as the thick matted grass of headlands and unmown places, piles of corn fodder, hay piles, or about haystacks, dried leaves under trees, particularly in hedgerows, or in any other like situation. In the course of very careful and extended investigations carried on in Kansas during a year of excessive chinch-bug abundance I failed entirely to find any basis for the above supposition. Repeated careful search throughout the late fall and winter failed to discover a single living chinch bug in any such situations, even when such supposedly favorable hibernating conditions occurred in and adjoining fields which were alive with chinch bugs late in the fall. The only writer who seems to have thrown any doubt on the commonly accepted ideas as to hibernation is Prof. Forbes, who, in his First Report as State Entomologist of Illinois for the year 1882 (p. 37), refers to the fact that although he made very careful search for hibernating adults in September, October, and November of that year, he failed, as I did, to find them in any of the situations which they were supposed to frequent. He mentions examining matted grass in fields, rubbish in corn fields, leaves under hedgerows, etc., without discovering a single specimen in these situations, although, as he states, they afforded every temptation to hibernating insects, and many other species occurred abundantly. Where the actual hibernation takes place Prof. Forbes says he was unable to determine.

Failing to find them in the situations noted, I carried the examination further, and finally discovered what is probably the normal hibernating place of the chinch bug in the dense stools of certain of the wild grasses, such as the blue stem and other sorts, perhaps including tame varieties, which incline to the stooling habit. Toward the last of September the chinch bug begins its autumnal flight, and very shortly thereafter disappears entirely from the cornfields. In this flight it frequently goes some distance from the fields which it has infested, and, finding in these grass stools favorable situations, works its way well down into the stool, almost or quite below the general surface of the ground. In these situations only were chinch bugs found during the winter, and so numerously, that a single stool of grass would conceal hundreds of the insects. By tearing the grass apart the hibernating bugs would be found massed between the stalks, well down into the earth, as thickly as they could force themselves into the crevices. The matted grass between the stools, which furnished considerable protection, did not harbor a single chinch bug. So marked is this hibernating habit, that it is reasonable to infer that it is the normal and ancient one of the species, the natural food-plant of which, before the advent of settlement and the growth of the cereals, must have been some of our native grasses.

Under date of October 8, 1883, Dr. Lintner gives an account of the chinch bug in the Albany Argus (republished in the Country Gentleman of October 18), recording some personal observations in which he seems to have come very close to the true facts, without, however, recognizing their importance, and ignoring them altogether in the general account of the insect in his second report, published some time after. Dr. Lintner says that in a field of timothy badly infested with the insect he found them October 5, 6, 1883, collecting in dense masses a few inches in diameter on the ground and on the sunny side of furrows running about like ants and elsewhere "concealed among the roots near to and about the bulbs, on which they seemed mainly to feed." The insects may here have been just beginning to enter the timothy stools for hibernation, although the denser stools of the wild grasses, where available, would probably be selected in preference.

In spite of my utter failure to find them in the winter quarters ordinarily designated and the similar experience recorded by Prof. Forbes, the reports of actual observations by others cannot be ignored, and it is probable that where grass stools are insufficient or wanting the chinch bug can and does hibernate more or less successfully in some of the other situations cited, but I am convinced that this is never done except of necessity.

This peculiarity of hibernation has an important bearing on one of the common recommendations as to remedies, namely, the burning or clearing up of all loose rubbish about farms, particularly the matted grass in fence corners and on headlands and leaves in hedgerows.

Recommendations have even gone so far as to suggest the removal of hedges to prevent chinch bugs using these as favorable locations for hibernation. All such measures seem to be of comparatively little value under the circumstances. Knowing that the chinch bug normally selects grass stools for its winter retreat, the burning over of such grass land would immediately suggest itself as an effective means of destroying the insect, and in a measure such action is advisable. To be at all successful, however, the burning should be done after a prolonged dry spell, so that the heat will penetrate well into the stools, otherwise many of the insects will escape because of being so deeply buried between the stalks and partly protected by earth and moisture. The burning should preferably be done during midwinter and after a succession of warm days, which might result in the emergence of the bugs from their deeper recesses under the influence of light and warmth. Early burning—that is, in December or January—is advisable, to longer subject the bugs escaping the action of the fire to the destructive agency of the winter storms, which should have good effect in the absence of the very great protection normally afforded by the grass.

The life-cycle of this insect for central Kansas may be summarized as follows:

April 10–20, spring flight from hibernating quarters in grass stools to wheatfields.

April 20–30, *in coitu* about the roots of wheat.

May 1–31, deposition of eggs on wheat roots beneath surface of the soil, with young hatching from May 15 to June 15.

July 1–15, maturing of the first brood, followed immediately by the midsummer flight, if a migration of immature and adult forms has not been previously occasioned by the harvesting of grain or the local failure of the food supply.

July 15–30, union of the sexes and deposition of eggs in the soil about late corn or millet, the young of this brood appearing in maximum numbers about August 5.

August 20–September 10, maturing of the second brood and partial flight of same to late corn or other green crops if in fields of corn already mature and dying.

September 15 to October 15, autumnal flight to grass lands and concealment in stools for hibernation.

THE MAPLE PSEUDOCOCCUS.

(*Pseudococcus aceris* Geoff.)

By L. O. Howard.

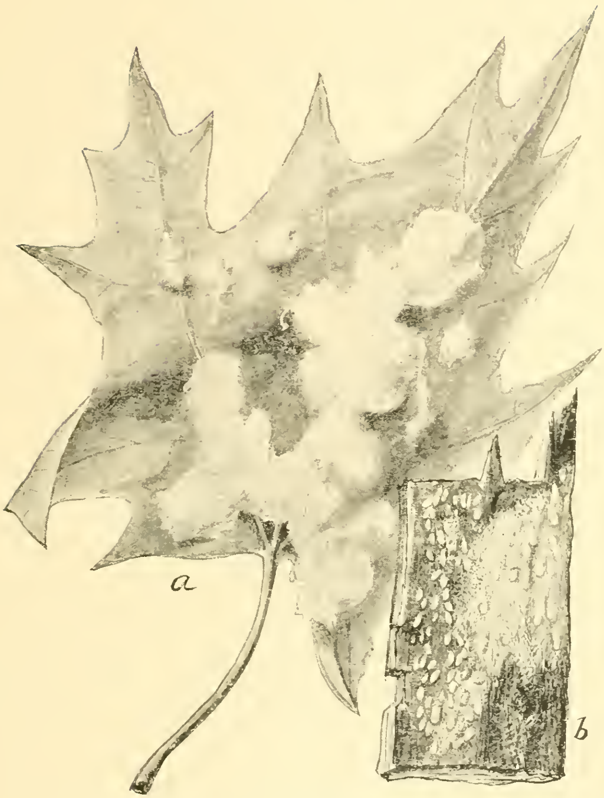

Fig. 23.—*Pseudococcus aceris*: *a*, adult females on leaf; *b*, young female and males on bark—natural size (original).

There exists in parts of the United States a scale upon maple which is identical with a European species, and which may have been imported into this country. It bears a superficial resemblance to the common cottony maple scale (*Pulvinaria innumerabilis* Rathv.), and is likely to be mistaken for the latter species at a hurried glance. The latter insect, however, is very common, while the species under consideration is rare, or at least has been rare until recently. But one account of the insect in the United States has been published, and this is Miss Emily A. Smith's "Biological and other notes on *Pseudococcus aceris*," published in the North American Entomologist for April, 1880. This journal had but a brief existence and comparatively few copies were published, so that this sole account is practically inaccessible. Miss Smith's observations were tolerably complete. She knew the egg, the young larva, the male pupa, the adult male, and the adult female. She also reared an interesting parasite, and followed the development of the Pseudococcus throughout the year. Her observations were made in Peoria, Ill., and she found the insect in only two localities in that city and upon the hard or sugar maple alone, whereas in Europe it is a very common species, and occurs also upon the elm, linden, and chestnut.

Since the publication of Miss Smith's article, and the receipt from her of specimens of this insect as well as its parasite, the species has never been received at this office, although many hundreds of sendings of Coccidæ of many forms and from very many parts of the country have come in. This fact alone fixes the rarity of the species. It is possible that it has been more abundant than this fact would indicate, and that it has been mistaken by casual observers for the cottony maple scale. This, however, is hardly likely, since the latter insect is one of the species most commonly received at the office. As has happened so many times with other comparatively rare insects, the maple Pseudococcus has suddenly become a species of more or less importance, and during the present season, after a lapse of fourteen years, we have received it from four different localities, each time with reports of abundance.

The first receipt was from Mr. John G. Jack, of the Arnold Arboretum, who writes me that the species is very abundant in some localities in the vicinity of Jamaica Plain, Mass. (five miles southwest of Boston), and in some parts of Brookline, particularly on some fine old sugar maples on the estate of Prof. C. S. Sargent. Specimens were sent by Mr. Jack, under date of July 21, and consisted of full-grown females bearing eggs, upon maple leaves. The second receipt was through the American Florist, at Chicago, from Rea Bros., of Norwood Nurseries, Norwood, Mass. Norwood is fifteen miles southwest from Boston. Rea Bros. sent specimens upon the bark of maple, and wrote that the maple from which the bark was taken had the main trunk and many branches covered with the insect, and that it was spreading to other maple trees near by. The third receipt was from Prof. W. G. Johnson, of the State Laboratory of National History, at Champaign, Ill., who, under date of August 29, sent specimens and wrote that he had received them on the leaf of a sugar maple from Mount Carmel, Ill. Mount Carmel is 175 miles southeast of Peoria, the locality in which Miss Smith originally studied the species. The fourth receipt was from Prof. L. F. Kinney, Horticulturist and Acting Botanist of the Rhode Island Experiment Station at Kingston, R. I. He sends specimens of the females on maple leaves under date of September 17, stating that his attention had been called to them several times during the present season, and that he had supposed them to be identical with the ordinary cottony maple scale. It is quite within the bounds of probability that the insect is much more widely distributed than the records indicate, and that it has not been more often recorded on account of its strong resemblance to the cottony maple scale. Almost any observer, no matter how familiar he might be with scale-insects, would mistake the species without careful examination. It must be stated further that in her paper, Miss Smith wrote that she had learned through J. D. Putnam, of Davenport, Iowa, that Dr. S. S. Rathvon, of Lancaster, Pa., had found the species upon hard maple in that city. An egg-mass was furnished to Miss Smith, and she judged it to be the same. This record, however, is not a positive one as Miss Smith does not seem to have seen the insect itself.

In view of this apparent increase of the species, it will be well to review in brief its life history, especially as Miss Smith's paper is difficult to consult. The different stages of the insect have been carefully figured, and will give a better idea of its appearance than any description.

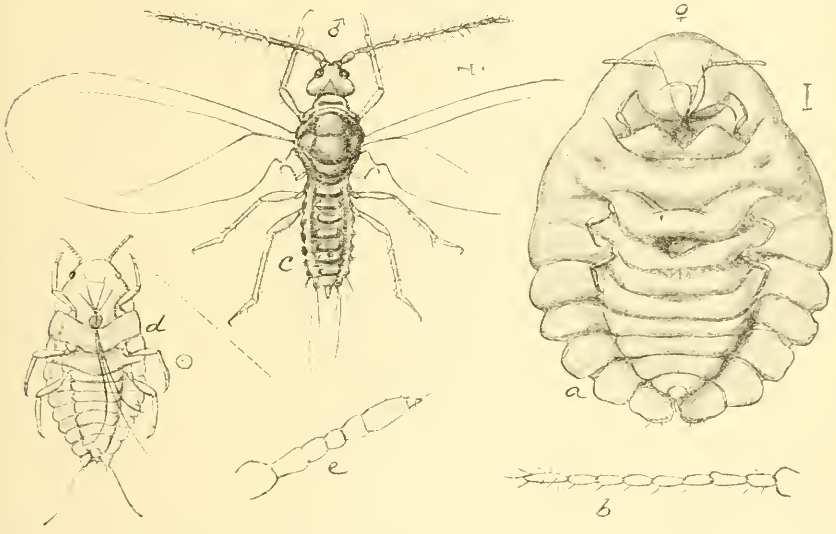

FIG. 24.—*Pseudococcus aceris: a*, adult female; *b*, antenna of same; *c*, adult male; *d*, young larva; *e*, antenna of same—*a, c, d*, greatly enlarged; *b, e*, still more enlarged (original).

The insect, as it occurs upon the leaves in summer, appears as an oval mass of powdery, slightly stringy, white wax about a quarter of an inch long and a little less in width (Fig. 23 *a*). This mass contains the body of the adult female and her eggs. The female herself occupies the anterior end of the mass and her body constitutes about one-fourth of its bulk (Fig. 24 *a*). She is light yellow in color, about 5^{mm} long by 3^{mm} in diameter; the upper surface of the body is covered with numerous spinnerets, which are more dense at the posterior extremity, and interspersed with short spines which are somewhat longer at the posterior end. The antennæ are 9-jointed (Fig. 24 *b*), joint 9 longest, joints 3–5 sub-equal and each somewhat shorter than 9. Joints 6–8 are also subequal in length, any two of them together being a little longer than joint 9. The tarsi are rather more than one-third the length of the tibiæ and the claws are unidentate at apex. The digitules are apparently capitate; the ano-genital ring is punctate and bears six long hairs.

The eggs, which are found very numerously in the waxy secretion, are from 0.3 to 0.4^{mm} long and about half as wide; they are light yellow in color. It may be stated here that there is something radically wrong about all of Miss Smith's measurements, the cause of which can not be satisfactorily guessed at. The egg, for instance, she says is from 5 to 6^{mm} long and from 3 to 4^{mm} wide. Even on the supposition that she meant tenths of millimeters instead of millimeters, her measurements would still be too large.

The female larva is pale yellow, elongate oval, tapering gently toward each end. The antennæ are 6-jointed, joint 6 about as long as the three preceding ones combined, joint 2 somewat longer than any of the following three, each of which gradually shortens from 2 to 4. The eyes are dark purplish. The head in front of the antennæ bears four slender hairs. There is one short spine just in front of each eye, three similar spines each side of the prothorax, and one on each side of all the remaining segments. The anal lobes bear two or three short hairs or spines and one long bristle.

The male larva is reddish yellow in color. The adult male is also red, and is shown in detail at Fig. 24 *c*.

When the eggs hatch, the young larvæ remain upon the leaf, unless this should be too crowded, when they crawl down the petiole and seek food from some healthier leaf. The male larvæ, on reaching full growth, become restless and wander about over the trunks and limbs of the trees for from seven to ten days (Fig. 23 *b*), and finally secrete themselves beneath the roughened outside bark of the tree and transform to pupa. In about fifteen days the perfect male issues from one end of the waxy cocoon. By this time the females have become mature, have left the leaves and wander about the limbs or trunk. Here they are sought by the males. The growth of the female thereafter is rapid, and she soon settles upon the underside of the leaf. In this stage the females seldom crowd the leaf, and Miss Smith states that not more than three or four remain upon a single leaf. In the specimens sent us by Mr. Jack, however, we have counted as many as thirteen on the under side of a single leaf. The waxy secretion soon becomes very dense, and the eggs are pushed out into it, both secretion and number of eggs increasing proportionately, and the number of eggs ranging from 500 upward. The body of the female gradually shrivels.

Miss Smith found that there are three generations each year. Through the winter months the larvæ are to be found in the crevices of the bark, on the trunk, and at the base of the larger limbs. During the warm days of winter they crawl out and are quite active. They make a lining in the crevices of the waxy secretion, and remain there the greater part of the time from October until May. They also convert the empty cocoons of Chrysopa into places of resort and concealment. The second brood is hatched in June and the third in August, and it is from mature females of the third brood that the young issue which winter over. It is worthy of note that the young of each generation possess the habit of migrating to the trunk of the tree. In the early generations, however, this is only for a short period, while the young of the last generation, as just stated, pass the winter on the trunk. A short time before the males enter the pupa state both sexes wander up and down the trunk and larger branches for a few days; the males make their cocoons, and the females repair to the leaves, where they become stationary.

Natural enemies.—Miss Smith found that the female is frequently parasitised about the time of oviposition by a minute chalcidid, for which she erected the new genus *Acerophagus* and the new species *coccois.* As pointed out by the writer in the Annual Report of the Department of Agriculture for 1880, p. 361, this species belongs to Foerster's genus Rhopus, and the species is redescribed and refigured at that place and upon Plate XXIV, at Figure 2. The only European species of this genus Rhopus (*R. testaceus*) is a parasite of *Lecanium racemosus* Ratz. This insect was the smallest encyrtine known up to the time when Miss Smith bred *R. coccois.* The European species is 0.6^{mm} long, while *R. coccois* is 0.55^{mm} in length. It is interesting to note that the only other Rhopus which has since been reared was bred by Mr. Coquillett from his *Pseudococcus yuccæ* from California.

Miss Smith also found a Syrphus larva feeding upon the young bark-lice, while from the puparium of this larva she reared a chalcidid which she stated to be a species of Eulophus. Three ladybirds (*Hyperaspis signata*, *Chilocorus bivulnerus*, and *Anatis 15-punctatus*) were found feeding upon the bark-lice, and a species of Chrysopa was engaged in the same work.

Among the specimens sent us by Mr. Jack a syrphid larva was also found, from which the adult was reared. It proved to be *Baccha fascipennis* Wied., and from the puparium of the Baccha was reared a species of Pachyneuron, which may be the insect referred to by Miss Smith as a species of Eulophus. On the larvæ received from Mr. Jack, *Hyperaspis signata* was also found to be feeding.

Identity of the species.—While there seems little doubt that the insect which we have received the present season is identical with that described by Miss Smith, there still remains some doubt that it is the *Pseudococcus aceris* of Geoffroy, unless Signoret's description of the latter should prove to be inaccurate in certain points. Thus, with our American form, all the stages of the male are red, while the female larva and all stages of the female remain yellow through life. Signoret described the European species as red or reddish-yellow, without distinguishing between male and female. The adult male, by the way, was unknown to Signoret. The description of the European *Pseudococcus æsculi* of Signoret in some respects more accurately fits our species. We mention these facts to indicate that there is still a doubt; comparison with authentic European specimens can alone settle the question.

Remedies.—Should this insect become so abundant as to threaten the health of valuable shade trees at any time, the most effective remedial work can be done during the winter. It will consist in scraping the bark of the trunk and larger branches and applying some oily insecticide. Miss Smith found by practical experience that a wash composed of 3 gallons water, $\frac{1}{8}$ pound white hellebore, and 1 teaspoonful carbolic acid, put on with a white-wash brush during the warm days of winter and early spring, was effectual.

Occurrence of the insect in England.—In The Entomologist's Monthly Magazine (vol. XXVI, p. 153) Mr. J. W. Douglas describes *Pseudococcus aceris* and refers to its first discovery in England May 24, 1889, in crevices of the bolls of lime trees. Douglas refers to Comstock's and Miss Smith's articles, and notes the discrepancy that the tarsus of the female imago is stated to be only half as long as the tibia, whereas Signoret says the tibia is three times longer than the tarsus. The position of the ovisac on the leaves, instead of on the trunks of the trees, also deviates from the habit of European examples, "but," says Douglas, "this may not have been the general habit;" a supposition which is not verified by this summer's observations. He also refers to the occurrence of a dipterous larva in the female ovisac. The adult was not reared.

NOTES ON COTTON INSECTS FOUND IN MISSISSIPPI.

By WM. H. ASHMEAD.

[Continued from INSECT LIFE, vol. VII, p. 29].

ORDER HYMENOPTERA.

Various kinds of bees and wasps are found quite plentifully in the blossoms of cotton and materially aid in pollenization. A long list of names could be furnished, but as no special effort was made in this direction, I shall confine myself here to recording my observations on such predaceous and parasitic forms as were brought directly under my notice.

Several distinct species of digger-wasps of the family Larridæ were observed in the cotton fields, searching eagerly for grasshoppers, crickets, locusts, etc., with which to provision their cells. Among these the most common were *Tachytes obscurus* Cr., *T. validus* Cr., and *Tachysphex terminatus* Smith. The last was observed twice dragging off a small immature cricket (*Nemobius* sp.).

The habits of the different species in the family Sphecidae are varied; some preying upon spiders; others on crickets, locusts, grasshoppers, cockroaches, etc., while still others prey upon cut-worms or other lepidopterous larvae. A large black digger-wasp belonging to the genus Sphex was observed carrying off a specimen of the cotton locust, *Orc he limum gossypii.*

The blue digger-wasp (*Chlorion cœruleum* Dr.) is a common species in all cotton fields and preys upon different species of crickets belonging to the genus Gryllus.

The blue mud-dauber (*Chalybion cœruleum* Linn.) was also common. I examined several nests built on the rafters of a cotton-gin shed and found they were almost entirely filled with the large green spider, *Oxyopes viridans*, so common on cotton.

The common mud-dauber (*Pelopæus cementarius* Dr.) was quite plentiful in the cotton fields, busily engaged in catching different spiders. From one of its nests I obtained no less than thirteen distinct species of spiders, although the most common of these was the *Oxyopes viridan s*

The Philadelphia digger-wasp (*Isodontia philadelphica* St. Farg.), although by no means common, was occasionally seen on cotton. It preys upon the cricket, *Œcanthus fasciatus* Fitch.

Ammophila pictipennis Walsh, *A. vulgaris* Cr., and *A. gryphus* Smith were also frequently met with in cotton fields, and I feel satisfied all prey on different lepidopterous larvæ found on the cotton.

In the family Pompilidæ four species were common, viz., *Pompilus philadelphica* St. Farg., *P. americanus* Beauv., *P. tropicus* Linn., and *P. æthiope* Cr. All are predaceous on spiders.

The services performed by the species belonging to the family of paper-making wasps, or Vespidæ, to the farmer, fruit-grower, and planter have never been thoroughly appreciated, and I am astonished to find so little in our literature concerning them. In many cases the services performed by these wasps are much more valuable than those of the true parasitic Hymenoptera, the ichneumon-flies, chalcis-flies, etc., and almost any one with a little observation of his own can readily substantiate this fact. The food of the young wasps is composed almost entirely of chewed-up caterpillars and other destructive insects, and supplied to them by either the worker or female wasp.

The following species were observed in the cotton fields:

The large-ringed wasp (*Polistes annularis* Linn.). This is one of the largest species in our fauna, and is common in the whole cotton belt. On August 14 I saw one of these large wasps seize a small-sized cotton worm, fly off with it to a neighboring bush, and then deliberately chew it up into small fragments, after which it flew away to its nest.

The Canadian wasp (*Polistes canadensis* Linn.). A smaller species than the preceding, but bearing a slight resemblance to it, was also observed chewing up a caterpillar, but the name of the caterpillar was not ascertained.

The valorous wasp (*Polistes bellicosa* Cr.). This species builds its nests in the old worm-fences inclosing cotton and corn fields. Many specimens were observed carrying off small rounded white particles, composed evidently of the chewed-up fragments of some larva.

The potter-wasps of the family Eumenidæ build cells formed of clay, or clay and sand mixed, attached to twigs or leaves, or occupy the old deserted cells of other wasps and bees. These they fill usually with lepidopterous or coleopterous larvæ, which they first paralyze with their powerful sting, for the subsistence of their young.

Three species were not uncommon flying about the cotton: The four-toothed potter wasp (*Monobia quadridens* Linn.) was frequently seen to carry off cutworms, and probably preys upon the cotton worm and bollworm. *Odynerus conformis* Sauss. and *O. fulvipes* Sauss. were also captured preying upon small lepidopterous larvæ.

There can be no longer any doubt of the important role played by many species of ants in the destruction of some of our more injurious insects, and while it is doubtful whether all of the species recorded below will attack and destroy large and vigorous caterpillars, most of them do, however, destroy those which are diseased or injured, as well as immense numbers of fresh pupæ and eggs. The species taken and observed by me were as follows:

The Pennsylvania wood ant (*Camponotus pennsylvanicus* DeG.). Observed only on low damp places contiguous to a wood, and never found in the middle of the fields or on high dry soil far away from timber. It is doubtful whether it ever attacks caterpillars.

The chestnut-colored ant (*Camponotus castaneus* Latr.). Occasionally seen with the former, but no observations on its habits were made.

The honey-yellow ant (*Camponotus melleus* Say.). Common in several fields, the formicaries being built in the ground, but although common on the cotton, running up and down the stems and over the leaves, I never discovered upon what it fed.

The coal-black ant (*Monomorium carbonarium* Smith). Twice observed feeding upon the pupa of the cotton worm and once on the bollworm. I first observed these ants August 11 destroying an Aletia pupa which had webbed up on a leaf of the cocklebur. It was fairly covered with from 40 to 50 individuals, and I have no reason to believe the chrysalis was injured before the ants attacked it.

The grooved-faced ant (*Solenopsis geminata* Fabr.). August 3 I took numerous specimens feeding on the pupa of a bollworm, and August 14 it was observed destroying the eggs of this same moth.

Only three species belonging to the family Proctotrypidæ were taken, viz., *Goniozus platynotæ* Ashm., a parasite on the cotton leaf-roller, *Platynota sentana; Ceraphron* sp., and *Anopedias* sp. The last two are probably parasitic on some cecidomyiid larva found on cotton.

A small black cynipid belonging to the genus *Hexaplasta* and closely allied to *H. zigzag* Riley, a common parasite on *Phora aletiæ* Comst., was not uncommon on the leaves. It is smaller than *H. zigzag*, with yellow legs and otherwise different in the relative length of the antennal joints.

In the family Braconidæ the little cotton-aphis parasite *Lysiphlebus testaceipes* Cr. was quite plentiful and fairly cleaned the leaves of this troublesome plant-louse. It was reared several times during July and August, and between this parasite, the larvæ of syrphid flies, golden-eye flies, and the Coccinellidæ, the aphis was having a terrible struggle for existence. Besides the above species three other braconids were captured on cotton which are evidently associated with some injurious insects found thereon, viz., *Iphiaulax triangularis* Ashm., *Chelonus texanus* Cr., and *Microdus sanctus* Say.

The following species of Ichneumonidæ are apparently new:

Zachresta dimidiata sp. n.

♀.—Length, 6.5 mm. Opaque black, thickly and closely punctate, covered with a whitish pubescence; scape and pedicel, mandibles, except teeth, palpi, tegulæ, anterior and middle coxæ and trochanters, white; flagellum brown; legs, reddish-yellow, the hind coxæ black, the hind tibiæ at base and apex and their tarsi, fuscous; abdomen from apical margin of second segment rufous, the base black. The clypeus is not separated, wings hyaline, the veins dark fuscous, the areolet sessile; metathorax areolated the spiracles ovate; claws pectinate; ovipositor very short, the sheaths black.

On cotton, Utica, Miss. Described from 1 ♀ specimen.

Limneria mississippiensis sp. n.

♀.—Length, 6 mm. Black, subopaque, closely punctate; abdomen, except the first and second segment and a blotch at base of third, rufous; scape and mandibles reddish-yellow; palpi white; legs, except hind coxæ, ferruginous, the tarsi and a spot at base and apex of hind tibiæ subfuscous; tegulæ and costæ toward base, white; wings subfuscous, the venation brown, the areolet petiolate; ovipositor about one-fourth the length of abdomen.

Taken on cotton at Utica, Miss. Described from 1 ♀ specimen.

Lymeon annulicornis sp. n.

♀.—Length, 6.5 mm.; ovipositor a little over 1 mm. Black; antennæ black, fulvous at tips, with apex of joint 6 and joints 7 to 12, white; face, clypeus, orbits above and below, mandibles, palpi, propectus, sides of collar, a band on the inner margins of the lateral mesothoracic lobes, a line on the axillar ridge, scutellum, tegulæ and a spot beneath, a spot beneath insertion of hind-wings, the posterior half of the mesosternum connected with a long broad band on middle of mesopleura, metepisterna, metapleura, a large band including the acute prominent angles of the metathorax, base and apex of petiole, broad band at apex of second abdominal segment, a narrow transverse band on middle of the third segment, and the apex of the fourth, fifth, and seventh segments, all white, or yellowish-white; legs, reddish-yellow, the anterior and middle coxæ and trochanters, white; wings hyaline, the stigma and venation, dark brown, the areolet open exteriorly.

Taken on cotton at Utica, Miss. Described from 1 ♀ specimen.

Otacustes chrysopæ sp.n.

Male.—Length 3.2 mm. Black, opaque, finely punctulate, sericeous, the pubescence on face glittering white; cheeks, scutellum and mesopleura smooth, shining; clypeus anteriorly, mandibles, two basal joints of antennæ, and legs, except as hereafter noted, ferruginous; palpi, tegulæ, anterior coxæ and trochanters, middle trochanters, annulus at base of hind tibiæ, tibial spurs and annuli at base of hind tarsal joints, white; tip of hind femora, their tibiæ and tarsi, except already noted, fuscous; flagellum brown; base of second abdominal segment and apical margins of second and following segments narrowly red.

Head transverse, a little wider than the thorax, the clypeus only separated at sides, truncate anteriorly; antennæ 21-jointed, the first and second flagellar joints about equal, the following gradually becoming shorter; thorax subovoid, the sides of collar rugulose, the mesonotum as broad as long, with the parapsidal furrows indicated by depressions only anteriorly but not sharply defined; mesopleura highly polished, separated from the mesopectus by a longitudinal crenate furrow and from the metapleura by a row of coarse punctures; metanotum short, rugulose, rather abruptly truncate behind and distinctly areolated; wings hyaline, the stigma and venation, except a spot at base of stigma and the veins toward base of wings which are white, brownish-black; the radial cell terminates half way between the stigma and tip of wing, while the areolet is large, pentagonal in position, but with the outer nervure wanting; abdomen a little longer than the head and thorax united, black, punctate, with the base of second segment and the apical margins of all the segments, except the first, narrowly red; petiole, or first segment, 1½ times as long as the second, shining, but with coarse although shallow punctures on the dilated portion, smoother toward base; body of abdomen sparsely pubescent, the venter ferruginous with two longitudinal folds.

Habitat.—Utica, Miss.

Described from 1 ♂ specimen, bred August 7, 1893, from the cocoon of *Chrysopa oculata* Say.

Otacustes atriceps sp. n.

Female.—Length 3 mm.; ovipositor 0.8 mm. Brownish yellow; the head, antennæ, from third joint, and ovipositor, black; clypeus, mandibles, and base of antennæ, ferruginous; hind tibiæ outwardly toward tips and their tarsi, slightly obscured or dusky.

Head transverse, a little wider than thorax, opaque, finely closely punctulate, the cheeks very narrow, polished, the face finely sericeous; clypeus transverse, entirely separated; antennæ 25-jointed, the first three joints of flagellum nearly of an equal length, the following gradually shortening; thorax subovoid, about twice as long as wide, the prothorax at sides rugulose; mesonotum a little wider than long, punctulate, opaque, the parapsidal furrows only slightly indicated by depressions anteriorly; scutellum triangular, smooth, carinate at sides by the extension of the mesothoracic ridges; mesopleura smooth on disk and separated from the mesosternum by an indistinct longitudinal depressed furrow below its middle, the portion below the furrows slightly aciculated; metathorax short, obliquely truncate posteriorly and distinctly areolated, the surface of the areas more or less distinctly rugulose; wings hyaline, the tegulæ, a spot at base of stigma and veins toward base of wings, whitish, the stigma and veins otherwise dark fuscous; the radial cell terminates half way between the stigma and tip of wing, the areolet being large and pentagonal, but with the outer nervure wanting; abdomen ovate, petiolate, very little longer than the head and thorax united, the petiole polished with some punctures toward the sides of the dilated apex, segments two and three finely punctate, the following smooth, impunctate.

Habitat.—Utica, Miss. Described from 1 ♀ specimen, bred August 17, 1893, from the cocoon of *Chrysopa oculata* Say.

The family Chalcididæ is without doubt the most extensive in the order Hymenoptera, and the species composing it are of incalculable value to the farmer and fruit-grower in destroying the more injurious insect pests. Many species, representing many genera, are common on cotton, the habits of only a few of which are yet known. Below I give a list of those taken by me in Mississippi, describing such of them as were reared from cotton insects, in order to complete, as far as possible, the life histories of these insects.

The clear-winged perilampid (*Perilampus hyalinus* Say). One small specimen of this species, measuring only 2^{mm} in length, was bred August 17, 1893, from the cocoon of *Chrysopa attenuata* Walk. Others were seen flying about cotton plants. The species has also been bred from lepidopterous pupæ.

Four species belonging to the Eurytominæ were captured on cotton: *Eurytoma* sp. ♀; *Eurytoma* sp. ♂; *Bruchophagus* sp. ♂; and *Isosoma* sp. ♂. All, except the last, are true parasites, and their hosts will probably be found to occur on cotton.

The ovate Chalcis (*Chalcis ovata* Say) was not unfrequently met with on cotton. It is parasitic on various lepidopterous larva and aids materially in destroying the cotton worm (*Aletia xylina*), from which it has been often bred.

Antigaster mirabilis Walsh was captured in the act of ovipositing in the eggs of *Œcanthus fasciatus* Fitch, a new host for it, while two distinct species belonging to the genus Eupelmus were taken running over cotton leaves.

The pleasure I have in announcing the discovery of a new genus in the subfamily Encyrtinæ is somewhat marred from the fact that the species is parasitic on one of the most beneficial insects we have—a chrysopa-fly. It was reared from Chrysopa cocoons on cotton, and for which I propose the name Chrysopophagus.

The genus may be readily recognized by the following brief diagnosis:

Chrysopophagus gen. nov.

General habitus of *Chiloneurus* Westw., the mesonotum with silvery white hairs. *Female.*—Head, viewed from in front, oblong, the eyes oblong-oval, bare, convergent above, the vertex narrowed, the lateral ocelli touching the border of eye, antennal furrows short but distinct; mandibles (?) bidentate; maxillary palpi 3-jointed, the first joint short, the last longer than the first two united; labial palpi 2-jointed; antennæ 11-jointed, the flagellum compressed and much enlarged toward apex, the pedicel shorter than the first funiclar joint, the joints after the third funiclar joint wider than long. Thorax ovoid, the pronotum lunate, the mesonotum transverse, twice as wide as long, plumbeous with silvery white hair; the scutellum triangular, with a tuft of erect black bristles at tip; the axillæ wedge-shaped, their points meeting at base of scutellum; wings with the marginal vein very long, fully twice as long as the stigmal vein, or a little longer; the postmarginal slightly shorter than stigmal. Abdomen conic-ovate, with seven distinct segments, the ovipositor only slightly exposed.

Male.—Differs from ♀ in having the eyes only slightly convergent above; the pedicel only about one-third the length of the first flagellar joint; the joints of the flagellum long, cylindrical, contracted at juncture, with long hairs irregularly arranged and not in half whorls as in *Chiloneurus*, while the scutellum is bare without a tuft of long black bristles.

This genus is intermediate apparently between *Chiloneurus* Westw. and *Comys* Först. From the former it is distinguished, however, in the ♀ by the pedicel being shorter than the first funiclar joint, the more dilated and compressed antennæ, and the longer marginal vein; in the ♂ by the longer marginal vein and the hairs on the antennæ not being arranged in half whorls; from the latter genus it is readily separated in the ♀ by its more slender form, a marked difference in the antennæ, the silvery white hairs of the mesonotum, and the very long marginal vein in front wings; and in the ♂ by having no tuft of bristles on the scutellum.

Chrysopophagus compressicornis sp. n.

♀.—Length, 1.6^{mm}. Head, scape, mandibles, except teeth, prothorax beneath and at sides, and mesopleura, brownish-yellow; flagellum and maxillary palpi black, or the latter sometimes brown; scutellum orange-red, with a tuft of black bristles; mesonotum plumbeous with silvery white hairs; front wings, except base, a small transverse streak at tip of postmarginal vein and extreme apex of wing, which are hyaline or whitish, fuliginous; abdomen æneous-black or submetallic; legs brownish-yellow, the apical joint of all tarsi, the middle tibiæ outwardly, and hind femora and tibiæ, except a white annulus at base, dark fuscous; hind tarsi white.

♂.—Length, 0.9^{mm}. Head, except vertex, scape, flagellum beneath, prothorax at sides and beneath, mesopleura, except upper half, which is metallic, and legs, except middle tarsi and hind femora tibiæ and tarsi, brownish-yellow; middle and hind tarsi and annulus at base of hind tibiæ white; hind femora and tibiæ, except the annulus, fuscous; vertex, upper surface of the thorax, and abdomen, metallic greenish, the scutellum duller.

Habitat.—Utica, Miss.

Described from 1 ♂ and 5 ♀ specimens bred August 15, 1893, from the cocoons of *Chrysopa attenuata* Walk.

ORDER COLEOPTERA.

In the United States, cotton is singularly free from the attacks of insects belonging to this order. I do not know of a single beetle that in any sense could be considered a serious enemy of this crop, and, indeed, not a single case that I can recall is mentioned in our literature on the subject. The beetles found on it are, with few exceptions, more or less beneficial, and are attracted to it in search of their prey—usually the eggs, larvæ, or imagos of other insects.

During my four weeks' stay in Mississippi, out of many beetles taken on cotton I found only three or four species which fed on it to any extent, and the injury done was comparatively slight. The vast majority of those taken were predaceous or pollen-feeders, and should be classified among beneficial species.

In the family Cicindelidæ three species, *Tetracha carolina* L., *T. virginica*, and *Cicindela 6-punctata*, known to be predaceous in both larva and imago stage on the cotton-worm and other insects, were captured in the cotton fields.

Several small species of Carabidæ were common, the most important being *Scarites subterraneus* Fab. and *Pterosticus permundus* Say.

Phalacrus politus Melsh. was taken on cotton leaves, but no observation on its habits was made.

In the family Coccinellidæ *Megilla maculata* DeG., *Hippodamia convergens* Guer., *Coccinella 9-notata* Hbst., and *C. sanguinea* Linn. were common in all stages, feeding upon the cotton aphis (*Aphis gossypii* Glover). *Chilocorus bivulnerus* Muls., *Exochomus marginipennis* Lec., and *Pentilia auralis* Lec., were observed feeding on the cotton Aleyrodes (*Aleyrodes gossypii* Fitch), while two species of scymnids, *Scymnus caudalis* Lec. and *S. cervicalis* Muls., fed on both the cotton aphis and the cotton Aleyrodes.

The Pennsylvania fire-fly, *Chauliognathus pennsylvanicus* DeG., and the yellow-margined fire-fly, *C. marginatus* Fab., were exceedingly abundant in the blossoms, with occasional specimens of *Pyropyga minuta* Lec. and *Photinus marginellus* Lec.

All these insects are beneficial as pollenizers, and the larvæ of the first two were frequently seen crawling over the ground beneath the cotton plants. In this stage they are said to feed on the cotton-worm and other lepidopterous larvæ.

In the Chrysomelidæ I took the following species: *Lema 6-punctata* Oliv., *Anomœa laticlavia* Först., *Cryptocephalus calidus* Suffr., *Myochrous denticollis* Say, *Colaspidia flavida* Say, *Nodonota tristis* Ol., *Phyllechthrus nigripennis* Lec., *Diabrotica 12-punctata* Ol., *D. vittata* Fab., and *Systena elongata* Fabr. Of these only three may be mentioned as injuring the plant. *Anomœa laticlavia* feeds on the leaves, while *Colaspidia flavida* and *Nodonota tristis* gnaw little irregular holes through the outer covering of the blossoms, and frequently gnaw into the epidermis, of the bolls, thus exposing them to the weather and causing them to drop. The Diabroticas were captured in the blossoms feeding on pollen; they evidently breed in neighboring cornfields.

One species of Bruchidæ was common in cotton blossoms—the four-spotted bean-weevil (*Bruchus 4-maculatus* Fabr.). It would be interesting to know whether or not this species lives in cotton seed.

The 8-spotted mordellid (*Mordella 8-punctata* Fabr.) was often seen in the blossoms, but in the larval state it is said to live in the stems of various plants.

Two species belonging to the family Anthicidæ, *Notoxus bicolor* Say and *Macratria murina* Fabr., as well as some weevils belonging to the family Curculionidæ, *Apion* sp., *Baris* sp., and *Centrinus picumnus* Fabr., and a Meloid, *Epicauta strigosa* Gyll., were common in cotton blossoms.

THE CODLING MOTH DOUBLE-BROODED.

By C. L. Marlatt.

The double-broodedness of the codling moth has been called in question by Prof. J. B. Smith as a result of experience during the last three seasons at New Brunswick, N. J., in which larvæ constituting the supposed first brood and maturing early in July remained in every instance unchanged in their cocoons until the next spring. (Ent. News, vol. V, p. 284.) Prof. Smith does not deny the possible occurrence of the second brood, which has been so generally accepted by nearly all later writers on the subject, but considers, and perhaps justly, that this experience leaves room for doubt, and asks for positive observations.

In the earliest American accounts, viz, those of Harris (Ins. Inj. to Veg., Flint Ed., p. 484), and Fitch (Third Report, No. 48) a single brood in general is somewhat indefinitely indicated, both of these writers apparently following or quoting the statements of Europeans rather than advancing any personal experience.

That the insect is single-brooded in northern Europe, including northern and central Germany, is asserted by German authors; and this is also true of England (Westwood, Gard. Mag., 1838, p. 237), while in the latitude of Vienna (48°) (Schmidtberger) and in France (Réaumur, Memoires des Ins. II, p. 499) it is double-brooded. Westwood and Réaumur give actual breeding records. The fact of single-broodedness in parts of Europe is alluded to by Prof. Riley (Third Report, p. 102) and by Mr. Howard (Ann. Rep. Dept. Agric., 1887, p. 90).

On looking over the later published records in this country of actual observations, the occurrence normally of a second or summer brood of moths throughout the United States, with the possible exception of the northeast Atlantic region, can not be doubted. That there are two broods in the Middle States is shown by the records given by Prof. Riley in several of his Missouri reports. He states in his Fourth Report (p. 22) that he has bred them nearly every year for ten years in different localities, and records for St. Louis (Sixth Report, p. 11) the earliest mature larva, June 23, and the earliest moth July 8.

Noteworthy among these records is the account by Le Baron, who made some very careful studies, and convinced himself of the double-broodedness of the insect throughout Illinois and the West, with the possibility of a third brood for the South. In the latitude of Chicago he found the great majority of the summer brood of moths to emerge in the last week of July and the first of August. I will quote merely the results of his examination of bands put on trees July 10, which shows that the larvæ transformed to pupæ and issued as moths generally throughout July and most of August. (See Le Baron's Third Report, p. 175.)

Dates of Examination.	Empty pupæ.	Pupæ not hatched.	Larvæ.	Total.
July 28	38	127	55	220
August 11	16	34	15	65
August 25	1	4	41	46
September 9	....	....	81	81
September 23	....	....	54	54

Mr. Gillette, for Iowa, states that the first larvæ begin to escape from the fruit about the 1st of July, and by the 4th of July fully one-half have emerged. On July 19 several moths were bred from these larvæ. (Iowa Exp. Sta. Bull. 7, p. 277.)

Prof. Washburn has also published a table, presumably based on breeding records, which indicates certainly two broods, and probably three, for Oregon. (Bull. 25, Oregon Exp. Station.)

Of California Mr. Coquillett says that his notes indicate that it is here three-brooded, "the moths from hibernating worms issuing in the latter part of March, and during the first half of April, those of the next brood appearing in June and during the first half of July, while the third brood of moths appear in August and early in September." (Bull. 30, Div. Entom. U. S. Dept. Agr., p. 30.)

But I wish to call attention more particularly to my own personal experience with this insect, recorded for the most part in the annual report of the Kansas Experiment Station for 1888. In the report of work with the codling moth by Prof. Popenoe and myself for that year, a record is given (p. 178) of the collection of larvæ and pupæ under bands during the season, amounting altogether to 17,245 of the former and 3,153 of the latter. The bands were examined and the insects removed at intervals of 6 to 10 days, from June 25 to October 13, the first larvæ appearing about July 1. The frequency of the examinations was designed to prevent the possible transformation and escape of any of the insects, and resulted in the collection of very many more larvæ than pupæ, few of the former having time to transform. But, nevertheless, the larvæ were steadily transforming to pupæ throughout the season, and a great many moths were bred in an attempt to secure all possible parasites.

An instance, also, of transformation the same season, and very late at that, is given by Mr. Howard (Report Dept. Agric., 1887, p. 92). He reports receiving pupæ from Mr. M. B. Newman, of Wyandotte, Kans., collected November 12. These were kept in a warm room and yielded moths January 8 and 14. A codling moth was also bred at the Department July 28, 1890, from cherries received July 11, 1890, from M. Bannister, of Ottumwa, Iowa.

If further evidence of this general occurrence of two broods were needed, it is forthcoming in the great increase in the percentage of unsound fruit in September and October, and this also by the attack of newly-hatched larvæ. This is contrary to the statements of Prof.

Smith, and of course would not be expected with the occurrence of a single brood, but conforms with the experience of nearly all who have made any positive observations on the subject. In substantiation of this fact, I quote from the table given on page 173 of the Kansas report cited. It represents the results of early and late picking from the same trees. About one-half of the fruit of each tree was gathered on the first date and the balance on the later date:

Variety.	Date of gathering.	Per cent wormy.	Date of gathering.	Per cent wormy.
Jonathan	Aug. 8, 9	10	Sept. 15	35
Yellow bellflower	do	29	do	54
Do	do	*13	do	53
Wagner	do	17	do	47

* This tree had received two applications of Paris green and the preceding tree one of Climax Insect Poison.

The great increase in the percentage of unsound fruit shown in the above record was almost altogether late in August and in September, and by larvæ recently hatched or less than half grown.

All these records practically coincide in recording the transformation of the first brood of larvæ into moths during the latter half of July and throughout August, and the occurrence of a second brood of larvæ from August to November. The normal and usual occurrence, therefore, can not be doubed of two well-defined broods in the portions of the United States directly referred to, with a third in California and probably in the South. Of these two broods the second is by far the more destructive.

The records of the State of Maine, however, indicate that normally one annual brood is the rule, with a partial or supplemental second brood, the abundance of the latter depending on the season. The most thorough and careful observations on this point are those of Mr. C. A. Atkins (Agriculture of Maine, 1883, pp. 356–363), whose work is a model of painstaking and systematic investigation and deserves wider publication. It covers the entire life-cycle of the insect, and in the matter of the number of broods establishes beyond a peradventure that the great majority of the larvæ—the immediate progeny of moths from hibernating larvæ—remain unchanged in the cocoons from the 1st of August to from June 15 to August of the following year, transforming chiefly between June 15 and July 15. In September, however, a very few moths came out from the August cocoons of the same year, and in all 50 moths were bred. Mr. Atherton, in discussing this paper, states that one brood is the rule in Maine, but that last season (an unusual year, 1882) there were two broods, apples taken from a tree in November containing small worms. Prof. F. L. Harvey states that his observations indicate two broods, having also observed half-grown larvæ in November (Ann. Rept. Maine Agl. Coll., 1888, p. 174); and Prof. William M. Munson states that "it was observed that a large percentage of the infested fruit (at gathering) had been attacked by the second brood and the larvæ were still present." (*Op. cit.*, 1891, p. 106.) The second brood referred to in these last records is a mere inference, but is supported by the undoubted rearing of small numbers of moths in September by Mr. Atkins.

It is evident from the European records and Mr. Atkins' studies, when compared with the records from the Middle and Western States, that the number of broods of this insect is merely a question of climate and temperature, and granting the correctness of Prof. Smith's observations, it must be inferred that the climate at New Brunswick differs in the summer season sufficiently from that of the Middle and Western States, even of Iowa and northern Illinois, to lead to the development of but one yearly brood. This difference in climate receives support from the discovery by Prof. Smith that the imported elm leaf-beetle has one brood less at New Brunswick than at Washington, although the difference between the two points is not great. Prof. Smith's experience makes it very desirable to have careful breeding records conducted not only for northern New Jersey to confirm his own experience, but for New York, the New England States, and Canada, throughout which region only can the double-broodedness be doubted.

A NEW SAWFLY WHICH IS INJURIOUS TO HOLLYHOCKS.

By T. D. A. Cockerell, *Las Cruces, N. Mex.*

On July 3 of the present year I found close to the cathedral at Santa Fé, N. Mex., a number of sawfly larvæ feeding on *Sphæralcea angustifolia* Spach. From these adults of both sexes were in due time bred. Although the Sphœralcea is extremely common at Santa Fé, and likewise at Las Cruces, N. Mex., I did not find it infested by these sawfly larvæ except at this one spot. In fact, of several plants there growing together some were very badly infested while others were nearly free. In August another generation of larvæ appeared, and again the same plants were infested in the same way, so that, although the sawflies were to be seen flying about in half circles at the time of emergence, they seemed to have returned in each case to oviposit on the plants from which they came. The plants, being twice defoliated, presented a sorry appearance. The leaves produced after defoliation appeared to be shorter, and broader in proportion to their length, than those on the normal plant.

The hollyhock (*Althæa rosea*) is commonly cultivated in gardens at Santa Fé, and I did not anywhere find it attacked by the sawfly larvæ except in the garden of Governor Thornton, which is only about 150 or 200 yards from the original Sphœralcea locality. This was on August 9, and the hollyhocks were badly injured by a brood which was intermediate between the two main Sphæralcea broods. Both old and young larvæ were found at this time; likewise two of the flies. The leaves of the plants were reduced to skeletons where attacked.

This occurrence was of much interest, as we had before us the beginning of a new invasion of the hollyhock from the Sphæralcea; and judging from what has before happened in like cases, we can readily appreciate the possibility of the pest spreading eastward and becoming a source of trouble in gardens.

The imago I considered, after some examination, to be a new species of Schizocera. It seemed judicious, before publishing, to submit an example to Mr. C. L. Marlatt, who now writes me that it "appears to belong to André's genus Nematoneura, which is very closely allied to the genus Schizocera." He adds that there is only one known species of Nematoneura, and that is European, so my insect is undoubtedly new. I have not access to the original diagnosis of Nematoneura, but the species now under consideration is separable from Schizocera by the fact that the second submarginal cell receives both recurrent nervures instead of only one.

The question must naturally arise whether *Nematoneura malvacearum*, as I call our species, is really congeneric with the European Nematoneura in a genealogical sense. It is certainly a fact that genera of sawflies have been founded to some extent artificially, so that it may be the case that two so-called congeneric species have originated independently from ancestors not exhibiting their now "generic" character by similar variation. This would seem the more probable, since the food-plant of our species is of Southern or Sonoran distribution, not by any means boreal; and, although the midalpine and Northern American Tenthredinidæ have been rather extensively collected, no Nematoneura has been found among them. I should like to ascertain more exactly the relationship of our speccies to the three species of Ptenus, which Norton has described, from Texas. These belong to the same sub-region of North America, and form, with our insect, the whole of its hylotomine fauna, so far as I have been able to definitely ascertain.

The following descriptions, though not very elaborate, will doubtless amply suffice for the recognition of the insect:

Nematoneura malvacearum n. sp.

Imago ♀.—$8\frac{1}{4}$ mm long; anterior wing $7\frac{1}{2}$, antenna $2\frac{1}{2}$ mm long. Stoutly built; head, wings, and legs black; thorax and abdomen orange-red. Head not so broad as thorax, shining black, crown appearing slightly rufous in some lights. Ocelli prominent, the anterior one but little anterior to the posterior (lateral) ones. Clypeus with some short, pale pubescence. Face with a descending ridge between the antennæ. Distance of antennæ from each other slightly less than distance of either from the nearest eye. Antennæ 3-jointed, black; first joint about as broad as long; second decidedly broader than long; third very long, forming the greater part of the antennæ. Thorax and abdomen shiny orange-red; under side of thorax black. End of ovipositor-sheath trifid, black, hairy. Anterior tibiæ with two about equal spines; posterior tibiæ spined; anterior tarsi with the first joint longer than 2 + 3 + 4, and the fifth (last) joint about as long as 2 + 3 + 4. Wings black, venation strong;

stigma black, about twice as long as broad; marginal cell elongate, tapering, its apex about twice as far from end of stigma as from apex of wing. Four submarginals, second a little longer than third; second receiving both recurrent nervures. A hyaline mark gives the third transverso-cubital nervure the appearance of being broken.

Male smaller, $6\frac{1}{2}^{mm}$ long; third joint of antennæ furcate, with a comb of hairs; wings hyaline, with a slightly smoky tinge; anterior portion of thorax dorsally black. The marginal cell usually presents a stump of a vein near its apex, springing from the marginal nervure.

Mature Larva about 14^{mm} long and 4 broad; head smooth, shiny, yellowish-pink; thoracic legs, black with a pale ring; body yellowish-pink, last segment dorsally black. Each segment has many black tubercles, which mostly are pellucid-dotted in the center, bearing a curious resemblance to the scales of *Aspidiotus ficus.* These tubercles are arranged in three transverse series on each segment. Those of the hindmost series are small, except for a couple of large ones on each side.

The series may be expressed thus: L = large, S = small, tubercle.

Anterior series:	S L	L S
Middle series:	L L L S L	L S L L L
Hind series:	L L S S S S S	S S S S S L L

The middle (dorsal) tubercles of the anterior series are further apart than those of the middle series, so that the four form a figure thus ·. .· The cast skins are whitish, with black tubercles and chestnut-colored heads; the pink color of the larvæ being entirely due to the blood. It might be worth while to inquire whether the pink pigment in the larvæ is not related to the pigment which gives the *Sphæralcea* flowers their scarlet color.

The young larvæ are pale greenish, with the ends yellowish; the red color is only gradually acquired as they mature.

The cocoon is pale brown, moderately dense.

NOTE ON HYLESINUS SERICEUS.

By E. A. Schwarz.

One of the most abundant species of scolytid beetles in the Rocky Mountains, as well as throughout the Northwest, is *Hylesinus sericeus* Mann. It develops under bark of various species of pine and spruce trees, and has no doubt a considerable economic importance, although at the present day no attention whatever is paid to the insect enemies of our Western forest trees. The beetle is abundant in the magnificent forests of the Coast and Cascade ranges in Oregon, Washington, and

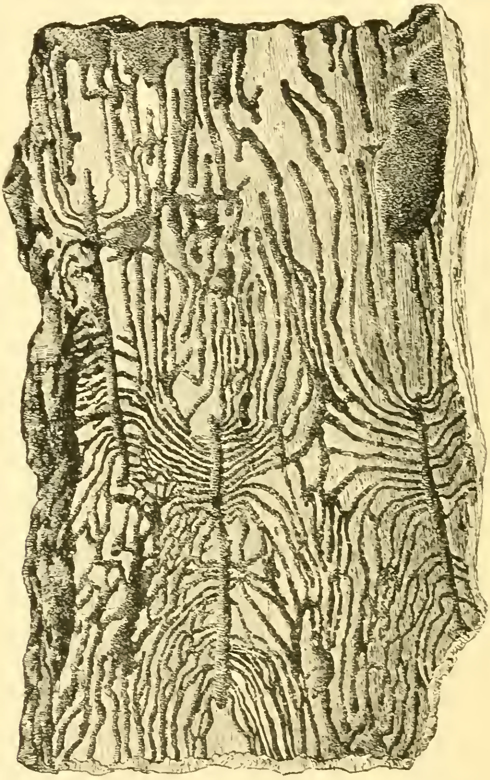

Fig. 25.—Work of *Hylesinus sericeus* under bark of *Picea engelmanni* (Marx del.).

British Columbia, but it would be foolish to speak of it as injurious in these regions, since whatever damage it may do sinks into utter insignificance when compared with the devastations caused by the lumberman. In the Rocky Mountains of the United States, where the forests are already considerably thinned out, the injurious work of this and some other scolytids of the genus Tomicus becomes much more apparent, as I recently witnessed myself on a vacation trip through the Wahsatch Mountains in Utah. The beautiful pine forests that once covered the canyons and higher plateaus have long since disappeared in consequence of the operations of the silver-mining industry, and except some remnants in the less accessible ravines and side canyons only a few scattered trees, or, at best, groups of trees, are left. These trees, already more or less weakened by their isolated and exposed position are preferably infested by this beetle and succumb, one by one, to its attacks.

In the mode of attack this *Hylesinus sericeus* does not differ from many other bark-boring Scolytidæ. The female beetle bores a hole through the bark and constructs a longitudinal gallery just between the bark and the sapwood. During this operation she deposits the eggs at regular intervals along the two sides of the gallery. The young larvæ commence to gnaw side galleries, which at first run horizontally, but gradually assume, or at least have a tendency to assume, a longitudinal direction.

The accompanying figure (Fig. 25), which illustrates the work of three female beetles and their numerous progeny, renders all further description unnecessary. It represents a small piece of the bark of Engelmann's spruce (*Picea engelmanni*), collected near Alta, at the head of Little Cottonwood canyon. The whole trunk of the tree was just as densely covered with these galleries as the small sample piece figured, and it is hardly necessary to remark that the tree had already succumbed.

This scolytid appears to be readily attracted to trap trees, for I saw at the mouth of Big Cottonwood canyon a pile of freshly sawed spruce wood which was densely beset with the galleries, and I have no doubt that a few pieces of wood laid out at the proper season and properly attended to (*i. e.*, decorticated before the larvæ are full grown) would protect the living trees for some distance around.

Scolytid beetles in the imago state are very difficult to distinguish from each other, but in most instances the species can be readily recognized from their mode of work; and this proves the importance of giving illustrations of the galleries. There is in the Rocky Mountain region no other pine-infesting scolytid* which constructs galleries similar to those of *Hylesinus sericeus*.

The gallery figured above differs radically from those known to be made by other species of Hylesinus, and the following remarks are added as an explanation of this discrepancy:

The species originally described by Mannerheim as *Hylurgus sericeus* and subsequently referred by LeConte to Hylesinus can not be retained in the latter genus. In Hylesinus the antennal club is distinctly compressed and the front coxæ are widely distant; the species live in deciduous trees, and the gallery made by the female beetle is transverse. *H.*

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* The following species of scolytidæ were observed in June, 1891, to live on *Picea engelmanni* in the Wahsatch Mountains of Utah, at an altitude from 8,000 to 10,000 feet: *Hylastes macer*, *Hylesinus sericeus*, *Dendroctonus rufipennis*, *Scolytus unispinosus*, *Tomicus hudsonicus*, *Pityogenes carinulatus* var., *Cryphalus intricatus*, *C. striatulus*, *Pityophthorus nitidulus*.

sericeus has the antennal club not compressed and the front coxæ narrowly separated; it lives in coniferous trees, where the female constructs longitudinal galleries, as figured above. A new genus will have to be erected ultimately for this species, but for the present it appears to be much better placed in Hylurgus than in Hylesinus.

A NEW PARASITE OF MYTILASPIS POMORUM.

By L. O. Howard.

The well-known oyster-shell bark-louse of the apple has a number of true parasites in the United States, although none have been elsewhere recorded. Those previously recorded are *Aphelinus mytilaspidis* LeB., *A. abnormis* How., *A. fuscipennis* How., and *Anaphes gracilis* How. During the past summer a fifth species has been received from Mr. John T. Boggs, of Liberty, S. C. It proves to be a new species of the genus Chiloneurus, to which I have given the specific name *C. diaspidinarum*, for the reason that it is the first species of the genus known to parasitize an armored scale insect. It is a very small species, as is necessary from the size of its host, is dark in color, and rather closely resembles the somewhat aberrant European *Chiloneurus microphagus* Mayr, the two together forming a distinct type in the genus. Concerning the habits of the European species we only know that it was reared from a scale-insect on oak by Von Heyden, and that two specimens were captured in June and August by Reinhard. It was named *Eucomys microphagus* by Foerster in 1856, but without description, and was first described by Mayr in 1875. The American species may be described as follows:

Chiloneurus diaspidinarum n. sp.

Female.—Length, 0.93 mm; expanse, 2 mm; greatest width of fore-wing, 0.39 mm. Closely resembles the European *C. microphagus* Mayr, the only difference from Mayr's description being that the wings are colorless instead of clouded with brown. First funicle joint of antennæ shorter than pedicel, about as long as broad; joints 2, 3, and 4 slightly shorter than 1, but about as broad; joints 5 and 6 longer and considerably wider, wider than long; club flattened oval, as long as four preceding funicle joints together; scape cylindrical, not expanded. Head thick antero-posteriorly; vertex long and narrow, shagreened, ocelli forming an acute-angled triangle. Silvery pile of mesoscutum rather sparse, interrupted on posterior border; mesoscutellum well rounded, densely shagreened above, smooth behind, tuft of bristles compact but not erect; abdomen flat, ovipositor very slightly extruded. General color shining black, vertex, cheeks, pleura, and abdomen with bluish metallic reflections; mesoscutellum with coppery reflections; antennæ brown, tip of pedicel and all of funicle joints 5 and 6 dirty yellow; front coxæ, all trochanters, base and tip of all tibiæ and all tarsi, except terminal joint, light yellowish. Wings clear; marginal vein short, as long as or little shorter than stigmal; post-marginal equal in length to stigmal; marginal cilia extremely short.

Described from two female specimens reared September 26 from female scales of *Mytilaspis pomorum* received from Liberty, S. C.

THE PATENT ON THE HYDROCYANIC ACID GAS PROCESS DECLARED INVALID.

By D. W. Coquillett.

On the 9th of April of the present year Judge E. M. Ross, of the Federal court for southern California, rendered a decision of considerable importance to the horticulturists of that State. Readers of Insect Life have in a previous issue been made aware of the fact that a few years ago three enterprising fruit-growers of southern California applied for and actually succeeded in obtaining a patent on the process of treating trees with hydrocyanic acid gas for the destruction of certain kinds of injurious insects—a process originating with and worked out by the writer. Shortly after obtaining their patent agents were sent out to different fruit-growers, offering them the right to use this process by paying the patentees a certain sum for each acre of trees upon which the process was to be used. However, with three or four exceptions, the growers refused to purchase the patent right, although the majority of them continued to use the process as in the past. After a number of them had thus been appealed to, they decided to form an organization for the express purpose of resisting the claims of the patentees. Accordingly, a large organization was soon effected, and the patentees found themselves confronted by a majority of the fruit-growers of southern California.

Finding their efforts in this direction futile, the patentees next sought to persuade the boards of supervisors of the different counties to purchase the patent right for their respective counties, but here again their attempts proved unsuccessful; in every case the matter was referred to the district attorney, and the latter decided either that the patentees had no moral nor legal right to the patent, or else that the supervisors were not authorized to expend any money for the purpose of purchasing a patent right.

Finally, the patentees decided to test the validity of their patent in the courts, and in the autumn of 1893 caused the arrest of one of the fruit-growers, charging him with the unlawful use of their patent, and seeking to obtain from him not only the first cost of the patent right but also the value of the profits that had accrued to him as a result of his having used the process covered by their patent. The organization of fruit-growers alluded to above then employed the proper counsel to represent them before the court, and in due time the trial took place, resulting in the rendering of the decision referred to in the opening paragraph of this article, to the effect that the patent is not a valid one.

In their specifications for this patent the applicants acknowledge that they were not the first to use this process, but based their claim upon the use of it "in the absence, substantially, of the actinic rays of light." In rendering his decision Judge Ross concludes as follows:

Yet, no method of excluding the light is stated or claimed. On the contrary, they declare that it may be done by means of the oiled tent or covering ordinarily used for such fumigation, provided the fumigation is done at night. Of course, night excludes the light. Everybody knows that. Nor is the night patentable. The ordinary tent or covering of the old process necessarily excludes, to a greater or less degree, depending upon the thickness of the covering and the extent to which it is colored, the actinic rays of light, which is that power of the sun's rays which changes the chemical nature of the mixture. So, also, will the clouds, to a greater or less degree, exclude such rays, depending upon the density of the clouds. And, after the sun sets and before it rises, they are entirely absent.

The old process, as described in the specifications, in no manner depends upon the time it is used. It consists, as the specification expressly recites, of fumigating trees and plants with hydrocyanic acid gas by means of the oiled tent or covering. Whether used by means of a thin or thick covering, heavily or lightly oiled, or in the twilight, or at night, or in the early morning, it is all the time the same process, which the public is entitled to use because it was old when the patentees applied for their patent. An old process does not become a new and patentable process by being used at night instead of in the daytime, or at any particular time, or in any particular state of the weather, or because better results are obtained by its use at one time than another.

The court, being of the opinion that the patent is void, for want of novelty and invention, and that, in view of its recitals, it is so plainly so that it can not be aided by evidence, it snould be so declared on demurrer, without subjecting the parties to the costs of producing proof.

When the announcement was first made public that the patent in question had actually been granted, it created no small degree of astonishment among the fruit-growers in that part of the country; and the very general impression prevailed that only by the grossest misrepresentation could such a result have been brought about.

As might naturally be expected, the decision of Judge Ross is a most welcome one to the citrus growers of southern California, who depend so largely upon the gas process for protecting their trees from the ravages of the destructive red scale. While these growers were convinced in their own minds that the patent was not a valid one, still the prospect of a prolonged and expensive litigation deterred several from using this process; but now that this incubus has been removed the process will evidently come into more general use than was the case during the existence of the patent.

A NEW PEAR INSECT.

A new and serious enemy to pear trees has recently been discovered in New Jersey by Dr. John B. Smith. It is a flat-headed borer of the genus Agrilus, and late investigations, following a suggestion made by Mr. E. A. Schwarz, of this office, indicate that it is *Agrilus sinuatus* Ol., of Europe, and therefore an introduced species. Dr. Smith shows that the larva bores between the bark and the sapwood, always in living tissue, and makes extremely long and irregular galleries, killing the wood beneath the burrow and causing the bark above it to crack. The accidental joining of a number of these galleries may girdle the tree, which then dies. When only a few larvæ infest it each year the tree dies gradually, the area available for the supply of sap being reduced from season to season. Dr. Smith has found that vigorous trees like the Kieffer will repair damages for some time, but that even

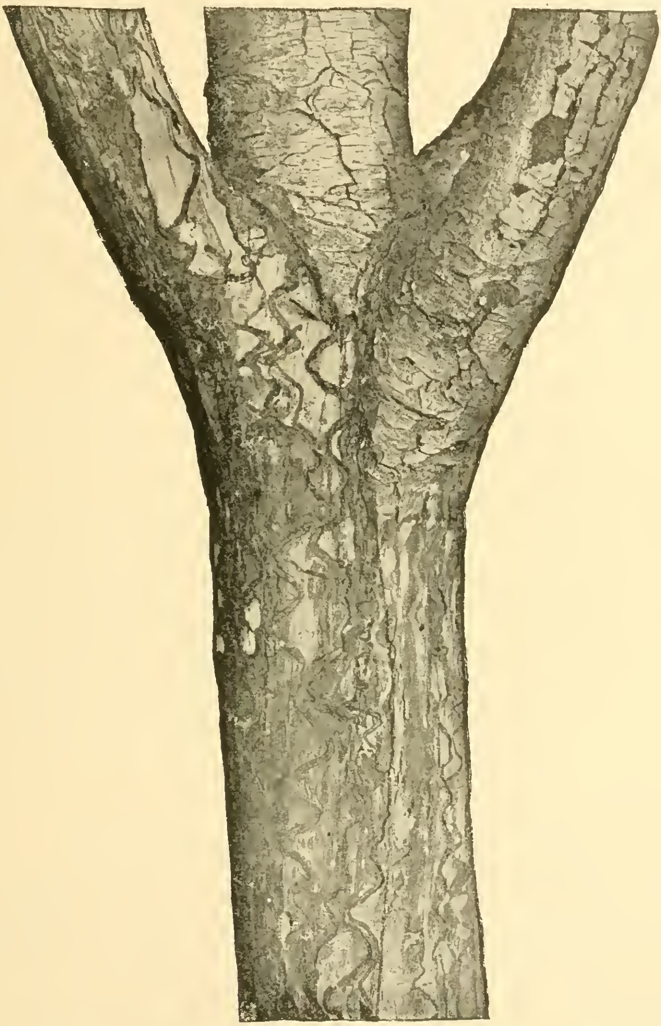

Fig. 26.—Work of *Agrilus sinuatus* in bark of pear; about one-sixth natural size. (After Smith.)

these succumb at last. The excellent illustration of the work of this destructive larva, which we present (Fig. 26), has been loaned us by Dr. Smith, and is reproduced from a photograph of a Seckel pear tree at the point of branching, the bark being removed from the trunk and one of the branches to show the galleries. This tree, he says, was between five and six inches in diameter, and had been healthy and a prolific bearer until the insects attacked it. The branches are attacked as well as the trunk, and sometimes the tree dies from the top. Young trees just from the nursery become infested. Dr. Smith records one case in which a small tree was set out one fall, became infested the following summer, and was dead the next spring. The burrows are extremely long, and one of them which was measured exceeded eight feet. The beetle is known to occur throughout middle and southern Europe, and was originally described in 1790 by Olivier, who found his specimens on various kinds of fruit trees in southern France. Of late years, since 1890, it has attracted considerable attention in Germany. and has been ably written about by Mr. R. Goethe, Director of the Royal Horticultural Academy at Geisenheim.* He calls the insect "one of the most dangerous enemies to fruit trees," and expresses astonishment that it is not even mentioned in treatises on injurious insects.

In Western Germany the adult beetles appear in June and July and deposit their eggs in the cracks or beneath the scales of the bark of the trees, apparently preferring the younger trees. The young larva eats its way through the bark and constructs there the strongly undulating galleries so characteristic of all tree-inhabiting larvæ of the genus Agrilus. After two years the larva has attained full growth, and assumes the pupa state in an elongate cavity constructed a little deeper in the solid wood.

As a means of protecting trees against this Agrilus, Mr. Goethe recommends the coating of the trunks with a thick layer of clay. He also found that a mixture of clay and cow's manure applied to the trunk and older branches of infested trees not only kills the larva in their galleries, but assists the trees materially in their recuperative efforts.

Dr. Smith finds that the insect was imported from Europe into a nursery in Union County, N. J., not more than ten years ago, and that it is already quite widespread in that State, probably also occurring in New York.

SCORPIONS, CENTIPEDES, AND TARANTULAS.

There has always been the greatest conflict of evidence among travelers in tropical regions as to the effect of the bite of the three classes of animals referred to in the above heading. The frequent introduction of all three into the larger cities of the United States in bunches of bananas and other tropical fruits brings the subject more or less prominently before our public.

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*The article is published in the Report of the Academy for 1890-'91 (1892), and reprinted in Entomolog. Nachrichten, 19, 1893, pp. 25-30. See also article by Puton, "L'Agrilus sinuatus destructeur des poiriers" (Revue d'Entomologie, 2, 1883, pp. 67-69), and Xambeu's "Moeurs et Metamorphoses d'Insectes" (l. c., 12, 1893, pp. 91-93).

Sifting the published evidence, Prof. Riley, in his article on "Poisonous Insects," in Wood's Reference Handbook of the Medical Sciences (vol. v, 1887), makes the following statements, after some little discussion of the characters and habits of the creatures considered:

Scorpions.— * * * They are dangerous in proportion to their size, their age, and the state of irritation they may be in. Temperature also influences the venom. The wounds inflicted even by the largest species rarely prove fatal. * * * There is no doubt that the sting of certain kinds common in South America causes fever, numbness in various parts of the body, tumors on the tongue, and dimness of sight, which symptoms last from twenty-four to forty-eight hours. * * * The effect of the sting upon a person diminishes in virulence with repetition, and may become innocuous.

Centipedes.— * * * The effect of the bite of a centipede in warm climates is very variable; sometimes excessively virulent and painful, at others causing little inconvenience.

Tarantulas.—This popular term refers only to the large, hairy Theraphosids. * * * The bite of these spiders is quite painful, but not by any means as dangerous as claimed. It produces a violent inflammation of short duration. Scars made by such bites are quite lasting, however, looking like those so frequently made during dissections.

Recent correspondence with Mr. Herbert H. Smith, the well-known collector in South and Central America and the West Indies, and with Dr. Eugene Murray-Aaron, who has collected throughout the West Indies, has given us some facts which should be placed upon record, and which, while they negative popular ideas, substantiate the conclusions arrived at by Prof. Riley, as above stated.

Mr. Smith writes as follows:

Scorpion stings are nearly always very painful; commonly there is great inflammation and swelling around the wound for two or three days, and occasionally this may extend so far as to be dangerous. My wife's uncle, a physician in Yucatan, was stung on one of the toes by a scorpion which had got into his shoe; the foot and leg inflamed so badly that he himself had nearly decided on amputation of the foot; he believed it would be necessary in order to save his life. However, the inflammation finally subsided and he got well. I do not know what remedies he used. I have heard, from Brazilian physicians, of similar cases, but I do not know of any case of death from a scorpion sting. Probably death might result in some cases, as (if reports are true) it does, rarely, from bee stings. I have never been stung by a scorpion. My wife was stung by a small one in the West Indies; the wound was on the end of the forefinger and was exceedingly painful. By the advice of a servant, she held the finger for an hour in hot sweet oil mixed with an equal measure of laudanum. There was no swelling, and three hours after all pain had left her. This remedy is a popular one in the West Indies, and the result seems to show that it is good. Once when I was traveling with Mr. O. A. Derby, he was stung on the hand by a scorpion. The swelling lasted for three days, making the hand useless and extending nearly to the elbow. He described the pain at first as terrible; he is a brave fellow, but I could see by his drawn face that he was suffering severely. Some scorpions are much worse than others. The rather small, slender, pale-colored kinds have the worst reputation, and country people in Brazil say that the sting of the very large black kinds is not particularly painful. By the way, why are certain places nearly free from scorpions, while others are overrun by them? The worst metropolis of them that I ever saw was a valley in the Tierra Templada of Mexico, a beautiful place, well watered, surrounded by forests, and apparently not very different from other places where scorpions were rare. Here I could not turn over a stone without finding three or four under it—a small, pale species, said to be very wicked.

About centipedes I can give you no reliable information. I never heard even a report of their being dangerous, though the bite is said to be painful. Some say that the legs are poisonous and that if the animal runs over the skin it leaves a trail like fire. This, I take it, is all imagination. I have had very small centipedes run over me, and they did not harm me at all. I never saw a centipede wound, and, according to my experience, the animals are so timid that they will not try to bite unless squeezed by a stick or forceps. Of course nobody would attempt to catch a large one with the hand, but a bare-foot might tread on one.

Spiders, on the contrary, are very pugnacious. Species an inch long, if threatened with a stick, will sometimes leap several inches at it. In one such case I was bitten on the finger. The pain was no greater than that produced by the sting of a small wasp, and there was hardly any swelling. In the American tropics "tarantulas" are any large spiders, but especially the large hairy Mygales. I do not think that these are dangerous, except, possibly, to a few persons. The only case of a Mygale bite which has come under my observation was that of a man who was bitten on the foot deep enough to draw a little blood. There was hardly any swelling and he paid no attention to it. The story of Mygales killing small birds is true, but I do not think that the birds are their regular prey. They eat roaches, large moths, etc., and sometimes grasshoppers.

Dr. Aaron writes as follows:

* * * I am convinced that no healthy adult need have serious alarm from the bite or sting of these creatures, although, as I have more than once found out to my cost, their poisons are the cause of much and excruciating pain.

Leprosy, yaws, the malignant forms of syphilis, are all very common among negroes, mestizos, and half-breeds in the American tropics, and it is among such subjects that the poisonous insects and minor poisonous reptiles find their victims of serious poisoning and death. But a man in good health, with pure blood and of good habits, will in every case (in my opinion) throw off their effects in from one to five days. My most serious personal experience was with a large "trap-door spider" (Mygale? sp.) in Haiti. The creature was lurking in the dried sheathes of a bamboo clump that I was cutting down for building purposes and it bit me twice on the back of the hand before I saw him (or rather her). From this bite, on which I used the usual remedies, I suffered more or less for four days and experienced slight pains for nearly a month. From the third to the thirtieth hours my hand and forearm were terribly swollen and discolored, and during part of the time, at irregular intervals, every pulsation was accompanied by pains akin to the worst earache. These involved the whole arm and the shoulder. A severe headache was also a natural feature. Fear had no part in this case, as I had been bitten before by a larger specimen at Port a Paix, Haiti. Why the effect was so severe I can not say.

While keeping house at Half Way Tree, Jamaica, I was severely stung at the base of the left thumb by a large female scorpion that had taken shelter in some letters that I was examining. It was an odd coincidence that I was just beginning an article for a New York syndicate on "Insect Poisons," and was looking for a letter from your predecessor, Prof. Riley, on the "red tick," "grass louse," bête rouge (Ixodes sp.?), when stung. The pain and the inflammation were much less than from the Mygale. I have been stung by scorpions several times while hunting in rotten timber and decaying vegetation for beetles, etc. Usually the effect is no worse than that from the sting of the "locust-killer" (*Stizus speciosus*). Bad enough, you will say, if you have ever had a tilt with that formidable hymenopter.

Centipedes have a fondness for vermin-infested beds, and the latter are as common in Tropical America as the hairs on a dog's back. So it has come that twice I have rolled over on fair-sized specimens of Julus (?). I am by no means sure of the manner of their poison infliction, but know that a red ridge, burning much as does the excoriation of the common nettle, is the result. The pain is less than that from the others, but the incident fever and distress of the head is greater than that of the scorpion, though less than that of Mygale.

Much has been written of the "dance of the tarantula," and wonderful are the tales the traveler may hear down there. In the Haiti case (bamboo cutting), already spoken of, I undoubtedly felt the symptoms that give rise to these stories. For perhaps a half hour, about four hours after the bite, I was afflicted with an utterly irresistible twitching of the muscles of the legs and arms, and the spasmodic action of the fingers, eyelids, lips, and tongue were most distressing. Only the utmost exertion of my self-control kept me from making more of an exhibition of myself than I did. As it was, my negro guide and carriers stood sympathetically around and compared notes in their French-patois jargon as to the probable hour of my demise. My entire recovery and subsequent apparent fearlessness regarding all poisonous things greatly increased their opinion of the Vaudoux powers with which they had already invested me.

GENERAL NOTES.

GRAIN INSECTS IN MILLS.

An article on the destruction of grain insects in mills, published in the American Miller for October 1, 1894, strikes us as so thoroughly practical that it is well worth republishing nearly in full. The article is by Mr. R. E. Hutton, who is evidently a man of wide experience. After reciting the trouble experienced in his mill from the presence of grain insects, Mr. Hutton says:

This was about the predicament in our mill, and we began to arrange a siege. The accompanying sketch shows a pair of small, round reels to tail over into a pair

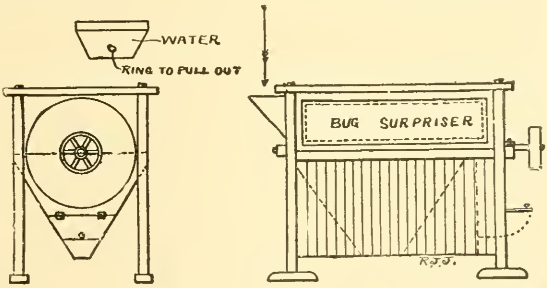

FIG. 27.—Machine for destruction of insects in mills (from American Miller).

of smooth rolls about the size of feeder rolls. These are to be placed over flour chests of various sizes and the bug family are gently scalped into said rollers and their backs cracked, when they are rolled into a box on the floor.

This plan was submitted to a firm of manufacturers of mill machinery, and with the substitution of a small tank for the rollers was adopted and put in operation.

Mr. Hutton continues:

The bisulphide is by no means to be abolished but continued with determination, and very soon the pest is under control. One or two annual extensive applications will be sufficient. Remove the elevator doors and take out the chop or stock from several cups in each stand and replace the door or lid after filling about two-thirds with bisulphide. Put at least two cups in each conveyor box, as that is the principal breeding-bed.

Keep padded mallets handy, and occasionally—several times a week—jar down the cant boards and spouts and allow no old dust to accumulate anywhere. These mallets are easily made of pieces of 2 by 4, the ends covered with odd pieces of old cotton belting neatly cut out at the corners, folded down, and nailed around the edges. Hard-wood broomsticks make good handles. Bore a hole in the end of the mallet and have one hanging at hand on each floor. These mallets are also convenient to use on the spouting in case of choke-ups.

In the construction of the aforesaid reels shoulders and conveyors should be avoided, and should be hoppered to discharge into a spout of about 4 by 4, so there would be no flour banks and no accumulations of flour in conveyors. The reels should extend a trifle past the partition of the tank chamber. They should be plain hoop reels, and not deflectors or carriers, so as not to fog or dust over. The cloth being coarse—No. 1 or 2—the capacity is immense. A reel four or five feet in length has a capacity of 350 barrels per 24 hours. They should be run at a speed of 30 revolutions a minute, and no brush or cloth cleaner is necessary. The water-tank should hold three or four gallons, and the edges should fit snug against the cant board.

A shelf may be provided in an upper corner where a cup of bisulphide may be placed to advantage over Sundays or while the mill is idle. Each of these reels require only a 2-inch belt over 14 or 16-inch pulleys, or several may be coupled tandem or a cross-counter gear drive utilized. In small mills, where this plan would be considered almost too elaborate, old scalpers of a small size may be arranged instead. You should avoid having conveyors and elevators between them and the flour chest if possible. The separation of bugs is not the only benefit to be derived; for mills carrying stocks of flour find sacks variously damaged, some infected with vermin, rats, and mice. This may all be fed direct to the flour elevator and the bug reel will renovate and separate.

In cold buildings where water in the tin tank would freeze, a sack made of table oil-cloth, with the oil side in, may be substituted. These bugs, as is said of some millers, will stand watching, as they are likely to crawl out of the sack. A sieve will not take the place of a reel, for the bugs will crawl over. I have found them riding purifier sieves and elevator belts with seeming enjoyment.

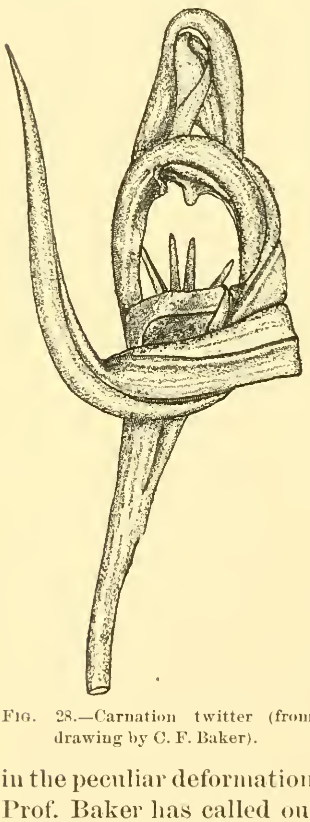

FIG. 28.—Carnation twitter (from drawing by C. F. Baker).

THE CARNATION TWITTER AGAIN.

From the notes which we have published on pages 45 and 343–345 of volume VI, INSECT LIFE, and from recent talks with florists, as well as from an interesting letter received from Prof. C. F. Baker, of Fort Collins, Colo., it appears that several insects are concerned in the peculiar deformation of carnations, known to growers as "twitter." Prof. Baker has called our attention to an article which he published in the American Florist for April 1, 1890, in which he attributes the common phase of twitter to the work of a plant-louse of the genus Siphonophora. He figures and describes the insect, but does not give it a specific name. In a recent letter he has sent us an interesting sketch of a form of twitter caused by the plant-louse in question, which we reproduce herewith. Kerosene emulsion will prove efficacious against the Siphonophora, but where examination shows that the anthomyiid larva mentioned upon page 45, volume VI., INSECT LIFE, is causing the damage there will be no remedy until the life history of the insect has been worked out, except to pull up and burn infested plants.

LEGISLATION AGAINST INSECTS IN BRITISH COLUMBIA.

Under the authority of the "Horticultural Board Act, 1894" the Provincial Board of Horticulture of British Columbia has published a set of fifteen rules and regulations providing for a complete system of inspection of fruit and fruit trees in that province. The Board, which is composed of the Minister of Agriculture, the Statistician of the Department of Agriculture, the Inspector of Fruit Pests, and a representative from each of five horticultural districts, declares that the word pests "shall mean and include woolly aphis, apple-tree aphis, scaly bark-louse, oyster shell bark-louse, San José scale, red scale, borers, codling moths, currant worms, or other known injurious insects, and all fungous diseases." Notification of the presence of pests is to be given by the owner of infested stock to the proper officer of the Board, and nursery stock shall not be distributed until a certificate is obtained from the Board that such stock appears to be clean; the certificate to remain in force for three months. Infected nursery stock is to be cleansed by using the remedies prescribed by the Board or approved by it, and shall not be distributed until certified as clean by the Board. Imported fruit is not to be taken from the wharf until inspected, and if found infested, shall be destroyed or returned to the shipper. Home-grown fruit is also subject to inspection, and if found infested shall be quarantined or destroyed.

The regulations prescribe that all infected nursery stock shall be disinfected either by dipping in a solution of one pound concentrated lye and one pound whale-oil soap in five Imperial gallons of water, or by fumigation with cyanide of potassium. A lime-salt-and-sulphur solution is recommended as a winter spray for the woolly aphis and scale insects; a mixture of whale-oil soap, sulphur, caustic soda, and commercial potash in water as a summer remedy for the San José scale, and the Bordeaux mixture for apple scab and all fungous diseases. All boxes, crates, or other packages which have contained infected nursery stock are to be burned immediately after the removal of the contents, and hop-fields, when infested with the hop louse, are to be sprayed under the direction of the Board. The penalty fixed for the violation of these rules is a fine not to exceed fifty dollars for each offense.

A NEW DEPARTMENT OF THE PASTEUR INSTITUTE.

In our article on the rise and present status of official economic entomology, in the last number of INSECT LIFE, we referred under the head of France to the establishment of the Laboratoire de Parasitologie de la Bourse de Commerce at Paris, and of an entomological department at the Institut Agronomique. We learn from Nature, of September 13, 1894, that a new department of the Pasteur Institute has been more recently established, which has for its especial object the experimental study of means of defense against injurious insects. M. Metchnikoff is superintendent, with M. J. Danysz as his assistant. The objects are as follows: (1) The collection and cultivation of all of the pathogenic microbes of insects and animals destructive to crops, (2) the study of the conditions of development of these microbes in animals and on various media, (3) the direction of field experiments, and (4) the superintendence and control of practical applications of results of laboratory work. The best means of applying these results will be discussed by a committee, some of the membeıs of which are MM. L. Brocchi, Costantin, Grandeau, Millardet, Sauvageot, Schribeaux, A. Giard, J. Künckel d'Herculaïs, A. Laboulbène, P. Marchal, and E. L. Ragonot. A bulletin will be published, as well as monographs of destructive insects and pathogenic bacteria, statistics concerning damage, and critical notes on all publications referring to these matters.

NITROGENOUS FOOD AND THE REPRODUCTIVE ORGANS.

Mr. J. T. Cunningham, in Nature for September 27, 1894 (p. 523), referring to Weismann's statement that the bee has the specific property of responding to imperfect nutrition in the larval state by an imperfect development of the ovaries, and that, as proof of this, blowflies from maggots partially starved, but fed exclusively upon meat like those which were not starved, laid eggs in normal abundance, calls attention to the fact that the larva of the worker bee is supplied with a diet low in nitrogen, while that of the queen bee is supplied with one highly nitrogenous. Evidence is required that the larva of the blowfly can fully develop its ovaries when deprived of nitrogenous food. He points out that Weismann himself, in one of his notes, shows that when blow-flies were fed upon carrots and sugar they laid no eggs for more than a month, but as soon as meat was supplied them sucked it greedily and laid great numbers of eggs the week afterwards. He further shows that in the case of Termites, Grassi has found that the fertile individuals are fed during development on the secretion of the salivary glands of other individuals, while sterile forms are supplied only with macerated wood dust.

SOME SOUTH AUSTRALIAN MATTERS.

The journal of the Agricultural Bureau of South Australia, published as an appendix to the Garden and Field for August, 1894, contains several items of interest to entomologists. It seems that the pear or cherry slug, *Eriocampa cerasi*, has been doing some little damage in parts of South Australia, and the Minister of Agriculture has issued a proclamation prohibiting the introduction into the colony of any tree, plant, or fruit in any way infested with this insect. Announcement is made of a public demonstration of the benefits to be derived from spraying fruit trees for protection against fungous diseases and the attacks of insects shortly to be held under the auspices of the Agricultural Bureau. The Phylloxera agitation still continues, and the officers of the Bureau are coming to the conclusion that in the use of American resistant stocks the salvation of the vine-growing industry of the colony is to be found. An application has been made for the removal of the restriction against the importation of oranges and lemons affected with *Mytilaspis citricola*, but in view of the fact that this insect is not known in South Australia the application was denied.

AN IMPORTANT MONOGRAPH.

M. G. V. Berthoumieu, in the first number of the current volume of the Annales de la Société Entomologique de France, has begun the publication of what bids fair to be a very complete monograph of the Ichneumonidæ of Europe. The first installment of 35 pages contains only preliminary matter. He divides the family into six tribes, which correspond to the five subfamilies given in Cresson's Synopsis, with the addition of the Agriotypini, and gives at length the general habits and characters of the typical tribe Ichneumonini. Important original observations are given upon the larval development of *Ichneumon rubens*, and the statement is made that the insects of this tribe or subfamily are exclusively parasitic upon the larvæ of Lepidoptera. In this opinion M. Berthoumieu follows Bridgman and other observers. Upon pages 151–152, vol. III, INSECT LIFE, in recording the office rearings of parasitic Hymenoptera, we have given three cases in which species of this subfamily have been reared from sawfly larvæ, and we are inclined to think that the general statement must be modified.

COÖPERATIVE WORK AGAINST INSECTS.

On page 376 of the last volume of INSECT LIFE we mentioned, under the above heading, the result of the offering of prizes by the Genesee Valley Forestry Association for the collection of cocoons of some insect, which we concluded, from the context in the newspaper paragraph in which we observed the statement, to be a Clisiocampa.

Mr. M. V. Slingerland, of Cornell University, seeing this item, has put us in possession of the facts in the case, and we quote his interesting letter in full:

In 1892, while attending the Association of Economic Entomologists at Rochester, and passing to and from the meetings, along some of the beautifully shaded streets, I saw immense numbers of the egg-masses of the white-marked tussock-moth (*Notolophus orgyia*) on the trunks of the trees and in many angles of the dwelling houses near by. The friend with whom I was staying belonged to the reportorial staff of one of the leading dailies in the city, and I was thus fortunate enough to be able to quickly sound the alarm. A few days later I again called the attention to the necessity of active measures being taken at once, and gave a detailed account of the insect in the same paper. Thus, I believe, I was the first to call the attention of the citizens to the pest, and by frequent short notices and telegrams sent at the request of the editor, public opinion was at last aroused so that in the spring 44,900 so-called "cocoons" were gathered by one boy. (I had suggested this method of interesting the school children in one of my communications.) This spring the prizes were larger and the work was vigorously pushed. Competition was close and when the time limit expired over 8,400,000 "cocoons" had been gathered by the children. The figures quoted from the American Cultivator represent only those "cocoons" gathered by one school before May 10. The contest did not close until June 1, when one boy was credited with 3,038,713, and another boy with over 1,500,000! I was somewhat curious to know just what these "cocoons" were, so I asked the principal of one school to send me a box just as they came in. I received a cigar box packed full and said to contain 2,000. It was a very dirty mess, as they had evidently been gathered in the vicinity of car-shops or other large coal-burning manufactories, so I did not question the accuracy enough to count them. I especially desired to find out how many of the "cocoons" were egg-masses among the stated 2,000 "cocoons." Most of the mass did consist of the cocoons of the male moth, all empty, of course. The city papers have reported the pest greatly reduced in numbers this summer as compared with other years. There is no doubt that the $600 expended in prizes by the Genesee Valley Forestry Association this spring was the cheapest and most e ective method of checking this pest that could have been used.

A NEW ZEALAND MOTH-CATCHING PLANT.

In our article upon the codling moth, in the annual report of this Department for 1887, we referred on page 98, to the insect-catching properties of the flowers of the different species of Physianthus, and to the interesting suggestion of a possible use for these plants as codling moth traps in New Zealand by Dr. Cheeseman, of the Auckland Museum, and Mr. J. T. Campbell, U. S. consul at Auckland. We further stated that a very large number of specimens of moths captured by these plants were received from Mr. Campbell, but among them were no codling moths. In Science Gossip for October, 1894, Mr. W. M. Maskell, of the University of New Zealand, at Wellington, publishes an interesting article upon this subject, identifying the principal moth-catching plant of New Zealand as *Araugia albens.* It is a native of the Cape of Good Hope, and was accidentally introduced into New Zealand. It captures such moths as visit the flowers for nectar, the proboscis of the moth being clasped by two pincer-like organs. Mr. Maskell states that a plant of Araugia covering a space 10 yards in length may frequently destroy as many as hundreds of moths in a night, and consequently prevent the ravages of fifty times as many larvæ. The varieties of moths are not indicated, but the statement is made that the codling moth does not frequent the plant.

THE ARMY WORM IN 1894.

During the season of 1893 the army worm, *Leucania unipuncta*, was reported several times from the States of Michigan and Wisconsin in June, and later in the season the so-called wheat-head army worm, or fall army worm, occupied practically the same territory. The present year in certain Eastern States the army worm has done more damage than has been reported to us since 1881. Beginning on May 29, when it was reported from Richmond, Va., specimens have been received at frequent intervals down to September 6. The record reads: Richmond, Va., May 29; Chester, Va., June 5; Easthampton, Long Island, N. Y., July 9; Augusta, Wis., July 10; Nadeau, Mich., July 18; Wausau, Wis., July 19; Conner, Pa., July 21; New Canton, Va., August 16; Belle Haven, Va., August 23; Woodford, Va., August 25; Lincoln, Del., September 6; St. Stephens Church, Va., September 11.

There is no doubt about the determination in any of these cases, as specimens have invariably been sent to the Department. This late occurrence of the insect in injurious numbers in Virginia and Delaware is entirely unprecedented. It has long been known that there are from four to five generations annually in the former State, and while in the majority of instances it is the first generation of larvæ, i. e., the offspring of the moths into which the over-wintered larvæ develop, which constitutes the injurious generation, as long ago as 1880, in the columns of the New York Semi-weekly Tribune, the writer gave an instance of a destructive army composed of individuals of the second generation. There can be little or no doubt that the occurrences of late August and early September in parts of Virginia illustrates the possibility of the development in injurious numbers of at least a third annual generation.

We can offer no suggestions as to the reasons for this anomalous occurrence, but it is only an evidence that there are possibilities of injury by the army worm which have been hitherto unsuspected. The early indications that 1894 would prove to be an army worm year were so strong that a circular was issued by the Division during the first part of June, and a copy will be sent to all applicants. The remarkable character of the late appearance of the worms is indicated by the opening sentence of this circular, in which it is stated that "In the months of May and June, and sometimes as late as July, wheat, oats, and other small grains, corn, timothy, blue grass, and other grasses, but seldom or never clover, are occasionally overrun," etc.

ABUNDANCE OF CHARÆAS GRAMINIS IN SCOTLAND.

On pages 48 and 49 of the current volume of INSECT LIFE, we referred to the extraordinary numbers of the larvæ of *Heliophobus popularis* in northern France during 1893, which was ascribed to the extremely long-continued dry weather of that season. We have noticed in the

English papers reports of similar abundance of the grass caterpillar, *Charæas graminis*, in northern Europe, especially during the past two years, and in The Entomologist for October, 1894, there is an interesting article by Robert Service concerning the recent abundance of this latter species in southern Scotland. He mentions one place where the drains and ditches were found in many cases to have been filled up with larvæ after heavy rainfalls, the masses of caterpillars lying, in some places, from 20 to 24 inches in depth. Anglers found every trout captured literally crammed to the mouth with these larvæ. The coincidence of the appearance of this insect in such extraordinary numbers with the outbreak of the vicarious army worm in the eastern part of this country is interesting, and indicates a similarity of weather conditions.

THE BUTTERFLY HUNTERS IN THE CARIBBEES.

Scribners have just published a handsome little volume under the above title, by Dr. Eugene Murray-Aaron, of New York. The book is intended for young people, and gives an interesting account of a journey made by two boys of fourteen and sixteen, under the care of an experienced traveler and naturalist, to the Bahamas, Haiti, and Jamaica. The object of the trip was primarily to collect butterflies, but general collections in other groups were also made, and the author has brought in many interesting historical and ethnological passages concerning the islands and the people inhabiting them. One who expects from the title a strictly entomological work will be disappointed, but there are many interesting entomological notes, and the volume is well calculated to hold the attention not only of the class for whom it was designed, but also of persons who are in any degree interested in natural history. The person reading it, in fact, can not but become more interested in nature. It is the intention of the author to follow it by another volume describing a journey by the same individuals to Central America. To the entomologist the book is chiefly interesting for its account of the methods used by insect collectors in tropical countries, a subject with which Dr. Murray-Aaron is perfectly familiar from personal experience. He has traveled over the entire ground in which the scenes are laid, and leaves nothing to hearsay.

DAMAGE BY ABBOTT'S BAGWORM.

Mrs. Annie Trumbull Slosson, in the Journal of the New York Entomological Society for September, 1894, states that at Punta Gorda, Fla., the baskets of *Oiketicus abbottii* were very numerous on various trees and shrubs. Orange and lemon trees were sometimes completely defoliated. Upon one Japanese plum they hung by hundreds, one small twig sometimes carrying eight or more, hanging not half an inch apart. Fortunately this insect is readily destroyed by an arsenical spray.

TWO MORE IMPORTANT VEDALIAS.

We have recently received from Mr. A. Alcock, superintendent of the Indian Museum at Calcutta, specimens of *Vedalia fumida*, var. *roseipennis* Muls., which has appeared in considerable numbers during the present season and is feeding on *Icerya ægyptiacum* on ornamental plants in the compound of the Museum. Whatever bearing this fact, and the rearing of an internal parasite of this Egyptian Icerya by Mr. Cotes last year, as recorded in INSECT LIFE, may have on the supposition that India is the original home of this insect, the fact remains that the new Indian Vedalia will be an important insect to import into the affected gardens of Alexandria, Egypt, where *I. ægyptiacum* has been doing so much damage.

Mr. C. H. Tyler Townsend, in the course of a recent journey to Mexico under a commission from this Department, discovered *Vedalia sieboldii* feeding upon *Icerya purchasi*. We have, therefore, a Vedalia at hand in case *I. purchasi* should reappear in dangerous numbers in California and the original stock of *V. cardinalis* die out. We have no knowledge of the life-history of the Mexican species, and it may prove to be a slower breeder than the famous *V. cardinalis*.

DAMAGE BY THE BROWN SAP-CHAFER.

An unusual number of complaints were received during the past season, from correspondents of this Division, of injuries by a common light grayish-brown beetle belonging to the family Scarabæidæ, known as *Euphoria inda* Linn., and generally referred to in works on economic entomology as the Indian Cetonia.

August 31, specimens were received from Pullman, Ill., where the beetle was reported to be feeding on the sap flowing from wounds made by borers in elm and ash trees, also from a correspondent at Hickory Hill, Pa., who wrote that it seemed to be very destructive to green corn, by eating the kernels off the cob. September 1 it was mailed to us from Dr. E. H. Jenkins, vice-director of the Connecticut Agricultural Experiment Station, with the information that the insect was damaging corn extensively at Westport, Conn. September 4 it was received through the editor of the New England Homestead, who reported the insect to be attacking tomatoes at Sterling, Mass. September 18 it was received from Greenwich, Conn., where the insect was found on sap exuding from oak trees. In the last instance, as in the first, our correspondent was laboring under the impression that the beetles had injured the trees, and was of the opinion that the insects, of which he states he had picked off hundreds from five oak trees, "sting" the bark, causing the sap to flow.

In the November number of Gardening (pp. 55–56) two similar cases are mentioned by correspondents in White Plains, N. Y., and Detroit, Mich. The first of these found the insects on a pear tree which was thought to be dying from their attacks. The second stated that the beetles were very destructive to Norway maple, beech, and birch trees

This insect and its kind, as is well known, feed, in their mature condition. on the sap or juices which exude from borer-infested trees and from fruit which is over-ripe or has been injured from any cause, but it is not probable that they often attack healthy fruit or seriously injure trees. Their mouths are formed for sipping or lapping vegetable juices and not for boring or biting. Their active life as adult beetles is short and they are incapable, therefore, of very extensive injuries except when present in great numbers, as in the past year.

The larva of this species is subterranean in habit, and has always been supposed to live like other allied forms on the rootlets of grass and other herbaceous plants. There is practically nothing published concerning its larval habits beyond the fact that it occurs in its various stages in the nests of ants. I have also reared it from larvæ taken at Cold Spring Harbor, L. I., with those of the allied *Allorhina nitida* in manure. The larvæ when found July 9 were encased in spherical cocoons, smaller than those of Allorhina, but very similar in appearance. Unfortunately I was unable to follow up the development of the species. A day or two after the finding of these larvæ I was called away and did not return until the last week of August, when the adults were found still living in their cocoons.

Two or three weeks after the beetles are noticed in August and September they disappear and there can be no doubt that they then enter the earth for hibernation. In the first warm days of spring they reappear, when they may be seen hovering just above the ground along pathways and in our gardens.

Hand-picking appears to be the only remedy for this insect.—F. H. C.

ABUNDANCE OF AN IMPORTED SNOUT-BEETLE IN MAINE.

During September of the present year a correspondent at Bangor, Me., sent to this office a small lot of a European snout beetle, *Sciaphilus asperatus* Bonsd. (*muricatus* Fab.), which has attracted some little attention in that city. Our correspondent informs us that the beetles gather on the fences, and "getting on the top rail just cluster and keeping still seem to enjoy life." They have a singular habit of "piling up on each other in a straight line, many at once and in many small groups." They were not, however, observed to be copulating. This unusual gathering took place during the first of September and was preparatory to hibernation.

The first notice of the occurrence of this insect in North America is by Mr. Samuel Henshaw, published in 1888 in Psyche (vol. v, p. 137). The insect was collected at Brookline, Mass., by Mr. F. C. Bowditch, on *Populus balsamifera*. In the Canadian Entomologist (vol. XXIII, pp. 23, 114, 1891) Mr. W. H. Harrington, reports this species at Sydney, Cape Breton, Nova Scotia. It was found in 1884 and 1890 and was not uncommon. In the National Museum collection there are also specimens from Malden and one other locality in Massachusetts, and Mr. M. L. Linell informs me that he has taken a specimen near Brooklyn, L. I.

It will be noticed that although the species was known to have been introduced at least ten years ago, that it is still limited to districts near the sea shore. Like other allied wingless species that have been introduced from Europe it will probably not extend its range much farther south, but will move gradually westward from the points where it has now established itself. It it a common European species and is known to feed on a great variety of deciduous trees and shrubs, and though it is impossible to forecaste the future it is not probable that it will ever be particularly injurious to cultivated plants in this country.—F. H. C.

DAMAGE TO CLOVER IN MICHIGAN.

Two of the most important insect enemies of the clover plant, both importations from Europe, have reached the State of Michigan on their westward march from the Atlantic coast, and during the past two seasons have done a great deal of damage. These are the clover-leaf weevil, *Phytonomus punctatus*, and the clover root-borer, *Hylastinus obscurus* Marsh. From an article in the Michigan Farmer for September 8, 1894, we learn that during the past two years the combination of the attacks of these two insects with the protracted drought has resulted in the most general failure of the clover crop in Michigan that has ever been known.

A NEW COTTON INSECT IN TEXAS.

We have recently received from San Diego County, Tex., specimens of cotton bolls damaged by *Anthonomus grandis* Boh. This insect was sent to Prof. Riley more than ten years ago by Dr. Edward Palmer (see Annual Report Department of Agriculture, 1885, p. 279), who found it feeding in dwarf cotton bolls in northern Mexico, but it has never been reported with certainty from the United States until the present summer. Dr. W. G. Dietz, in his revision of the Anthonomini (Tr. Am. Ent. Soc., vol. XVIII, p. 205), has, indeed, reported the species from Texas on the basis of a specimen in Mr. Schwarz's collection bearing a Texas label, but Mr. Schwarz informs us that he has recently learned that the specimen referred to was from Mexico and came indirectly from the same source as did Prof. Riley's specimens. The larva lives within the bolls and is full grown before the end of September. The bolls which were sent in October contained adult larvæ, pupæ, and full-grown insects as well. The life-history of the insect is not fully known, and we can not at the present time suggest any competent remedy. It will possibly prove a very important enemy to the cotton crop in the southwest. A more detailed account will be published in the next number of INSECT LIFE.

THE PEAR MIDGE IN ENGLAND.

Rev. E. N. Bloomfield, of Hastings, England, in a note in the July, 1894, number of Science-Gossip, states that the pear midge (*Diplosis pyrivora*) has been very destructive in his garden the present spring, spoiling almost the whole produce of some of his pear trees. Mr. Bloomfield is familiar with Prof. Riley's first account of this important pear enemy, published in the Annual Report of this Department for 1885, pp. 283–289, but is evidently not acquainted with the results of Prof. J. B. Smith's important experiments with remedies against this insect. Prof. Smith finds that a heavy top dressing with kainit destroys the pear midge while it is pupating beneath the surface of the ground.

DESTRUCTIVE GRASSHOPPERS IN NEW YORK.

The long-continued drought of the past summer, particularly in the Northeastern States, has been very favorable to the uninterrupted development of swarms of the local or nonmigratory species of grasshoppers, especially of *Caloptenus femur-rubrum*, the common red-legged locust or grasshopper, and *C. bivittatus*, the two-striped locust. New York papers have contained many items, for the most part somewhat exaggerated, of the condition of affairs, but indicating by their number that a very considerable amount of damage has been done to growing crops. In the western portion of the State, in Genesee and Wyoming counties, and in the south-central portion, they have injured oats and buckwheat, after damaging the hay crop to some extent. Garden vegetables have also suffered somewhat. In the northern portion of the State the damage has been almost equally great, while along the Hudson Valley both the species above mentioned have been exceptionally abundant. During late September in Greene County, among the Catskills, the red-legged species was more abundant than we have ever seen it before—so much so, in fact, that the insects would fly up in perfect clouds before one walking through the fields.

No systematic remedial work was undertaken, and it is doubtful whether either of these insects will be more abundant than usual next season. We have noticed a newspaper statement that a farmer residing near Perry adopted the driving method with some little success. He hired several men, armed them with branches of trees, and took a trip across his bean field, driving the grasshoppers into his neighbor's field of grain. This enterprising individual saved his bean crop, but we understand he and his neighbor are no longer upon speaking terms.

A correspondent in Sullivan County, writing under date of October 9, states that much damage was done to grass, oats, and gardens. Some farmers were obliged to plow their oats under and pasture, and those who cut their hay late suffered quite a serious loss. Heads of timothy grass were completely stripped, nothing but the bare stalk being left. After the grass was gone the insects attacked the tall weeds in the hedge rows.

THE WESTERN CRICKET IN UTAH IN THE FORTIES.

Perhaps the earliest instance of damage to cultivated crops by the western cricket (*Anabrus simplex* Hald.) is that reported by the Hon. George Q. Cannon in a recent speech as temporary chairman of the third irrigation congress (Irrigation Age, 1894, p. 188). This account is also interesting from the complete destruction of the cricket in this instance by gulls. In describing the agricultural conditions in Utah in 1848, Mr. Cannon states that the "black crickets came down by millions and destroyed our grain crops; promising fields of wheat in the morning were by evening as smooth as a man's hand—devoured by the crickets." At this juncture, he says, "Sea gulls came by hundreds and thousands, and before the crops were entirely destroyed these gulls devoured the insects so that our fields were entirely freed from them." * * * "I have been along the ditches in the morning," he adds, "and have seen lumps of these crickets vomited up by the gulls so that they could begin killing them again."

The cricket here referred to will be remembered as the one that frequently travels in enormous hordes in the West, stopping at no obstacle, river or other, and is the one also, on the authority of Thomas, eaten by the Indians, either roasted or simply after the head and limbs have been removed. A recent account of damage by it is given in INSECT LIFE (vol. VI, p. 17).*

On the authority of Dr. A. K. Fisher, of this Department, the bird referred to above is undoubtedly Franklin's gull, (*Larus franklini*) which occurs in enormous flocks about the small fresh-water lakes of the Northwest, and feeds in great companies on Orthoptera of all sorts.

Mr. Vernon Bailey, in the Annual Report of the Ornithologist for 1887, describes the feeding of large flocks on grasshoppers in Dakota, near Devils Lake, and Dr. Fisher says that this habit is frequently observed throughout the grasshopper and cricket regions. In this the gulls are assisted by certain hawks, the work of the latter being noted also by Mr. Thomas in the report of his western journey of 1871. A flock of 500 Swainson's hawk (*Buteo swainsoni*) which is probably the species seen by Thomas and others, was observed feeding on Anabrus in Colorado by Mr. A. S. Bennett, and the stomach of one of the hawks shot at the time contained six of the insects.†—C. L. M.

AN IMPORTANT SCALE INSECT ON COTTONWOOD.

Mr. W. S. Connor, of East Atchison, Mo., has sent us a large and striking scale insect upon young cottonwood trees which is seriously damaging a very considerable plantation in his vicinity. The insect belongs to the genus Prosopophora and is a new species. It is, as before stated, very large and conspicuous, and clusters upon the trunks of

*See also U. S. E. C., vol. II, p. 163; Ibid., vol. III, p. 61.

†Hawks and Owls of the United States, Fisher, p. 77.

young trees in extraordinary numbers. The result is that many trees two inches or less in diameter, planted in 1893, are dead this season. The strip of affected timber is about one and one-half miles long and skirts the bank of the Missouri River. Fortunately many of the specimens received were pierced with the exit holes of some hymenopterous parasite. This adds another to the already large list of insects affecting young trees on tree claims in the West.

THE SPIDER WHICH BITES.

The spider mentioned in the stories told by Dr. E. R. Corson, in his lengthy letter published in INSECT LIFE (vol. I, p. 280–2), has never been determined. We hazarded the guess that the privy-inhabiting species might have belonged to either of the genera Amaurobius or Cælotes, or possibly to Tegenaria, Pholcus, or Dictyna. The well-known habits of *Latrodectus mactans*, however, seemed to indicate that it could not be the species the bite of which brought about such serious results in the cases mentioned by Dr. Corson. We have recently received a letter, however, from Mr. Frank M. Jones, of Wilmington, Del., with which he transmitted specimens of a spider which he captured in an irregularly spun web a few inches below the level of the seat in a privy at Milledgeville, Baldwin County, Ga. This insect proved to be *Latrodectus mactans*, and, in view of this direct evidence, it seems likely that in some at least of the cases described by Dr. Corson this species was concerned.

PSEUDOPARASITIC HAIRS OF TACHINIDS.

M. A. Giard, at a meeting of the Société Entomologique de France of April 25, presented a short communication on the subject above mentioned. He said that at the previous meeting he had exhibited a Tachina fly (*Exorista excavata*) which carried certain bizarre appendages, the nature of which was problematical. Later examination, however, indicated that they were hairs of a bombycid caterpillar, probably of the genus Chelonia. He shows that Girschner had mistaken similar objects for specialized macrochetæ, while Mik had recognized in another case the hairs of *Chelonia villica*. This reminds us that upon one occasion we gave a small hymenopterous insect to an artist to figure, and when the preliminary sketch was completed we were surprised to find two very curious barbed hairs represented as proceeding symmetrically from the hind femora. We examined the specimen and found that the artist had depicted what was really present, but the peculiar hairs were undoubtedly those of a dermestid larva and formed no part of the insect itself.

CICADA CHIMNEYS.

We had the pleasure in August of listening to a paper read by Dr. J. A. Lintner before Section F of the American Association for the Advancement of Science, on the subject of the remarkable structures which are built by the pupa of the periodical cicada above ground shortly before the adults issue. Dr. Lintner brought together the facts concerning a large number of observations made the present year, and showed that the earlier supposition of Riley and others, that these chimneys are built only in wet ground, is unjustified, and showed further that the orifice at the bottom of the chimneys and next to the surface of the ground, as figured by Riley, is at least abnormal. Dr. Lintner was, however, unable to give a satisfactory explanation of the cause of this chimney-building.

Mr. Benjamin Lander, in the Scientific American for October 13, publishes a lengthy communication on the same subject, accompanying it with very good illustrations of the chimneys, both entire and in section, and offering an explanation which is new. His observations lead him to believe that these chimneys are built only where the soil is very thin and covers a rock ledge. He showed further that the month of April was phenomenally hot, and he concludes that the pupæ in the shallow earth, covering the smooth, unbroken, impervious rock, would be early stirred to activity by the unwonted heat, and would build their burrows to the surface in advance of those in deeper and cooler ground, obeying the same impulse that the latter would feel when the warmth of the more advanced season should reach their more remote abiding places. Especially would this be the case where the woods had been recently burned over, as was the case with several chimney localities which Mr. Lander observed. The closed extensions to the short burrows Mr. Lander therefore supposes to be built as a protection from premature heat and possibly to shut out injurious intruders during the accidentally lengthened period which they would have to wait for full development.

This strikes us as an ingenious theory, and likely to be to a certain extent correct, provided no exceptions to the rule of shallow soil be found. Our own experience with these chimneys is, however, too limited to justify criticism. A well-known entomologist recently suggested to us in conversation the idea that inasmuch as the chimneys are most frequently built upon ground which is comparatively free from trees and shrubs, they are constructed to provide the pupa with an eminence upon which to crawl and to which to attach itself while shedding its skin and unfolding its wings. That it seems necessary for the insect to crawl upon a tree, a shrub, a fence, or something of that sort to perform this operation is well known, and this theory, too, is therefore very plausible, provided it be found that the chimneys are confined to comparatively open places. If we remember correctly, however, one of Dr. Lintner's photographs showed the chimneys to be very abundant in a patch of comparatively dense undergrowth, and we have also seen them in a grove of large trees.

BIRD-LICE AS MUTUALISTS.

Mr. James Weir, jr., in The American Naturalist for August, 1894, advances the opinion that the true bird-lice are true mutualists. He considers most of them absolutely necessary to the health and well-being of their hosts, and their absence to be an indication of disease in some form or other in those animals on whose bodies they are not to be found. Observation has showed him that the lice immediately abandon the bodies of fowls which are the victims of cholera and kindred diseases. Their office seems to be to remove the exfoliated epithelium and to prey upon all of the waste products of the skin, as well as to freshen and beautify the feathers.

OCCURRENCE OF THE PEAR-LEAF BLISTER-MITE UPON THE PACIFIC COAST.

We learn from the recent California newspapers that the pear-leaf blister-mite (*Phytoptus pyri*) was discovered in California in July by Mr. Alexander Craw; that it has recently made its appearance in several localities in Oregon, and that it has also been found in Idaho. This is one of the injurious species which is very readily transmitted to new localities on nursery stock, since, as has been shown by recent investigators, it leaves the leaves and hibernates in the axils of the twigs and under the bud scales. The time will come, in our opinion, when fruit-growers will buy nursery stock only from those nurserymen who make a practice of thoroughly fumigating all stock before shipment.

THE OLD GENUS TARANTULA.

After devious wanderings through the class Arachnida, Fabricius' genus Tarantula, long familiar to laymen as applied indiscriminately to certain large hairy spiders of the family Teraphosidæ, has at last been saddled by Mr. R. I. Pocock upon certain forms belonging to the Pedipalpi which have generally been referred to the family Phrynidæ, a tropical group allied to the so-called whip-tailed scorpions. The family name Tarantulidæ is made by Mr. Pocock coextensive with the old family Phrynidæ. The type species, *Tarantula reniformis* (Linn.) he considers to be synonymical with Blanchard's *Phrynus pallasii*. Where will these researches based upon the law of priority lead us next?

SYNONYMY CORRECTED.

On page 372 of the preceding volume of INSECT LIFE, by a clerical or typographical error, the anthomyiid described by Dr. Fitch as *Hylemyia deceptiva* is made a synonym of the previously described *Phorbia fuscipes* Zett. This latter name should have been *P. fusciceps* Zett. The error is the more unfortunate owing to the fact that Zetterstedt described an anthomyiid under the name of *Anthomyza fuscipes*, but this is a very different species from Fitch's.

NOTES FROM CORRESPONDENCE.

Maggots in poor butter.—Dr. E. G. Love, of New York City, has sent us specimens of maggots found in poor butter. These maggots seem to belong to the genus Drosophila, but can not be determined specifically.

New Habitats for the Florida Red Scale and White Fly.—We have received from Mr. F. W. Mally, Dickinson, Tex., leaves of a lemon tree affected by the Florida red scale (*Aspidiotus ficus* Ashm.) and of the white fly (*Aleyrodes citri* R. & H.). Neither of these insects has previously been recorded west of Louisiana. The probabilities are that both were introduced from Florida into Louisiana during the New Orleans Cotton Exposition of 1885. The original home of the former insect is the West Indies or South America, while that of the latter is not known.

Northward Range of the Wheel Bug.—In reply to our inquiry in a previous number of INSECT LIFE, Mr. Thomas K. Parker, of Providence, R. I., writes us that in past summers he has noticed the wheel bug (*Prionidus cristatus*) in the vicinity of Providence. He has seen both the insects and their eggs upon board fences.

The Potato Scab-gnat in Missouri.—Dr. R. M. Higgins, of Webster Groves, Mo., has sent us specimens of potatoes affected by Mr. Hopkins' new *Epidapus scabies*, producing a similar form of scab to that described in volume VI of INSECT LIFE (p. 349) and in the last volume (p. 147).

Oklahoma Food of the Harlequin Cabbage-bug.—Dr. J. C. Neal, director of the Oklahoma Agricultural Experiment Station, writes us that the alkali mustard (*Cleomella angustifolia* Torr.) is one of the food plants of the harlequin cabbage-bug which is slowly spreading over Oklahoma Territory. The Cleomella, according to Dr. Neal, grows from choice over thousands of acres of alkali flats and gives an early start to the cabbage-bug.

The Apple Maggot in North Carolina.—In an apple received by the Pomologist from Mr. George E. Boggs, of Waynesville, N. C., we found larvæ of *Trypeta pomonella*, the well known apple-maggot fly of the Northern States. We place the fact on record, as from our information the locality is new.

Abundance of Army Worm Moths.—In view of the fact that 1894 has been an Army Worm year in Virginia and Maryland, it is interesting to note that Mr. Frank M. Jones, of Wilmington, Del., in the course of his collecting at electric lights in that city, out of a total of 9,500 specimens found that 8,000 were army worm moths.

The Sugar-cane Weevil in the Fiji Islands.—Mr. Albert Koebele informs us that the Colonial Sugar Company of the Fiji Islands has been trapping the sugar-cane weevil (*Sphenophorus obscurus*) in large numbers with pieces of split cane. In this way no less than eleven and a half millions of the beetles have been collected with the practical results that while two years ago 32 per cent of the cane was infested the present season only 7 per cent was infested.

Inoculation against Insect Stings.—Mr. Herbert H. Smith writes us that in his experience particular parts of the body may become temporarily inoculated against insect stings. He used to catch small wasps in his net with his fingers. The fore-finger of the left hand was stung so often that it lost all susceptibility even to severe stings, and it remained so for two or three years. It is now, however, as susceptible as ever.

The Ceylonese Spider Parasite.—In our first note on the external parasites of spiders, in INSECT LIFE (vol. I p. 42), we mentioned the illustrated article by Mr. E. Ernest Green, of Punduloya, Ceylon, in Hardwicke's Science Gossip, for July, 1888. Only recently Mr. Green has had the kindness to send us specimens of the spider and of the parasite itself, and it is interesting to note that the parasite proves to belong to the genus Zatypota, to which at least one of our American external spider parasites also belongs. The spider itself is a handsome little species with a triangular abdomen, which Dr. Marx tells us belongs to Cambridge's genus Chrisso.

Some Rearings of Parasites.—Prof. H. A. Morgan, Entomologist to the Louisiana Experiment Station, at Baton Rouge, La., sends us certain parasites, which he has reared, as follows: *Telenomus graptæ* How., from the eggs, and *Cratotechus brevicapitatus* C. & D., from the caterpillar of *Sierodonta bilineata; Tetrastichus* sp., from spider's nest; *Chalcis ovata* Say, from bagworm on flowering pomegranate, and from chrysalis of Argynnis on passion flower; *Elaschistus* sp., from *Apatura clyton*; *Ennyomma clistoides* Town., and *Sigalphus* sp., from *Chalcodermus æneus*; *Sarcophaga* sp., from an adult scarabæid; and *Chelonus electus* Cr., from lepidopterous larvæ.

Another Swarm of Ants.—Mr. F. F. Fiske, of Mast Yard, N. H., writes us that last September, when forest fires were greatly feared, a quantity of smoke was seen rising above a group of pines. Instant investigation was made, when it was found to be a false alarm and the smoke was an immense swarm of winged ants. This note was sent us apropos to the interesting note by Mr. A. H. Mackay, of Halifax, N. S., published upon page 52 of the current volume of INSECT LIFE.

Horn Fly on Horses again.—Mr. L. F. Abbott, of the Lewiston Journal, Lewiston, Me., writes us that he has found the horn fly annoying horses at South Harper, Me., both in 1893 and 1894. The flies have been abundant near Lewiston from early in May to the last week in October of the present year. The remedy adopted is half a pint of pine tar to a quart of fish oil smeared upon the neck, shoulders, and along the back of the animals.

The Barnacle Scale in Louisiana.—The well-known Florida barnacle scale (*Ceroplastes cirripediformis*), which occurs rarely upon orange and lemon trees in Florida, but more commonly, perhaps, upon Eupatorium and quince, has, as we learn from Prof. H. A. Morgan, become extremely abundant in Louisiana (we assume in Baton Rouge). Prof. Morgan writes that it has simply ruined the China-ball trees, which on some of the streets are largely used for shade. To such an extent has this insect appeared that the city authorities are taking the matter of its extermination into consideration.

The Hen Flea on Horses.—Prof. J. C. Hartzell, jr., has sent us specimens of *Sarcopsylla gallinacea*, which he took on horses in the region of Orangeburg, S. C. He is of the opinion that the occurrence is not accidental nor due to the proximity of chicken houses to horse stables, since for the past six months it has occurred upon horses which have been shipped by the carload to Orangeburg from various points.

More Damage by Brochymena annulata.—Apropos to damage to apple trees in Virginia by *Brochymena annulata*, referred to in the first number of this volume (p. 47), Prof. F. M. Webster writes us that this insect injured both apple and plum trees in southern Ohio last spring.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

Vol. VII. No. 4.

INSECT LIFE.

DEVOTED TO THE ECONOMY AND LIFE-HABITS OF INSECTS, ESPECIALLY IN THEIR RELATIONS TO AGRICULTURE.

EDITED BY

L. O. HOWARD, Entomologist,

WITH THE ASSISTANCE OF OTHER MEMBERS OF THE DIVISIONAL FORCE.

(PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.)

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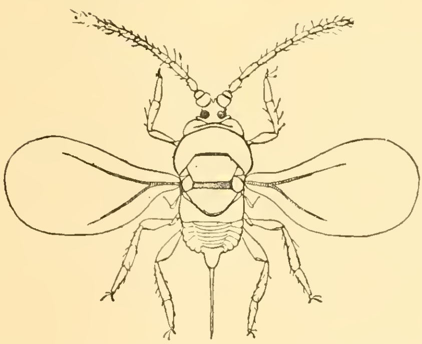

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CONTENTS.

SPECIAL NOTES.

The New Cotton-boll Weevil.—Under the heading "A New Cotton Insect in Texas" we mentioned in the last number of INSECT LIFE the introduction of *Anthonomus grandis* from Mexico into Texas cotton fields, and promised a more detailed account of the insect in this number. The matter seems so important that Mr. C. H. Tyler Townsend has been employed as a special agent, and in December was sent on a preliminary investigating tour through the infested region. He will remain at Brownsville, Tex., during the remaining months of the fiscal year engaged in following out the complete life history of the species. Mr. Townsend has submitted a preliminary report, which we publish in this number, and which will afford a good basis for future investigations, and will at the same time inform cotton planters thoroughly of what is known down to the present time. The Honorable Assistant Secretary of Agriculture has notified the governor of Texas of the serious nature of the outlook, and has urged the importance of immediate legislation which will provide for quarantining and the enforcement of remedial work.

Florida Insects and the December Freeze.—Press dispatches of December 30 and 31, in referring to the great damage done to the orange and other crops in Florida by the extraordinarily low temperature of December 29, stated incidentally that the freeze also caused great mortality among injurious insects. Mr. H. G. Hubbard, of this office, went to Florida the last week in December, and has written us that the newspaper reports were not exaggerated. During the first week in January he made observations upon the effect of the cold upon injurious insects. Gardens and fruit were all frozen, and the orange trees were seriously injured, but not all killed. Green leaves and tender vegetation were frozen so suddenly and completely that in many cases they dried up without changing color. The orange trees changed from green to brown. Unnumbered millions of insects were killed by the cold. All the cockroaches in sight were destroyed, even those in houses, and only those will survive which happen to have been exceptionally well sheltered. All young scale insects which have not passed the second molt are killed. Plenty of eggs, however, survive, and some adults of both sexes. Sometimes half of the eggs under a scale are killed. Nitidulid beetles in decaying fruit were all killed. In the flowers of Aulocasia and Brugmansia multitudes of small gnats were frozen. Not a living colony of plant-lice upon orange or other trees could be found.

But the insect which seems to have been most effectually damaged is the white fly, *Aleyrodes citri*. Mr. Hubbard could not find a living specimen, up to the date of writing. They were killed wholesale, and there were plenty of them in all stages upon the younger leaves of citrus plants. As the eggs are laid upon the leaves normally, and every leaf will drop long before the new growth appears, it seems that the cold wave may have seriously checked this pest. The only conditions under which it will have survived will be in the case of eggs which may have been accidentally laid upon the bark. Mr. Hubbard has, however, been unable to find any. Mr. Schwarz observed in August at Baton Rouge, La., that *Aleyrodes citri* occurs upon the Cape jasmine, but not on the few orange trees grown at that point and later observations by Mr. Hubbard show that there has been a survival of the white fly upon the former plant. He is therefore urging Florida orange growers to cut down and burn their Cape jasmines.

It is unfortunate that this condition could not have been produced without the corresponding damage to vegetation. As it is, however, the severe shock which the trees have received will put them more than ever at the mercy of injurious insects. An important point is suggested by Mr. Hubbard, namely, that as the breeding of nearly all the injurious insects of the orange has been completely suspended, for some weeks at least, there will be an excellent opportunity, with the advent of warm weather and the revival of vegetation, to completely clear the trees of scale and some other pests, with the aid of comparatively mild insecticides. Orange growers will naturally be timid about applying any wash to their trees while they are in the critical period of recovery from such a severe shock. Experiments will, however, be conducted at the earliest opportunity to ascertain the effect of applications under these conditions.

Bulletin 33, Division of Entomology.—Bulletin 33 of this Division, which has just been issued in small edition, is a compilation of the laws which have been adopted in the United States and British Columbia against injurious insects. It also includes the laws of New York and Utah against foul brood in bees. The publication of this bulletin at this time has been thought desirable because of the prominence which the question of legislation against insects is assuming, and because many horticultural societies will desire to draw up bills for the consideration of State legislatures.

FURTHER NOTES ON THE SAN JOSE SCALE.

By L. O. Howard.

In a paper read before the Association of Economic Entomologists last August, and published in the current volume of Insect Life (pp. 153–163), the writer showed that the extensive distribution of Circular No. 3, of this Division, announcing the appearance of the San Jose or pernicious scale in the East had resulted in the ascertaining of the fact that the scale had already made its appearance in Neavitt, Talbot County, Md.; Chestertown, Kent County, Md.; Bartle, Washington County, Ind.; many points in New Jersey; Atglen, Chester County, Pa.; Lewisburg, Union County, Pa.; as well as in Walton County, Fla., Charles County, Md., and in the vicinity of Charlottesville, Va., these last three localities having been mentioned in the circular. It was further noted that the scale had also made its appearance in Idaho and British Columbia.

This paper was prepared about the first of August, and at that time, from the energy with which owners of infested orchards were taking hold of the matter of remedies, and from the apparently efficacious results of two or three summer sprayings with kerosene emulsion in certain cases, the writer, after having examined the ground thoroughly, was inclined to the opinion that the insect would be speedily reduced to comparative harmlessness in all of the localities in which it was then found. From the inconspicuousness of the insect (except upon fruit), when occurring in reasonably small numbers, I was tolerably certain, however, that we had by no means ascertained all of the eastern localities in which the insect would be found—the more particularly as we had been informed by Professor Smith that two large New Jersey nurseries, to which we had traced nearly all of the eastern occurrences, had, for certainly five or six years, been sending out infested stock broadcast. This supposition has been abundantly justified by the finding of the scale in very large numbers in several localities not recorded in August; and late fall observations upon trees sprayed during the summer have indicated the comparative futility of the application of washes during the summer. Moreover, extensive winter work has shown that the winter washes which are reported to be so effective in California and the other Pacific States are much less effective in the East, a fact which is probably due to the much colder climate and a more complete dormancy on the part of the insect. Absolute extermination is therefore not to be expected. The San Jose scale has come to stay, and must be added to the long list of orchard insects which the Eastern horticulturist must always watch and fight.

ADDITIONAL LOCALITIES.

At the meeting of the Association of Economic Entomologists in Brooklyn, in August, it developed in discussion that the insect had been reported in New York papers from Columbia County, N. Y., in the excellent fruit-growing region lying on the east bank of the Hudson River below Albany. This occurrence has since been investigated by Dr. J. A. Lintner, State Entomologist of New York, and the proprietors of the infested trees are reported to be fully alive to the importance of remedial work and as being ready to adopt strenuous measures to hold the scale in check. Almost immediately after the adjournment of the Association, Messrs. F. A. Sirrine and Victor H. Lowe, entomologists in the employ of the Geneva (New York) Agricultural Experiment Station, stationed at Jamaica, L. I., who had been in attendance at the meeting, and had listened to the papers on this insect read by the writer and Prof. John B. Smith, found the insect in several localities on Long Island. They have carefully investigated the matter of the introduction of the scale into Long Island orchards, without, however, arriving at satisfactory conclusions, and have instigated remedial work.

It is reported, however, that certain of the Long Island nurserymen have refused to apply remedies, and in consequence a bill has been drafted, and will be presented to the New York legislature at its present session, which will admit of the enforcement of work with remedies. The proposed bill follows:

An Act to provide for the extermination of the San Jose scale in the State of New York.

The people of the State of New York, represented in senate and assembly, do enact as follows:

SECTION 1. Whenever the State entomologist may have knowledge of the existence of the San Jose scale, or has reason to believe in the probability of its existence, in any locality within the State of New York on any trees, plants, vines, or fruit, he shall notify the Commissioner of Agriculture, who shall thereupon appoint one or more experts who shall be sufficiently familiar with the scale to be able to recognize it, for the prompt inspection of the infested or suspected locality.

SEC. 2. Such agent shall make thorough inspection of the locality named, and if the existence of the scale is found therein, he shall notify the owner or owners of the orchard, nursery, or ground in which the insect is found, of its existence therein, and serve a notice containing a statement of all the facts found to exist, upon the owner or owners, with an order that within thirty days they shall take such measures as have been proven to be effectual in the destruction of the scale before its further distribution, and to continue them until its extermination has been effected.

SEC. 3. If the owner or owners shall refuse to comply with the order of the agent, as above stated, the agent shall be charged with its execution, and for this purpose, shall employ all necessary assistance; and such agent or his employees may enter upon any and all premises within the town or city for the purpose of the speedy extermination of the scale. Such agent shall be entitled to such compensation for his services under this section at the rate of $2 for each full day spent by him in the discharge of his duties, and the necessary disbursements paid or incurred by him thereon, which shall be a county charge.

SEC. 4. Any and all of such sums so paid shall be and become a lien on the property and premises from which the scale has been abated or destroyed in pursuance of this act, and may be recovered by an action against such property and premises, which action to foreclose all such liens shall be in the proper court, in the name and for the benefit of the county making such payment or payments; and when the property is sold, enough of the proceeds shall be paid into the county treasury of such county to satisfy the lien and costs, and an attorney fee in such foreclosures of ——— dollars, and the surplus if any there be, shall be paid to the owner or owners of the property.

SEC. 5. This act shall take effect immediately.

Later in the fall the scale was found to be abundant at three new localities in Maryland: one in Prince George County, one in Anne Arundel County, and one in Washington County.

Still later, specimens were received from extreme south Georgia, and the sender claims to have received them originally from a Maryland nursery. This claim has been partially substantiated by investigation. The sender of the Georgia specimens further expresses the opinion that the insect has been extensively introduced throughout south Georgia, although but a single locality has been definitely established.

In December we received information from Prof. F. M. Webster, Entomologist of the Ohio State Agricultural Experiment Station, that he had received the San Jose scale from a correspondent in the midst of a large orchard district in southern Ohio (Clermont County). About fifty trees in the middle of an orchard of six hundred trees, were reported by Mr. Webster to be thoroughly plastered with the scale, and about as many more were more or less affected. These trees were received from one of the original New Jersey nurseries. Mr. Webster reported the owners as being thoroughly aroused, and anxious to do everything possible to stamp out the pest.

About the middle of January of the present year the scale was received from Newcastle County, Del. The trees affected were few in number and were young Lawson pears, received from New Jersey in April, 1893, and planted in a small block separated from an older orchard by a private roadway. As soon as the scale was discovered by the owner the trees of the entire block, including some replants of 1894, which seemed to be perfectly free from scales, were cut off even with the ground and burned. The owner examined the adjoining trees very thoroughly and found no scales on them, but to satisfy himself of their freedom from infestation he requested an examination by some-one from this office. Mr. Marlatt accordingly visited the orchard, gave the trees adjoining the infested block a most thorough examination, and was unable to find upon them any San Jose scales whatever. The entire orchard was in a most excellent condition, and showed a vigor of growth, a healthful appearance, and a care in management which are seldom seen. The prompt action taken in this case, if followed by all who have infested stock, would materially aid in the ultimate extermination of the scale in the East.

A little later specimens were received from Jefferson County, Ind., but here the owner of the affected orchard thinks he has exterminated the scale by burning all infested trees.

Another new locality which has been given us by Prof. W. B. Alwood, is City Point, Prince George's County, Va. We have not seen specimens from this locality, but Professor Alwood's determination must be considered authoritative.

The last new locality is Bristol, Pa. At this point the scale was introduced upon a dozen Japan plum trees purchased three years ago from a New Jersey nurseryman. It has spread to a short row of pears on the one side and to a row of plums on the other—perhaps thirty trees in all. The owner has washed with whale-oil soap and kerosene emulsion, but has been advised, in view of the small number of trees affected, to cut them all down and burn them.

WORK WHICH HAS BEEN DONE IN THE OLDER LOCALITIES.

We have already reported the apparent success of the thorough treatment with hydrocyanic acid gas, which was given to the orchard of Dr. C. H. Hedges, at Charlottesville, Va., in March last, under the immediate and skilled supervision of Mr. D. W. Coquillett. The operation was as thorough as it could be made. That a few of the insects survived the treatment, however, was shown by the receipt of living specimens late in the fall from Dr. Hedges. The State Board of Agriculture is informed concerning this condition of affairs, and we learn from Hon. Thomas Whitehead, Commissioner of Agriculture, that the Board has made an appropriation for the purpose of conducting a final campaign, which will be instituted before spring. Moreover, the entomologist of the State Agricultural Station, Prof. W. B. Alwood, is greatly interested in the matter, and is giving it his earnest attention.

At the old locality in Kent county, Md., it is most fortunate for the neighboring fruit-growers that the owner of the infested orchard is an exceptionally able and energetic man, as well as a man of means. He has, unaided, applied a rather expensive but effective whale-oil soap winter wash to every suspected tree, and expresses himself as willing to wash the whole orchard once more if, upon expert examination, it is found that any scales remain alive.

In late October we visited personally the infested locality in Union county, Pa., and found the scale restricted to a very small orchard of comparatively young trees, with no other orchards within several miles. The owner is Dr. Geo. G. Groff, of Bucknell College, who is not only willing but anxious to exterminate the insect, at no matter how great trouble and expense. He has been washing his trees with undiluted kerosene emulsion.

The Florida outbreak, it will be remembered, was a very extensive and dangerous one. The Director of the State Experiment Station, Prof. O. Clute, has taken a lively interest in the matter, and inasmuch as the affected locality is near the headquarters of an active fruit-growers' association, remedial work is in proper train. Dividing the expense between the station and fruit-growers, California washes have been applied with care and thoroughness, and at last reports a determination existed to repeat the application as often as might be necessary before spring.

LIFE-HISTORY OF THE INSECT.

Although this insect has been known in California for about twenty years, its life-history has not been carefully worked out by California writers. Professor Comstock described simply the male and female scales, and the body of the adult female. The male was unknown to him. In his work on the Injurious Insects of the Orchard, Vineyard, etc., published at Sacramento in 1883, Mr. Matthew Cooke briefly described the male insect and published a crude figure of it. He further stated that the species produces three broods in California, the first "about the time the cherries begin to color, the second in July, and the third in October." The statement is made by Comstock that the eggs are white, and Cooke further says that "each female produces from 35 to 50 eggs."

Upon the appearance of the insect in the East, potted pear trees were secured for the Insectary of this Division, and colonies of the scale were established on them. Their life-history has been followed with more or less care throughout the season, and the following brief statement of the life-cycle of the insect is based upon daily observations made during the summer by Mr. Pergande.

It had already been ascertained during the late summer and fall of 1893 that the insect is viviparous, that is, gives birth to living young, and that it does not lay eggs. We were unable to reconcile this condition of affairs with the statements just quoted from Comstock and Cooke, but it occurred to us that, as with certain of the plant-lice, there might be winter eggs, with viviparous females in summer. When winter came on, however, it was found that the insect hibernated in the nearly full-grown female condition, and that these females, about the middle of May, began to give birth to living young as their ancestors did the previous fall. In no instance, therefore, have we observed the egg (unless the young still in the body of the female and enveloped in the embryonic membrane may be so called). Over-wintered females continued to give birth to living young day after day for six weeks. This condition of affairs produces, early in the season, a confusion of generations, which makes observations upon the life-history of the insect extremely difficult, and only to be accomplished by isolation of individuals. It also seriously complicates the matter of remedies, since, as numbers of the larvæ are hatching every day, and as they begin to form their almost impervious scales in two or three days, a spraying operation at any given time will destroy only those larvæ which happen to be at that time less than three days old, while on the day after the spraying new larvæ will be born to take the place of those just killed.

Observations upon isolated individuals show that the newly-hatched larvæ, after crawling about for a few hours, settle down and commence at once to form a scale. The secretion is white and fibrous. In two days the insect becomes invisible, being covered by a pale, grayish-yellow shield, with a projecting nipple at the center. This nipple is at first white in color. Twelve days after hatching the first skin is cast. The males at this time are rather larger than the females, and have large purple eyes, while the females have lost their eyes entirely. The legs and antennæ have disappeared in both cases. Six days later the males begin to change to pupa, while the females have not yet cast the second skin. At this time the females are so tightly cemented to the scale that they can not be removed without crushing. In two or three days more, or twenty to twenty-one days after hatching, the females cast their second skin, which splits around the margin of the body. At 24 days the males begin to issue, emerging from their scales, as a general thing, at night. At 30 days the females are about full-grown, and embryonic young can be seen within their bodies; and at from 33 to 40 days the larvæ begin to make their appearance.

These observations were made upon young which were born of over-wintered mothers late in June, but it must be remembered that similar larvæ had been hatching since the middle of May. The period of 38 to 40 days may be accepted as the length of time occupied by a single generation; but, while this particular generation came out in the insectary about the first of August, the adults of the second generation from the earliest-born individuals would have made their appearance toward the end of June. Full-grown females which began to give birth to the second generation of young on August 1 were kept in view. Three weeks later they were seen still to contain numerous embryos. Young larvæ were running about, while others of the same generation were in all stages of development. The male scales were fully formed, and some contained mature pupæ. The small trees upon which these insects were colonized the third week in June were almost completely covered with the scale. The larvæ evidently made no effort to crawl away from the tree, and none, in fact, reached the rim of the flower-pot. The greatest distance away from the tree at which larvæ were noticed was about two inches. Up to this time the insects had confined themselves almost entirely to the branches, and the leaves were still quite free. The first males of the second generation were noticed on August 27. By September 7, or five weeks and a half after the adult females of the first brood began to give birth to young, some of them were still living and giving birth to occasional young. The majority of them, however, were dead, or nearly exhausted, while their first larvæ were almost ready to reproduce. Five days later a few of them were still giving birth to an occasional young, while their early offspring were also rapidly reproducing.

At the rate of development observed, between May 15 and October 15, four generations from the over-wintered females developed. The larvæ continued to issue until after the first frost in October at Washington, and on October 24, at Lewisburg, Pa., the writer saw recently-settled larvæ of not more than five days of age.

There seem, then, to be five generations in the latitude of Washington. Owing to the method of reproduction these generations immediately become inextricably confused, and the insect after the middle of June may be found at any time in almost any condition. The females which over-winter have, in the great majority of cases, reached a sufficient degree of maturity to have become impregnated by late-issuing males. It seems probable that the male rarely hibernates in any stage, although we received on April 3 from Charlottesville, Va., twigs which carried a few male scales containing males in the pupa state. These probably hibernated as full-grown male larvæ. Whether unfertilized females over-winter we are not certain; if they do, these occasional over-wintering males will fertilize them.

The San Jose scale differs from all others in the peculiar reddening effect which it produces upon the skin of the fruit and of tender twigs. This very characteristic feature of the insect's work renders it easy to distinguish. Around the margin of each female scale is a circular band of this reddish discoloration, and the cambium layer of a young twig where the scales are massed together frequently becomes deep red or purplish. Small spots on fruit produced by a common fungus, *Entomosporium maculatum* Lev., sometimes so closely resemble the spots made by the scale as to require close examination with a lens. When occurring in winter upon the bark of a twig in large numbers, the scales lie close together, frequently overlapping, and are at such times difficult to distinguish without a magnifying glass. The general appearance which they present is of a grayish, very slightly roughened, scurfy deposit. The rich natural reddish color of the twigs of peach and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being thickly coated with lime or ashes. Even without a magnifying glass, however, their presence can be readily noted if the twig be scraped with the finger nail, when a yellowish oily liquid will appear, resulting from the crushing of the bodies of the insects.

PARASITES.

The only parasite which has been reared in the East is *Aphelinus fuscipennis* How., a common and widespread parasite of armored scales Several specimens of this insect have been reared in New Jersey by Professor Smith, and on November 18, 1894, I found scales at Riverside, Md., pierced with parasite holes, which were probably made by this species. In California Mr. Coquillett has reared a number of specimens of the same parasite from *Aspidiotus perniciosus*, and Mr. E. M. Ehrhorn states that it is the most abundant parasite of this species around San Francisco. Mr. Ehrhorn also reared from the same scale insect *Aphelinus mytilaspidis* LeBaron, and *Aspidiotiphagus citrinus* (Craw). Mr. Alex. Craw, in the report of the State Board of Horticulture of California for 1891, made the statement that the *Aphelinus fuscipennis* just mentioned had been found doing such effective work in subduing the San Jose scale in an orchard in the neighborhood of Los Angeles that the complete restoration of the orchard was confidently looked for. Mr. Coquillett informs me, however, that while this orchard did recover to a very large extent, it afterwards became reinfested, and he is not at all sure that the partial restoration was due to the work of this parasite. Several times in his experience he has seen trees recover and the scales die off, without apparent cause. No exit holes of parasites were found in the scales, and the insects seemed to have died from some disease. A figure of *Aphelinus diaspidis* is introduced, which will assist in the identification of *A. fuscipennis*, the only eastern parasite yet found.*

FIG. 29.—*Aphelinus diaspidis* How.; greatly enlarged (from *Insect Life*).

NEW FACTS AS TO THE ORIGINAL HOME OF THE SPECIES.

At the time of the printing of Circular No. 3, in April 1894, I was obliged to follow the latest California utterances on the subject of the probable original home of the San Jose scale, and stated that it was, according to the most trustworthy authority, first brought to California on trees imported from Chile by the late James Lick, about 1870. This statement was derived from a paper read by Mr. Alex. Craw before one of the California Horticultural Conventions, and Mr. Craw gave as his authority Mr. John Britton. I have since corresponded

* Since this was written a single specimen of *Anaphes gracilis* How. was reared from specimens of the scale collected at Riverside, Md. The type of this species was reared in 1880 from *Mytilaspis pomorum*, the common oyster shell bark-louse of the apple.

with Mr. Britton, who informs me that the sole bases for this supposition were (1) That the scale first became epidemic in the orchard of the late Mr. Lick, and first spread to those orchards which had communication with his orchard; and (2) that Mr. Lick was an energetic importer of trees and shrubs, and had resided in Chile for a long period before coming to California. Mr. Britton states that Mr. Lick imported trees and shrubs from other localities, and that there is no further basis for the Chile supposition than the above.

I have made an effort to ascertain whether the insect is known in Chile, and have written at different times to naturalists residing in that country, sending copies of Circular No. 3 to each. The only definite information secured has come from Mr. Edwyn C. Reed, of Baños de Cauquenas, who writes that he has traveled a great deal throughout Chile, but has seen the San Jose scale only occasionally on pears from Santiago. The first time he met with it was in 1872, when dining with Mr. Henry Meigs, the railway contractor. The scale was noticed upon pears brought on with the dessert. The pears were so badly infested that they could not be eaten, and Mr. Reed studied the insect closely and applied some washes to the trees. The significant point is, *that these trees were introduced into Chile from the United States.* Mr. Meigs died shortly thereafter, and Mr. Reed has not since visited his garden. The only evidence we have, therefore, of the occurrence of the San Jose scale in Chile indicates at the same time that it was introduced into that country from the United States.

So far as we have been able to learn, the insect does not occur in Japan. Correspondence with Mr. Otoji Takahashi, a skilled entomologist, who studied scale insects particularly with Comstock at Cornell University, has resulted negatively. Mr. Takahashi has studied the scale insects of Japan to a certain extent since returning to that country in 1893, but has not found *Aspidiotus perniciosus.*

In Australia the species has been found. Mr. A. Sidney Olliff, Government Entomologist of New South Wales, reports having received specimens of it in 1892.

Mr. Koebele, writing under date of September 30, 1894, states that he personally has not met with the species in Australia, and that Mr. Harold, of the Town and Country Journal, does not know anything about it. Mr. Koebele further states that he has found it upon the island of Kauai, upon prune and peach trees imported from California. One of the trees had been destroyed by the scale, and some branches of the others were quite badly infested. Mr. Koebele expected to visit Ceylon in December, Java in January, and subsequently Japan and perhaps China, although the war may interfere with his visits to the last-named countries. From Mr. Koebele's familiarity with scale insects we hope to gain some definite information as the result of his extended trip. From the facts now in my possession, we are forced to the conclusion that it is more likely the scale was originally introduced from

Australia than that it came from any other country. I am able to add before this number goes to press, that on January 5 Mr. Koebele wrote from Kandy, Ceylon, that he had been unable to find this scale in Ceylon.

POSSIBLE FUTURE SPREAD.

It may prove to be a significant fact that, although nursery stock affected by this scale has for six or seven years back been sent to all the fruit-growing regions of the Eastern States, according to our present information the scale has established itself only in regions contained within the so-called austral life-zone. Mapping the points of establishment it is very interesting to see how accurately this distribution has been followed. Professor Smith last summer called attention to the fact that the spread of the insect in New Jersey seemed to be limited on the north by the so-called "red shale" line, extending, approximately, from Perth Amboy on the east to Trenton on the west. The significance of this fact is shown when we remember that the transition region enters northwestern New Jersey. The more northern occurrence of the scale in Columbia County, N. Y., is similarly significant, since the upper austral zone extends up the Hudson River. The occurrences at Lewisburg and Bristol, and Atglen, Pa., are all within the extension of the upper austral into the southeastern one-fifth of Pennsylvania. The three Idaho occurrences are all in the narrow upper Sonoran or upper austral band along the Snake River, with the exception of the one at Lewiston, which is the only locality in the panhandle of Idaho where the Sonoran dips in from the west. Should future observations support the apparent significance of the occurrences so far known, the scale will not establish itself to any serious extent in transition regions. This fact will relieve New England fruit growers north of southern Connecticut; those inhabiting the greater portion of Pennsylvania, except in the southeastern one-fifth and a western strip; those in New York, except for the strip up the Hudson River and the loop which comes in from the northwest and includes the counties bordering Lake Ontario on the south, as well as those inhabiting the northern portion of the lower peninsula of Michigan and all of northern Wisconsin, from any fear of this insect. Such a condition of affairs would seem almost too good to be true, but the possibility of its truth is suggested by what we know up to the present time. Against its probability may be urged the fact that, in general, scale insects belong to the group of potential cosmopolites and that they are seldom restricted by geographical limitations which hold with other insects.

REMEDIES.

If the horticulturist who possesses an orchard infested by the San Jose scale wishes to apply as summer washes either the summer resin wash or ordinary dilute kerosene-soap emulsion as formulated in Farmers' Bulletin 19 of this Department, he will be able to keep the insects from increasing to any serious extent by three applications at intervals through the summer, but he cannot expect to greatly reduce their numbers. Where three applications have been properly made I have seen healthy scales as abundant on the trees upon the advent of winter as they were in the month of April preceding. Our main reliance must be either upon the gas treatment or upon winter washes. Between November 20 and December 25, 1894, twenty-nine different washes were most carefully applied to badly infested trees in Charles County, Md. These applications were made either by Mr. Marlatt or Mr. Coquillett, or by both together, and the writer was present at some of the applications. The substances used and the results obtained may be briefly stated as follows:

Whale-oil soap:

1. Three pounds dissolved in one gallon of water. Fatal to all the scales on the trees sprayed with it.
2. Two pounds in one gallon of water. Same result.
3. One and one-half pounds in one gallon water. Fatal to ninety per cent of the scales.
4. One pound in one gallon of water. Fatal to eighty per cent of the scales.
5. One-half pound in one gallon of water. Fatal to one-half the scales.

Resin wash:

6. Six times summer strength. Resin, 120 pounds; caustic soda, 30 pounds; fish-oil, 15 pints; water sufficient to make 100 gallons. Fatal to all the scales on the tree sprayed with it.
7. Four times summer strength. Resin, 80 pounds; caustic soda, 20 pounds; fish-oil, 10 pints; water sufficient to make 100 gallons. Fatal to eighty-five per cent of the scales.

Kerosene emulsion:

8. Pure. Fatal to ninety per cent of the scales.
9. One part of emulsion and one of water. Fatal to eighty per cent of scales.
10. One part of emulsion and two of water. Fatal to one-half the scales.
11. One part emulsion and three of water. Fatal to thirty per cent of scales.
12. One part of emulsion in four of water proved fatal to only a small percentage of the scales. (On potted plants in Insectary.)
13. One part of the emulsion in six of water. fatal to a very small percentage of scales. (On potted plants in the Insectary.)

Hard laundry soap:

14. Two pounds dissolved in one gallon of water. Fatal to eighty-five per cent of the scales.
15. One and one-half pounds in one gallon of water. Same result.
16. One pound in one gallon of water. Fatal to sixty per cent of the scales.
17. One-half pound in one gallon of water. Fatal to twenty per cent of scales.
18. One-fourth pound in one gallon of water. Fatal to ten per cent of scales.

Concentrated potash lye:

19. Two pounds in one gallon of water. Fatal to eighty-five per cent of scales.
20. One pound in one gallon. Fatal to seventy-five per cent of the scales.
21. One-half pound in one gallon. Fatal to one-half the scales.
22. One-fourth pound in one gallon. Fatal to twenty per cent of the scales.

Fish-oil soap, homemade:

23. One and one-half pounds in one gallon of water. Fatal to half the scales.
24. One pound in one gallon. Fatal to twenty per cent.
25. One-half pound in one gallon of water. Fatal to five per cent of the scales.

Oregon winter wash:

26. (Ordinary strength.) Sulphur, 15 pounds; slaked lime, 15 pounds; bluestone, $1\frac{1}{4}$ pounds; water sufficient to make 100 gallons. Fatal to a comparatively small percentage of the scales.
27. (Double strength.) Sulphur, 30 pounds; slaked lime, 30 pounds; bluestone, $2\frac{1}{2}$ pounds; water sufficient to make 100 gallons. Quite a large percentage of the scales escaped destruction.

California lime-sulphur-and-salt wash:

28. (Ordinary strength.) Sulphur, 25 pounds; lime, 50 pounds; salt, 18 pounds; water sufficient to make 100 gallons. Fatal to a comparatively small percentage of the scales.
29. (Double strength.) Sulphur, 50 pounds; lime, 100 pounds; salt, 36 pounds; water to make 100 gallons. A rather large percentage of the scales not destroyed.

NOTE.—Experiments 8 to 11 and 14 to 25 were followed in from seven to ten hours after application of the washes by a hard shower of ten or fifteen minutes' duration. Experiments 3 to 7 had been on the trees a little over twenty-four hours previous to this rainfall. The other experiments were of earlier date, and were not influenced by rains for a considerable time after the applications were made.

The experiments, on the whole, were made under rather disadvantageous circumstances. Rather heavy rains followed within a few hours of the majority of the applications, but this is to be expected in any applications which may be made during the winter season in this climate. Some difference was noted in the effectiveness of certain of the washes upon different portions of the tree, and we believe it may be stated that most washes will be more effective on the sunny side than on the shady side of the trees.

As anticipated from experiments made in Washington, D. C., during the winter of 1893–94, by Mr. Marlatt upon the new peach scale, *Diaspis lanatus*, the California lime-salt-and-sulphur wash, by means of which many Californians have reduced the numbers of the San Jose scale to insignificance, has proved entirely ineffective in this climate. The same must also be said of the Oregon wash, which resembles the California wash in its ingredients, except in the substitution of bluestone for salt.

The only absolutely perfect results which have been reached have come from the application of two pounds or more of commercial whale-oil soap to the gallon of water, and from the application of a resin wash of six times the normal summer strength. The effects following the application of these washes leave nothing to be desired. In all cases the most careful search over the sprayed trees has failed to show a single living scale. The washes which have destroyed 85 per cent or more of the scales have been: One and one-half pounds of whale-oil soap to the gallon of water; resin wash four times summer strength; pure kerosene emulsion; one and one-half pounds or more of hard laundry soap to the gallon of water, and concentrated potash lye, 2 pounds to the gallon of water. We do not advise the use of the last substance in this strength on account of danger of injury to the tree. We are practically then, so far as the experiments have progressed, reduced to the use of a strong solution of whale-oil soap, or a very strong resin wash (See experiments 2 and 6.) Both these washes are expensive; we have not yet found a cheaper whale-oil soap than 4 cents per pound by the barrel. This would make the wash cost 8 cents per gallon, and the cost of application will increase the cost of the remedy to such an extent that many fruit-growers will not be disposed to use it.

The resin wash, however, is even more expensive, and the first cost of the tents for the gas process, to say nothing of the labor required to operate the tents, is such that the whale-oil soap solution remains the cheapest of the known effective remedies. It is safe to say that trees once attacked by the scale will not recuperate without active remedial work, and the choice therefore remains to the fruit-grower between losing his trees and applying one of these washes, expensive as they may seem. One well-known orchardist of our acquaintance has unhesitatingly applied, during the present winter, the whale-oil soap wash. It has cost him a good round sum to spray his large orchard; but considering the value of his orchard, he is of the opinion that he has come out of the fight at small cost, provided that the insect does not reappear.

Comparison of California results and climate with the results and climate of Maryland seems to indicate two things: First, that in Florida and Georgia, and perhaps even farther north, weaker washes than those found necessary in Maryland will suffice. Secondly, that in Maryland and more northern States, winter applications should be made as soon as leaves fall, since at this time the insects will undoubtedly be more susceptible than later in the season.

REPORT ON THE MEXICAN COTTON-BOLL WEEVIL IN TEXAS.

(*Anthonomus grandis* Boh.)

By C. H. Tyler Townsend, *Temporary Field Agent.*

LETTER OF SUBMITTAL.

Las Cruces, N. Mex., *December 20, 1894.*

Sir: I have the honor to submit the inclosed report on an investigation of *Anthonomus grandis* and its injury to the cotton crop in Texas, made between November 15 and December 15, 1894. Following your instructions, I visited the infested cotton regions of Texas, as well as parts of the infested regions in adjacent Mexican territory; also the border points of Eagle Pass, Laredo, and Brownsville, to determine where the insect crossed from Mexico into the United States. During this time I investigated its life-history, particularly its method of hibernation, so far as was possible at this season of the year; its present spread in Texas; the amount of damage caused by it in Texas in 1894; its history in previous years; the way in which it has been imported from Mexico, its original home, into the cotton regions of southern Texas; and other points mentioned in your instructions, as well as all that suggested themselves during the course of the work.

My thanks are due to Mr. G. Hoellich, of the firm of J. Cram & Co., of Eagle Pass, and C. Porfirio Diaz; to Don Marcos Benavides, Don Jesus R. Rios, and Mr. J. M. Ruiloba, of San Juan de Allende, Coahuila; to Major W. S. Dugat, of Beeville, Tex., Mr. C. H. De Ryee, of Corpus Christi; Mr. Wm. A. Tinney, of San Diego; Mr. V. E. Sebree and Mr. Fred E. Stark, jr., of Brownsville; and Major B. Coopwood, of Laredo. These gentlemen, and many others, gave me much valuable aid in my investigations.

Very respectfully, yours,

C. H. Tyler Townsend.

Mr. L. O. Howard,
Chief, Division of Entomology,
U. S. Department of Agriculture.

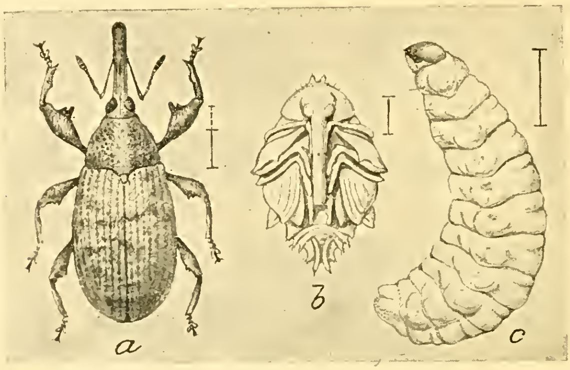

Fig. 30.—*Anthonomus grandis:* *a*, adult beetle; *b*, pupa; *c*, larva—all enlarged (original).

DESCRIPTION.

The egg was not found, it being too late in the season.

The larva is represented in the accompanying illustration (Fig. 30, *c*). It measures 6 to 7^{mm} when curved, 9 to 10^{mm} when nearly straightened out. It is a curved, whitish grub, of robust form, tapering a little at each end, more so at the anal end. The head has a brownish or yellowish tinge.

The pupa, shown in the figure at *b*, measures from 4 to 7^{mm}. It is entirely whitish, with the eyes black. The elytra, when partly formed, are bluish. More mature pupæ are tinged with brownish on the thoracic dorsum and beak.

The adult is represented at *a*. It measures 5^{mm} in length. Newly transformed weevils in the bolls are reddish. When first issued, they are usually covered with a yellowish bloom, which becomes grayish as they mature.

In the eastern and northeastern districts of Coahuila, Mexico, this insect is known as the "picudo," and in the infested regions of Texas as the "sharpshooter," in allusion to the effect produced by it upon the bolls, small exit holes through which the beetles issue being left in them.

LIFE-HISTORY AND HABITS.

The life-cycle is as yet imperfectly known, but so far as can now be judged is as follows: When the insects first appear the eggs are deposited in the squares and bolls, and the larvæ hatch and feed on the interior substance of the buds and bolls. The larvæ sometimes feed on the interior of the seed, leaving only the shell, but usually eat seed or fiber indifferently. The larva gradually reaches full growth, having by this time formed a cell of sufficient size to accommodate itself, and in this it pupates. The cell is usually formed next the outer wall or pericarp of the boll, so that the weevil, when transformed, has only to make its way through this wall to escape. In issuing, it thus leaves a small hole in the pericarp, which marks the cell in the infested lock of the boll. As many as eleven larvæ have been found in one boll.

Judging from the habits of the allied species, *Anthonomus signatus*, and allowing for differences in size and climatic conditions, the duration of the life-cycle is probably about thirty days.

In the newly infested region in Texas, the weevils were first noticed in the cotton fields from about the middle of August to the last of September; in the newly infested region of Coahuila, a month earlier; in the older infested regions of Texas (Brownsville) and Coahuila (Hermanas), as early as May to June. Approximate dates of their first appearance in newly infested regions have been received as follows: Corpus Christi (Nueces region), middle of August; Beeville, last of August and first of September; San Diego, first of September.

Nothing is known positively concerning the number of annual broods, but I think there is no doubt that there were two broods in the newly infested region, and in the older districts, where the weevils appear in May and June, there must be four or more broods annually.

At San Juan Allende, Coahuila, two very small larvæ were found in buds, November 23, and at Alice, Tex., another was found in a green bud, December 12. This seems to indicate a very late brood if, indeed, the broods are at all regular. I am inclined to think that, egg-laying goes on at all times, so that the broods are more or less irregular.

Food plants and habits of feeding of the adult.—The only food plant so far as known is cotton. The adults seem to feed both on the buds and bolls, and throughout the season as long as the weather is warm. By means of the small jaws at the end of its beak, the weevil eats through the skin of the bud or boll, making a small hole therein. Specimens were found as late as December 10, 36 miles north of Brownsville, with their beaks sunk to full length in half-grown green bolls, apparently feeding on the juices within.

Extended inquiry, confirmed by my own observations, shows that the weevils always remain within the squares or on the bolls, and never feed on the leaves, nor are they ever seen on the latter.

The weevils were found at San Tomas, and just north of Brownsville, infesting fields of sea-island cotton as badly as the upland variety.

There seems no hope, therefore, of finding a variety of cotton that will not be attacked by it.

If the weevil has another, an original food plant, as it must have unless it has always fed on cotton, it will probably be found in the Monclova region of Coahuila. No wild malvaceous plant could be found in the regions visited, and the insect was not found on any other plant than cotton. Information obtained from Monclova by Don Jesus R. Rios, and communicated to me by letter, states that the insect has never been known there on any other plant.

Oviposition.—The weevils deposit their eggs first in the buds, which are to be found within the squares. When the buds are all infested, the females oviposit in the smallest bolls, then in the next largest, until all are attacked that are still green. Judging from the egg-laying habits of the genus, the female makes the hole in the bud or boll with her beak, and then turning around, applies the tip of the abdomen to the hole and deposits an egg therein. The same female may deposit a considerable number of eggs.

Appearance of an infested field.—As the weevils attack first of all the buds within the squares, these usually die and drop off. Therefore as soon as a field becomes well infested the presence of the insect can be told at once by the fact that few or no blooms are to be seen on the plants. A field may be in full bloom, but as soon as the insect gets well spread over it and accomplishes its work hardly a bloom will be seen. Soon after the squares are attacked they mostly turn yellow and fall to the ground.

Method of hibernation.—In one or two localities, during spells of cool weather, I was able to make some observations on the hibernation of the insect.

It seems probable that a considerable percentage of the weevils winter over in the bolls, in the cells which they have formed therein, either as transformed weevils or as pupæ, or perhaps even as larvæ. That they may sometimes winter as larvæ seems proven from the finding, as above mentioned, of very small larvæ from the last of November to the middle of December. They probably winter more frequently as pupæ, the latter having been found in the bolls as late as any examinations were made, i. e., up to the middle of December. Newly transformed adults were found plentifully in the bolls also during the whole time of my investigations.

But there are many other individuals belonging to earlier broods which have issued and certainly will not reenter the bolls to hibernate. The question is, where do these hibernate? In San Juan Allende, where the fields are irrigated, there are many cracks in the earth, caused by the rapid drying of the soil after irrigating. On a cold day there I found that some of the weevils had crawled into these cracks, and I think there is no doubt that many weevils crawl into them and under clods of earth, under leaves, and other refuse to hibernate. I found cotton fields in many instances with dry dead leaves on the ground among the green plants, notably at Beeville and at San Diego, although planters often contend that the leaves stay on the plants until they crumble or blow away. Weevils were also found in Allende on the cold day above referred to (November 23) around the base of plants, under dry fallen leaves.

In fields where neither cracks, clods, nor fallen leaves exist, as happens often in southern Texas, where the plants remain green until late in winter, I am inclined to think that many weevils winter in the squares and under the leaves at the base of the bolls. At Alice and Benavides, Tex., the plants were perfectly green December 12, there having been no frost. In a field there, on that date, I found weevils very numerous inside the squares, as many as four in one square; also at the bases of the bolls. Many were neither feeding nor ovipositing, but were perfectly inactive. The squares afford excellent protection to the weevils in cold or in rainy weather. During rainy weather in San Juan Allende (November 28) weevils were found numerously huddled in the squares by threes and fours.

At Monclova occasional frosts occur, and very light ones at Matamoras and Brownsville. It is not probable that even freezing would affect the weevil, as it is a hardy insect; but it is safe to say that it can withstand as great a degree of frost as can the cotton plant.

PARASITES AND PROBABLE ENEMIES.

In San Diego, December 6, I found a hymenopterous parasite in the larval state on a larva of the weevil in its cell. This pupated about December 15. Apparently the same parasite was found, also on a larva, in San Juan Allende, November 26. At the latter place adults of a small black hymenopterous parasite, which may attack the weevil, were plentiful in the fields.

Larvæ of Syrphus flies are often met with in the squares. These most probably feed on aphides, though it is just possible that they may attack the small larvæ of the weevil.

In San Juan Allende a pretty little coccinellid was very common in the squares, as were also several species of Scymnus, and it is quite possible that these may attack the eggs or young larvæ.

As worthy of notice, it should be mentioned that on several occasions a small spider that mimics the weevil was found in the squares with the weevils.

A fungoid parasite, a species of Cordyceps, apparently, was found growing out of a dead pupa in its cell in a boll, November 26, in a field in San Juan Allende.

ITS ORIGINAL HABITAT AND HISTORY OF ITS SPREAD.

It seems proven beyond much doubt, from repeated testimony received, that the original home of this insect is the region around Monclova, in the state of Coahuila, Mexico. Monclova is about 150 miles south of Eagle Pass (see map), on the Mexican International Railway. It was known in this locality long before it was heard of elsewhere in Mexico.

Don Jesus R. Rios writes me, from information he has received from Monclova, that the weevil first appeared there in 1856. For six years, from 1856 to 1862, it was so bad that cotton planting was abandoned thereafter in that district. The insects were said to appear there in the fields as early as May, and by July to have completely infested the crop. I received information from another source stating that the weevil was known in Monclova as early as 1847, and in Matamoras as early as 1851, but I am inclined to believe that my informant was mistaken in the insect, and that these data refer perhaps to the boll worm.

Maj. B. Coopwood, who was engaged in cotton raising at Hermanas, Coahuila, in 1867, informed me that the weevil was known there in that year, and that it destroyed much of the crop. He stated that it appeared about the last of June or first of July.

In Sabinas the weevil has been known to be injurious for three years.

At San Juan Allende, Morelos, and Zaragoza, it was not known until 1894. At Zaragoza the weevil was first seen in the fields, according to Mr. Rios, the last ot July, but in Allende not until the last of August.

When it first appeared in Matamoras is uncertain. Mr. H. Nielsen, of that city, writes me that he has known of it in that locality for the last few years, but in less numbers this year.

From Matamoras it came across to Brownsville, and within the past two years or more spread north into the whole cotton region of southern Texas.

The Agricultural Department received the first notice of the injurious nature of this insect about ten years ago, when Dr. Edward Palmer sent specimens from the state of Coahuila, with the information that they were bred from cotton bolls.

In the neighborhood of Matamoras a good deal of cotton has been raised for the past ten years, but I am informed that not much was raised before that. At Zaragoza and Allende cotton has been raised for many years. In the San Diego region it has been cultivated in any quantity for only four or five years.

PRESENT SPREAD IN TEXAS.

At present this weevil is known in the Brownsville region, and I found it December 10 in all the cotton fields along the stage road up to 36 miles north of Brownsville. No fields were to be seen on the road beyond that. It is reported also to be as far up the Rio Grande on the Texas side as Hidalgo, but this needs verification.

It occurs from Corpus Christi to Benavides, along the Mexican National Railway, particularly around San Diego and Alice. It is known for 20 miles north of San Diego; at Amargoza, about 12 miles northeast of San Diego, and at La Rosita, 12 to 18 miles west of the same place. It is also reported by Mr. G. W. Newberry to have caused damage in Live Oak County, about 30 miles northeast of Alice.

It is found all the way up the Nueces River, for 40 or 50 miles above Corpus Christi. I also found it 8 miles south of Corpus Christi, on the coast. Rosita, San Patricio, and Sharpesburg are localities within the infested region on the Nueces. It is found around Beeville and 30 miles to the south of there, and is reported on good authority at La Parra, about halfway between Corpus Christi and Brownsville.

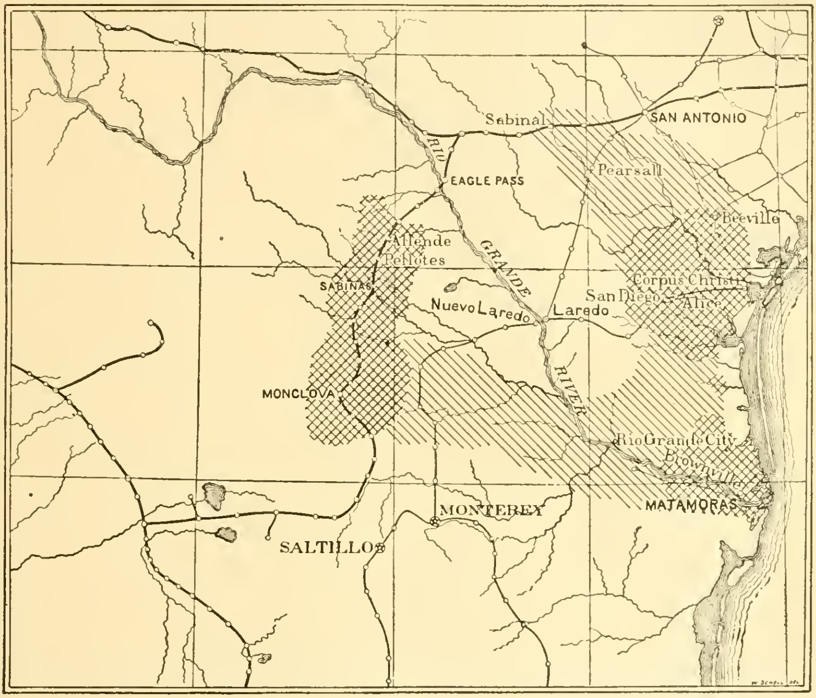

FIG. 31.—Map showing the present known distribution of the cotton-boll weevil in Texas and Mexico (original).

At Pearsall and at Sabinal it was reported to me as present, but search at the latter place and at Moore, near Pearsall, did not reveal either the weevil or any *unmistakable* sign of its work. It was said to be abundant in all the cotton fields around Pearsall, but I was unable to examine them. Bolls collected at Sabinal may have been attacked by it. Pearsall is over a hundred miles across country from San Diego, and I am told that cotton fields are scattered all through the intervening region. Mr. Fred. E. Stark, jr., informed me that he has known the insect, off and on, at San Tomas, 8 miles down the river from Brownsville, for about ten years. The Brownsville region is, therefore, doubtless the first point where it appeared in Texas. At La Noria, about 14 miles north of Brownsville, I was told that it had been known for three years. At La Parra, above mentioned, it appeared in 1893, so I was informed by Mr. D. M. Murphy. Twenty miles north of San Diego Mr. H. J. Delamer says that it appeared in his field in September, 1892.

In the other localities mentioned in Texas, this year was, according to all reports, the first of its appearance, but it is very probable that it has been present for two years or more in the San Diego and Nueces region, without its being noticed.

The weevil was reported not found or heard of at Moore, Del Rio, the San Antonio region (including Devine, Lightall, and Medina), and the region to the north and east of San Antonio.

At Flower Bluff, 12 miles south of Corpus Christi, on the coast, it was reported that the weevil did not occur.

METHOD OF ITS IMPORTATION.

Cotton grown close to the Rio Grande on both sides.—In the lower Rio Grande region there are localities where cotton is grown on both sides of the river. This is the case at Matamoras and Brownsville. It is self-evident, therefore, that the weevil came across here, perhaps also at other places further up the river, but not at either Laredo or Eagle Pass, as the insect does not occur there, and no cotton is raised at either place on the American side. Granting, therefore, that it got across from Mexico to the United States in the Brownsville region, we will proceed to consider how it spread to the San Diego and Nueces region, 150 to 250 miles north of there, it being known that between these regions there is a stretch of 60 miles or more where little or no cotton is raised.

Not shipped in ginned seed.—This subject was carefully gone into, because I was informed that in 1893 much ginned seed had been shipped from C. P. Diaz, some of which might have come from the infested Monclova region, to stock feeders in Eagle Pass and to the Houston oil mills. Much search was made among freshly-ginned seed in San Juan Allende, a badly infested district, for signs of this weevil, and the only thing found was a portion of a dead weevil, which had been broken in going through the gin. The seeds are often found eaten out inside, leaving only the shell inclosing the pupa, or transformed weevil, but in going through the gin the thin shell is broken and the weevil killed. It is thus not at all likely that the weevil can be spread in *ginned* seed.

Spread north by shipments of cotton in the seed.—There is no cotton gin in the Brownsville region, unless it has been very recently put up.* Therefore cotton in years past had to be shipped *in the seed* to one of four places for ginning—New Orleans, Galveston (to these by steamer), San Diego, or Alice (to these overland by ox carts).†

* Mr. Townsend writes from Brownsville under date of February 2, that this statement was based upon misinformation. It seems that there is a gin at Brownsville. Nevertheless cotton has been shipped in seed to Galveston and may have been shipped in small quantities to Alice.—L. O. H.

† That which is shipped by steamer now goes to New Orleans preferably, because a better price can be gotten there for the lint cotton, and the freight rate from Galveston to New Orleans is avoided.—C. H. T. T.

There has been a gin at Alice for three years and one at San Diego five years. As soon as the latter went up more or less cotton came overland *in the seed* from parts, especially more northerly parts, of the Brownsville region to be ginned, ox-carting direct to San Diego being much cheaper than carting to Brownsville, and then sending by train, lighter, and steamer to New Orleans. Now, it has already been pointed out that in many instances the weevils may be gathered in the picking of the cotton, in case the seed alone has been eaten out and the fiber not injured, when the boll is not prevented from bursting. This cotton being shipped in the seed during 1890 and 1891 to San Diego, and more or less since then to Alice,* has resulted in introducing the weevils into that region, from which they have since easily spread through contiguous fields over the whole region now infested.

The regular daily stage each way between Alice and Brownsville has been running since July, 1893. From 1868 to 1876 (about) a stage was run from Brownsville to San Diego. These stages, of course, carried no freight. Freighting was formerly carried on by means of ox teams and carts between Brownsville and San Antonio, via San Diego. Such freighting is probably nearly abandoned now, but may be carried on to some extent as far as San Diego or Alice. It is said that cotton seed was carried on the road by these freighters for the purpose of feeding the oxen. A stage also runs from Rio Grande City to Peña.

AMOUNT OF DAMAGE CAUSED BY IT IN TEXAS.

During the year 1894 in the Brownsville region (San Tomas) the loss of crop was estimated at over 90 per cent. In the San Diego region the loss was about 90 per cent. At La Rosita, 12 to 18 miles west of San Diego, the damage was estimated to be something over 75 per cent. At Rosita, on the Nueces, about 15 miles below Sharpsburg, 90 per cent of the crop was destroyed. At Sharpsburg fields amounting to 6,000 acres yielded not over 1,500 bales. In Bee County 50 per cent or over of the whole crop of the county was estimated as destroyed. In a field of 1,200 acres about 30 miles south of Beeville the weevil was very bad in all but about 50 acres, which produced fine cotton, while the rest was badly damaged. At Pearsall damage to cotton crop was estimated at 25 to 50 per cent, but it is not yet known whether this was the weevil or the boll worm.

In previous years at Brownsville, Mr. Stark, jr., informed me, the weevil was worst in 1892, the entire crop having been destroyed by it in that year. In 1893 it was not noticed to cause much damage. At La Noria it was reported to have ruined the whole crop in 1892, two miles east of there. On Mr. Delamer's place of 300 acres, twenty

*A competing line of railroad from Skidmore to Alice makes cheaper freight rates on the lint cotton east from Alice than from San Diego, which is farther west. Therefore as soon as a gin went up in Alice cotton for ginning went there in preference to San Diego.—C. H. T. T.

miles north of San Diego, it is reported to have destroyed 75 per cent of crop in 1892.

In Mexico this year (1894) the damage to crop in Zaragoza and San Juan Allende region of Coahuila was estimated at 90 per cent. The damage over 30 years ago in the Monclova district was between 90 and 100 per cent. In Matamoras the damage this year was over 90 per cent also. This is considerably greater than the damage there in previous years, according to Mr. H. Nielsen.

There seems to be some evidence pointing to greater damage by the weevil in wet years. Mr. Delámer, whose field (north of San Diego) was badly damaged in 1892, says that he had much rain that year in his immediate vicinity, while other localities around him had none.

Mr. Rios writes also that the prevailing impression in the Monclova district is that the weevil was worse in wet years.

REMEDIES NECESSARY TO EXTERMINATE IT.

The insect is by far the worst pest that has ever appeared on cotton, and the most difficult to combat. Like all weevils, it is very tenacious of life, and its habit of frequenting the squares renders it not amenable to ordinary treatment.

Burning the fields.—If possible all infested fields should be burned completely during the winter, while the weevils are in a state of hibernation. Cotton planters in general argue that it will be very difficult to do this. If, however, the plants are all cut down and distributed evenly over the fields it should be possible to completely burn all the stalks and any possible leaves or débris there may be upon the ground. If this is done the weevils that are in the bolls and those that may be under the leaves on the ground will be destroyed. This will be a very large percentage of them, and if there are no cracks in the ground nor clods to any extent it will take nearly all of them. It is almost certain that the great majority of the weevils remain in the cotton fields through the winter, and spread into new fields only during the early part of the season following.

Flooding.—In localities where irrigation is practiced, as at San Juan Allende, Coahuila, it will be easy to flood the fields after burning them over and allow the water to stand on them for a week or two. This would kill any weevils that had crawled into cracks in the ground, and would greatly increase the growth of the plants the following season. In Brownsville irrigation is accomplished only by pumping up water with machinery and then distributing it, and flooding there would thus be more difficult. It would, however, be possible at some expense, and less irrigation would be necessary during the summer months if this winter flooding were practiced.

Rotation of crops.—In addition to burning and flooding, or burning alone, rotation of crops should be practiced. No cotton, not even a single plant, should be allowed to grow for two years anywhere in the region known to be infested by the weevil. If there are in the infested regions any wild malvaceous plants (which is doubtful) in which the weevil could breed, these should be destroyed. In this way the insect would be starved out. It might exist for one year under these conditions, but two (preferably three) years of such treatment would probably result in its extermination.

The great drawback to rotation of crops is that in most of the infested region there is not enough rain to mature any crop except cotton, and irrigation is impossible except at Brownsville. But rye and barley could, I believe, be produced in this region.

Application of arsenites.—Paris green or London purple, applied in solution of one pound of poison to 150 gallons of water when the bolls begin to form, may kill a certain per cent of the weevils, if good judgment is used in its application. As the weevils do not feed on the leaves, the application of it simply to the foliage will give no result. It will be practically impossible to apply it so that it will reach the inside of the squares in sufficient quantity, therefore its application before the small bolls appear will be practically useless. But if a coating of the poison can, by means of spraying, be put on the young bolls as soon as the flower drops, the weevils, in eating through the skin to feed or deposit their eggs, will doubtless be killed. This is on the same principle as spraying young plums to kill the plum weevil. Though the cotton weevil is very tenacious of life, if it eats a certain amount of the poison it must necessarily succumb. Much practical experiment may be needed to determine the time and method of application of the arsenites which will secure the best results, but it seems certain that it will be hopeless to try to reach the weevils by these means while they are engaged within the squares.

ACCESSORY REMEDIES.

Picking and burning the bolls.—If during cotton picking time all the infested bolls are gathered in heaps and completely burned, great numbers of the weevils will be destroyed with little extra labor or expense. Each cotton picker could be provided with a separate receptacle for receiving the infested bolls, and it would involve little extra labor to gather these at the same time that the cotton is picked from each plant. As soon as the field is picked, the heaps of infested bolls can be burned. This would kill a very large percentage of the weevils, and if thoroughly done at each picking, it would almost dispense with the necessity of burning the fields over in the winter. It is too late to do this now, and that is why the cotton fields should be burned over at once this winter.

Dusting lime and ashes in the squares.—Either ashes alone or a mixture of one part of lime to two parts of ashes, if it could be dusted on the plants in such a way as to enter the squares, would undoubtedly repel the weevils to a considerable extent. It should be applied as soon as the first weevils appear in the fields. The repellant power of ashes on the weevils seems to have been partly demonstrated in the case of a few plants so treated at San Juan Allende, Coahuila.

Turning cattle, hogs, etc., into cotton fields.—I have been informed by some planters that cattle will eat all the bolls, whether green or dry, that are left on the plants after picking. Others say that they will not touch the dry bolls. It would be well to turn cattle, sheep, hogs, etc., into the fields this winter in localities where it is wholly impossible to burn the fields, and where the plants or bolls are still green. But this means should never be resorted to in place of gathering and burning the bolls during picking time.

FALLACIOUS REMEDIES.

Soaking the seed before planting in copperas water or Paris green water will be of no use whatever, as the insects are not to be found in the ginned seeds (this has already been pointed out); and none of the properties of these substances will enter into the pl nts from soaking the seeds. Neither will the application of sulphur or other substances at the roots of the plants have any effect on the insect.

Experiments should be carried on along the lines already suggested, as these principally are the ones that offer any promise of success. Practical deviations from these may suggest themselves to the good judgment of planters, but it will be useless to experiment on the lines just mentioned, the fallacy of which has been well proven.

QUARANTINE AND PROHIBITIVE MEASURES AGAINST NEW IMPORTATIONS.

Prohibitive measures should be adopted to guard against any new importation of the pest from Mexico, if such should threaten. Cotton in the seed, and especially cotton bolls, should not be allowed to enter our territory from Mexico. There is no probability of this happening, as there are sufficient ginning facilities in Mexico, and a much better market there. It must be remembered that Mexico consumes all the cotton she produces and more. None has ever been shipped from Mexico into the United States. The only part of the plant that has been shipped from Mexico into our territory is the ginned seed.

That no cotton is raised on the American side anywhere in the neighborhood of Eagle Pass and Laredo is to be considered a most fortunate circumstance. This condition of things should be maintained as long as possible. The weevil exists in great numbers only 30 miles south of Eagle Pass, and may at any time reach the cotton fields of Ciudad Porfirio Diaz, which is on the Rio Grande, opposite Eagle Pass.

I was informed that for about 50 miles to the south of Alice and San Diego, and then for about 50 miles to the north of Brownsville, there is more or less cotton raised. This leaves about 50 or 60 miles of country where none is grown, with the exception of the isolated district at La Parra.

Some cotton is raised at Concepcion, about 15 miles off the railroad to the south of Benavides station; also at San Antonio Viejo, which is on the stage road about half way between Peña and Rio Grande City. About 10 or 15 bales *in the seed* are sent annually from San Antonio Viejo up to Peña, en route to Benavides to be ginned. No cotton is raised anywhere around Peña, nor between Peña and Benavides, and none between Peña and Laredo.

To the north of Laredo none is raised for 70 or 80 miles. The first fields seen on the International and Great Northern Railway going north from Laredo are at Dilley, which is 79 miles from Laredo. Very large fields exist around Pearsall and farther north. Up to three years ago some cotton was raised at Catulla (south of Dilley), but drought has caused the abandonment of it.

Cotton is raised more or less along the Rio Grande on the Mexican side all the way from Matamoras up to opposite Eagle Pass and Del Rio. The corresponding cotton region on the American side exists only from Brownsville to Carrizo and at Del Rio. This territory represents only a small region compared to the cotton-producing region on the Mexican side, as none is grown near the river anywhere between Carrizo and Del Rio.

I was informed that cotton is not at present grown near Nuevo Laredo, but that its cultivation was attempted there three or four years ago and since abandoned. As it may be resumed there at any time, the weevil is apt to reach that district from the nearest infested district in Mexico. Considerable cotton is grown around Ciudad Porfirio Diaz and up and down the river on the Mexican side, and these localities will doubtless soon become infested.

ISOLATION OF OUR COTTON REGION FROM THAT OF MEXICO.

In order to prevent new installments of the weevil being received from Mexico, it will be necessary for cotton raising to be abandoned throughout a wide strip of country all along the Texas border. The cotton fields of Texas can be maintained against new invasion from Mexico in this way only. Cotton should be abandoned at Brownsville and as far up as Carrizo. This will be no great hardship, as this is only a small strip of country, comparatively, and much more valuable and important crops can be produced in this wonderful lower Rio Grande region with a certainty of success, while cotton, if persisted in, will only fall to the weevil. It would be better also to abandon cotton at Del Rio, although that is quite well isolated from the other cotton districts of Texas, and might be allowed to remain until it becomes infested, inasmuch as other crops would not do well there. In case it were found necessary to make a complete non-cotton belt, however, Del Rio would have to be included. A complete protective non-cotton belt on our border would involve the abandonment of cotton in the regions of Brownsville, Santa Maria, Hidalgo, Rio Grande City, Carrizo, and Del Rio only—in short, all along the lower Rio Grande on the Texas side for a distance of about 50 miles into the interior, and in the Del Rio region on the upper Rio Grande. We would then have a non-cotton belt on our frontier that would, in conjunction with proper quarantine regulations, present an insurmountable barrier to new importations of the weevil. More valuable crops than cotton by far could be raised in all this territory (except perhaps at Del Rio), as there is plenty of water for irrigation, or certainly will be as soon as the two Governments agree on the use of the waters of the Rio Grande for irrigating purposes.

THE SERIOUS ASPECT OF THE QUESTION, AS IT AFFECTS THE COTTON MARKET.

I estimate that one-fifth, or at least one-sixth, of the entire cotton-producing region of Texas is infested with the weevil. The damage this year in the infested region averaged 90 per cent, which is about 15 per cent of the entire crop of the State. If the weevil is not exterminated or greatly reduced in numbers this winter it will spread over a considerable additional area the coming season. If the conditions for its spread are at all favorable, as they are very apt to be, the new area that will be invaded next season will doubtless equal in extent the area already infested. The damage to the crop in such case will range from 75 per cent to over 90 per cent in the whole region infested. Thus, it is extremely probable that, unless some means are speedily taken to prevent, the cotton crop of Texas in 1895 will be reduced by more than 25 per cent.

These conditions will continue to grow indefinitely worse in succeeding years, until cotton raising will have to be abandoned in many districts (as at Monclova, in Mexico), if not in all; and the least unfavorable outlook that can be predicted is that a much greater outlay of expense and labor will be necessary to raise cotton than formerly. At the same time it is true that it will command a much higher price, but all far-seeing persons will realize that the gain in price can not begin to recompense either the State or the individual planter for the immense decline in production that will ensue.

CONCERTED ACTION AND COMPULSORY LEGISLATION.

In attempting to exterminate the weevil or reduce its numbers to any appreciable extent, the most thoroughly concerted action of all the cotton growers in the infested regions will be necessary. Every infested field must be treated in the same way, else the weevils will spread from untreated fields and again overrun the whole region.

Concerted action over a large area like this can only be secured by the aid of legislation. Laws should be passed compelling everyone who grew cotton in 1894 in the infested districts to thoroughly treat every one of his fields according to the best means that can be suggested. Inspectors should be appointed to see that these laws are faithfully carried out. In case they are not properly complied with at once the inspectors should have power to hire this work done, and attach the property for compensation to the State. In this way only can we hope to secure concerted action, and without concerted action all efforts to subdue the pest will be in vain.

Compulsory abandonment of cotton growing on the border.—The reasons why cotton growing should be abandoned on the Texas border have already been fully detailed and are very cogent. Laws should be passed decreeing the Rio Grande border of Texas for a width of 50 miles to be a non-cotton-producing belt, compelling all persons to abandon the raising of cotton in that area, and providing for the destruction of all cotton plants (and other malvaceæ, if such exist) within the same. If, by the greatest good judgment and most efficient and concerted labor, the weevil is exterminated in the present infested districts in Texas, and this non cotton zone fails to be established on the border, fresh importations will occur constantly, and all the labor will have to be performed over again. The only alternative lies in Mexico exterminating the weevil within her borders, which it will be almost impossible for her to do, as that is its natural home and its original food-plants probably exist there in quantity.

Cotton growers should organize.—Cotton growers in the State of Texas, in both the infested and the uninfested regions, should organize at once and petition the State legislature to pass suitable laws for the extermination of the pest within the limits of the State, and for the establishment of a non-cotton border zone. Growers in the infested region should desire to rid themselves of the pest, while those in the uninfested region should be equally interested in preventing its further spread and preserving their fields from its attack. If these measures are not carried out, the time is near when Texas will cease to hold its own as the greatest cotton-producing region of the globe.

THE COTTON OR MELON PLANT-LOUSE.

(*Aphis gossypii* Glover.)

By Theodor Pergande.

Aphis gossypii Glover, Pat. Off. Rept. 1854, p. 62; do. 1855, p. 68; Rept. Dept. Agric. 1876, p. 36.

Aphis (*Siphonophora*) *citrifolii* Ashm. (In part) "Orange Insects," 1880.

Aphis citrulli Ashm. "Florida Dispatch." n. s., vol. I, p. 241, 1882.

Aphis cucumeris Forbes, Twelfth Rept. Nox. & Benef. Ins. Ill., pp. 83–91, 1883.

(?) *Aphis forbesi* Weed, Ohio Agr. Exp. Stat. Bull., vol. II, No. 6, pp. 148–150, 1889.

After a thorough and careful examination and comparison of thousands of specimens from a large variety of plants, from widely separated localities, and after carefully comparing them with most of the descriptions both of American and foreign aphids at my command, I have arrived at the conclusion that the species infesting so disastrously the various kinds of cucurbitaceous plants is identically the same as *Aphis gossypii* Glover, and that the descriptions of *Aphis citrifolii* Ashm. in part; *A. citrulli* Ashm.; *A. cucumeris* Forbes, and probably *A. forbesi* Weed. are referable to the same species. I am also of the opinion that part of the description of *A. rumicis*, by Prof. C. Thomas, may be referred to it.

Whether or not any of the described European species are identical with it, I am at present unable to decide, since none of the descriptions fit our American insect exactly.

From the very large quantity of material at my command, I have been enabled to observe extreme variability of coloration both in adults and larvæ, whether on the same or different plants, whereas all the important structural characters remain the same in all.

The darkest of its apterous forms, and also the pupæ, bear a great general resemblance to *A. rumicis*, which, however, is a considerably larger and more robust insect, having longer and stouter antennæ and larger nectaries, while the antennal sensoria are more numerous and more irregularly arranged than in this species.

The first account of this plant-louse was published by Prof. Townend Glover in the Patent Office Report for 1854, p. 62, with figures on Plate 3, which article was reproduced in the Patent Office Report for 1855, p. 68, Plate VI, Fig. 2, though the specific name was first applied in the Report of the Department of Agriculture for 1876, p. 36, Fig. 39.

Professor Glover's account of this plant-louse is in substance as follows:

When the cotton plant is very young and tender, it is particularly subject to the attacks of the cotton louse, and the constant puncturing and drainage of sap from the young leaves enfeeble the plants to such a degree that the leaves are caused to curl, turn yellow, and subsequently wither away and fall to the ground; and although young plants are most subject to these attacks, he has seen old stands of cotton in Georgia with their young shoots completely covered with this pest as late as November.

In 1880 Mr. Wm. H. Ashmead redescribed this species in his pamphlet on "Orange Insects," under the name of *Siphonophora citrifolii*, which he found to be infesting his orange trees, without being aware that the same insect infests also cotton and had been described previously.

Again in 1882, Mr. Ashmead, in a paper on the "Aphididae of Florida" in the Canadian Entomologist (vol. XIV, p. 91), in discussing dimorphism among insects, besides reproducing his original description, makes the serious mistake of describing on page 92 another species as a dimorphic form of his *citrifolii*, which, however, according to the characters given in this description, is neither a true Aphis nor a Siphonophora, but appears to belong to the genus Rhopalosiphum. Mixed colonies of closely related and other species of aphides are frequently found infesting the same plant at the same time, which, however, does not indicate dimorphism.

The same was again briefly described by Mr. Ashmead in the Florida Dispatch (new series, vol. I, p. 241, July 7, 1882), under the name *Aphis citrulli*, with an account in the same paper for July 27, 1882, of its destructiveness to watermelons in Florida and Georgia.

In 1883 Professor Forbes described and figured this species again in the Twelfth Report on the Noxious and Beneficial Insects of the State of Illinois, in an article on the "Melon Plant Louse" (pp. 83–91), under the name of *Aphis cucumeris*, stating that it had first been noticed by Prof. Cyrus Thomas in 1880, when it was reported to him as doing much damage to nutmeg muskmelons and cucumber vines, and that in some instances it had almost entirely destroyed fields of vines in southern Illinois.

It was reported by Professor Forbes as having made its appearance in 1881 in great numbers in the cucumber fields at Marengo in northern Illinois. He stated, however, that it disappeared before the end of the season without doing grave injury. It appeared again early in the spring of 1882 at Normal and in many other localities of Illinois in overwhelming numbers upon both watermelons and muskmelons, so that vines six to seven feet long were literally covered and killed by it. By the first of July it again attracted attention in large fields of cucumbers at Normal, spreading rapidly and arresting the growth of the worst-infested plants, though where muskmelons and cucumbers grew together, the latter were comparatively uninjured, whereas the melons were sometimes completely destroyed.

What will prove, no doubt, to be the same species, was again described by Prof. C. M. Weed in the Bulletin of the Ohio Agricultural Experiment Station (vol. II, no. 6, second series, no. 13, Sept., 1889, pp. 148–150), in an article on the "Strawberry Root-louse" under the name of *Aphis forbesi*. In this article Mr. Weed cites an interesting observation on the habits of this species, published by Prof. S. A. Forbes in the Thirteenth Report of the State Entomologist of Illinois (pp. 102–103), as follows:

In the latter part of September, 1882, an assistant, Mr. Garman, observed upon strawberry plants near Centralia numerous clusters of dark-green plant-lice, gathered on the crowns and between the bases of the roots, at and just beneath the surface of the earth. In November they were still found at the same place and in the same situation as before. They were all wingless and of various sizes, but most of them adults, actively engaged in oviposition; the eggs, some black, some yellow and freshly laid, being abundant among them.

In some fields near Centralia half or two-thirds of the stools were occupied by them; but I was not able, at that late season, to estimate the damage due to them.

No plant-lice of any species were seen upon the strawberry elsewhere in southern Illinois, nor have any been seen there since. Even in these very same fields not a louse of any sort was discovered the following May, at which time the plants were thoroughly searched for them.

The same species was also found in the same situation upon plants near Normal, in the latter part of September, a fact showing the wide distribution of this form.

Since these observations were made in 1882 it appears that no one has met with it again until Professor Weed's attention was called to it by Mr. S. R. Kramer, of Gahanna, Franklin County, Ohio, who submitted specimens during the latter part of August, 1889, which he found to infest the roots of his strawberry plants, with the report that he first noticed them to be very abundant upon his plants about the middle of July, since which time they had ruined a plantation some two and a half acres in extent. An investigation by Mr. Weed of the plants upon the station grounds at Columbus, Ohio, showed that a large proportion of them were also infested by the same insect. He ascertained also that it was quite generally distributed over the State.

Prof. J. B. Smith, in an article on the melon aphis published in Bulletin 72 of the New Jersey Agricultural Experiment Station (October 4, 1890, pp. 24–26), makes the statement that this species has been very destructive to all kinds of cucurbitaceous vines for years, and that numerous complaints of injury had been received in the fall of 1889 from farmers in all parts of the state.

The notes of this office regarding distribution of, and damage caused by, this species date back as far as July, 1878, when it was reported as being very numerous on the leaves of orange trees at Fort Reed, Fla.

During March, 1879, it was again reported as being very numerous on orange trees at Savannah, Ga., while in May of the same year complaints were received from Selma, Ala., where it appeared in large numbers on the leaves of cotton.

Early in the spring of 1880 it was found by Mr. A. Koebele also on cotton, at Bonito, province of Pernambuco, Brazil; while in April of the same year it was reported by H. S. Williams, Rockledge, Fla., as doing some damage to the leaves of orange. The same species was sent us in June by W. F. Morgan, Palmyra, N. J., with the statement that it was very destructive to citron vines, a variety of watermelon, the underside of the leaves of which were completely covered with them. In July we received it from J. E. Pierson, Fremont, N. C., with the statement that it was doing some damage to cotton.

During 1881 no complaints were received, except from Mr. J. R. Martin, Clarksville, Tenn., that his cucumbers, melons, and cantaloupes were badly infested with it during September.

From 1881 to 1888 it seems to have done little or no damage anywhere; since then, however, it has been received regularly every year from different sections of the country.

During 1888 it was reported in June by M. G. Acton, Sarasota, Fla., as doing considerable damage to his melon vines; it was also received in September from J. A. Shuler, Bonifacio, Fla., and from R. H. Whittacker, Gardner, Kans., with the statement that much damage was done on melon and cucumber vines.

In 1889 it was found infesting leaves of oranges at Los Angeles, Cal., by Mr. D. W. Coquillett.

In 1890 we received it from F. A. Brown, Everett, Mass., and T. A. Williams, Ashland, Nebr., found on watermelons and cucumbers. Specimens of the same species, found infesting leaves of orange, were brought by Mr. A. Koebele from Adelaide, Australia.

In June of 1891 it was again reported as being injurious to orange trees by Dr. L. G. Yates, Santa Barbara, Cal., while Mr. Edward Burrough, of Merchantsville, N. J., stated that it had caused thousands of dollars' worth of damage to melon vines in that section of the State. Reports from J. B. de Vincenzi, Fort Bowie, Ariz., and F. S. Earle, of southern Mississippi, were to the effect that considerable damage was done to melon and cucumber vines.

During 1892 it was reported as being injurious to oranges at Hamilton, Bermuda, and Lakeside, Cal.; to melons at Punta Gorda, Fla., and Laredo, Tex.; to squashes at Lincoln, Nebr., and to cucumbers at Dalcour, La.

In 1893 it was injurious in Kansas and Oklahoma.

In 1894 it was brought by Mr. H. G. Hubbard from Montserrat, British West Indies, found in considerable numbers on orange leaves. Mr. E. A. Schwarz, while investigating cotton insects during the month of August, reported it to be extremely abundant on melons at Rockport, Tex., and in lesser numbers on cotton at Baton Rouge, La. It was also reported as doing some damage to melons at San Diego, Cal. During September it was reported by Prof. C. H. T. Townsend as being quite plentiful on cotton at Zaragoza, San Juan de Allende, and Matamoras, Mexico.

FOOD PLANTS OF APHIS GOSSYPII.

During the past season an effort has been made to ascertain the various food-plants, besides the cucurbitaceæ, upon which this species may be able to subsist and to multiply, and we have succeeded in tracing it to the following long list of plants, to which, in the course of time, many others will, no doubt, be added:

Purslane (*Portulaca oleracea*), in larger and smaller colonies, from early in June until the plants are killed by frost. On a leaf of one of these plants infested by this aphidid a winter egg was found late in October.

Shepherd's-purse (*Capsella bursa-pastoris*), frequently in large colonies on flowers and flower stalks; September to January or later; even after heavy frosts, sleet, and snow.

Pepper-grass (*Lepidium virginicum*), in large numbers on flower-stalk in October.

Amarantus sp? leaves, October.

Dock (*Rumex crispus* and other species), October.

Burdock (*Lappa major*), small numbers, early in December.

Dandelion (*Taraxacum dens-leonis*), quite numerous in October.

Pigweed (*Chenopodium album*), often plentiful on flower-stalks and leaves, October and later.

Wormseed (*Chenopodium anthelminthicum*), October, in small numbers.

Plantain (*Plantago virginica*), in numbers on leaves from October until December.

Chickweed (*Stellaria media*), in considerable numbers, October.

Morning glory (*Convolvulus* sp?), few, October.

Three-seeded mercury (*Acalypha virginica*), a few, during October.

Button-weed (*Diodia teres*), few, in October.

Ground ivy (*Nepeta glechoma*), few, October.

Red clover (*Trifolium pratense*), small colonies on leaves, August to October.

Indian strawberry (*Fragaria indica*), numerous on underside of leaves, November and December.

Mallow (*Malva rotundifolia*), few, October.

Cultivated strawberry (Fragaria), September until March or later; frequently very numerous on underside of leaves, petioles and between the folds of young leaves; with them was found a winter egg in January, deposited in the angle formed by the midrib, and a vein on the underside of a leaf.

Dwarf bean (*Phaseolus nanus*), quite common during October.

Spinach (*Spinaeia oleracea*), scattering on leaves in November.

Hop (*Humulus lupulus*), a few small colonies in July.

Cotton (*Gossypium herbaceum*), extremely numerous from August till the middle of December, by which time they had killed all the leaves, flowers, and young bolls.

Pear (*Pyrus communis*), quite numerous on young leaves in June, causing them to curl. Observed also a large colony on young leaves and tender shoots of a potted tree in the Insectary of the Department during November.

European Dogwood (*Cornus mas*), very numerous during October and November, curling the leaves.

Orange (*Citrus aurantium* and other varieties), in the orange house of the Department of Agriculture, very numerous on young leaves and shoots at almost any time of the year.

They were also found to be extremely numerous on many hot-house plants, particularly so on Hydrangea and Begonia; considerable numbers were also observed upon the leaves of the Jamestown weed (*Datura stramonium*) growing in the Insectary of the Department.

It will be seen from these notes that this particular species is not alone a very general feeder, but that it has also a very extensive distribution.

DESCRIPTION OF THE SPECIES.

Apterous viviparous female.—Length of the fully mature female, 1.6–1.8^{mm}; greatest diameter across the abdomen, about 0.6^{mm}. Abdomen pyriform; antennæ rather short and slender, reaching to or beyond the middle of the abdomen. Nectaries about twice the length of hind tarsi, conico-cylindrical. Rostrum rather stout, reaching nearly to third coxæ. A prominent conical and fleshy lateral tubercle may be observed each side of the prothorax and behind the nectaries, and four smaller ones each side of the abdomen in front of the nectaries.

Color very variable, even in the same colony. The oldest females may be either yellow or different shades of green to black, frequently marked with irregular darker shadings; this variation in color is, however, often as pronounced in the different younger stages. Eyes dark brown. Antennæ whitish or pale yellowish with the apex of the sixth and the last joint black, legs white or pale yellowish; the coxæ, apex of tibiæ, and the tarsi, dusky or black. Nectaries black; tail greenish or dusky. All are covered with a very delicate, more or less observable, pruinose excretion.

Pupa.—Color also quite variable, varying in different individuals from dark green to orange or reddish-brown, though in some cases they are of a beautiful, pale, bluish-gray. Head and prothorax dusky; the meso- and metathorax either whitish, yellowish, or glaucous green, frequently marked with two faintly dusky medio-dorsal stripes. Wingpads and nectaries black; the rest as in the apterous females. The whole body is more or less distinctly pruinose and generally marked on the abdomen with four longitudinal rows of round, white, pulverulent spots, which give them a peculiarly pretty appearance.

Winged female.—Expanse of wings, 4.6 to 6^{mm}; length, 1.2 to 1.8^{mm}. Shape more slender than in the apterous form, antennæ barely reaching to nectaries. Legs longer and more slender, and the nectaries and tail rather shorter, than in the apterous form. General color yellow, yellowish-green, or quite dark green, with the base of the abdomen in the darker forms more or less distinctly orange. Eyes dark brown, antennæ black, head, a broad band across the prothorax, mesothoracic lobes and sternal plate, four lateral abdominal spots and nectaries black. Remaining parts of thorax more or less decidedly orange. Legs yellowish, the coxæ, apical portion of femora and tibiæ, and the tarsi, blackish. Rostrum yellowish, its base and apex blackish. Tail greenish or dusky; wings delicate, colorless, iridescent, base and subcosta more or less distinctly yellowish. Veins black and very slender. Stigma pale greenish or yellowish gray. Antennal joints, except the two basal ones, distinctly serrated or imbricated. Joint seven is somewhat the longest, while the third comes next in length; joints four and five are subequal in length, each somewhat shorter than the third; joint three provided with a quite regular, straight row of five to seven sensoria and one near apex of fifth and sixth joints.

The sexes have so far remained unknown, though the winter eggs, which resemble closely those of other aphides, were discovered on Portulaca and strawberry; they measure about 0.6^{mm} in length and are of a regularly oval shape. Their color is yellowish or greenish when recently deposited, which soon changes to jet black.

ENEMIES AND PARASITES.

Among the most active enemies of this as well as other plant-lice, may be mentioned the different species of Coccinellidæ or ladybirds, the syrphid flies, and aphis lions or lace-wing flies. The most effective, however, are the parasitic Braconidæ, belonging to the genus Lysiphlebus, among which *L. testaceipes* Cr. and *L. citraphis* Ashm. appear to be the most important in keeping this particular aphidid in check.

THE COTTON WORM QUESTION IN 1894.

By E. A. Schwarz.

A rapid trip made under the direction of the Entomologist through the more important parts of the cotton belt from Texas to Alabama showed that up to the middle of August there were no cotton worms anywhere in the whole cotton belt except in the bottom lands of Texas south of the Southern Pacific Railroad. But even there the worms were not found in alarming numbers, and it could be easily foreseen that even under the most favorable conditions the spread of the insects would not be a general one this season. Some individual farmers in the Colorado bottom, south of Eagle Lake, had found it advisable to poison their cotton fields, but these isolated places constitute all that I could learn of remedial measures taken by the planters this season.

From all information obtained on my trip, as well as from the records published within the past fifteen years, it is evident that the field work of the cotton worm investigation by the U. S. Department of Agriculture and the U. S. Entomological Commission coincided with the end of a period of a severe cotton worm visitation which culminated in the year 1877. In 1881 the worms were not generally distributed, and in the following years they were still more restricted. In the years 1889–1892 there was, however, a noticeable increase in the number of worms although they were not nearly as destructive as in the years 1877–1879, nor did they spread over the entire cotton belt as in the years mentioned. Some general application of remedies was practiced in Texas, Louisiana, Mississippi, and Alabama in 1889 and 1890, while in southern Texas it was found necessary to continue the poisoning for two years longer. Compared with the widespread and severe destruction brought about by the cotton worm previous to 1880 the last fourteen years constituted a period of comparative immunity from cotton worm injury. During this period there were years decidedly favorable to the development of Aletia, but there are various reasons why, in spite of favorable climatic conditions, the worms did not multiply and spread to any considerable extent. There can be no question that the change that has taken place in Southern agriculture is a very important factor in the cotton worm question. Before entering upon my trip I was of course aware that diversity of agriculture has taken a firm foothold in the South, but I was not prepared for the magnitude of the change brought about by diversified agriculture in the aspect of the southern fields.

Fourteen years ago, when I traversed the whole length of the cotton belt, there was in the bottom lands and on the prairies of southern Texas, in the Mississippi bottoms of Louisiana and Mississippi, in the canebrake region of Alabama—in fact just in those places which have always been considered as the centers from which the cotton worm spread over the rest of the cotton belt—hardly anything cultivated but cotton. To-day, in the same regions, the cotton fields are everywhere broken up by fields of corn and the present conditions may best be illustrated by a single example: Mr. George Little, of Columbus, Tex., had, in 1880, 500 acres of cotton under cultivation in the "bent" of the Colorado River. This year (1894) he has of the same area 300 acres in corn, 100 acres in Johnson grass, and only 100 acres in cotton. It is hardly necessary to say that this diminution of the cotton acreage, and especially the breaking up of the immense cotton fields of former years, has contributed largely to prevent an excessive multiplication of the worms and consequently the migration of the moths.

Another point which must have no little contributed to the immunity from cotton worms is the change that has taken place in the cotton plant itself since the development of the cotton-seed oil industry. In the richest portions of the southwestern cotton belt the planters cultivated in former years extremely tall and rank varieties of cotton bearing few seeds, but producing a long fiber; to-day, where cotton seed is worth from $9 to $15 per ton, they cultivate much smaller varieties, with short fiber, but producing plenty of seeds. The fields in the bottom lands look to day quite differently from what they did fourteen years ago. They are much more open, and one can readily walk or drive through them in all directions; in short, they do not longer offer the same favorable conditions for the earlier broods of the cotton worm as in former years.

Above all, there is one thing that more than anything else has deprived the cotton worm of its dread and power of destruction which in former years accompanied its apparently mysterious appearance. Only a little over twenty years have elapsed since the time when a few individual farmers commenced in a feeble way a rational warfare against the cotton worm, and even as late as 1879 many farmers despaired of ever being able to successfully cope with the worms. At that time, one generation after another of the worms was allowed to develop unmolested, and the poison only applied when it was too late, or almost too late, to save the crop. Today there is everywhere a greater watchfulness for the first appearance of the worms and a much greater readiness in applying the proper remedies. In short, on my trip through the South, in 1894, I was extremely gratified to find that this feeling of helplessness had entirely died out, and that throughout the cotton belt, wherever I stopped to make inquiries, the farmers uniformly and emphatically expressed the utmost confidence in their ability to fight the worms. "We regard the cotton-worm question as solved." These were the words with which a prominent planter in the Brazos River bottom, near Bryan, Tex., greeted me; and I heard these welcome words at many other places in Texas, Louisiana, Mississippi, and Alabama.

The remedies relied upon for the destruction of the worms are still the old ones, viz, Paris green and London purple, all other forms of arsenical mixtures, patented or not patented, having disappeared. But Paris green is immensely more in favor than London purple; in fact, during my whole trip I struck only one locality (the Brazos bottom land at Bryan and Hearne, Tex.) where the latter is extensively and successfully used. The reasons for this preference are not difficult to point out. Paris green was the first poison successfully used by the planters and has never given any reason for complaint; even a strong overdose, such as is likely to occur with the present mode of application, never does any harm to the plant, and a very minute quantity is equally effective. Moreover, the strongest point which, in former years, was urged in favor of London purple, viz, its cheaper price, has considerably lost in importance since Paris green is now sold at 15 cents per pound, whereas London purple is now at from 7 cents to 8 cents per pound. On the other hand, I found that the recent discovery of mixing London purple with lime, thus avoiding any scorching of the plants, has remained entirely unknown in the South. At any rate, the cost of material, which in former years formed one of the principal objections to the application of arsenical poisons in dry form, plays now rather a subordinate role, as will presently be shown.

A uniform mode of application of arsenical poisons prevails now throughout the cotton belt, and to anyone who has witnessed the mode of warfare against the cotton worm, as largely practiced in 1879 and 1880, the contrast must appear a most striking one. At that time the whole energy and ingenuity of the South as well as of the men employed in the government investigations of the cotton worm were directed toward the improvement of the application of arsenical poisons in liquid form. That all the numerous sprinklers, spraying machines, and nozzles, which were then invented, are now altogether discarded; that the two important inventions made in the course of the government investigation, viz, the cyclone nozzle and the kerosene emulsion, should prove to be preeminently useful against all sorts of other insect pests, but not against the cotton worm—all this forms certainly a remarkable chapter in the history of economic entomology.

To be sure everyone recognized at that time the superiority of the dry application of Paris green over all other remedies, but this method as then practiced was a very costly one, and the general desire of lessening the cost of and poisoning many rows at once led toward the efforts to improve the wet application. However, the magnitude of the chief objection to this method, although frequently alluded to in the published reports, viz, the difficulty in obtaining water on most cotton fields, had been greatly underrated. Moreover it was generally found that all spraying machines could, on account of their weight, only operate with difficulty on heavy soils and in wet weather; finally, the machines after having been used for one season were found to be rendered useless by rust the next season. Thus after one or two trials with the spraying machines the planters generally returned to the dry application, and the old method, viz, mixing the poison with a larger or smaller quantity of flour and sifting it over the plants by means of a bread sieve * still largely prevails with owners of small fields, especially in Texas.

The larger planters in the States visited by me have now generally adopted the "pole-system," which has been practiced by individual farmers as early as 1878. This method is now so universally known that a further explanation is unnecessary; it suffices to say that the pole itself, the mode of fastening the bags, the material of which the latter is made, vary greatly according to the individual experience of the planters, and that only one improvement—but a very important one—

* See Comstock's Cotton Insect Report, p. 246, and Riley's Report, p. 141.

has been generally introduced several years since.* It has been found to be perfectly feasible to use the poison in the pure state, i. e., without admixture of flour, thus saving the cost of the ingredients and the trouble in mixing. Some farmers still persist in poisoning only two rows of cotton at one time. The practice most prevailing now in Texas is to cover three rows at one time, i. e., the two rows between which the mule or horse is trotting, and adjacent parts of the two adjoining rows. Where cotton is smaller and the rows closer together it has been found practicable to poison more than 3 rows at a time, and as many as 8 rows have been effectually treated by planters in the canebrake region of Alabama in 1889 and 1890.†

The great waste of poison that is inevitably connected with the pole system, and the want of uniformity in the distribution of the poison over the plants, led to the invention of several machines intended for the even distribution of a given amount of dry poison over many rows. The increase of the worms in the year 1889 was the impetus that brought forth these machines. So far as I could learn three machines were patented in 1890—the "Roach cotton worm destroyer," patented by the James P. Roach Manufacturing Company, Vicksburg, Miss.; the "Richard's dry poison distributer," patented by Richards & Co., LaGrange, Tex. (U. S. patent, No. 423814, March 18, 1890), and the Brown machine, manufactured and sold by L. M. Rumsey & Co., St. Louis, Mo. Owing to the fact that these machines had not been used for at least two years, I had great difficulty in seeing any of them, and those I saw were in rather dilapidated condition. Owing to the high price ($50 and upward) very few of these machines have been sold, and on my trip I met only with a few planters who have used the Richards and Brown machines.‡ Circulars sent out by the inventors claim that in a favorable breeze the poison is blown from the machine over 15 rows of cotton or more, while I was informed by planters that from 7 to 8 rows can be satisfactorily poisoned during calm weather, but that owing to the unreliable negro labor the working of the machines in the field has to be constantly superintended.§

After passing through four of the most important cotton States I have come to the conclusion that these machines will never become very popular, mainly for the reason that the pole system has given such

* I have not been able to ascertain on my trip when and where this improvement was first suggested.

† The practice of dusting many rows of cotton with the pole system in the State of Alabama has been fully treated of by Prof. G. F. Atkinson in Bull. 17, Ala. Agr. Exp. Stat. (July, 1890). Owing to the absence of worms in 1894 I had no opportunity of witnessing this mode of poisoning.

‡ I did not see the Roach machine, and while at Vicksburg, Miss., I ascertained that the Roach Manufacturing Company had gone out of business. Professor Atkinson, in the bulletin above referred to, records some favorable experience with this machine, made by planters in Alabama.

§ A fourth machine of the same type is the Strawson Seeder and Fertilizer (U. S. patent, No. 411692, September 24, 1889, and previously patented in England). I am not aware that it has been used anywhere in the cotton States.

universal satisfaction and that the few simple implements necessary thereto can always be rigged up by the planters themselves at a moment's notice.

NOTES ON COTTON INSECTS FOUND IN MISSISSIPPI.

By William H. Ashmead.

(Continued from Insect Life, vol. vii, p. 247.)

ORDER HEMIPTERA.

The strong-nerved plant-bug (*Hymenarcys nervosa* Say). A few specimens seen feeding on the stalk.

The black plant-bug (*Proxys punctulatus* Beauv). Not rare. Feeds on the sap of the cotton plant, although other observers state that it will also attack the cotton-worm and other injurious caterpillars.

The single-spotted soldier-bug (*Euschistus pyrrhocerus* Herr.-Sch.). Not rare. Punctures new shoots and terminal branches.

The green soldier-bug (*Nezara hilaris* Say). Common on the stalk, sucking its juices. Also said to prey upon the cotton-worm, but I never detected one in the act.

The flat-horned coreid (*Chariesterus antennator* Fabr.). Common in all fields visited. Feeds on juices of the plant and is very active. Its egg is triquetrous, of a golden bronze color, with fine hexagonal reticulations and measures 1^{mm} in length; each side measures 0.6^{mm} in width. The young larvæ escape by gnawing a hole at one end, leaving behind a larval exuvium in making their escape. An egg taken on a cotton leaf August 15, hatched three days later. On account of having all the joints of the antennæ and the legs broadly dilated the larva is quite dissimilar to its parent.

The thick-thighed Metapodius (*Metapodius femoratus* Fabr.). Captured several times puncturing the young bolls, and while not especially numerous does considerable injury.

The egg has not been described, although frequently met with on cotton leaves. In shape it is very similar to that of *Chariesterus antennator* but much larger. It is 3^{mm} long by 2.2^{mm} wide, triquetrous, pale-greenish in color, with a submetallic luster, its surface being finely reticulated, the reticulations forming small hexagons.

The leaf-footed plant bug (*Leptoglossus phyllopus* Linn.) was of common occurrence. I observed it feeding on the bolls and in and on the blossoms, its preference being for young bolls. Sometimes as many as three or four together were observed feeding on a single boll.

The plain leaf-footed plant bug (*Leptoglossus oppositus* Say) was of rare occurrence on cotton.

The spined Neides (*Neides muticus* Say) is quite frequently met with on cotton leaves. It feeds, apparently, on plant tissues, but is never in sufficient numbers to do any appreciable injury.

The garnished plant-bug (*Geocoris bullatus* Say). Nymph and imago frequently found together feeding upon the tender terminal branches and in the blossoms, although not in great numbers.

The bordered plant-bug (*Largus succinctus* Herr.-Schf.). Numerous specimens of the newly hatched young of this species were taken on the under side of a cotton leaf and along the leaf petioles. They measured 2.5mm in length and were of a blue-black color, smooth and shining, but clothed with a short fine pubescence; the beak, except the last joint, two basal joints and legs, except the last joint of the tarsi, being red.

The swift capsid (*Calocoris rapidus* Say) is exceedingly common on cotton. It feeds in both the nymph and adult stage in the blossoms, upon the petals, and on the corolla.

The false chinch-bug (*Triphleps insidiosus* Say). Common in blossoms, puncturing the stamens.

The crowned soldier-bug (*Sinea diadema* Fabr.) was common in all the cotton fields visited, and does great service in destroying the cotton aphides, small caterpillars, including the cotton-worm, and other injurious species.

The eggs are deposited in clusters to the number of eight, ten, or more, on either the upper or lower surface of the leaf, and are closely held together in a sticky, dark honey-yellow, or reddish yellow secretion. Each egg measures about 1.2mm in length, or a little more than twice as long as thick, of a cylindrical shape, rounded at bottom and truncate at top. The top is surrounded by a broad, silky, white, marginal fringe, in the center of which is a cone-shaped cap or lid, which is removed when the young nymph makes its exit from the egg. A freshly laid cluster of these eggs, deposited August 7, hatched on the 17th, so that the duration of the egg state, under ordinary circumstances, can not be more than ten or twelve days.

The newly hatched larva may be described as follows:

Length 1.8mm, and of a piceous or shining black color; the antennæ, except at extreme base, the apical half of middle and posterior tibiæ and all tarsi being brownish-yellow, while the middle and hind legs, except as already noted, are dark piceous. The antennæ are cylindrical, 4-jointed, as long as the body, the first and last joints being nearly equal in length, while the second and third united are a little shorter than the first; the head is large, oblong and smooth, widest anteriorly, and as long as the thorax; the beak is stout, extending to between the middle coxæ; the thorax is divided into two lobes, each of which bears a pair of spines; abdomen short and not longer than the hind lobe of thorax; the anterior femora are longer and much stouter than the others and armed with strong spines above and beneath, their tibiæ shorter and slenderer, pilose and with three spines beneath; while the middle and hind legs are shorter and more slender, without spines, although, more or less pilose.

The clubbed soldier-bug (*Heza clavata* Guer.). Much rarer than the preceding and observed feeding upon the cotton aphis.

The bull-horned soldier-bug (*Repipta taurus* Fabr.). The sanguineous color, the two long horns on the head, and the smooth slender legs readily distinguish this species from all others found on cotton. Not rare. Observed feeding on the cotton aphis and the cotton Aleyrodes. In Florida I have seen it feed upon various aphides, and scale insects of the genus Lecanium.

The two-spined green soldier-bug (*Diplodus luridus* Stal.) is similar in its habits to those just mentioned; both the nymph and imago were found on cotton.

The social soldier-bug (*Diplodus socius* Uhl.). Rare. Habits are the same as allied species.

The mosquito-shaped soldier bug (*Stenopoda culiciformis* Fabr.) bears a superficial resemblance to some of the above species, but is very much larger and differs in many respects. It does much good in destroying various caterpillars, impaling them upon its short stout beak and sucking them dry.

The white Ormenis (*Ormenis* sp.) was seen upon cotton but twice, and is mentioned here only as an occasional cotton insect.

The common Lamenia (*Lamenia vulgaris* Fitch). Not uncommon on cotton, always sucking the juices from the stem. It is a small insect and the injury it does is slight and not apparent to the naked eye.

The grooved-legged Scolops (*Scolops sulcipes* Say). Only occasionally found on cotton, its food plant being usually coarse grasses, and the injury from the punctures of its beak is but slight.

The notch-backed tree-hopper (*Entilia sinuata* Fabr.). I was surprised to find this well-known membracid, distinguished at once by the deep notch or excavation on the middle of the back, occurring in numbers on the terminal shoots and newly-formed leaves of cotton. It seems thoroughly established on the cotton, and I observed it puncturing and feeding on the sap. The form was slightly smaller and darker colored than that found near Washington, but otherwise appeared identical. While I did not succeed in finding the eggs, I have no doubt that they are deposited under the epidermis of the young shoots and the whole transformation from egg to imago takes place on the plant. No appreciable injury from their attacks was observed, as they occurred only on plants of vigorous growth.

The white-margined sharpshooter (*Oncometopia costalis* Fabr.), an elongate black and white tree-hopper, was not uncommon on the stalk, puncturing and sucking its juices.

The wave-mark sharpshooter (*Oncometopia undata* Fabr.) is much more frequently met with than *O. costalis*.

The glassy-winged sharpshooter (*Homalodisca coagulata* Say) can always be found in plenty feeding on the stalk or a branch of the cotton. It invariably clings to the stalk with the head pointed downward and when disturbed flies off with a whirring noise. An account of its life-history by Riley and Howard is given in INSECT LIFE (vol. V, p. 150).

The yellow-headed tree-hopper (*Diedrocephala flaviceps* Riley) is better known as a wheat insect. I took several specimens feeding on cotton.

The crafty tree-hopper (*Diedrocephala versuta* Say) is widely distributed throughout the United States and has many food-plants. I found it very common on cotton in Mississippi, its preference being for the terminal sprouts and tender, newly-formed leaves. Although quite numerous no serious injury seemed to follow its punctures.

The irrorated sharpshooter (*Aulacizes irrorata* Fabr.). Frequently found associated with *Homalodisca coagulata*, which it somewhat resembles in appearance and in its habits.

The garnished jassid (*Phlepsius excultus* Uhl.) is common all over the South, and its natural food plant is evidently some native grass. It was only occasionally observed on cotton.

The half-clothed jassid (*Eutettix seminudus* Say) was often taken on the stalk of the cotton, and was observed to feed upon the juices of the plant. It is an omnivorous feeder, and will probably never become so numerous on any one plant as to be considered a serious pest.

In addition to the above, I took feeding on cotton, *Cicadula 4-lineata* Forbes, *C. 6-punctata* Fabr., and *Chloroneura* sp.

The cotton aphis (*Aphis gossypii* Glover) was exceedingly common, but was prevented from increasing too rapidly by its natural parasite, *Lysiphlebus testaceipes* Cr., many of which were bred from it, and by numerous predaceous insects belonging to the families Coccinellidæ, Chrysopidæ, Hemerobiidæ, and Syrphidæ.

The cotton Aleyrodes (*A. gossypii* Fitch). I see no valid reason for believing this insect anything else than the species described by Fitch under the name of *Aspidiotus gossypii*, he evidently having mistaken a dried pupa of an Aleyrodes, attached to a leaf of cotton, for a coccid belonging to the genus Aspidiotus.

This species lives on the leaves, and toward the latter part of July and to the middle of August becomes exceedingly numerous, many hundreds occurring on a single plant, and when disturbed they fly up in powdery clouds.

The eggs, from fifty to a hundred or more, are laid on the under side of a leaf, without any regard to order, resembling those of the orange Aleyrodes, only somewhat smaller, with a shorter pedicel, paler color, and with the surface perfectly smooth and shining. These hatch in from four to five days, and the young larvæ attach themselves to the leaf and begin feeding on its juices.

Although occurring by the thousands, I could detect but slight injury caused by these insects.

ORDER LEPIDOPTERA.

The most serious insect enemies to cotton are found in this order. Many insects belonging to other orders live and feed upon cotton, but as may be seen by these brief notes, these do not as a rule become serious pests, and while it is important that they should be destroyed whenever practicable, no apprehension should be felt on their appearing occasionally in the cotton fields.

No caterpillar of any butterfly, except *Thecla pœas* so far as I am aware, feeds upon cotton, although several species of butterflies are found in numbers flying through the cotton fields, alighting ever and anon upon the cotton blossoms to feed upon their sweets.

Three butterflies, *Callidryas eubule* Linn., *Terias nicippe* Cram., and *Euptoieta claudia* Cram., are so frequently seen in cotton fields throughout the whole cotton belt that it is but natural for the cotton grower to suspect them to be genuine cotton insects. They are mentioned here as of special interest on account of a remarkable theory in regard to one of them, originating and held by Mr. John W. Brown, the planter with whom I was staying, namely, that *Callidryas eubule*, which he called the "vandal fly," produces the boll-worm (*Heliothis armiger*). Notwithstanding I explained to Mr. Brown the utter impossibility of such widely separated species originating from one another, the first belonging to the section Rhopalocera, or butterflies, and the second to the section Heterocera, or moths, he most strenuously held to his theory, and claimed to have proven it by a series of experiments carried on for a period of three years.

It is scarcely necessary to state that at no time did I believe such a remarkable theory. Mr. Brown, however, was so positive in his statements about rearing his "vandal-fly" that I, for a time, thought it quite probable the caterpillar might feed on cotton, and my experiments with it, therefore, were conducted more toward proving or disproving its food-habits.

I shall enter into no details respecting my experiments. Suffice to say, several efforts were made to induce the butterflies to oviposit on cotton, but all proved unsuccessful, the "vandal-fly" again and again refusing to lay its eggs on cotton. I ascertained that its food-plant was Cassia and allied species; and, on procuring some wild coffee (*Cassia occidentalis*), had no difficulty in getting it to oviposit. I inclosed the butterfly in a gauze net with this food plant, and from the eggs thus obtained succeeded in hatching the young larvæ.

It is in the section Heterocera, or moths, that we find the most serious pests of the cotton plant, but only three species cause the planter any serious apprehension, and when they appear he should at once resort to the best remedies known for their destruction, or he will run the risk of losing his crop. These are the larvæ or caterpillars of three nocturnal moths, namely, the boll-worm (*Heliothis armiger* Hübn.), the cotton-worm or cotton leaf-worm (*Aletia argillacea* Hübn.), and the cotton cut-worm (*Prodenia lineatella* Harvey). The habits and destructiveness of the first two have been the subject of such thorough investigation by this Department and the U. S. Entomological Commission that very little remains to be discovered respecting them, and they, therefore, need not be mentioned here.

The cotton cut-worm (*Prodenia lineatella* Harvey) is not mentioned among cotton insects by either Comstock or Riley, although in reading through the correspondence of the Department, as published in their reports, frequent allusions to its ravages can be found. Mr. F. W. Mally (*see* Bull. 24, Div. Ent., U. S. Dept. Agr., p. 24) appears to have been the first to notice its occurrence on cotton, but describes neither the worm nor the moth. He says: "This fleshy worm was observed entering into nearly grown bolls and feeding on their contents. Its ravages are exactly like those of a nearly grown boll-worm, and the two can not be distinguished." This statement is scarcely correct, as in its earlier stage it is totally dissimilar to the boll-worm, and in its final larval stage there is only the most superficial resemblance. It is not as a destroyer of the boll, however, that it is to be feared, but rather as a cut-worm on young plants in early spring. In the latter capacity, should climatic and other conditions favor its increase, it may yet become a most destructive pest. I first met with it July 26, in the young larval stage, feeding in the newly forming boll. It had not only eaten irregular holes through the outer sheaths of the boll and the petals of the flower, but had also gnawed sufficiently into the corolla to destroy it.

Mr. J. W. Brown recognized this cut-worm and stated that at this season it was rare. They were quite numerous earlier in the season and very destructive, attacking young cotton-plants as they appeared above ground, acres being sometimes destroyed and having to be reset to secure a good crop.

It was successfully bred to the imago. In one case the larva pupated August 4, the moth issuing on the 16th; in another the pupa stage was reached August 6, the moth appearing on the 19th, thus giving twelve and thirteen days, respectively, as the duration for the pupa state.

One of the larvæ, after the last molt, measured 1.25 inch in length. It had a dirty white or yellowish white dorsal lateral line, with two subtriangular or semilunate velvety black spots on dorsal segments 2 to 11, a V-shaped mark on cervical shield, and a large black spot over the fifth spiracle; there is a pale indistinct median dorsal line that becomes entirely obliterated on segments 3 and 4, and distinct brownish stigmal lines; laterally, below the stigmata, are numerous granulated white spots; the labrum is broader than long and triangularly emarginated; while the legs are green, immaculate, with black claws.

The larvæ of three or four species of geometrid moths, termed "measuring worm," were also taken on cotton, but were rare and did but slight injury to the plant.

ORDER DIPTERA.

The species in the family Asilidæ are predaceous on other insects, seizing them upon the wing and alighting and sucking their juices. Many of them are large and powerful and sting quite severely with their strong, piercing proboscis. The majority of the species appear devoid of fear, and will attack a bee or wasp as readily as a moth or fly. An asilid in capturing a bee or wasp seizes it immediately back of the head so that the abdomen is extended forward and it can make no defense with its sting in its effort to escape.

The Germans call these insects "robber-flies," and several species are common in the cotton fields. I have observed them seizing moths, beetles, dragon-flies, bees, etc. The following species were taken on the Brown plantation: *Diogmites platypterus* Loew, *Erax lateralis* Macq., *Erax ? bastardi*, *Atomosia puella* Wied., *A. rufipes* Macq., and *Holcocephala abdominalis* Say.

The habits of the Syrphidæ are varied, although many of them in the larva state are beneficial, as they feed upon destructive aphides. The following were observed on cotton: *Mesograpta polita* Say, *Eristalis vinetorum* Fabr., and *Baccha fuscipennis* Say, all on the blossoms feeding upon pollen, while the larva of the last-mentioned was feeding upon the cotton aphis.

The larva of *Mesograpta polita* Say was also common on corn, feeding on the pollen and juices of the plant. The blades of the corn were covered with its puparia. From these I bred two parasites, a cynipid (*Solenaspis hyalinus* Ashm.) and a chalcidid (*Encyrtus mesograptæ* Ashm.).

Pipunculus subvirescens Loew. was found associating with certain jassids affecting cotton, and I believe it to be parasitic on *Diedrocephala versuta* Say.

Several distinct species of Tachinidæ were captured on cotton, but as none were bred, no effort has been made to identify them.

Phora aletiæ Comst., formerly supposed to be a true parasite of the cotton-worm, was common in all the fields, and lives in almost any decaying animal or vegetable substance, the frass and excreta of the boll-worm being a favorite place in which it deposits its eggs. I bred many specimens from such places, as well as from nothing but decomposing cotton leaves, the excremental pellets of various larvæ, and from decomposing insects. It is certainly only a scavenger, and not a true parasite.

ON THE DISTRIBUTION OF CERTAIN IMPORTED BEETLES.

By F. H. Chittenden.

In the list of Coleoptera collected by the writer in the foreign agricultural exhibits at the World's Columbian Exposition, and published by Professor Riley in Insect Life (vol. VI, pp. 218–221), several species were only partially identified. Since the publication of this list the doubtful forms have been given further study, and it is now possible to furnish the names of some of the more important species, as well as some information regarding their synonymy and geographic and economic status. At the same time I have thought it well to include in this connection certain other exotic forms that have recently been received at this office, species that have been introduced in this country, or that are often brought living to our shores. Some of the more injurious of the species here considered have been kept under observation, and more detailed accounts of them are in course of preparation. In the determination of the more difficult forms I am indebted for assistance to Dr. David Sharp, to Dr. George H. Horn, and to Mr. E. A. Schwarz.

Pharaxonotha kirschi Reitt.—The most interesting of all the imported species, from an economic as well as zoologic standpoint, is the one mentioned at number 12 of the list just referred to, and found in corn meal and edible tubers from Mexico and Guatemala. This species was first classified with the Cryptophagidæ by Reitter, who published a description in the Deutsche Entomologische Zeitschrift in 1875 (vol. XIX, p. 44), but afterwards removed the genus to the Erotylidæ. The types were found in Silesia, Germany, but were brought from Mexico. I know of no record of this insect having established itself in Europe, but it is included in Reitter's recently published Catalogus Coleopterorum Europæ, and from what I have learned of its habits I am firmly of the belief that it is only a matter of time when it will be introduced in our Southern States. The species is also known from Brazil.

Dinoderus truncatus Horn.—Of scarcely less importance than the preceding is the species numbered 25, found in grain and edible tubers of the same exhibits. As the original description of *truncatus* (Pr. Am. Phil. Soc., vol. XVII, p. 550, 1878), was drawn up from mutilated specimens, from California, Dr. Horn has kindly compared our specimens with the types, and writes that they can not be separated. There are two divisional records of the importation of this insect in the United States, but there is no evidence that the species has obtained a foothold within our territory.

Dinoderus bifoveolatus Woll.—This insect was taken at the Columbian Exposition, but not having been found in the foreign exhibits it could not properly be included in the list of such species. It was taken on the lake shore, where it had been washed up by the waves. The species was first identified by a recently-published table for the determination of the Bostrychidæ of Europe and adjoining countries, given by Vl. Zoufal in volume XIII of the Wiener Entomologische Zeitung (p. 41), and this determination has been verified by Dr. Horn, who also confirms the identity of this species with *Dinoderus brevis* Horn, by which name we have always heretofore known the insect.

The species differs from all the others that have been referred to this genus by its eleven-jointed antennæ, also by its short form, whence the name *brevis*. At first glance it would readily be mistaken for a Xyleborus. Under this latter name the species was described by Dr. Horn in 1878 (Pr. Am. Phil. Soc., vol. XVII, p. 550) from material received from New Orleans, La. In INSECT LIFE (vol. VI, p. 274) it is mentioned as having been received from Kingston, Jamaica, in bamboo, and we have received it from other sources, also boring in bamboo.

It is somewhat doubtful whether this species is entitled to be added to the list of Coleoptera common to Europe, North America, and northern Asia, as its naturalization in this country has not yet been established. Zoufal gives the distribution simply: Europe, Asia, North America. There is a large series in the National Museum collection recently received from Japan.

Lyctus brunneus Steph.—The Lyctus mentioned as number 31 in the list has been identified by Dr. Sharp as the above species. A comparison of this with our North American representatives of the genus shows that it is distinct.

At the Exposition it was found in several jars of rhizomes and roots in the Paraguayan exhibit, of which the following bore labels: Peppertree (*Schinus molle*); tayuya (*Trianospermia* sp.), and yerba del lucera (*Conyza* sp.).

There are records of the occurrence of the species in middle and southern Europe, Japan, Madeira, and the West Indies, but it is not known to occur in the United States.

Lyctus unipunctatus Hbst. (*canaliculatus* Fab.)—Mr. Schwarz has called my attention to the identity of this European species with the *Lyctus striatus* Melsh. of American collections. In Europe the species is widely known, but from the fact that considerable confusion has always existed in regard to the identity of the various North American representatives of the genus, the distribution of this particular one in America has not been defined.

Specimens of the Lyctus mentioned by Dr. Hagen in the Canadian Entomologist (vol. XVIII, p. 154) as injuring supple-jack (a vine imported from Jamaica and used as walking-sticks) are in the collection of Messrs. Hubbard and Schwarz, and are of this species. The beetles, Mr. Hubbard informs me, continued at work in the supple-jack, in spite of every effort to eject them, for about fifteen years, and until the entire lot was "powder-posted" and completely ruined.

In local collections the species is represented from Massachusetts, New York, Ohio, Iowa, Michigan, North Carolina, Texas, California, and the District of Columbia.

Spermophagus pectoralis Sharp.—The bean-weevil mentioned in the list at number 49 has been identified by Dr. Sharp as the above-mentioned species. It is described in Biologia Centrali-Americana (Insecta Coleoptera, vol. V., p. 492), and the distribution given is: Mexico, Guatemala, Nicaragua, and Panama. At the Columbian Exposition it was also found from Brazil. As it breeds like our common bean-weevil for successive generations in stored beans, and is congeneric with several species native to the United States, its introduction is to be feared. A supply of the beetles and of the infested beans that were brought to Washington from the Exposition failed to survive the winter; but no great significance attaches to this, as I have noticed that our common bean-weevils "die out" when breeding in small bottles or jars with a limited food supply.

The North American species of the three genera, Tribolium, Echocerus, and Palorus, have been treated by the writer systematically in revisional form in a paper to be published in the Proceedings of the National Museum, but as the subject of the distribution of these species outside of our own faunal limits has not been discussed, a few remarks on this head will not be out of place. The injurious forms, of which there are five species, are destructive to grain, flour, and meal, and are popularly known as "flour weevils."

The three species of Tribolium have been separated in our local collections with rather surprising results as regards distribution.

Tribolium confusum Duv. derives its name from the fact that the species has been generally confused with *ferrugineum*. Prior to the appearance of Duval's description, published in 1868, both species were known under the latter name, and until within the year the same has been the case in America. As a consequence our literature, mostly treating of *ferrugineum*, may refer to either species.

At the Columbian Exposition a large series of the genus was gathered from many exhibits from nearly all of the warmer countries represented in the Agricultural Department. Of these all but a small lot from Liberia were identified as *ferrugineum*. In the National Museum collection the order was reversed, *ferrugineum* being represented by only a small series while of *confusum* there was an unlimited supply. Duval and other writers of his time appear to have known *confusum* only from the south of France, and in the 1891 edition of the "Catalogus Coleopterorum Europæ" we find only France, Germany, and Italy as its distribution in Europe. E. A. Fitch and others, however, had previously recorded this insect from England. There are records of its occurrence in Siberia, Mexico, and Japan, and we may now add Liberia, and Montserrat, West Indies. In the United States there is undoubted proof of its occurrence over nearly the entire country. I have identified specimens from Michigan, New York, Pennsylvania, Massachusetts, District of Columbia, West Virginia, Kansas, California, New Mexico, Arizona, and Dakota.

Tribolium ferrugineum Fab.—Of this species I have seen specimens from North Carolina, South Carolina, Georgia, Florida, Louisiana, Texas, Nebraska, Oklahoma, and California. Although all except our latest foreign records of distribution are unreliable, it is undoubtedly widely distributed over Europe and Asia, and its recorded occurrence at Panama, Hawaii, Guadeloupe, Madeira, and the Canary Islands is probably in all cases correct. At the World's Fair it occurred in exhibits from Mexico, Guatemala, Costa Rica, Curaçao, Argentine, Brazil, Paraguay, and Siam. Mr. Hubbard also has it from Jamaica, West Indies.

Tribolium madens Charp.—It has been repeatedly said of this species that it is found abundantly wherever meal or grain is stored, but it is certainly quite rare in American collections, and I know of no authentic record of its occurrence in flour or meal, or of its breeding indoors.

In Europe it is recorded from France, Germany, Italy, and Russia. Redtenbacher, who described this species as *Margus obscurus*, says that it is "very rare in beehives and under poplar bark." The larva is probably subcortical, but nothing of the breeding habits of the species appears to be known.

Mr. Schwarz has specimens taken June 26 and July 4 at Marquette and Eagle Harbor, Mich., all found on the shores of Lake Superior. It was also taken June 17, at Park City, Utah, at an elevation of about 8,500 feet, by beating in the woods. Snow was still on the ground at this time. A single specimen was picked up in the neighborhood of Washington, D. C.

Very recently Mr. C. P. Gillette sent us for identification specimens of this insect. In response to our inquiry relative to the source from which they were obtained, he writes that of the four individuals found all were taken separately in general collecting at Fort Collins, Colo. One was found under a board October 30, one while sweeping alfalfa, May 19, and the other two in June and July. It has also been recorded from New Mexico, Pennsylvania, and Hamilton and Ottawa, Canada. It is not known in Mexico and Central America.

A glance at the above localities will show that the species has most often been met with in the North, and it is not impossible that it is indigenous in boreal Europe and America. It is certainly not tropical.

Echocerus (*Gnathocerus*) *cornutus* Fab. is cosmopolitan in the broader sense of the term, but in North America appears to be somewhat restricted in its distribution. In the Californian region it is firmly established both indoors and, in the San Diego district, also under bark. The species is said to occur in New York, New Jersey, Louisiana, and Alaska, but it is doubtful if it has obtained a permanent footing as far north as Alaska. The species is also known from Mexico, Guatemala, Brazil, and Chile on this continent, from New Caledonia and Hawaii, and is rather common in Europe, particularly in the southern portion of the continent.

Echocerus maxillosus Fab., represented in the list at 55, from Brazilian exhibit, is recorded also from Mexico, Lower California, Guatemala, Nicaragua, Chile, Venezuela, Colombia, West Indies, New Caledonia, Madeira, and the Canary Islands. Unfortunately for our records of its distribution in this country another species has been very generally confused with it. It is abundant in the South, where it occurs both indoors and in the field. I have living specimens from the District of Columbia and have seen a series from Kentucky and Ohio. It probably occurs with us still farther north.

European writers, including Fauvel, have considered these two species as of oriental origin, and if this supposition be correct they were evidently introduced in South and Central America at a very early period. *E. maxillosus* was described from South America nearly a century ago and has only in recent years been catalogued from Europe. Its occurrence there was not mentioned in the Munich catalogue, published in 1869, and in the Catalogus Coleopterorum Europæ it is recorded only from southern France.

Echocerus dentiger Chittn., a species which I have recently separated from *maxillosus*, is apparently native to this region, extending northward as far as Pennsylvania. *E. curvicornis* Champ., of which *E. recurvartus* Chittn. appears to be a synonym, is evidently indigenous to Mexico and the Florida Keys, and possibly also to the entire Antillean region. *E. analis* Champ. has been described from Guatemala. Is it not probable that all these species originated on this continent?

Palorus melinus Hbst. (*depressus* Fab.), mentioned in the list at number 53, from Brazil, has been for many years firmly established in the United States. The first record of the insect's occurrence in this country appears to be in Bulletin No. 2 of this Division, where it is stated to have caused much annoyance in 1882 in a mill at Detroit, Mich. It has also been recorded from Texas, Kansas, and Pennsylvania, and in addition there are specimens in the National Museum from Tallahassee, Fla.; Selma, Ala.; Illinois; Fresno, Cal., and Brooklyn, N. Y. I have also seen specimens from Kansas and Georgia, and it has been twice found in the District of Columbia. In September of the past year living examples arrived from Lebanon, Ind. I have at hand records of its occurrence in Mexico, Australia, "South America," and probably Damaran Island, and Morocco.

In the Catalogus Coleopterorum Europæ the specific name *depressus* Fab. is retained, but, according to Gemminger and Harold, Herbst's description appeared in 1784, while that of Fabricius was not published until six years later. Herbst's name therefore has priority.

Calandra linearis Hbst. is the species numbered 62 in the list. It is occasionally picked up in the southern Atlantic and Gulf States, but, in my opinion, should not be inserted in our faunal list until it can be ascertained that the species breeds in some plant that grows within our faunal limits. This species was described nearly a century ago from the West Indies, where it had been introduced with its food-plant, the tamarind. This plant, *Tamarindus indica*, although attributed to India, is positively asserted to be indigenous in Africa and Australia, and by introduction has been widely diffused through the tropics, and is cultivated for its fruit and timber and for shade and ornament. It is grown also to some extent in Florida, and in greenhouses elsewhere, but is nonproductive within the boundaries of the United States. *Calandra linearis* develops in the seeds within the pods of the tamarind, and this plant appears to be its natural and only food-plant. It remains to be learned whether or not it can breed in stored grain or other seeds.

It is probable that the species has been introduced wherever its food-plant grows. Specimens have been received during the past two years from Brazil (Columbian Exposition), from Mr. T. D. A. Cockerell, from Kingston, Jamaica, and from Mr. Hubbard, from Montserrat, West Indies. Some of the latter have been kept breeding in tamarinds for nearly a year. The adults feed on some of the seeds of cereals that have been confined with them, but there is as yet no indication of the possibility of their breeding in them.

Calandra rugicollis Cas. and *Palembus ocularis* Cas., both described from an indefinite locality in Florida, are in the same category with the above. The first was described from a single specimen taken in southern Florida, and its food-habits and origin are unknown. The second is undoubtedly exotic, and as its only known food-plant is the same as that of *Calandra linearis* it is quite possible that these two species have a common origin. It was received from Kingston, Jamaica, November 17, 1892, from Mr. Cockerell, and during the present year from Mr. Hubbard, from Montserrat, in both cases in the pods of tamarind infested with *Calandra linearis*. About ten years ago Mr. H. K. Morrison found both species at Key West, Fla., and a good series of this lot came into the possession of the late Mr. W. Juelich, from whom Captain Casey received the type specimen.

The two exotic scolytids, *Cryphalus jalappæ* Letz. and *Coccotrypes dactyliperda* Fab., are also in this category. The former evidently lives exclusively on commercial jalap and the latter on seeds of dates or nuts of other palms.

INJURIOUS INSECTS AND COMMERCE.*

By L. O. Howard.

That in commerce is the wealth of nations is a very old and well-known truth; but that in commerce is also the means of destroying the wealth of nations is an equal truth which has only become apparent in comparatively late years. It is by commerce that injurious insects, noxious weeds, and fungous and bacterial diseases of cultivated plants have become and are becoming distributed over the face of the globe. Animals and plants are naturally restricted in their spread; they are confined by nature to certain so-called faunal and floral regions or zones. Progressive agriculture and horticulture, however, have interfered with this natural restriction, and by artificial cultivation and forcing have succeeded in growing crops far away from their natural surroundings. Their original natural enemies have followed these crops, and, brought into contact with new insect enemies and diseases, these have accommodated themselves to the new-coming plants, already

* Read before the Peninsula Horticultural Society at Dover, Del., Jan. 11, 1895.

less resistant through removal from their proper homes. Without the assistance of commerce the pests of one region would always be lacking, to a greater or less extent, in another; commerce, however, distributes them freely. In supplies of grain or other food it has carried everywhere the insects which injure stored grain, until nearly all of these insects have become practically cosmopolitan. In the more recently developed commerce in nursery stock, and the still more recently developed long-distance trade in fruit, brought about by rapid transit and cold storage, we have carried, and are carrying, potential destruction in almost every carload or ship cargo. To such an extent has this distribution of injurious insects been brought about, that it is difficult in many cases to ascertain the original home of many species.

Horticulture is perhaps the greatest sufferer from this commercial distribution of insect enemies of plants, and the injurious insects most readily distributed are the scale insects, since these creatures remain attached to the plant throughout their entire life-round. In the United States we have, in round numbers, more than one hundred species of scale insects, and of these, probably forty have been introduced from other countries. These forty, moreover, include nearly all the species of great economic importance. It seems to be a rule that introduced species in this country become far more injurious than in their native home, and far more injurious than the species which already exist here. It is unnecessary to discuss at length any of the reasons for this state of affairs, and in fact, they are not well understood. In many cases it is due, partly at least, to the fact that the imported species did not bring their parasites with them, while in others we can only attribute it to the fact that through long association our native crops have become more or less immune to the attacks of native species, but are less resistant to new enemies.

A few familiar instances may be mentioned. The oyster-shell bark-louse of the apple is a European species introduced into this country toward the close of the last century. It speedily became more destructive than the native scurfy bark-louse, and during the first half century of its existence upon American soil was the principal insect enemy of the apple crop; of late it has become less important. The red scale of the orange in Florida is an introduction from the West Indies or South America; the red scale of the orange in California is an introduction from the Pacific islands. The fluted scale or cottony cushion scale of the Pacific Coast was originally an importation from Australia. The common flat scale and the hemispherical scale of our northern greenhouses and our southern orchards are European species. The San Jose, or pernicious scale, which for twenty years has been seriously damaging the orchards of the far west, and which, during the last few years, has made a most destructive onslaught on many of our eastern orchards, is also probably an Australian species.

But the scales are by no means the only insects injurious to horticulture which have been introduced. The plum curculio, it is true, is a native, and so is the apple maggot, or railroad worm. But the Codling moth is European, the principal currant worm is European, the grape-berry moth originally inhabited the Mediterranean regions, and a number of others have been introduced from different parts of the world. Our danger is by no means past; fresh introductions are coming all the time. Many of these are for a time limited in their distribution, but all are capable of spreading throughout a large portion of the country. The European gypsy moth, one of the most ravenous defoliators of fruit and shade trees known to entomologists, has for the last ten years made itself so conspicuous in parts of Massachusetts that the State government has expended over $300,000 in attempting to stamp it out. The European leopard moth, now confined to the immediate vicinity of New York City, is an insect which, in the larval state, bores into the twigs of many trees, including fruit trees, and threatens to spread and do great damage. A new pear borer, imported in nursery stock from Europe, has begun to spread in the State of New Jersey, and this is one of the most serious enemies to an important crop which is known to us. It is capable of killing a vigorous pear tree outright in two seasons.

The injurious insects of Europe are well known, and we are familiar with the species which are liable to be imported. Of the injurious insects of other foreign countries with which the United States is in active commercial relations, we are, however, in comparative ignorance. In many of them scientific research is comparatively at a standstill, and the ascertaining of the proper information is difficult. My predecessor, Professor Riley, made an effort to learn something of the injurious insects of Japan through the temporary appointment of a special agent in that country, and I have recently made a similar effort to learn something of the injurious insects of Mexico, anticipating that the new activity in railroad building from the United States into this country can not but result in the eventual carrying of new injurious insects across our borders. The latter investigation was started none too soon, since already a most serious enemy to the cotton crop has crossed from Mexico to Texas and threatens great damage.

But it is not alone against foreign countries that we must be on our guard; interstate commerce is distributing injurious insects as well. The sudden appearance of the San Jose scale in the East, just mentioned, is a case in point. The harlequin cabbage-bug is steadily advancing from the South. The potato-tuber moth bids fair to continue its eastward progress from Colorado, into which State it has been brought from California. The sweet-potato root-borer is working up through our southern states from Florida and Texas. The clover root-borer and the clover-leaf weevil are working westward through Indiana and Michigan. The hop plant-louse and the pear blister-mite, well known eastern insects, have recently made their first appearance on the Pacific Slope, and the well-known eastern spread of the Colorado potato-beetle from the plains of the West, at first slow and accomplished only by the flight of the perfect insect, but afterwards carried on in great jumps, assisted by the railroads, is a startling case within the recollection of everyone.

I have said enough, perhaps, to indicate the great importance of this subject and the absolute necessity of the immediate and serious consideration of the question of defense. The employment of state entomologists or the attaching of men trained in the study of insects to the staffs of the state experiment stations, is the first step. The majority of the injurious insects of the regions which these men supervise become known to them sooner or later, and in most cases a new insect pest will be brought to their notice. It will, however, very often happen, and, indeed, has happened, that a new insect will have gained a foothold and will have achieved a considerable spread before the fruit-growers or farmers become aware of the fact, and before entomologists learn of it, so that certain local measures restricting the importation or sale of uninspected material which may carry injurious insects are necessary.

The greatest sufferers from imported injurious insects have, perhaps, been the fruit-growers of California, and this State was naturally the first to pass quarantine and inspection laws. The first efficient regulation of this character was passed by the legislature of California in the spring of 1881, and was entitled "An act to protect and promote the horticultural interests of the State." This law has since been amended and enlarged, until its present effect is eminently satisfactory. Nursery stock, and fruit in particular, have been invariably inspected with care, quarantined if found infested, submitted to thorough fumigation with hydrocyanic acid gas, and confiscated and destroyed if this is found to be necessary. Moreover, penalties are enforced for the exposing of infested fruit for sale in the markets. Cargoes arriving at California ports are examined, and nursery stock coming by rail from the East also receives inspection. California is thus reasonably well protected, but, unfortunately, there is nothing in her law which prohibits the sending of infested fruit or stock to her less fortunate eastern neighbors. A man will be fined if he exposes for sale in San Francisco or Los Angeles a crate of California pears covered with the San Jose scale, but if he boxes up his crate and sells it to a merchant in Chicago or New York he will get his price, with no penalty, except, let us hope, qualms of conscience.

Following the adoption of the California regulations, several of the Australian colonies, New Zealand, and Cape Colony adopted restrictive regulations. Later Oregon, Washington, and Idaho in this country adopted similar measures, and British Columbia has, within a year, revised her acts concerning the Provincial Board of Horticulture, and established a series of rules and regulations for the purpose of preventing the spread of contagious diseases in orchards, gardens, among fruit and fruit trees, for the prevention, treatment, cure, and extirpation of fruit pests, etc.

The subject of similar regulations in the Eastern States has been agitated to a certain degree. Objections of greater or less weight have been urged, but the necessity for some regulation of traffic has not been given anything like its proper prominence. The ablest discussion of the question which I have seen was printed editorially in Garden and Forest during the past fall. The great difficulty of establishing an official quarantine on the borders of every State in the Union is pointed out, and it is shown that the legitimate outcome of any effort at inspection which should aim to be thorough would probably be the ultimate expenditure of a sum larger than the loss occasioned by the ravages of the pests themselves. The important point that legislation in individual States can be locally beneficial only when there is a strong public sentiment behind it is noted, and the probability of rousing a spirit of individual independence and a sentiment of retaliation on the part of one community against another is pointed out. The final conclusion is that the main thing for the Federal and State governments to do, is to give liberal support to the scientific study of injurious insects and plant diseases.

It will be found difficult to frame any legislation which will avoid the objections thus urged, but should the enlightened public sentiment of the horticulturists and agriculturists of any given county in the eastern United States see the necessity of enforcing insecticide and fungicide work, or should an emergency arise which would demand immediate remedy, there exist no laws under which operations could be begun. The immediate adoption by all Eastern States of a law which shall declare, as does the Idaho law, that it is the duty of every agriculturist to adopt and apply, from time to time, proper methods for the destruction of insects; which gives the governor or ruling body of the State Board of Agriculture power to appoint county commissioners upon proper request, and which shall further provide that these commissioners shall have the power to enforce remedial work when horticultural interests are threatened through the neglect of individuals, be the details what they may, should be urged by all prominent bodies of horticulturists. Another necessity is the passage of a law providing a penalty for the knowing sale of nursery stock or fruit affected by injurious insects, although the necessity for such a regulation will be obviated to a great degree if horticulturists will demand a written guarantee of non-infestation with every invoice of nursery stock purchased.

In States containing ports of entry, regulations should be adopted which will provide for the inspection and quarantining of infested substances from abroad. These regulations may be based upon the California law. This is perhaps the crying need of the present time. The western coast is reasonably well protected; the eastern coast has only the protection afforded by the employment in almost every State of a trained entomologist. From our Canadian border there is no great danger, and the States of the northern tier almost without exception employ State entomologists. The Mexican border is unprotected, and legislation on the part of Texas is most desirable. Pending such legislation, the Department of Agriculture has temporarily employed an agent upon the Mexican border, whose prime business is to study the cotton-boll weevil recently introduced, but also to watch after other possibilites in the way of imported pests. This same agent, during the fall of 1894, traveled extensively through northern Mexico, and sent in an account of all the injurious insects prevalent in the cultivated regions which came under his observation, and from this account it appears that there are a number of species which should be rigidly guarded against.

The matter of interstate protection is a more difficult one. The objections which have been urged by the editor of Garden and Forest are very sound. Such a thing as interstate quarantine seems to the writer, after careful consideration of the subject, to be impracticable. Where, however, such State regulations as we have just outlined are in force, where intelligent and efficient county commissioners have been appointed in each county, and where the law has been properly worded as to the details of the authority of these county commissioners, there is no reason why the practical effect of a quarantine without its serious objections may not be attained.

Given present conditions, therefore, does it not become the plain and immediate duty of influential agricultural and horticultural organizations to agitate the subject of legislative protection? Should they not at once and in all of our Eastern States establish committees to at least give the question careful consideration and, if thought advisable, to draft bills for presentation before their legislatures? Reviewing the field I am convinced that immediate action is desirable, and that the sooner any given State passes a law enabling its State board of agriculture to handle emergencies, at least, by county commissioners, the sooner will that State be in a position to protect efficiently and intelligently her agricultural and horticultural interests.

With one word more to the individual horticulturist, let me close. There is no doubt that the prime agent in the distribution of injurious insects, particularly scale insects, is the nurseryman. Too frequently an orchard is handicapped from the start by the negligent planting of stock which bears some destructive scale insect, or contains some injurious borer, or bears the eggs of leaf-feeders or other enemies. Not a single tree should be set out without the most careful examination, and in fact we may almost go so far as to say that no stock should be planted without having been thoroughly washed with some strong insecticide, or, better, fumigated with hydrocyanic acid gas. At the very least, as I have suggested before, require from the person from whom the nursery stock is bought, a clean bill of health, a guarantee of freedom from injurious insects. With such a guarantee, it is reasonable to suppose that damages can be gained if the stock should subsequently prove to be infected. No nurseryman could do a wiser thing than habitually to give such a guarantee, and to advertise the fact that all stock has been thoroughly fumigated before it is sent out. Had such a custom prevailed in the past it is safe to say that a very large proportion of the damage which has been done by injurious insects to orchard trees all over the United States would have been absolutely prevented, and the spread of scale insects in particular would have been limited almost to insignificance. With such a custom prevailing in the future, these centers of infection, which gather new injurious insects from all parts of the world and distribute them broadcast upon young plants, will then cease to perform this destructive office, and a large measure of the danger to which every fruit grower is now subject will have been wiped out.

IS CYRTONEURA CÆSIA AN INJURIOUS INSECT?

By D. W. Coquillett.

On March 16, 1892, four specimens of a muscid fly were received at this office from Prof. C. P. Gillette, accompanied by the statement that they were bred from squash roots. A recent study of these specimens indicates that they belong to *Cyrtoneura cæsia* Meigen, a European species not heretofore reported as occurring in this country (Fig. 32).

Professor Gillette has given an account of what is evidently the same insect in Bulletin No. 19, of the State Experiment Station of Colorado, under the name of *Cyrtoneura stabulans* (?) Fabr., according to the identification by Dr. S. W. Williston, as stated in a footnote. Professor Gillette terms its larva the "squash root-maggot," and states that when the early-planted squashes were beginning to send out vines many of them wilted and died, the ground at their bases becoming wet with their juices, and upon examination it was found that the stems of these plants beneath the surface of the ground had been completely honey-combed by a white, dipterous larva. In the adjacent soil, the eggs, larvæ, and puparia of this insect occurred as late as July 13, and from some of these puparia the flies issued on the last day of July. The eggs were of a pure white color, about 1.25^{mm} long, ribbed lengthwise excepting on one side, which was perfectly smooth; they were deposited in clusters between the earth and the stems of the plants.

This same insect was also bred by the writer at Anaheim, Cal., during the winter of 1884, from larvæ found in the moist soil beneath a wooden box containing a partially decomposed watermelon. The juices of the melon had passed through the cracks in the bottom of the box, completely saturating the earth beneath it, and in this moistened soil the larvæ were running riot. They were first observed December 10, and two of them assumed the adult form on the 24th of the same month, the date of pupation not having been noted.

In Europe, Gercke has bred this species from mushrooms, while other members of this genus have been bred from decaying vegetable and animal substances, including insects, from garden mold, mushrooms, the nests of wild bees, etc.

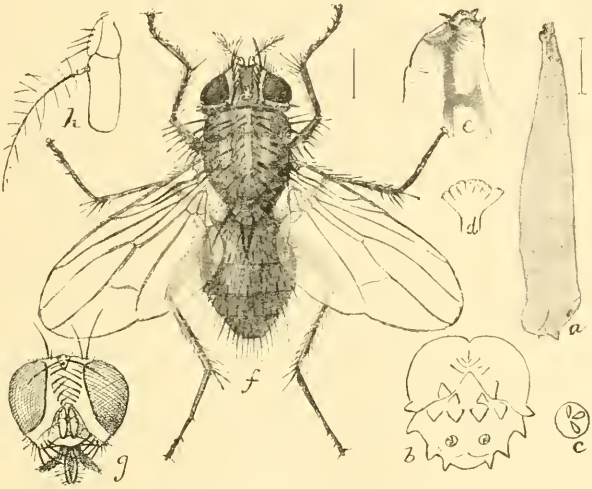

FIG. 32.—*Cyrtoneura cæsia*: *a*, larva; *f*, adult—greatly enlarged; *b*, anal end of larva; *e*, head of larva; *g*, head of adult—still more enlarged; *c*, anal spiracular orifice of larva; *d*, thoracic spiracular opening of same; *h*, antenna of adult—still more highly magnified (original).

The question naturally arises, Did the larvæ observed by Professor Gillette really cause the death of the squash-vines, or were they simply scavengers that had followed the workings of some other insect? In England an allied species, the *Cyrtoneura stabulans*, is reported to have been bred from onions infested with larvæ of *Phorbia ceparum*, but in this instance the last-named insect was the destructive one, while the Cyrtoneura evidently acted as a scavenger. May not the case recorded by Professor Gillette be of precisely the same nature as this one?

INSECT FERTILIZATION OF AN AROID PLANT.

By Henry G. Hubbard.

In the dense forests of the West Indian Islands a very characteristic feature of the luxuriant vegetation is afforded by the abundance of aroid plants. The giants of the family, Anthurium, Monstera, and their allies, are everywhere present, ascending the tree-trunks, or climbing along the outstretched branches and sending down their cord-like roots in a tangle of llanas; others less arboreal overhanging the

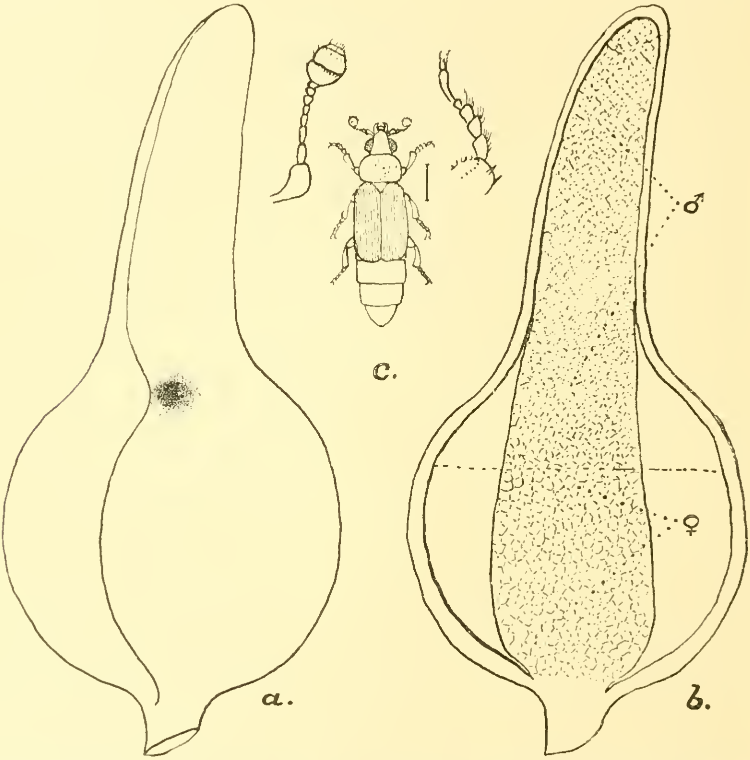

Fig. 33.—Inflorescence of *Philodendron* sp.: *a*, exterior of spathe, showing fungus spot; *b*, section of spathe, showing spadix one-half natural size; *c*, *Macrostola lutea* enlarged—front leg and antenna do.—more enlarged. (From diagrammatic drawing by the author.)

rocky ledges and spreading over the path their huge caladium-like leaves to intercept any ray of sunlight that may chance to penetrate the arboreal shield overhead. Among the varied forms, one of the largest is a species of Philodendron. This plant is nearly terrestrial, growing among rocks or upon fallen tree trunks. It is an indifferent climber and its root-stalk, although six or eight inches in diameter, does not, as a rule, exceed four feet in length. Being a very accessible and at the same time a very common plant, no wanderer in the mountain forests can fail to observe its inflorescence. This consists of greenish or purplish flask-shaped organs, resembling huge unopened buds, growing upright in groups upon the rhizome, at the bases of the leaf-stalks.

The flower case has about the size and very much the shape of a sixteen ounce Florence flask. When cut open and examined it is found to consist of a thick and leathery spathe wrapped in a spiral about an upright, cylindrical spadix. The enveloping spathe tightly clasps in its embrace the upper, pollen-producing portion of the spadix, but expanding below, leaves the fruiting portion free, in a cavity which is partially filled with a mucilaginous liquid. All evaporation is prevented by the overlapping of the spathe, and the floral organs thus hermetically sealed within the flask would seem to be destined to self-fertilization most rigidly enforced. Indeed it is difficult to conceive how any fertilization could be accomplished by the plant itself, since the pollen tubes of the spadix, being tightly enrolled by the inner folds of the spathe, are unable to give forth their fertilizing grains.

During a recent visit to the island of Montserrat, one of the Leeward group of the Lesser Antilles, I had occasion to observe that the maturing flowers of this plant are infested with numerous larvæ of sap-loving beetles and flies, which swarm in the flower-cases, feeding upon the envelope and breaking it down, until at last the ripening fruits surrounding the base of the spadix are stripped of their covering and stand exposed, to be carried away by birds and other agencies which aid in the dissemination of the seed. The immature inflorescence, however, contained at first no insects, but in every case, sooner or later, a brownish spot, caused apparently by a rot-fungus, made its appearance upon the exterior of the flower-case (spathe). It was remarked that the fungus spot invariably occupied the same position, occurring always at the extreme outer edge of the overlapping spathe, opposite a deep sinus which cuts into the margin. The accompanying diagrams, although they do not attempt to reproduce exactly the structure of the floral organs, will serve to illustrate the general features of the inflorescence. Fig. 33 *a* represents the flask-like spathe upon which the fungus spot will be seen in process of development. Fig. 33 *b* gives a section of the same, showing the internal cavity, and the spadix with its base immersed in liquid, the surface of which is indicated by a horizontal line.*

* Fig. 33 *b* is reproduced from rough field notes, and does not present an actual section of the spathe, in which the upper male portion of the spadix is enrolled within the inner flap of the spathe. The upper portion of the inflexed spathe goes more than once around the spadix, which does not come in contact with the outer walls as shown in the figure. Of the double envelope thus formed, the inner walls should descend around the spadix very nearly to the surface of the liquid.

As the result of the examination of numerous flower-cases, the fungus-spot was found to increase in area until it reached the size of a shilling piece. Its growth then ceased. In the meantime the tissues affected by the fungus shrink and finally split, leaving an opening into the cavity of the spathe through which saprophagous insects can enter at will.

In examining flowers not yet attacked by the fungus, or in which its presence is barely indicated by a slight discoloration, the author of the contrivance is frequently disclosed. This is no other than a sap-beetle of the family Nitidulidæ, a pair of which, male and female, are invariably found together, forcing their thin bodies under the overlapping fold of the spathe. Mr. E. A. Schwarz has identified this beetle with *Macrostola lutea* Murray, described from Cumana, Venezuela.

Fig. 33, *c* gives an outline of the beetle, with its antenna and front leg more enlarged. The hair line at the side of the figure shows the natural size.

The Macrostolas evidently consume some days in gaining an entrance into the flower-case. In this laborious effort they are materially assisted, first by the plant, which has accommodatingly reduced the distance to be traversed by the beetle by means of the sinus in the edge of the spathe, without, however, in the least degree breaking the seal of the flower-case. The instinct of the beetle in selecting this weakest point for its attack appears to be unerring. Secondly, I believe that the aid afforded by the rot fungus, which promptly attacks the surface gnawed by the beetles in their effort to cut a passage onward, is most material in causing the tissues of the thick and leathery spathe to soften and perhaps to warp slightly in shrinking Thus the beetles are enabled to accomplish that which without this assistance would be impossible to their feeble powers. At any rate, the passage of the pair of insects is made without, for the time being, breaking the closely guarded seal of the plant, and they enter into undisturbed possession of their new home. The point of entrance lies just above the surface of the liquid in the cavity. Once inside, the beetles make their way to the spadix, and force a passage upward along its polleniferous portion. The female, as she proceeds, deposits eggs, which soon produce a numerous colony of larvæ. By the time their progeny are half grown, the parent beetles, having fulfilled the measure of their existence, perish. Their dead bodies will invariably be found together at the upper end of the spadix, firmly wedged beneath the fold of the spathe, and incased in a thick paste of pollen grains agglutinated by the mucilage of the plant.*

The brood of larvæ live and complete their growth within the flower-case, feeding upon the pollen, in search of which they burrow and mine

* A similar life-long attachment and association of a single pair of adult beetles has been noticed by me in the case of *Epuræa monogama* Crotch, another member of the family Nitidulidæ. Compare, "Inhabitants of a Fungus." (Can. Ent., vol. xxiv, 1892, pp. 250 ff.)

along the spadix, thus detaching the inner coils of the spathe from their grasp upon the anther cells. A copious discharge of mucus from the walls of the spathe causes the released pollen to stream down into the cavity below, converting the limpid liquid into a turbid, soup-like mixture. Every portion of the interior is soon bedaubed with a farinaceous paste, upon which the swarming larvæ live and feed riotously. They finally pupate and transform to perfect beetles. In the meantime the diseased spot in the spathe completes its growth and drops away, leaving a yawning orifice, through which other saprophagous insects gain an entrance and add their increase to the swarming population of the flower. Prominent among these is a fly maggot, similar to those which infest fungi. This maggot feeds upon the ripening parenchyma of the floral envelope and destroys it. The liquid within the cavity becomes putrid, and finally escapes through the breaking down of the containing walls.

The brood of Macrostola beetles, by this demolition of their domicile, are driven forth to mate and betake themselves to neighboring flowers, where they repeat the process just described. They bear with them in the pollen paste with which their bodies are plentifully bedaubed, the material necessary for the fructification of the new inflorescences into which they enter.

The part played by the rot-fungus is an important one, equally advantageous to the beetles and to the plant. It aids the former by first softening the tissues of the spathe, thus allowing the beetles to advance in their passage into the flower-case, and afterwards hardening and for the time being effectually closing the entrance against other intruders. After the Macrostolas, in undisturbed possession of the flower-case, have accomplished the fertilization of the stigmas and released the pollen, the fungus in maturing breaks the seal of the plant and admits destructive insects. The aroid thus secures the expulsion of its pollenizers as well as the proper ripening and disseminating of its seed.

Observations upon the fertilization of aroids are not often met with in botanical literature. The flowers of the more common northern species have been studied by various authors, but the tropical forms have been seldom examined in their native habitats, and most of the observations upon their methods of fertilization have been made in European greenhouses.

The flower-cases of many species exhale powerful, often foul and putrescent, odors, which attract scavenger insects of various kinds, and slugs, also, being particularly abundant in greenhouses, have often been observed creeping about the flowers. Not a few of the records made under these unnatural conditions add but little to our knowledge of the manner in which the fertilization of these plants is accomplished in the tropical forests where they are at home.

The treatise of A. Engler upon the arrangement of the sexual organs and methods of pollenization in the Araceæ (Botan. Jahrb., IV, pp. 341–352, 1883), in which, in addition to his own profound researches, those of all previous writers on this subject are summed up, shows that the disposition of the sexes and the modifications in form of the inflorescence in this family are exceedingly varied and complex. Contrivances adapted to insure cross-fertilization abound. A great number, perhaps the majority of the species that have been noted, are proterogynous, i. e., the female element of the flowers or flower-spike precedes the male in time of blooming. To this class most, if not all, of the Philodendrons belong.

Among those aroids in which the upper portion of the spadix bears male and the lower part female flowers, Engler notes eleven distinct arrangements of the sexes upon the spadix, or modifications of the spathe with respect to these arrangements. Those species in which the spathe is open and the entire spadix free, may be fertilized by insects of many kinds and even by snails. The odors given off by aroids having an inflorescence of this character are often fragrant, or at least not offensive to man, and are such as attract most insects, and the list of species which have been observed to enter the spathes is a very extended one. Some aroids of this class on the other hand exhale the odor of carrion and are visited by carrion insects, such as *Lucilia cæsar*, the common blow fly, or carrion beetles, *Saprinus nitidulus*, etc.

Many aroids, as noted by Engler, have the spathe constricted in various ways so as to partly inclose the spadix and divide more or less completely the portion bearing male from that bearing female flowers. The fertilization of the inflorescence in such cases must be effected by those insects which are adapted to creep through narrow apertures or to live in dark quarters, and the majority of insects which frequent ordinary flowers are excluded. The pollen in aroid flowers of this class is usually given off in vermiform masses, and is more or less glutinous and not dry as in open flowers. The odors in the few cases in which they have been noticed are said to be disagreeable or peculiar.

In *Pinellia tuberifera* Ten. the spathe is constricted, so that an aperture only one square millimeter in dimensions connects the male with the female chambers. Breitenbach and Engler also observed that swarms of small gnats passed freely through the minute opening, and that they were able to carry off pollen adhering to their bodies. It is probable, however, that in the tropics aroids, in which the spadix is wholly inclosed or difficult of access, are fertilized for the most part by sap-beetles. And when the life-histories of the numerous tropical species of Cillæus, Macrostola, Brachypeplus, Conotelus, and their near allies, shall have been made known, many of them will no doubt be found to be connected with the economy of some aroid, the plant and the beetle being mutually dependent the one upon the other.

No entomologist, as far as I am aware, has given any attention to the fertilization of West Indian aroids by insects, but Sallé and Fleutiaux (Ann. Soc. Ent. de France, 1889) record *Cillæus linearis* Er. as occurring in decaying aroid flowers in the island of Guadeloupe.

In the Montserrat aroid, having the spadix entirely within a flask-shaped spathe,* the inflorescence is proterogynous. Whether or not some of the female flowers remain receptive at the time the pollen is released by the Macrostola beetles, I am unable to say. Even were this the case, it seems likely that, as in *Dracunculus vulgaris* Schott and some other aroids in which the fact has been ascertained, the pollen is not potent to effect fertilization within the inflorescence, and setting of the fruit follows only upon the introduction of foreign pollen from without. Upon this assumption, taken in connection with the observed facts, the following summary may be given of the successive stages in the flowering of this plant:

1. Female flowers at base of spadix receptive, and immersed in liquid; upper portion of spadix male; flowers immature, and tightly enrolled by inner fold of spathe.
2. Entrance of a single pair of Macrostola beetles, bringing with them upon their bodies the pollen from an older inflorescence; fertilization of the receptive female flowers by the foreign pollen, aided by the mucus of the plant.
3. Maturing of the anther cells in upper portion of the spadix, and pollen released by the Macrostolas and their offspring.
4. Seal of the inflorescence broken by the ripening of the rot-fungus; entrance of saprophagous insects and destruction of the spathe; Macrostolas ejected, bearing pollen upon their bodies to enter and fertilize other flower cases.
5. Ripening of the fruiting portion of the spadix in open air, and dissemination of the exposed seed.

NOTES AND OBSERVATIONS ON THE TWIG GIRDLER.

(*Oncideres cingulata* Say.)

By Theo. H. Scheffer, *Lawrence, Kans.*

The beetle usually known as the hickory twig girdler, injurious also to the persimmon among forest trees and the apple and pear in orchards, has appeared in eastern Kansas, as a depredator upon the white elm (*Ulmus americana*). So far has it departed from its known and recorded preference† that hickory groves and orchards in this vicinity show no signs of its work, while elms, both in natural groves and in yards and parks, are more or less affected.

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* The material at hand is unfortunately insufficient for the proper classification of the plant, and the species can not be determined. It is apparently a Philodendron belonging to Engler's section IV of this genus, as given in his classification of aroids (Die natürlichen Pflanzen-Familien, Endlicher u. Prantl; Araceæ von A. Engler, p. 134).

† Note.—Since writing the above my attention has been called to a short article in the Kansas Horticultural Report for 1882, in which this insect is spoken of in connection with its work upon elms.—T. H. S.

It is also mentioned as attacking elm by Professor Riley, in the third volume of the *American Entomologist* (p. 297, December, 1880). See also First Report South Carolina Agr. Exp. St. 1888–'89, pp. 40, 41.—Ed.

The attention of the Department of Entomology of the State University here was first called to the matter in late summer last year, when a farmer brought a girdled branch to the laboratory. The girdling plainly showed that it had been done by Oncideres, and later on one or two specimens of the insect were secured. While no serious damage has been reported this season, many trees planted for shade have suffered considerably, and there is evidence that the insect is spreading. Trees that are the worse affected this year show a relatively small number of last season's scars. The elms on the university campus continued to drop their branches for four weeks or more, every moderately strong wind bringing down fresh ones.

On the fourteenth of September your correspondent visited the farm of Mr. Harvey, near Blue Mound, to make observations on the work ot the girdler. Some of the shade trees in his yard looked as if they had been pruned of nearly all the limbs ranging in size from one-fourth to one-half of an inch in diameter, the ground underneath being quite covered with them. Owing to the brittleness of the heart wood in elm, the branches always fall off with the first breeze that sways them after they have been girdled deep enough. Though some of the trees stood in the edge of an apple orchard, the apple trees were not affected. Mr. Harvey stated, however, that he had noticed one girdled cherry limb and two or three of a locust. As these trees stood beneath taller elms, it is probable that the girdling was a mere accidental circumstance.

A girdler being found at work, her performances were watched for more than half an hour. She stood upon the part of the limb that would fall, clasping the groove with the front tarsi, and working slowly around, sometimes to the right and sometimes to the left, deepened the channel, though not perceptibly, of course, at each round. The work was nearly completed when she was first seen, the groove having reached the heart wood and being about one-eighth of an inch in width. When working on the under side of the limb, she would face about once in a while and, to all appearances, dislodge chips from her mandibles.

From the fact that the insect is almost invariably found on the freshly fallen branch, one might infer that through instinct she always stands beyond the notch and facing the tree so that she may go down with the branch and finish her ovipositing in case she had not already done so. In nearly every case that came under my observation, however, the egg-laying was finished when the branch fell, and the insect was found either resting or feeding on the tender bark near the end of a twig. In one instance, at least, the girdler was still ovipositing when the branch was picked up an hour or so after it had fallen. Numerous gnawed places on the tender side shoots attest to the quality of a working beetle's appetite.

The line of girdling is usually very regular, and curves around the limb nearly at right angles to its longitudinal axis. Very rarely an unskilled worker fails to make exact connections in coming around to the starting point, and in consequence has more gnawing to do than if it had not made this mistake in the preliminary survey. The channel slopes in a very little from either side, not unlike the notch made by a beaver in gnawing off a tree.

The eggs are deposited beneath the bark of the girdled branches, and just at the base of side shoots or aborted buds. Usually there is but one at a shoot, but in case the latter is large there may be two or three. The aperture of the puncture is somewhat oval in form, being slightly flattened on the under side. Immediately beneath it, and capped with a gummy substance for protection, is the egg, a pale white elongated body, with a longitudinal diameter about three times as great as the transverse. It lies just under the bark, or in some cases, between the layers of the bark. The number of eggs thus deposited by a single female varies somewhat. Of seven branches examined, two had eight punctures each, two nine, and three fourteen. The girdler seems to be very careful to place all its eggs along the main axis of the limb. In no case was there a puncture on a side shoot, no matter how many twigs or buds it might have.

These eggs were found to hatch in from three to four weeks after the branches had dropped, the larvæ appearing as very small cream-colored footless grubs. As these larvæ are still very small at this writing (November 12), they will doubtless pass the winter in this state, feed and grow rapidly when spring comes, transform in mid-summer, and emerge as a perfect insect about the first of August.

A detailed description of the beetle is hardly necessary, as it is figured and described in several reports on insects injurious to forest trees, and in horticultural reports. To those, however, who might not have such report at hand, a means of roughly identifying it may be acceptable. It has the characteristic long antennæ of most Cerambycidæ, is sub-cylindrical in shape, and varies from about eight to eleven-sixteenths of an inch in length, the males being smaller than the females. The general color is a reddish, ash-sprinkled brown, with a broad ashy belt nearly midway across the elytra. The thorax is also ashy, contrasting slightly with the color of the head and the humeral belt. Numerous ochreous spots dotting the elytra can be seen by close inspection.

The drawing (after Riley) figured in most reports on the insect is not quite true to life in one or two points. The girdler at work should be located on that portion of the branch containing the punctures for ovipositing, and not on the stub that will remain on the tree. The egg, also, should be nearly twice as long as figured, in order to preserve the true proportions when based on the transverse diameter shown in the drawing.

It ought not to be very difficult to get rid of these pruners in a yard or park, for one has only to carefully collect and burn all fallen or lodged branches in order to destroy all the eggs and larvæ for the next season's brood.

A CECIDOMYIID THAT LIVES ON POISON OAK.

By D. W. Coquillett.

Up to the present time no case has been recorded in this country of any species of Cecidomyiidæ living on plants belonging to the genus Rhus, which contains our various kinds of sumacs. The rearing during the past summer of a species of Cecidomyia from galls on the roots of the common poison oak or poison ivy (*Rhus toxicodendron*) will therefore not to be without interest.

On the 29th of March, 1894, Mr. W. H. Harrison, of Lebanon Springs, N. Y., sent to the Division of Entomology roots of the poison oak upon which were numerous Cecidomyiid galls which at that date contained only the reddish larvæ. The perfect flies began to issue May 3, and continued issuing up to the 18th of the same month. The species is evidently new to science, and may be characterized as follows:

Cecidomyia rhois n. sp.

Brownish-black, the hypopygium of the male and the abdomen of the female yellow. Thorax tinged with red, considerably produced anteriorly, its front end at the attachment of the head being nearly horizontal to the plane of the body. Antennæ of male nearly as long as the body, 15-jointed, the joints pedunculated, the peduncles being one-half as long as the thickened part of the joints; the latter are furnished with numerous rather long, yellowish hairs. Antennæ of female less than one-third as long as the body, rather long pilose, 13-jointed, the joints sessile. Pile of thorax short, dark brown, disposed in four longitudinal rows, that of the abdomen rather long, pale yellow. Wings grayish, the pubescence and fringe of long hairs on its posterior margin dark brown; veins brown, the small cross vein and forks of the last vein almost colorless; the first vein lies close to the costa, and the second issues from it slightly before its middle, is nearly straight, and terminates at the last fourth of the distance between the tip of the first vein and the extreme apex of the wing; the third vein forks slightly beyond its middle, the lower fork extending in an oblique direction to the wing-margin, while the upper one continues in the same course as the præfurca, but curves slightly upward throughout its entire course; it is twice as long as the lower fork, and terminates twice as far from the extreme tip of the wing as the second vein does; small cross vein very oblique, slightly shorter than the lower fork of the third vein, joining the second vein near the base of the latter. Legs covered with a sericeous, somewhat yellowish pubescence. Length 1.5 to 2^{mm}. Three males and one female.

Gall.—Pale brown, elongate-oval, but somewhat irregular in outline, from once and a half to twice as long as broad; naked, sparsely covered with small raised spots of various shapes and sizes. Length of the largest specimen, 5^{mm}. Occurs singly on the small, fibrous roots of *Rhus toxicodendron*, at a point where the root forks.

A MIGRATION OF COCKROACHES.

By L. O. Howard.

It is a matter of common observation in many of our more southern cities that new houses are often found to be suddenly overrun by cockroaches and particularly by the little Croton bug or "water bug" (*Ectobia germanica*). The why and wherefore have been guessed at, but no definite observations are upon record. On a dark drizzly day in September, 1893, Mr. P. H. Dorsett came to me and stated that he had just seen a remarkable sight on D street, near the Department grounds. A vast army of cockroaches, according to his story, was crossing the street. A few hours later I visited the spot in company with Mr. Marlatt and found that the bulk of the army had disappeared, but that many stragglers still remained. Mr. Dorsett is an assistant in the Division of Vegetable Pathology, and according to his statement the army issued from the rear of an old restaurant fronting upon Pennsylvania avenue and marched across the muddy street, undeterred by pools of water, ash heaps, and other barriers, directly south to the front of the building opposite.

This building was a machine shop and at the direction of the foreman several of the men took brooms and swept back the advancing horde. They swept until their arms were tired, but were unable to stem the advancing tide. The foreman then directed that a line of hot ashes from the furnace be laid along the brick sidewalk. This proved an effective barricade. The foremost cockroaches burned their antennæ and their front legs and the army divided to either side and scurried down into the area ways of adjoining buildings in which they disappeared. The march is said to have continued for two or three hours and many thousands of the insects crossed in this way. A moment's glance, after arriving at the spot, showed me that the insect was the Croton bug and that nearly all of the individuals were females carrying egg-cases.

I called at the restaurant and found to my surprise that no house cleaning had been going on and that no especial effort had been made by the application of insecticides to rid the establishment of the roaches.

It seems then to have been a true migration, a development of the true migratory instinct in the Croton bug. The restaurant had become overpopulated, perhaps not for its actual denizens, but certainly for the thousands of about-to-be-born young. The maternal instinct originated the migratory instinct and the army by one common impulse started on its journey for more commodious quarters. The darkness of the day is significant, and there is no reason to suppose that similar migrations do not frequently occur but undoubtedly under ordinary circumstances at night. This is the way that new houses become infested.

THE POTATO-BUD WEEVIL.

(*Anthonomus nigrinus* Boh.)

By F. H. Chittenden.

The recent outbreak of *Anthonomus signatus* Say or strawberry weevil induced the writer to investigate the habits of other bud-feeding Coleoptera. A rather common species in this locality closely resembling *A. signatus* both biologically and structurally is *A. nigrinus* Boh. It breeds in the unopened flower-buds of solanaceous plants after the manner of its injurious congener in the strawberry and red-bud.

The adult beetle resembles the latter in form, but is of a little larger size. In color it is uniform dull black, sparsely clothed with fine, whitish pubescence. It is commonly found on the horse-nettle (*Solanum carolinense*), and when the potato (*S. tuberosum*) blossoms this also is attacked. In food habit it appears to be restricted to the Solanaceæ, if not to the genus Solanum.

In distribution it is also limited; evidently more so than the horse-nettle. Its recorded distribution is: District of Columbia, North Carolina, Louisiana, and Virginia. It occurs also in Maryland, but it is doubtful if it extends much farther to the north. Common as is the species in this vicinity, it is comparatively rare in collections.

This insect has never been reported as injurious, but as it attacks one of our most important cultivated food-plants, an account of its habits may be of interest.

It has the same habit as *A. signatus* of severing the stems in which it oviposits, and also cuts off the buds, apparently often in pure wantonness, but in reality, probably, for food. In one potato patch near Washington which I visited July 4, not half a dozen flowers could be found, but many beetles were present. The plants had been very recently attacked, evidently during the preceding night, as the majority of the buds were still upon the stems, although many were severed and the remainder dropped off at the slightest touch. All but a few of the smallest buds were severed. In some instances, a bunch or cluster of four or five minute buds had all been cut off by a single girdling of their common stem. It hardly seemed possible that all of these buds, the majority of which barely measured an eighth of an inch, and were too small for the development of the weevil, could have been cut off by this insect. But the ends of the stems presented the same appearance as did those of the horse-nettle, which were cut off after oviposition.

The explanation of this attack would appear to be that a lot of plants of the horse-nettle, which appears to be the favorite larval food-plant of the species, had been cut down in the immediate vicinity, and the adult beetles had found the juice of the stems of the cultivated Solanum quite to their liking.

The beetles make their appearance simultaneously with the maturing of the buds of the horse-nettle, in this vicinity during the latter days of May, and continue on the plants until quite late in the season. The plants are in blossom from early June till September.

Oviposition begins with the development of the bud, and evidently extends over a much longer period than in the case of *signatus*. The bud is punctured usually at about the same point for oviposition, near the center, just above the calyx, but in feeding the insect is not fastidious, and if the bud be only slightly opened, it crawls in and feasts upon the pollen and petals.

The eggs are inserted in or between the anthers, on which the young larvæ feed. They undergo all their transformations within the bud. The larva and pupa are almost exact counterparts of those of *signatus*, but are of larger size and of uniform whitish color. Full grown specimens of the larva vary in length from about 3 to 3.5^{mm}, dorsal measurement; greatest width, near the middle of the body, 0.6 to 0.7^{mm}.

As with *A. signatus*, only a single individual normally develops in a bud, but occasionally two, and, in one instance, three beetles bred from a single bud. In such cases each individual had formed for itself of its own excrement a separate chamber in which it underwent its transformations.

A single larva will usually devour the entire interior of the bud which it inhabits. They often gnaw holes through the enveloping corolla so that their bodies may be seen as they work within. If exposed to dampness they always cut through the corolla and force their excrement through the orifice thus made. *A. signatus* has the same habit. The imago usually issues from an irregular hole made in the corolla near the calyx at the stem end of the body. In one instance a beetle bred from a bud that had never been severed.

The duration of the periods of the preparatory stages are nearly as in *signatus*. The dates noted are as follows: Eggs, observed June 5 to July 4; larvæ, full grown June 26 to 29; pupæ, June 29 to July 18; new brood of adults, July 2 to August 2. The pupa state was observed to last four and five days in different individuals, as follows: June 28 to July 2; June 30 to July 3; July 1 to July 5.

Unlike the strawberry weevil this species appears to avoid the sun, passing the day in partial concealment and inactivity. I have never witnessed oviposition or copulation and hence believe the species nocturnal. I am also inclined to believe that it is single-brooded, but there is more chance of double-broodedness than in *signatus* as the adults may be found abroad during a much longer period. Individuals of the new brood kept in confinement fed freely, but no eggs could be found in the buds punctured.

Three parasitic Hymenoptera were reared with this insect, two chalcidids which Mr. Ashmead has identified as *Catolaccus anthonomi* Ashm. and *Entedon lithocolletidis* Ashm., and a braconid doubtfully determined as a variety of *Phanerotoma tibialis* Hald. The first named, which was described and figured from specimens reared from *A. signatus* (INSECT LIFE, vol. V, p. 185) is an undoubted parasite of *nigrinus*, and the others are probably also parasites. A single specimen of each of the latter was reared with no other host present. It is rather noticeable that the parasites usually issued at the opposite end of the bud to that used as a place of exit by the host.

AN ORTALID FLY INJURING GROWING CEREALS.

(*Chætopsis ænea* Wied.)

There is a rather common greenish-black fly, with black banded wings, as shown in the accompanying illustration, which ranges all the way from Canada on the north to the Gulf of Mexico on the south, occurring also in Cuba and the Bermudas, which belongs to the family Ortalidæ, and is known as *Chætopsis ænea*. The larva of this insect

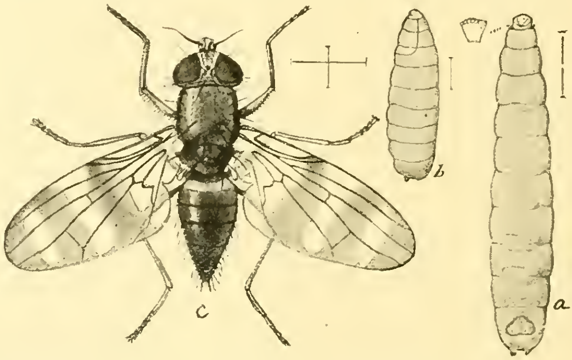

FIG. 34.—*Chætopsis ænea*. *a*, larva, with spiracular opening, highly magnified, at left; *b*, puparium; *c*, adult, enlarged (original).

lives in a cavity which it forms within the stems of different cereal plants, including wheat, oats, corn, and sugar-cane. It works, as a general thing, near the base of the young growing plant, and either kills it outright or interferes with its growth to such an extent that it never perfectly matures. The eggs are laid in the leaf sheath, and the larva transforms to pupa in the same position.

This insect was first brought to the attention of this office in July, 1881, when larvæ found in a piece of sugar-cane, which had been damaged by the sugar-cane beetle, *Ligyrus rugiceps*, were sent in by Mr. W. T. Holmes, of Cypremont, La. Later it was rather carefully studied in its relation to the oat crop by Mr. W. B. Alwood, in June, 1886. Mr. Alwood was then employed as an agent of the Division and was stationed at Columbus, Ohio. The larvæ were found about the middle of June in an oat field, and had the effect of killing the blades at the base, making the field appear in patches, as Mr. Alwood describes it, as if a fire had swept over it.

The eggs were found on May 9 of the same year, and from his notes we learn that they are inserted just under the edge of the leaf sheath in groups of 2, 3, and 5, and also singly. The egg is of a pure pearly white color, five times as long as broad, and tapering to a point at each end. The larvæ, after hatching, distribute themselves along under the sheath, ten to fifteen under one sheath, thus exhausting the juices of the plant, the outer leaves first becoming brown and seared, and the whole stalk finally withering away. The puparia are formed under the sheath, although in two instances the larva had eaten a slit into the blade, inserted its body part of the way, and there transformed into a puparium.

In April, 1894, specimens of a young sugar-cane plant were received through the Division of Chemistry, to which Division it had been sent by Mr. E. Nelson Fell, of Narcoossee, Osceola County, Fla., with the information that about 5 per cent of the sprouts were affected by an insect, which proved upon examination to be the larva of this species. The damage done by the insect had been seen by the Chemist of the Department, Dr. H. W. Wiley, during a visit to the Department Sugar Experiment Station at Runnymede, Fla., in the spring of the same year. The infested plant was kept under observation in the insectary and the adult flies issued from April 28 to May 5. No complaint of damage to sugar-cane has since been received. In August, 1893, specimens of the adult insect were received from Prof. C. P. Gillette, of Ames, Iowa, who wrote that they had been reared from larvæ found boring in the center of a stalk of corn on July 5. This note is quoted in INSECT LIFE, vol. II, p. 281).

On the 26th of June, 1894, Mr. William Saunders, Superintendent of the Department grounds, brought to this office a small cornstalk infested with the larvæ of this insect. The plant had been obtained from some point in Maryland, but the exact locality was not ascertained. The larvæ had formed a cavity of considerable size, the interior of which presented a brownish appearance. The perfect insect issued July 5.

We know nothing of the method of hibernation of this insect, and the only available remedy, from our present knowledge, will consist in the pulling up and destroying of infested plants as soon as the presence of the insect is noticed. It is evident from these isolated observations that the damage done by this species is quite widespread. It lives hidden from view and thus escapes detection. Its transformations are rapidly accomplished, and there are probably several annual generations. The rapidity of its transformations is such that it has probably frequently accomplished its work and escaped before its presence has even been suspected. It is practically a new insect enemy of cereals, and it is quite within the bounds of possibility that it may, at some future time, increase to such an extent that the damage which it does will be very appreciable. In the first sugar-cane case mentioned, the work of the larvæ followed damage by another insect, but there seems no doubt that the species frequently and perhaps normally attacks healthy plants.

The insect has been identified by Mr. D. W. Coquillett, who has also revised the accompanying illustration.

THE GRAY HAIR-STREAK BUTTERFLY AND ITS DAMAGE TO BEANS.

(*Uranotes melinus* Hübn.)

There is a handsome little butterfly of the old genus Thecla, which is widely distributed in the United States, which feeds upon a variety of plants, and which has recently been brought to our attention as an enemy to the bean crop. The insect was described by Hübner in the early part of the century from North American specimens. The adult

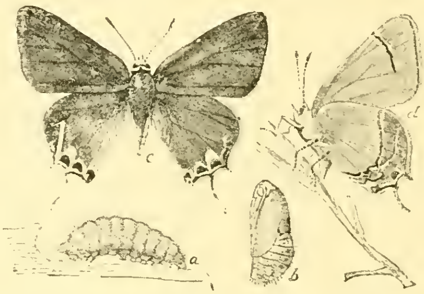

FIG. 35.—*Uranotes melinus*: *a*, larva; *b*, chrysalis; *c*, adult, from above; *d*, same, from side—natural size (original).

is bluish-black in color, with dark reddish luster, and the light spots on the hinder border of the hind-wings, as shown in the illustration, are bright red. The species is found in every part of the United States, excluding Alaska. It occurs also, rarely, in Canada, and extends south to the Indian River, in Florida, and quite to the Mexican border. It is also recorded from Mexico, Central America, from Venezuela, and the Antilles.

The caterpillar, which is green in color and, when full grown, is represented at Figure 35*a*, is found most commonly upon the hop, devouring the heads and causing considerable injury. In the South it feeds upon Cratægus and Hypericum, while in Massachusetts it is found feeding upon Cynoglossum. Abbot mentioned the fact that in Georgia it feeds upon "pine and snap beans," but further references to this injurious habit are lacking.

In August, 1886, one injured larva was received from the well-known horticulturist, Mr. J. T. Lovett, of Little Silver, N. J., which he had found feeding upon Lima beans. Mr. Lovett wrote that the larva eats a small hole through the pod in such a way as to reach the bean, which is entirely excavated. July 6, 1892, Mr. Pergande, of this office, found one of these larvæ eating into the pod of a garden bean near Ivy City, in the District of Columbia. July 14 this larva changed to a chrysalis, and the butterfly issued July 25. October 18 of the same year one of these larvæ was found in the same locality eating into the pod of a Lima bean.

Mr. Coquillett informs us that he found a larva of this species feeding on beans at Los Angeles, Cal., September 5, 1889. It pupated September 9, and the butterfly issued September 20.

This insect is not likely to become a serious enemy to the bean crop, although in Harris's time some farmers are said to have been obliged to abandon hop cultivation on account of the work of these larvæ. The larva is parasitised by an Ichneumon fly known as *Anomalon pseudargiole* How., the adult of which issues from the chrysalis, and this insect may be an important factor in regulating the increase of the butterfly.

The very sensible measure which Mr. Scudder adopted in his great work on the butterflies of New England, of giving a final paragraph under the consideration of each species to the subject of desiderata, enables us to say at once that even from these fragmentary observations we have added something to the general knowledge of the life-history of this insect. Mr. Scudder says: "We have then scarcely a single satisfactory datum whereon to build the history of this insect." The facts recorded above show that in the District of Columbia there are at least two generations annually, and that the duration of the chrysalis state in midsummer is about eleven days; while in Southern California, more than two broods apparently occur, the duration of the chrysalis stage in September being the same as that with the midsummer brood in the District of Columbia.

GENERAL NOTES.

A HOMEMADE COVER FOR FUMIGATION WITH BISULPHIDE OF CARBON.

Mr. Edward R. Taylor, of Cleveland, Ohio, in a recent letter suggests the following method of making a cheap cover for use in fumigating low-growing plants with bisulphide of carbon:

Take a barrel hoop, cut it in two, and fasten the pieces at right angles to each other, by making a hole with a brad awl through both and inserting a screw eye with the eye on the convex side, to be used as a handle for lifting. Spring the hoops to make a cover of the size wanted, notch the ends, and tie a string around, as in making a kite; or better use stiff wire or a full hoop. Take manila or even newspaper, cover all of one side with paste, and cover one section (one-fourth of the "dome") with it, turning all the surplus paper inside. The other three sections are covered with paper in the same way, turning the surplus paper either inside or outside, as it would naturally go. A bundle of rags or cotton can be tied inside where the hoops cross to receive the charge of bisulphide. Any of the chemical left after treating one hill can be carried with little loss to the next. This will make a more substantial cover than one would at first think, even when made of newspapers, as when dry the paste will make them very stiff, especially when there are several thicknesses of paper. The covers will also be very resistant to the vapors of the bisulphide of carbon.

THE IMPORTED PARASITE OF THE HESSIAN FLY.

Entomologists will have noticed in the last few reports of Professor Riley, as chief of this division, accounts of attempts which he has

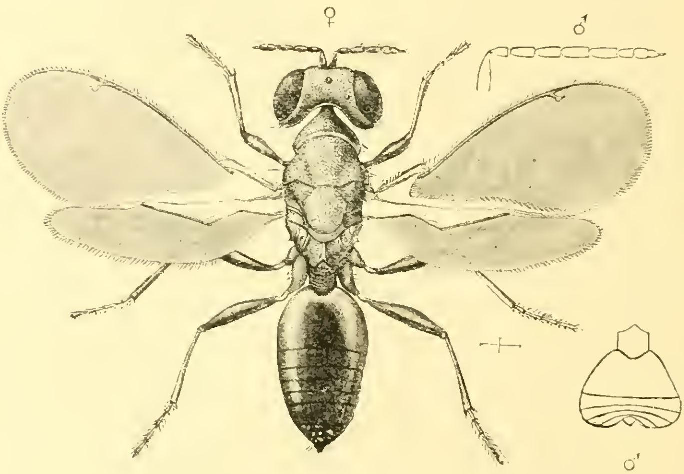

FIG. 36.—*Entedon epigonus* Walk.—enlarged (original.)

made to introduce into this country one of the common European parasites of the Hessian fly, known as *Semiotellus nigripes* = *Entedon epigonus* Walker. With the assistance of Mr. Fred Enock, of London, Professor Riley several times distributed parasitised flax-seeds of the Hessian fly to observers who were favorably located in this country. The attempt which gave the best promise of success occurred in 1891, when Professor Forbes, of Illinois, received a large number of parasitised puparia and distributed them in a field, and later found living specimens of the parasite. Specimens have been cared for by Professor Cook in the vicinity of Agricultural College, Mich.; by Mr. James Fletcher in the vicinity of Ottawa, Canada, and by Professor Forbes in Illinois.

We are able to publish herewith a satisfactory figure of this species which was drawn by Miss Sullivan some months ago at Professor Riley's direction. We believe it important to publish this figure as early as possible in order to assist entomologists in recognizing the species should it be found to have established itself at any point in this country.

A REMARKABLE MIGRATION OF BUTTERFLIES.

Through the kindness of Mr. Geo. W. Knight, of San Marcos, Tex., we have received reports of a remarkable migration of the so-called snout butterfly, *Hypatus bachmani*, a species which belongs properly to the Carolinian fauna, but which has been occasionally found as far north as Ontario. On September 1 Mr. Knight sent specimens of the insect to the Department, and reported that they were flying in an eastward direction in vast numbers. At our request he instituted inquiries in the surrounding counties as to the occurrence of the species, and ascertained that at about the time mentioned swarms of the butterflies were observed flying in a general eastward direction over a territory almost one hundred miles square. Taking the city of Austin, Travis County, as the northeastern corner of this territory, it may be bounded as follows: Westward 75 miles to Fredericksburg, Gillespie County; thence due south 100 miles to Pearsall, Frio County; thence eastward to Karnes City, Karnes County, 75 miles. The butterflies were also reported from the following towns lying within this territory: Boerne, Kendall County; Castroville, Medina County; New Braunfels, Comal County, and San Marcos, Hays County.

At our suggestion a part of Mr. Knight's inquiry was directed to ascertaining the abundance of the hackberry, *Celtis occidentalis*, throughout the territory covered by this migration. This is the only food plant known for the species, and the reports received by Mr. Knight show that it grows more or less plentifully at nearly all the places where the migration was observed.

Hypatus bachmani is a common butterfly throughout Texas wherever the hackberry tree grows, but migratory movements of this species have never been reported before. It would appear to us that the flights observed this season in Texas were brought about by the rather abnormal weather of the past season. Mr. Schwarz, who visited Texas in August, tells us that during the months of June and July there was a period of severe drought all over the State, which was suddenly followed in the first week of August by an equally pronounced rainy season of several weeks' duration. This very moist and at the same time hot weather must have favored the simultaneous issuing of an unusually large number of specimens from their chrysalids and thus brought about the primary condition under which migratory instinct is developed in many insects.

We may add that the larvæ of this butterfly, as well as those of the other Celtis butterflies (*Apatura celtis* and *A. clyton*), are not voracious feeders and can hardly be considered as injurious species except where they occur on very young trees planted in the streets.

ARE TUMBLE-BUGS BENEFICIAL?

In an interesting article (The Entomologist, vol. XXVII, 1894, pp. 229–232, and Proc. Ent. Soc., London, 1894, pp. xx), Miss E. A. Ormerod speaks of the injury done to pasture lands in the Argentine Republic by the larva of a lamellicorn beetle (*Diloboderus abderus*).* The interesting fact connected therewith is that the injury is followed by an improvement of the pasture, i. e., the coarse and more worthless grasses disappear and the more useful grasses flourish. This improvement has, however, been noticed exclusively on lands that were fenced in and where cattle have been kept.

Among the specimens of *Diloboderus abderus* sent to Miss Ormerod from such places were two other species of lamellicorn beetles, *Eucranium arachnoides*† and *Megathopa violacea*, belonging to the so-called "tumble-bugs" which, as is generally known, have the habit of rolling about balls of dung and burying the same in the ground. Various species of these tumble-bugs are known to be extremely abundant in the Argentine Republic, and Miss Ormerod now raises the question whether the improvement of the pastures mentioned above could possibly be attributed to the work of these beetles. This question could only be answered, in our opinion, upon an examination of the pasture lands, but in a general way it may be said that if the tumble-bugs are extremely abundant in a circumscribed locality, where they can concentrate their efforts in burying dung balls, a sufficient amount of manure could be carried underground by them to appreciably improve the fertility of the soil. On the other side, where live stock is allowed to roam over large tracts of land the beneficial influence of the beetles is of course so small as to be beyond appreciation.

Tumble-bugs are extremely abundant in Texas (much more so than in any other portion of the United States), but no one would pretend to assert that the richness of its soil is in any way increased by the action of the beetles. However, when I had lately an opportunity of watching the surprising celerity with which they are able to dispose of patches of cow dung I could not help thinking that they may possibly be beneficial in another way, viz. in preventing the development of many dung-feeding Diptera, and more especially of the horn fly.

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*The nearest relative to this species in our fauna is *Xyloryctes satyrus*, whose larva is common in the vicinity of Washington among grass roots on pastures and deserted fields. This habit has already been observed by Walsh (Amer. Ent., vol. I, p. 60), though later observers found the larva preferably in decaying roots of ash trees.

†There is a short note on the habits of this species in Stett. Ent. Zeit., XXXVII, 1876, p. 407.

As a fact not generally known it may be stated in this connection that the unity in habit is not maintained in the North American species of Canthon, since one species, *C. viridis*, never rolls balls of dung, but lives exclusively under layers of decayed leaves. It larva has not been observed, but feeds, no doubt, on vegetable mold in the manner of several species of Ataenius.—E. A. S.

MARGARODES IN THE UNITED STATES.

At the May, 1894, meeting of the Entomological Society of Washington, as mentioned upon page 380, vol. VI, of INSECT LIFE, Professor Riley read an interesting paper upon the very curious Coccidæ of the genus Margarodes, two species of which he had studied in his then recent trip to the West Indies. In the West Indies these species are known as "ground pearls," and are found in many localities under the surface of the ground. The large pearly-white species found in the island of Montserrat Professor Riley stated to be probably identical with *Margarodes formicarum* Guilding, described by the Rev. Lansdowne Guilding in the early thirties as found upon the island of St. Vincent. Another species Professor Riley had bought, made up in the form of necklace, in Jamaica. The Jamaican form seemed to differ from the Montserrat form, the necklace being composed of smaller specimens, which, instead of being light pearly-yellowish in color, were more golden brown. So far as we know no species of this genus has ever been found in the United States until the present season. Early in January, however, we received a small package from Mr. W. T. Swingle, of the Division of Vegetable Pathology, who collected them on Key Largo and Elliott's Key, in Florida. The specimens received were small in size, golden brown in color, and resemble those composing the necklace bought by Professor Riley in Jamaica.

Mr. Swingle writes that in some places over an area ten feet or more in diameter the soil (what there is of it between the coral rocks) is composed very largely of these roundish laminated bodies. Those on the surface are clean and beautifully iridescent, while those buried more deeply are dull in color. Mr. Swingle was informed by several persons that such patches of soil occurred in the uncleared hammocks, and on one occasion he saw some of them along a path leading through a hammock. He saw them at several points on Key Largo and Elliott's Key, and his boatman informed him that he had seen them at Key West. All local observers called them "singers' eggs." Mr. Swingle found them at a depth of over a foot, composing over half the soil.

NOTES FROM CORRESPONDENCE.

The Scale-insects of Arizona.—We learn from Prof. J. W. Toumey, of the University of Arizona, that the only scale-insects so far collected in Arizona are *Aspidiotus perniciosus*, on apple, pear, peach, and apricot; *Lecanium pruinosum*, on

Osage orange; *Parlatoria* sp., on date palm imported from Africa; *Lecanium oleæ*, on oleander and on peach and apricot when growing near oleander; *Aspidiotus* sp., on lilac; *Tachardia larreæ*, on *Larrea mexicana*; *Diaspis rosæ*, on roses; *Lecanium phoradendri*, on *Phoradendron flavescens*; *Diaspis cacti*, on *Opuntia arborescens*, and also quite a number of scales unknown to Professor Toumey on native plants.

Larvæ in Mincemeat.—We have recently received from a firm of consulting chemists in New York specimens of larvæ found in commercial mincemeat sent them for examination by clients of theirs who are large manufacturers of this article. The larvæ were those of a species of Drosophila, the eggs of which may have been laid in the fruit used in the mincemeat before manufacture, or in the finished product itself if the adult flies had access to it at any time. Later we received direct from the same manufacturers other specimens of larvæ found in currants, but these, upon examination, proved to be the larvæ of the Indian-meal moth, *Plodia interpunctella* Hübn.

A Lachnosterna damaging Wheat in Texas.—During the past season we received from two sources specimens of *Lachnosterna cribrosa* Lec., with the report that the insect was doing great damage to wheat in Baylor County, Tex. They were reported by Judge J. G. Kenan to have first made their appearance in small numbers four years ago. They increased gradually, until the present year they devoured several crops of wheat. They make their appearance early in spring, hide under ground during the middle of the day, and late in the afternoon come out and feed. The insect is one of the wingless May beetles, and the outbreak is similar to that mentioned by Comstock in the Annual Report of this Department for 1879 (p. 247), *Lachnosterna farcta* having been the species concerned in the earlier instance.

Spread of Cryptorhynchus lapathi.—This imported European beetle which feeds upon willows and alders and which has heretofore been found in this country only in the vicinity of New York City has been found by Mr. E. E. Fernald, of Boston, Mass., as he reports to us in a recent letter, in large numbers on a willow in his garden at Melrose, Mass. A single specimen, according to Mr. Fernald, was taken at Stoneham, Mass., a mile away, resting upon a young hickory tree in the woods.

New Food-plant for the San Jose Scale.—Prof. A. J. Cook, of Pomona College, Claremont, Cal., and Mr. W. E. Collins, of Pomona, Cal., have sent us specimens of *Aspidiotus perniciosus* upon loquat (*Photinia japonica*).

A new Locality for the Juniper Scale.—In 1880 Prof. J. H. Comstock announced the occurrence of *Diaspis carueli* Targ. Tozz., on several species of juniper and arbor vitæ, growing in the Botanical Gardens at Washington, D. C. We have recently received specimens of the same species from Mr. John G. Jack, of Jamaica Plain, Mass., who found them upon a branch of *Juniperus sphærica* brought over from Germany four or five years ago. "Lately," he writes, "it has become well covered with a species of scale which has also been seen on other junipers, I think, in the same nursery."

The new Plum Aspidiotus in Illinois.—Mr. W. G. Johnson, of Champaign, Ill., has sent us specimens of Mr. Cockerell's recently described *Aspidiotus howardi*, with the information that the species occurs abundantly upon cherry trees at Champaign. The type specimens were taken upon plum in Colorado by Prof. C. P. Gillette.

The Florida Red Scale in a Northern Greenhouse.—Mr. George W. Pool, of Gloversville, N. Y., sends us specimens of *Aspidiotus ficus* which occurred so abundantly upon a palm in his greenhouse as to threaten the life of the plant.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

Vol. VII. No. 5.

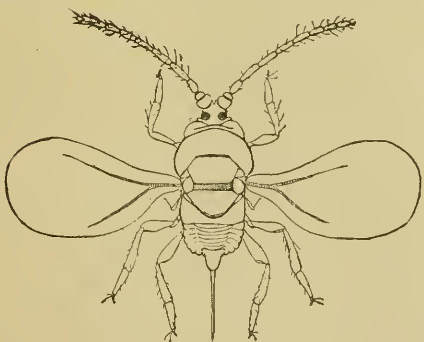
INSECT LIFE.

DEVOTED TO THE ECONOMY AND LIFE HABITS OF INSECTS, ESPECIALLY IN THEIR RELATIONS TO AGRICULTURE.

EDITED BY

L. O. HOWARD, Entomologist,

WITH THE ASSISTANCE OF OTHER MEMBERS OF THE DIVISIONAL FORCE.



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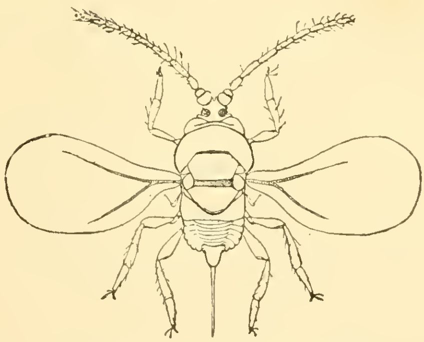

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CONTENTS.

SPECIAL NOTES.

This is the Last Number of Insect Life.—For administrative reasons it has been decided to close the publication of INSECT LIFE with this number, which completes volume VII. That the publication has been of value to its many classes of readers, including working naturalists and teachers, and especially farmers and fruit-growers, we can not doubt, for many appreciative expressions have reached this office. "Nature," for instance, probably the highest scientific authority printed in the English language, has recently (No. 1325, March 21, 1895) been good enough to refer to INSECT LIFE as "the premier of entomological bulletins," and refers to the fact that the results achieved by American workers should lead the English Government to a more generous recognition of work in economic entomology. Furthermore, it has been of great value to the Department, giving an opportunity for the speedy publication of results of immediate importance, and of short notes which, while of interest, would perhaps not have been published in any other form; but far more from the fact that it has greatly increased the number of correspondents of the Division of Entomology and has interested a large corps of accurate observers, not only in the work of the division, but in the science of entomology in general.

For the immediate future, at least, the place of INSECT LIFE will be filled by the publication of two series of bulletins from the Division of Entomology. A new series of general bulletins will be begun, the old series concluding with No. 33, published March 4, 1895. These bulletins will comprise short reports on special observations, and the miscellaneous results of the work of the division in practical and economic lines and in directions of general interest, thus including in the main many of the classes of articles which have been published in INSECT LIFE. The second series of bulletins, published at rarer intervals, will contain the results of the purely scientific work of the members of the office force, and will consist largely of longer or shorter monographic papers on groups of North American insects. The bulletins of the second series will be distributed only to libraries and to working entomologists, and will be published, therefore, in small editions. Those of the first series, however, will be sent to all of the present readers of

INSECT LIFE who desire them. The publication of the divisional series of circulars of information upon especially injurious insects, of Farmers' Bulletins upon special entomological topics, principally methods of treatment, and of occasional special reports, will be continued.

Mistakes about the Cotton-Boll Weevil in Texas.—The tendency to give the same popular name to different animals in different parts of the country has frequently been productive not only of great confusion but of very considerable harm. A marked instance of this fact is seen in the case of the cotton-boll weevil recently imported from Mexico into Texas. Cotton planters in the South have for many years been accustomed to designate any piercing of the cotton boll by the term "sharpshooter work." Several true bugs have been concerned in this damage, and as we have shown in INSECT LIFE (vol. V, p. 150) several of the leaf-hoppers, and particularly *Proconia undata* and *Homalodisca coagulata*, also produce this damage to bolls. On the first appearance of the Mexican boll weevil in the vicinity of Brownsville the planters applied to it the term "sharpshooter," and this has operated to prevent alarm among the cotton growers in other parts of the State, since they say that the "sharpshooters," like the poor, are always with us. The indifference with which, until recently, prominent cotton planters have regarded the advent of this new weevil is due entirely to the fact that they have supposed that the reports of damage referred to the work of the older and well-known insects. We have given full details concerning this point in Circular No. 6, Second Series, of the Division of Entomology, recently issued from the press and widely distributed throughout the State of Texas.

In our special note on page 281 of the last number of INSECT LIFE we mentioned the fact that the Assistant Secretary of Agriculture had notified the governor of Texas of the serious nature of the Mexican weevil, and had urged the importance of immediate legislation providing for quarantine and enforcement of remedial work.

In transmitting his recommendations, the Assistant Secretary gave a brief review of what is known of the habits of the Mexican weevil, which has been contradicted in Texas by cotton planters, largely, we think, on account of the misunderstanding of the difference between the new weevil and the old sharpshooter. In the Galveston News for March 12, for instance, "a prominent Nueces County farmer" is reported to have said that the information sent out from this Department is entirely incorrect; that the weevil is never known to enter the boll except when the boll is very young; and that as soon as the weevil enters it the boll drops off; further, that the pest makes it a point to attack the square or bloom as soon as formed, thereby preventing the formation of the boll. The facts are, that the weevil attacks the boll at all times as long as it is green. Mr. Townsend has repeatedly found the insect attacking full-grown green bolls as late as December. Only a few of the smallest bolls, when attacked, drop off; and this is the case, usually, only in the early part of the season. Even buds, when attacked, often remain on the stalk without dropping. Mr. Townsend has picked hundreds of full-grown bolls and dead bolls from the stalks, which contained weevils—sometimes as many as eleven in a single boll.

At the end of March, in the vicinity of Brownsville, there were quantities of infested dead and dry bolls still hanging firmly on the dead and dry last year's stalks; and Mr. Townsend found the larvæ of weevils in such bolls long after the February snow, and as late as March 24.

Popular Names.—The matter of popular names, referred to in a paragraph above, is a most difficult one to handle; and the genesis of popular names is always interesting. For many years entomologists have been in the habit of proposing popular names for insects, and in proposing these names an attempt has naturally been made to avoid duplication and the consequent confusion. Field naturalists in general have shown a certain contempt for these proposals, which they designate "book" names, and this attitude has been shared by some practical men, farmers among the rest. This has been largely due to the absurd character of many of the popular names so proposed; but after all, what is one to do?

It is nearly always impossible to trace the origin of a popular name which grows up among the people. It is rarely specifically distinctive, but it is catchy, frequently phonetic, and more or less descriptive. The names in use among the people should always be adopted by entomological writers, unless the probability of serious confusion should exist. Where the insect comes into prominence for the first time an attempt should be made to suggest a catchy, descriptive popular title, which will cause no confusion. Such a name will be readily and generally adopted, whereas if a bookish name (like those, for instance, commonly in vogue among collectors of Lepidoptera in England) be selected, it will not be taken up by the people, and some other name may come into use which may be far worse, on account of its preoccupation by some other insect, either of the same general region or of some other part of the country. The "gypsy moth," for example, is a book name, but it is short, and easily remembered, and readily came into popular use. The "red-humped prominent," however, or the "Brighton wainscot," or the "Pigmy Footman," are examples of a class of names to be avoided. They convey no idea to the ordinary individual, and are bookish to the last degree.

Where the scientific generic name of an insect is short and euphonious, experience has shown that it will be gradually adopted. We have many such examples in botany, such as Geranium, Magnolia, Gladiolus, and a host of others. Why should not the same process take place with insects? In California everyone knows the "Icerya," and in the South many cotton planters know the "Aletia." In the latter case, however, the term cotton caterpillar or cotton worm had come into previous use, and there is really no necessity for the adoption of Aletia. Professor Riley, when he began the publication of his reports on the insects of Missouri, obviously appreciated the importance of this question of popular names very strongly. He saw the desirability of the restriction of a single popular name to a single species of insect, and wherever confusion existed, he made an effort to reduce the confusion by the suggestion of new names for all but one of the species concerned. His names for the commoner of our cutworms, for example, were good and descriptive. The greasy cutworm; the glassy cutworm; the speckled cutworm, are very good, popular terms. We commend the question, as a whole, to the serious consideration of all persons who are writing upon entomological subjects for the benefit of farmers.

Australian Ladybirds in the East.—Through the kindness of Mr. J. F. McIntyre, of Fillmore, Cal., we have received a sending of *Rhizobius ventralis*, one of the Australian ladybirds sent over by Mr. Koebele on his second Australian trip. The insects were packed in a tin box containing living specimens of *Lecanium oleæ* for food on the journey. On arrival in Washington they were found to be in excellent condition, only one having died. They were liberated a few days later on purple-leaf plum trees in the grounds of the Department of Agriculture which bore upon their branches many specimens of a species of Lecanium. The ladybirds made themselves at home at once, and one individual was observed to begin feeding immediately upon a half-grown Lecanium. There were two larvæ and several pupæ in the box, which gives hope that the species will breed, the carriage of adults being sometimes disappointing from the fact that they may have laid all their eggs before having been collected.

Credit for Divisional Observations.—We have had frequent occasion in the pages of the present volume of INSECT LIFE to refer to the "notes of the Division" or the "notes of the office." In all such cases it must be remembered that Professor Riley was in charge of the office from June, 1878, to May, 1879; that Prof. J. H. Comstock was chief entomologist from May, 1879, to June, 1881; and that Professor Riley at that time resumed charge, remaining the chief officer of the division until June 1, 1894, when he resigned. As a result the office notes were accumulated under the direction of the individuals named for the periods mentioned. References to notes in INSECT LIFE have always been accompanied by dates, so that the reader of this paragraph will readily be able to give personal credit, if he desires to do so.

EXPERIMENTS WITH WINTER WASHES AGAINST THE SAN JOSÉ SCALE, SEASON OF 1894–95.

By C. L. Marlatt.

A preliminary report on the winter treatment of the San José scale, as conducted by the Division of Entomology, was given by Mr. Howard in a paper on this insect in the last number of Insect Life (pp. 293, 294). Additional experiments have since been made, and later notes made on the older ones, and the following detailed record of experiments and summary of results, with deductions based on them, may be considered supplementary to the report referred to. The numbers of the experiments in this article follow the actual order of their application, and do not correspond with the numbering in the first report, but they are similarly classified, and no difficulty will be experienced in referring from one to the other

GENERAL NOTES.

History and condition of trees treated.—All the experiments were conducted in the orchard of Mr. E. Dows, near Riverside, Md. The orchard is chiefly of peach, with some apple trees intermixed, and originally contained about 2,000 peach and 250 apple trees. A portion of the apple and peach stock was obtained from the Lovett Nurseries and planted in 1888. This was the source of infestation. The greater portion of the orchard was, however, obtained from a Virginia nursery in 1891, and was infested by the gradual spread of the scale from the Lovett stock. Experiments were conducted on both lots of trees, but for the most part on trees of or adjoining the original Lovett stock. The trees treated were all heavily infested with the scale, the worst infested trees being selected; and from this fact, as will be noted later, the death of certain trees, or portions of them, subsequent to treatment, is due, with two or three exceptions, rather than to the effect of the washes.

Dates of, and conditions following treatment.—The applications were made at four different times, as follows:

The first series was made on October 25 and 26, 1894, and comprised experiments 1 to 5. The trees at this time were still in leaf, but the foliage was mature and ready to fall.

The second series was made November 17, and included experiments 6 to 9. Subsequent to these applications (series 1 and 2) the weather conditions were very favorable, no rains occurring for some days, and in fact the months of October and November, 1894, were exceptionally dry.

The third series was made December 15, from 4 to 5 p. m., including experiments 10 to 14; and on December 16, from 11 a. m. to 2 p. m., including experiments 15 to 30. A light rain of ten or fifteen minutes' duration occurred on the evening of December 16, about 9.30 p. m., with two or three days thereafter without rain.

The final series of experiments was made January 23, 1895, from 4 to 6 p. m., including experiments 31 to 42; and on January 24, from 10 to 12 a. m., including experiments 43 to 46. On January 25 a light rain with sleet occurred in the evening, and on the 28th there was a heavy fall of snow.

Varying results on different parts of the same tree.—Later examination of the trees treated exhibited a marked difference in the results of many of the washes on different parts of the trees. It was found that where the scales were most thickly massed on the older and lower parts of the trunk the wash had been most efficient, and frequently in these situations scarcely a living scale could be found, while on the extremities of the branches, where the scales were scattering, the percentage of living scale insects greatly increased. This is evidently due to the fact that the smooth terminals, especially those of peach, do not retain much of the wash, and lose it more readily under the action of rains; also that the scales in these situations are better nourished and perhaps more vigorous than where more thickly clustered. The dense incrustation of the scales on the bark produces also a roughness which holds the emulsion, and the emulsion naturally accumulates on the basal portion of the branches. With many of the more satisfactory experiments a certain patchy result was noted. In other words, on particular branches or sides of branches every scale would be destroyed, while elsewhere a considerable percentage of living scales would be found, sometimes confined to small areas. This would seem to indicate either a failure to drench the tree evenly, or else that the patchiness was due to the action of subsequent rains and snows. The former is not likely, because especial care was taken to thoroughly wet the trees, and careful examination was made after each spraying to see that this had been accomplished. The latter theory is probably the correct one, and it is supported by the fact that the experiments of December 15 and 16 were followed by a light rain of a few minutes' duration from the northwest, while those of January 23 and 24 were affected by the irregular melting of subsequent snows, which lodged to a considerable extent in the trees.

The facts noted offer an additional reason for making the treatment early in the fall, viz, that the wash may act over as long a period as possible. That treatment is best made as soon as the leaves fall has already been suggested by Mr. Howard, on the ground that the insects at this time are more susceptible than later in the fall. (INSECT LIFE, vol. VII, p. 295.) A third advantage which would accrue in the East is, that at this season rains are much less frequent than they are in mid or late winter or early spring.

Slow action of insecticides on dormant scales.—An examination of the records of these experiments, in connection with results with other scale insects, strongly emphasizes the point that in the dormant resting condition scale insects respond to insecticides very slowly and gradually, and this has an important bearing on the determination of the usefulness of an application. The scale larvæ during the growing season are killed in a few minutes, or a few hours at farthest, just as other soft-bodied insects, but the mature scale does not for some time exhibit the effect of the wash unless it be so radically strong as to be unnecessarily expensive or as to endanger the life of the plant. It will be seen that little can be predicated of the ultimate result within two weeks, and at the end of a month the estimate can be only a provisional one, while at least two months are necessary to reach approximately final conclusions.

The slow progressive death of the scales must be largely due to the gradual penetration of the insecticide, and also indirectly to the softening and loosening of the scale itself, enabling the weather conditions of moisture and cold to be more fatal.

It will be noted, also, that it is the destruction of the last 5 or 6 per cent of the scale insects which necessitates the great strength of the wash and the accompanying heavy expense. It is comparatively easy to kill 75 to 90 per cent of the scales, and this with comparatively weak and inexpensive washes, but to reach the remaining few, double or treble strength is required.*

Effect of the washes on the health of the tree and on the fruit.—With some of the stronger washes, particularly those of soap and resin, a marked diminution was shown in the amount of bloom and in the fruit set. This, however, was usually accompanied by an increase in the amount of foliage, and the results in this direction were especially marked in the cases of the two stronger whale-oil soap washes. The two trees so treated were noticeably vigorous in foliage, and presented a finer appearance than any in the orchard, but contained scarcely any fruit. The general effect of the washes on the trees was, however, in large measure vitiated by the damage already done them by the scale; and in most instances where there was a greater or less amount of injury, or the death of the tree resulted, it was due to the scale rather than the wash, as evidenced by the similar condition of adjoining untreated trees. The pure kerosene emulsion, however, had a disastrous effect on the trees, and pure kerosene killed outright the trees treated with it. An application of soap made late in spring, or after the trees were already blooming, did not seem to affect seriously the setting of the fruit in the case of the peach, and in the case of the

* This is illustrated notably in the resin wash experiments against *Diaspis lanatus* in the winter of 1894–95, where a double summer strength killed 90 per cent, an application twice as strong only 95 per cent, and one three times as strong, or six times summer strength, was necessary to effect complete extermination.

apple no injury whatever was noted, even where applied at the rate of 2 pounds to the gallon, with the trees in full bloom.

Behavior of different washes and their cost.—The diluted washes presented no difficulties in application, nor is there any trouble in applying the Oregon and California washes at twice the ordinary strength. Pure kerosene emulsion can not be very satisfactorily sprayed with an ordinary nozzle, as the liquid is too heavy for this purpose. The strongest resin wash may be applied hot with an ordinary nozzle, but on cooling the resin will separate out within an hour or two, hence the necessity, at the greatest strengths used, of applying the liquid hot. Whale oil soap washes, even at 3 pounds to the gallon, are thin enough when cool to be sprayed without much difficulty, and no trouble whatever was experienced with 1½ to 2 pounds to the gallon. Hard soap, used in this experiment, solidified almost immediately into a rather tenacious soft soap, even at 1 pound to the gallon, and in this or greater strengths can not be sprayed except at very high temperatures. When once on the tree, however, it adheres much better than fish-oil soaps, or at least the evidence of its presence on the tree is much more apparent, the whitening of the bark being noticeable months afterwards. Whale-oil soaps do not give this marked appearance to the tree, and even at the start the tree remains only somewhat darker, as though wet.

The cost of the stronger applications are approximately as follows:

Whale-oil soap, at 4 cents per pound, using 2 pounds to the gallon, gives an 8 cents per gallon wash. It was found impossible to make a soap by buying the ingredients any cheaper than it could be obtained from the soap manufacturers.

Resin wash at six times summer strength costs about 6 cents per gallon by buying the ingredients in wholesale lots, viz, lye in drums of 800 pounds capacity, and the resin and oil by the several barrel lots. This does not include the expense of preparation, which is considerable.

Kerosene at 6 cents per gallon for a cheap grade, with soap at 4 cents per pound, would represent a cost for the pure emulsion of a little less than 5 cents per gallon, and for the once diluted mixture, 2½ cents.

The crystal potash lye was secured at retail and cost 15 cents a pound, making the strongest wash applied cost 30 cents a gallon.

GENERAL CONCLUSIONS.

1. The Oregon and California washes are practically valueless under the conditions obtaining in Maryland, even at twice the strength reported to be effective on the Pacific Slope. They are without action on the health or fruiting of the plant.

2. Lye washes are, in the first place, too expensive for use at the excessive strength required to accomplish any valuable results; and at this strength they also endanger the health of the plant. They do not seem to affect the blooming.

3. Pure kerosene applied to the entire plant kills the scales, but unfortunately also the plant, at least in the case of peach.

4. Kerosene and soap emulsion pure endangers the life of the plant. Diluted with one part of water it is not thoroughly effective, and this, with the trouble and expense of its preparation, renders its use inadvisable. Diluted with one part of water, or in greater dilution, it does not seem to affect fruiting or the health of the tree.

5. Resin wash, to be effective, must be used at a strength involving an expenditure for materials which, with the trouble and difficulty of its preparation, makes it of little practical value. Its effect on the health of the trees is not prejudicial, but in the stronger washes it prevents blooming the following season.

6 Soap washes, particularly of whale-oil soap, have yielded the most satisfactory results; and at the rate of 2 pounds to the gallon, under the conditions of thorough drenching of the entire plant, with five or six days of subsequent fair weather, will destroy all the scales, whether applied in fall or in spring. The results with soap in less strength indicate that under the most favorable conditions the same result may be reached with mixtures containing only a pound and a half, or more, of soap. The action of the soap at the rate of 1 pound or more to the gallon, applied in the fall, is generally to prevent blooming and fruiting the following spring, but the vigor and healthfulness of the tree are greatly increased. Applied in spring at the time of blooming, it does not injure the plant nor affect the setting of the fruit to any material extent in the case of the peach, and not at all in the case of the apple.

7. The experiments as a whole indicate the vastly superior merit of the soap wash and its fall application. The greater vigor of the plant resulting from the fall treatment more than offsets the possible failing of bloom. Owing to the impossibility of controlling weather conditions and the practical difficulty of wetting every part of the plant, one spraying can not often be relied on to accomplish the death of all of the scales, but two conscientious drenchings may be expected to accomplish this result. These may be (1) at the time of, or shortly after, the falling of the foliage in autumn, and (2) just before blooming in spring.

RECORD OF EXPERIMENTS.

Unless otherwise noted, the applications were all made to peach trees.

Whale-oil soap.

Experiment 2:

October 25, 3 pounds soap to the gallon of water; November 17, fatal to all scales; December 16, above result confirmed by subsequent examination; May 4, no living scales found on tree, nearly all dead scales washed off by action of rain; tree in exceptionally vigorous condition, and with luxuriant foliage, but with only one or two fruit set. Adjoining trees in full fruit, but very much inferior in general appearance and in development of foliage.

Experiment 1:

October 25, 2 pounds soap to the gallon of water; November 17, fatal to all scales; December 16, same result confirmed by additional examination; May 4, 1895, tree in exceptionally vigorous condition, but without fruit.

Experiment 43:

January 24, 1895, same strength as preceding; March 11, fatal to 95 per cent of the scales; May 4, 95 per cent of scales on living portion of tree killed. Half the tree dead, evidently from the scale, with which it was thickly incrusted. Living portion of the tree in full leaf, but without fruit.

Experiment 10:

December 15, 1½ pounds to the gallon; January 17, fatal to 90 per cent of the scales; March 11, 5 per cent living; May 4, not above 5 per cent of scales living. Tree in leaf and healthy, but without fruit.

Experiment 34:

January 23, 1½ pounds of soap to the gallon; March 11, fatal to 90 per cent of the scales; May 4, less than 5 per cent of the scales living; only 2 healthy scales found. Tree originally very heavily infested; some of the branches killed, evidently from the effects of the scale, others vigorous, but without fruit.

Experiment 46:

January 24, same strength as last; March 11, fatal to 90 per cent of the scales; May 4, tree dead, with the exception of two vigorous branches or new shoots of last year's growth. On these branches 10 per cent of the scales are living.

Experiment 35:

January 23, 1⅛ pounds to the gallon; March 11, fatal to 90 per cent of the scales; May 4, 5 per cent of the scales living, limited to terminals. Trees vigorous and in fruit.

Experiment 11:

December 15, 1 pound of soap to the gallon of water; January 17, fatal to 80 per cent of the scales; March 11, but 10 per cent of the scales living; May 4, 10 per cent of the scales alive (on terminals). Tree in good condition and in fruit.

Experiment 44:

January 24, same strength as last; March 11, fatal to at least 70 per cent of scales; May 4, 85 per cent of scales dead. Tree in vigorous condition, with fruit.

Experiment 45:

January 24, same strength as last and yielding the same results.

Experiment 36:

January 23, ¾ pound of soap to the gallon of water; March 11, fatal to about 70 per cent of the scales; May 4, 85 per cent of the scales have succumbed. Tree vigorous, with the exception of two branches, which are evidently killed by the scale; the whole tree originally densely infested; fruit in very small quantity.

Experiment 12:

December 15, ½ pound of soap to the gallon; January 17, fatal to about 50 per cent of the scales. Tree afterwards subjected to the general treatment given the orchard.

Experiment 37:

January 23, ⅝ pound to the gallon; March 11, upward of 50 per cent of scales killed. Tree afterwards subjected to general treatment given the orchard.

Hard laundry soap.

Experiment 18:

December 16, 2 pounds to the gallon; January 17, fatal to 85 per cent of the scales; March 11, no living scales could be found after extensive examination; May 4, in patches; a few living scales found; more than 97 per cent killed. Tree was originally very heavily incrusted with scales, and about one-half the branches are dead, probably from this cause; no bloom or fruit present.

Experiment 19:

December 16, $1\frac{1}{2}$ pounds of soap to the gallon; January 17, fatal to 85 per cent of the scales; March 11, no living scales found, except two, in doubtful condition; tree still whitened with the soap; tree originally densely incrusted; May 4, fatal to at least 95 per cent of the scales; tree uninjured, but without bloom or fruit.

Experiment 20:

December 16, 1 pound of soap to the gallon; January 17, fatal to 60 per cent of the scales; March 11, but 10 per cent of the scales remain alive; May 4, percentage of living scales unchanged; tree uninjured and with fruit.

Experiment 21:

December 16, $\frac{1}{2}$ pound of soap to the gallon; January 17, fatal to about 20 per cent of the scales; tree was subsequently subjected to additional treatment.

Experiment 22:

December 16, $\frac{1}{4}$ pound to the gallon; January 17, fatal to about 10 per cent of the scales; tree subsequently subjected to general treatment given the orchard.

Home-made fish-oil soap.

Experiment 15:

December 16, $1\frac{1}{2}$ pounds of soap to the gallon; January 17, fatal to 50 per cent of the scales; May 4, fatal to about 75 per cent of scales; tree in leaf and fruit, vigorous.

Experiment 16:

December 16, 1 pound of soap to the gallon; January 17, fatal to about 20 per cent of the scales; tree subsequently subjected to general treatment given the orchard.

Experiment 17:

December 16, $\frac{1}{2}$ pound of soap to the gallon; January 17, fatal to only about 5 per cent of the scales; March 11, more than 50 per cent of the scales living; tree afterwards subjected to general treatment given the orchard.

Resin wash.

Experiment 13:

December 15, six times strength of summer wash; applied to an *apple* tree very warm, almost scalding hot. January 17, examination indicated the death of all the scales, some of which were not yet completely dried up; March 11, no living scales found; May 4, most careful and extended examination resulted in discovering 4 living scales; tree vigorous, but without bloom; trees on either side in bloom, but other trees in neighborhood, untreated, also without bloom.

Experiment 31:

January 23, same strength as last, applied warm; March 11, fatal to 95 per cent of the scales; May 4, tree killed, except one vigorous shoot of last year's growth, springing from near base; tree densely incrusted with scales, and its death probably due to this fact; scales on the living branch not very numerous and no living ones found.

Experiment 14:

December 15, four times strength of summer wash; January 17, fatal to 85 per cent of the scales; March 11, but 5 per cent living; May 4, all but the new growth of last year dead, evidently from the scales which densely incrust the bark; fruit is set in one or two instances on the living portion; on the entire tree 95 per cent of the scales are killed.

Experiment 32:

January 23, same strength as last; March 11, fatal to 90 per cent of the scales; May 4, tree healthy, with scattering fruit. Not above 10 per cent of the scales living, and these confined to the terminals.

Experiment 5:

October 25, twice summer strength. This experiment was ineffective, the resin having separated out somewhat, and the wash was therefore much weaker than intended. Tree afterwards subjected to the general treatment given the orchard.

Experiment 33:

January 23, same strength as last; March 11, fatal to 75 per cent of the scales. Tree afterwards subjected to general treatment given the orchard.

Kerosene oil.

Experiment 42:

January 23, application made to two trees, one badly incrusted with scales, the other a vigorous tree, less infested. March 11, fatal to all the scales; May 4, both trees dead.

Kerosene emulsion.

Experiment 23:

December 16, undiluted emulsion; January 17, fatal to 90 per cent of the scales, a few on terminals apparently living; May 4, all scales dead except in isolated spots, evidently where the wash did not reach. Tree dead or dying, except one limb, which is in leaf and fruit, but this also will probably not survive the present season. This result due partly to the wash, although greatly assisted by the dense scale incrustation.

Experiment 38:

January 23, same strength as last; March 11, fatal to all scales; May 4, tree dead, with the exception of one or two branches, which are making feeble effort to leaf out. Tree originally badly infested, but not enough so to have caused death, which must soon result.

Experiment 24:

December 16, emulsion diluted with 1 part water; January 17, fatal to 80 per cent of the scales; May 4, only some half dozen scales found after careful examination; about 98 per cent killed; tree in full leaf and fruit.

Experiment 39:

January 23, same strength as last; March 11, fatal to 95 per cent of the scales. Part of the tree vigorous, uninjured, and in full leaf, with some fruit; remainder dead, probably from the effect of the scales. Some few living scales on terminals, perhaps 5 per cent.

Experiment 25:

December 16, emulsion diluted with 2 parts water; January 17, fatal to 50 per cent of the scales. Tree afterwards subjected to general treatment given the orchard.

Experiment 40:

January 23, same strength as last; March 11, fatal to 75 per cent of the scales; on some parts of the tree all the scales were killed; May 4, tree dead, probably from effect of scales and borer. Effects of latter were very marked about base of tree. The tree was also densely incrusted with scales.

Experiment 26:

December 16, emulsion diluted with 3 parts water; January 17, fatal to about 30 per cent of the scales; tree afterwards subjected to general treatment given orchard.

Experiment 41:

January 23, same strength as last; March 11, fatal to 75 per cent of scales; May 4, tree dead, with the exception of new shoot of last year's growth from near base; scales dead on this branch, which was not in very healthy condition and the experiment has therefore little value.

Experiment 3:

October 25, emulsion diluted with 4 parts water; November 17, not very effective; tree afterwards subjected to general treatment given orchard.

Experiment 4:

October 25, emulsion diluted with 6 parts water. Result as in preceding experiment; tree afterwards subjected to general treatment given orchard.

Concentrated crystal potash lye.

Experiment 27:

December 16, 2 pounds lye dissolved in a gallon of water; January 17, fatal to 85 per cent of scales; March 11, fatality estimated at nearly 80 per cent; May 4, about 15 per cent of scales estimated to be living, the living ones occurring somewhat in patches. Tree in leaf and fruit, not especially injured though some of the smaller terminals died after blooming. This and the other trees treated with lye present a beautiful, bright, clean appearance, and have a very noticeable red color.

Experiment 28:

December 16, 1 pound to the gallon; January 17, fatal to 75 per cent of the scales; March 11, no change in condition noted. Tree afterwards subjected to general treatment given the orchard.

Experiment 29:

December 16, ½ pound lye to the gallon; January 17, fatal to upwards of 50 per cent of the scales. Tree afterwards subjected to general treatment given the orchard.

Experiment 30:

December 16, ¼ pound lye to the gallon. January 17, fatal to 20 per cent of the scales. Tree afterwards given general treatment.

Oregon wash.

Experiment 6:

November 17, ordinary strength (sulphur 15 pounds, slaked lime 15 pounds, bluestone 1¼ pounds, water to make 100 gallons); December 15, fatal to only a small percentage of the scales; tree afterwards subjected to general treatment given the orchard.

Experiment 7:

November 17, double strength; December 15, fatal to very small percentage of scales; May 4, tree still whitened with wash; larger scales, representing at least 50 per cent, alive.

California wash—Lime-salt-sulphur.

Experiment 8:

November 17, ordinary strength (sulphur 25 pounds, lime 50 pounds, salt 18 pounds, water to make 100 gallons); December 15, fatal to only a small percentage of scales; tree afterwards subjected to general orchard treatment.

Experiment 9:

December 15, double strength; fatal to very inconsiderable percentage of the scales; tree afterwards subjected to general treatment of the orchard.

General treatment of the orchard.—The general orchard treatment referred to as following a number of the above experiments was carried out by the owner during April, the conclusion of the work being about the 22d. The treatment was based on the results of the foregoing experiments, and consisted in applying a compound soap wash made by dissolving a pound and a half of whale-oil soap and one-half pound of hard soap in a gallon of water. The soap mixture was kept hot during the application by the use of an oil stove taken into the orchard, and so high was the temperature of the liquid when applied that the pump was frequently too hot to hold. During the latter part of the treatment of the peach orchard the trees were in partial bloom, and the latest apple trees treated were in full bloom. The effect on the bloom and foliage of the trees has already been noted. The wash resulted in the death of at least 95 per cent of the scales, taking the orchard as a whole. In the case of a number of the apple trees last treated, there was afterwards a period of five or six days without any rain, and the wash, so far as could be discovered by most careful examination, had proven perfectly effective, no living scales being found. A result slightly inferior to the general average was noted on five rows, on which the wash had been applied with a brush, the penetration and saturation of the bark, as remarked by the owner at the time, being evidently less thoroughly accomplished by this means than when applied as a spray.

THE HIPPELATES PLAGUE IN FLORIDA.

By E. A. Schwarz.

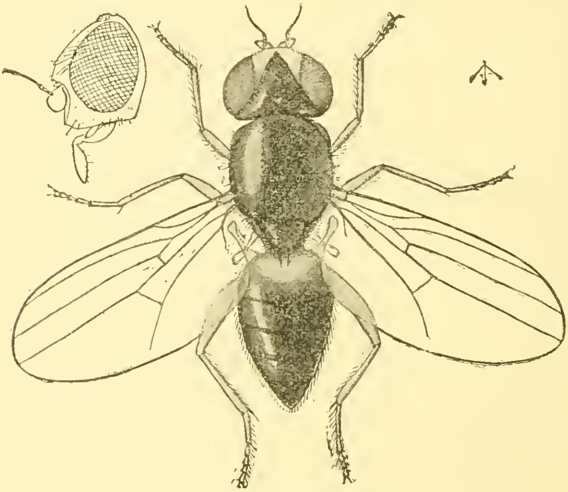

Fig. 37.—*Hippelates flavipes*: much enlarged (original).

During various trips to Florida in former years I had opportunity to get acquainted with the annoyance caused by certain minute flies. They are justly dreaded by the natives and summer residents of that State, and generally designated by them with the comprehensive term "gnats." Mosquitoes and sand-flies (Ceratopogon) are not more annoying in Florida in summer time than elsewhere, except near the coast, and the same may be said of the other annoying species of Diptera (house flies, horse flies, and fleas). But these little "gnats," which prove to be certain species of the genus Hippelates, are during daytime constantly about you in swarms, and render life more burdensome than any other insect pest.

When, in July, 1894, I stopped for a few days at Crescent City, Fla., and visited, in the company of Mr. H. G. Hubbard, other parts of this State, I was more than ever impressed with the importance of these little tormentors, so that I fail to understand why in all our literature there is not even the slightest allusion to them. Since no one else seems to be willing to make a beginning, I have ventured to record the following fragmentary notes* for the sole purpose of drawing attention to this subject. Nothing is known at present of the life history or early stages of these flies.

Since these flies can not "bite" it may properly be asked wherein the nature of the annoyance consists and what renders them such an unbearable and dangerous nuisance. First, they "sing" almost as perceptibly as a mosquito, and since everyone is quite sensible to this well-known sound it is, to say the least, not very pleasant to have these flies constantly around you. Secondly, they settle in crowds all over your person to suck up the perspiration, and the annoyance caused by their crawling over the face, neck, and hands is much greater than one would expect from such small insects. But this kind of annoyance could readily be endured with a little patience and practice by all persons who are not of a nervous temperament if the flies had not the pernicious habit and passion to settle in the corners of the eyes, being attracted by the moisture of this place. This causes the greatest and almost unbearable annoyance and irritation which is of course still further increased by constant efforts to wipe the flies away.

The above relates solely to the annoyance caused by the Hippelates flies, but there are other facts which stamp them as one of our most dangerous pests: Sore spots, scratches, ulcers, and other open wounds have the greatest attraction for them; they not only thickly crowd on such places which may be about your head and hands, but they crawl beneath your clothing if a sore or other wound should happen to be on your leg or breast.

If only your own person were concerned the matter would present no particularly dangerous aspect, but look at the dog lying on the ground only a few steps from you. From flea bites or other causes he has suppurating sores on the back or belly, which, of course, are thickly covered with the flies. Unable to stand longer the irritation the dog suddenly rises and shakes off the flies. You can plainly see that many of them come toward you and settle on your person, some of them sure to get in the corners of your eyes. Or, another person approaches you on the road: the man is plainly suffering from "sore eyes," a common disease among poor people in the South, or you happen to know that the person is afflicted with some other disease. He is, of course,

* These notes were read before the meeting of the Entomological Society of Washington held October 11, 1894. Several members of the society participated in the discussion and some valuable additional information was thus obtained, which is included in this article.

enveloped in a cloud of the Hippelates, and in passing him some hundreds of the flies now follow you.

If it has been proven that infectious diseases are disseminated by mosquitoes, house flies, and other flies, the danger arising from the Hippelates as carriers of contagious diseases is perhaps more evident than in many other cases on record.* Mr. H. G. Hubbard, who has passed many summers in Florida, remarked on this point "that in Florida a serious disease of the eyelid is often prevalent. It is known as 'sore eye' and becomes absolutely epidemic from time to time. He feels certain that this Hippelates carries the disease, since it is well-known that even the use of the same handkerchief will convey the disease from a sore-eyed person to a healthy one. He has known it to start with a single person and run through an entire school or community, and he thinks Hippelates alone accounts for the rapid spread. Moreover, the irritation caused by the flies greatly aggravates the disease, which becomes very serious, the patient seldom recovering entirely from it, being affected by weak eyes ever afterwards."† This danger of diseases being carried by the flies exists not only between man and man, but also among domestic animals and between man and animal.

Geographical distribution.—The Hippelates plague reaches, in my experience, its maximum height in Florida, but I also encountered the flies in annoying numbers at Selma, Ala., and Columbus, Tex. Mr. L. O. Howard observed some years ago swarms of a small fly greatly annoying his dog, in the vicinity of Washington, and fortunately collected and preserved specimens; finally Mr. C. L. Marlatt reports a similar experience near the same place. The meager material thus collected was submitted to Mr. Coquillett and was found by him to represent three species. The species from the District of Columbia collected by Mr. Howard, *H. flavipes* Loew (Fig. 37), proved to be identical with that observed at Crescent City, Fla., and judging from memory. the same species occurs at Selma, Ala. Specimens collected at Bartow, Fla., were determined by Mr. Coquillett as *H. pusio* Loew, while those found by the writer at Columbus, Tex., and by Mr. Chittenden at Rosslyn, Va., proved to be *H. plebejus* Loew (Fig. 38). It is safe to assume that other species of the same genus will be found to possess the same habit, but since these small flies have never been carefully collected nothing definite is known at present regarding the geographical extent of any of their species. All that can be said at present is that the genus Hippelates seems to be confined to the more southern portions of the country.‡

* The literature on the subject appears to be quite extended but is not readily accessible. Most of the articles which I was able to consult deal with the dangers arising from house flies and mosquitoes, but it is evident that the writers on the subject of ophthalmia refer to other species of Diptera, though no names are given.

† Proc. Ent. Soc. Wash., vol. III, p. 179.

‡ Osten Sacken's Catalogue enumerates two species from Texas, one from the District of Columbia, one from Illinois, four from Cuba, and one from California. The latter locality is open to doubt.

It is not the object of this note to enter into a description of the species of Hippelates mentioned above. They are carefully described by Loew in his "Centuriæ," and the characteristic features of two species (*H. flavipes* and *H. plebejus*) are well set out by the accompanying illustrations, which were drawn by Miss L. Sullivan, under supervision of Mr. Coquillett. It suffices to say here that in form of body, general appearance, and mode of locomotion the Hippelates resemble our common house fly, but they are much smaller than the latter, averaging not more than about 1.75^{mm}. in length. In spite of their small size they are, when alive, quite conspicuous by the bright color of the legs and of a part of the abdomen, which, in the case of *H. flavipes* and *H. pusio*, strongly contrast with the brilliantly black color of head and thorax. In *H. plebejus* almost the entire abdomen is yellow, but the forepart of the body is opaque and grayish. A peculiarity of Hippe-

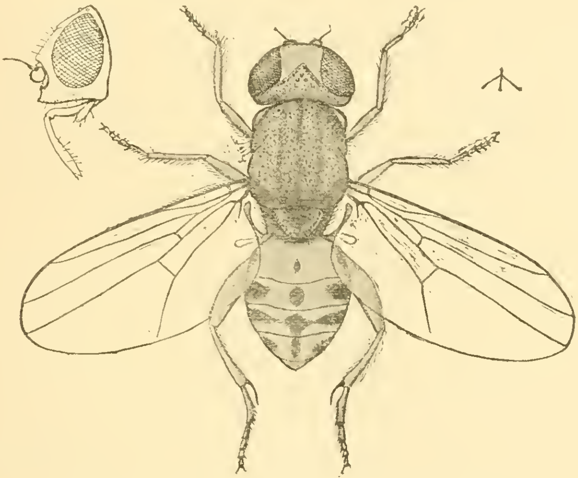

FIG. 38.—*Hippelates plebejus:* much enlarged (original).

lates is the hardness of their bodies, and a slap with the hand which would be sufficient to crush any mosquito or house fly does not hurt them in the least.

Notes on the habits.—The flies are strictly diurnal, and continue to be troublesome from early morning till near sunset, being most aggressive during the hot and sultry hours of the afternoon. They preferably frequent open and sunny places, while in the shade of dense forests their presence is not noticeable. They are equally troublesome in the open country away from human habitations and in the streets of small towns, but I do not recollect having seen them in any number on the streets of the larger cities. They enter the houses, but evidently do not feel at ease in the rooms, for they do not attack people, but congregate on the panes of the windows if these happen to be closed. When not on the wing the flies can be seen sitting on the leaves of trees, shrubs, and all sorts of lower plants, the exuding sap of which probably constitutes their natural food. Neither in Florida nor at other places in the South did I notice them near the ocean shore, perhaps because they are unable to endure the constant breeze. It is further my experience that the flies are exceedingly abundant only wherever the soil is sandy; they are either entirely absent or hardly noticeable in regions where the soil is rich and heavy. During the month of August I traveled through the "black land" region of the cotton States, and was annoyed by the flies only at two places, viz, in the suburbs of Columbus, Tex., where the soil is dry and light, and at Selma, Ala. At the latter place not a single specimen was to be seen on the right side of the Alabama River, where the soil is black and heavy, while just across the river, where it is sandy, the flies were almost as bad as I have experienced them in the interior of Florida. Persons visiting or residing in Florida during winter or early spring are not molested, the flies at this season being either not numerous enough to attract attention, or they are not aggressive. Mr. Hubbard says that they commence to be troublesome when the weather gets really warm, or about the month of May. In July, with the beginning of the rainy season, they are out in full force, but how long they continue to torture man and animals has not been ascertained.

Life history.—As stated above, we know nothing thus far of the earlier stages of the genus Hippelates. The records* of the larval habits of other genera of the family Oscinidæ show that the larvæ of the majority of them breed in stems of graminaceous plants. It is possible that Hippelates has the same habit, but Mr. Hubbard remarked that "if the insect is really an above-ground leaf-miner or stem-miner its work would have been noticed by him, as, on account of the great number of the flies, the work of the larvæ must be very extensive and readily seen." The records further show that some other Oscinid larvæ breed in decaying stems of plants, in worm-eaten nuts, and under the bark of old trees, and Mr. Marlatt suggests "that the attractiveness of the moisture of the eyes and of sores would indicate that the larva is perhaps saprophagous in its habits, and may be found in decaying vegetation."

The sandy regions of Florida, where the Hippelates flies occur most numerously, are for the most part covered with open pine woods, and their chief characteristics consist in numerous smaller or larger ponds and lakes which are usually surrounded with a belt of rushes and reeds. From this feature of the country I am inclined to believe that the Hippelates larvæ will be found to live either within the stems of the living reeds or under or within the piles of the decaying reeds which usually line the shores of the lake.

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*As collected by Brauer (Die Zweiflügler d. k. Hofm. Wien, part 3, pp. 84, 85), and Townsend (Can. Ent., 25, 1893, p. 14).

Remedies.—Until some light is thrown on the life history of the flies it is impossible to suggest any remedial measures to be adopted for the general abatement of this pest in a given region. Very little can be said regarding protective measures. To kill the flies as we instinctively do the mosquitoes, by a slap of the hand, is of no avail against the Hippelates, because they are too numerous and for obvious other reasons. A close-fitting veil would no doubt protect the eyes, but in the hot days of a southern summer the wearing of a veil is a torture almost equal to that of the flies. For the same reason applications of oil of tar, oil of pennyroyal, and similar substances, which are more or less satisfactorily used in the North against mosquitoes, black-flies, and sand-flies, is hardly bearable in the South. Smoking cigars or a pipe offers good protection to those that indulge in this vice, but even an inveterate smoker can not smoke constantly when he is outdoors. A good smudge also drives away the flies, but, of course, can not be classed among the remedies that are handy and available at every hour and at every place. Sprinkling the coat collar and other parts of the clothing with Eucalyptus oil (and no doubt, also, other strongly-smelling etheric oils) as lately recommended as a good repellant against house flies, should be tried, and promises, in my opinion, good results.

THE BEET-LEAF PEGOMYIA.

(*Pegomyia vicina* Lintn.)

By L. O. Howard.

Dr. J. A. Lintner, State entomologist of New York, in his first annual report, gives an interesting account of some anthomyians mining beet leaves. He reared a large series of flies from larvæ found mining the leaves of beets in a vegetable garden in Middleburg, N. Y., and was surprised to find that his bred specimens comprised three species. One of them was *Phorbia floccosa* Macquart, which Mr. Slingerland believes to be a synonym of *Phorbia brassicæ* Bouché, one of our principal cabbage root-maggots. The other two Dr. Lintner described as new, viz, *Chortophila betarum* and *Pegomyia vicina*. Other similar beet leaf-mining larvæ were found by Dr. Lintner later at Bennington, Vt., but no adults were reared, so that the species remained undetermined. The species under consideration was found to be at work during the latter part of July and the specimens from which the description was drawn issued August 7. Other specimens issued August 15 and 25.

An interesting occurrence of the same insect in California, where it was found to be doing very considerable damage in the extensive sugar-beet plantations of the Western Sugar Beet Company at Castroville and Watsonville, Cal., was brought to the attention of this Department in 1891. Specimens were first sent May 22, 1891, by Mr. W. A. Gaffy to the Assistant Secretary of Agriculture, with the statement that 1,000 acres of promising sugar beets were all more or less affected by the insect. Dr. Riley sent Mr. Koebele in June to the spot, and while his observations did not result in the ascertaining of practical remedies, he collected material from which the accompanying figure of the different stages of the insect has been drawn. On June 6 he collected about 2,000 eggs of the insect, all before mid-day, and nearly all on the underside of the leaves. All but about 10 had hatched on June 9, and the remaining 10 were mature the following morning, indicating that the insect remains in the egg state for from three to four days.

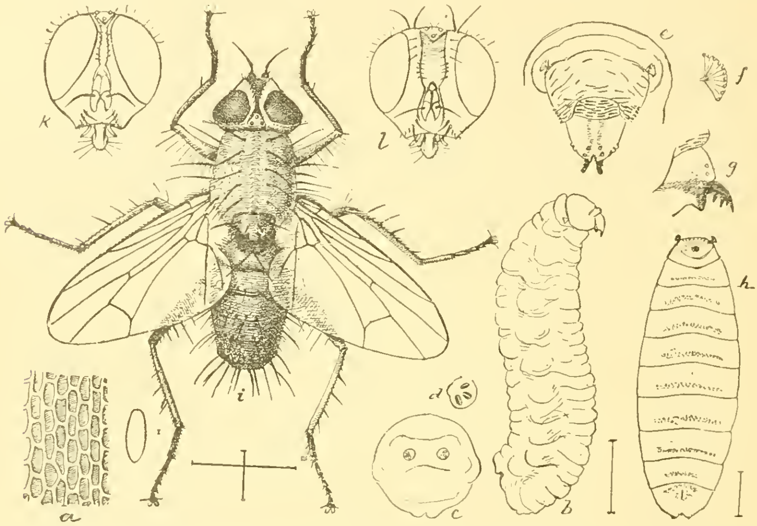

FIG. 39.—*Pegomyia vicina*: *a*, surface of egg, very highly magnified; *b*, larva; *c*, last segment of same; *d*, anal spiracles; *e*, head; *f*, thoracic spiracles; *g*, cephalic hooks of larva; *h*, puparium; *i*, adult fly; *k*, head of adult male; *l*, head of female—*b*, *h*, *i*, enlarged, other figures still more enlarged (original).

On June 7 two plants, which Mr. Koebele had brought to his home in Alameda, were cleaned of all larvæ and stocked with unhatched eggs. On June 8 the young larvæ began to mine the leaves, and by June 11 had become nearly full grown. They did not transform to puparia, however, until June 16, making the length of the larval state to be 8 days, which, however, is probably shortened under perfectly natural conditions. While in the field he also collected about 300 larvæ, most of which pupated on June 8. The first flies issued June 28 and the remainder the following week. We have, then, as the duration of a generation, egg stage, three to four days; larval stage, seven to eight days; puparium, twenty days, or about one generation per month.

As above stated, the attention of the Department was first called to the matter in May, when the work of the insect was already evident. Mr. Koebele reared another generation in June. The following year the company forwarded specimens to Dr. Riley in September, which were nearly all in the pupa state and from which flies issued September 8. In October of the following year (1893) Mr. J. W. Morse, of the Western Beet Sugar Company, sent from Watsonville, Cal., three beet roots, accompanied by considerable soil, and in this soil were found puparia of the Pegomyia from which, however, no adults issued. There seem, therefore, in California, to be at least five annual generations, but we are unable to state definitely the method of hibernation. Judging from the habits of allied species the insect will hibernate in the puparium stage.

Remedies.—There is little which can be done in the way of direct remedies for this insect without sacrificing the foliage, but the foliage is not important to the beet crop after a certain time. After the tubers become well grown it will be obviously practical and quite efficient as a preventive of damage the following year to cut, remove, and destroy the beet tops. There will, of course, at any season of the year be a greater or less number of puparia in the ground about the roots but the numbers of the insect can be greatly reduced by this means. If this plan be adopted and if the field be plowed and harrowed after the roots are dug, the probabilities are that no serious damage will follow next season.

TWO DIPTEROUS LEAF-MINERS ON GARDEN VEGETABLES.

By D. W. Coquillett.

A LEAF-MINER ON RADISHES.

A new injurious insect has made its appearance in this country within the past few years in the shape of a small, two-winged fly, whose larvæ form rather large blotch mines in the leaves of the garden radish. It was first observed on June 12, 1892, by Mr. Theodore Pergande, of this division. In one of the gardens of Ivy City, D. C., he noticed that quite a large number of the radish leaves had been mined by the larvæ of a dipterous insect; the greater number of the mines were empty, but a few of them still contained larvæ, three of which pupated the next day, and the adults emerged eight days later. One of these is represented in the accompanying illustration (Fig. 40). The color is a pale yellowish, with the antennal arista, an ocellar dot, the tip of the abdomen and of each tarsus blackish.

A recent study of these specimens indicates that they belong to *Drosophila flaveola* Meigen, a rather common European insect, not hitherto reported as occurring in this country. In Europe it has been bred from larvæ found mining the leaves of turnips, pease, *Cochlearia officinalis*, *Anthyllis vulneraria*, and *Tropæolum canariense*. As many as five larvæ sometimes occupy the same mine, and when the leaf containing the mine is small they usually desert it and form new mines in the adjoining leaves. *Drosophila pallida* Zett., and *Scaptomyza apicalis* Hardy, are regarded as being synonymous with the present species.

Prof. H. Garman, the entomologist of the Kentucky Experiment Station, in his Bulletin No. 40, issued in March, 1892, has given a very interesting account of what is evidently a different, although closely related, species of Drosophila, the larvæ of which mine the leaves of the turnip in that State. It was first observed during the month of October, 1891, when it infested about one-fifth of the leaves in the turnip-field of the station. The description of the adult insect given by Professor Garman accords very well with *Drosophila graminum* Fallén, a common and widespread European species, reported many years ago as occurring in this country, having been recognized by the well-known German dipterist, Dr. Loew. Recently Prof. A. D. Hopkins, of the

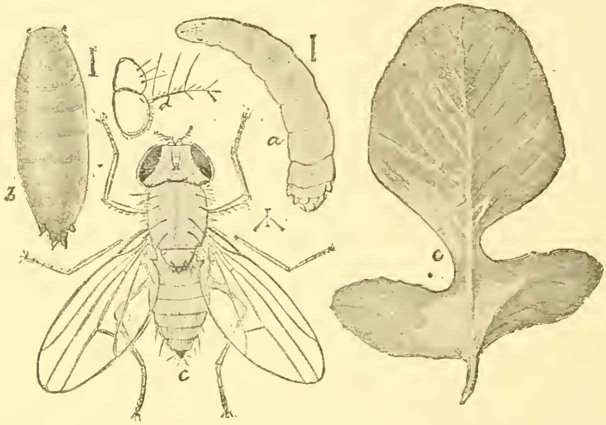

FIG. 40.—*Drosophila flaveola*: *a*, larva; *b*, puparium; *c*, adult; *d*, antennæ of adult; *e*, larval mine in radish leaf—*a*, *b*, *c*, enlarged; *d*, still more enlarged; *e*, natural size (original).

West Virginia Experiment Station, submitted specimens of this species, with the statement that he reared them during the past season from larvæ found mining the leaves of cabbage in his locality. This insect seems to be quite a general feeder; besides the plants mentioned above, it has been bred in Europe from *Stellaria media*, *Lychnis githago*, *Chenopodium album*, *Viscaria oculata*, and *Silene armeria*.

The genus Drosophila contains two groups of species which, while closely related by structural details, differ from each other in regard to food habits. In one of these groups, which contains the well-known vinegar fly (*Drosophila ampelophila* Loew), the larvæ live in fermenting or decomposing vegetable substances of a liquid nature; while those of the second group mine the leaves of growing plants. The species of the latter group have been separated into a distinct genus under the name of Scaptomyza by the English entomologist, Hardy; but the best authorities on this subject accord it only subgeneric rank.

Although no experiments have as yet been made in this direction, so far as we can learn, still there is a possibility that the attacks of this insect may be prevented by sprinkling the plants with Paris green and water, at the rate of 1 pound of the poison in 200 gallons of water, first mixing the former with an equal quantity of freshly slaked lime, adding water to the mixture, and allowing it to stand for several hours before using. The addition of the lime is for the purpose of rendering the poison harmless to the plants. It will, of course, be advisable to make the application before the plants have been attacked;

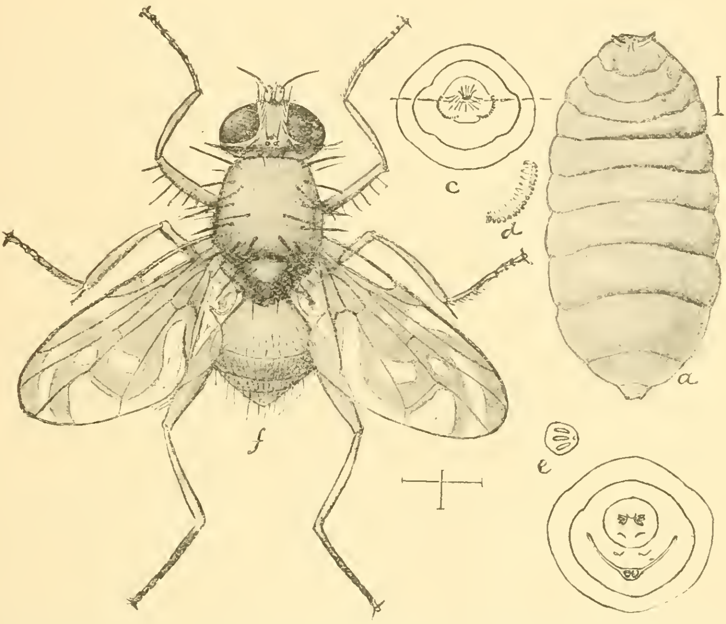

FIG. 41.— *Trypeta fratria*: *a*, larva; *f*, adult—enlarged; *c*, *d*, *e*, anterior and posterior extremities of larva—still more enlarged (original).

after once the larvæ have made their way to the interior of the leaves it will be difficult to reach them by means of any external application, although there is a possibility that even then a penetrating liquid like the kerosene emulsion might find its way to them and accomplish their destruction.

THE PARSNIP LEAF-MINER.

So little attention has been given in the past to a study of the life histories of our Diptera that the early stages of only a very limited number are at present known. An extended search through the published records has failed to bring to light a single fact bearing upon the life history of *Trypeta fratria* Loew, which may be called the parsnip leaf-miner.

On June 11, 1891, Dr. Riley received a package of parsnip leaves from Mr. J. G. Barlow, of Cadet, Mo. These had been quite extensively mined by the larvæ of a two-winged fly, and from three puparia found in one of the mines the adults issued on the 23d of the same month. These belong to *Trypeta fratria*, a rather rare species, which extends from the Atlantic seaboard westward at least as far as the State of Missouri. Dr. Loew, who has published a monograph on this group of insects, has expressed the opinion that one of the forms described from California by the Swedish entomologist, Thompson, may prove to be identical with the present species, in which event its distribution would be extended across the continent.

The European species belonging to the same group or subgenus (Acidia) as this one, are principally leaf-miners in the larva state, and the nearest related species (*Trypeta heraclei* Linn.) has been bred from larvæ found mining the leaves of Rumex, Heracleum, Ligusticum, Archangelica, and the common garden celery. Several of these plants belong to the same natural family as the parsnip.

The remedies mentioned as of value against the radish leaf-miner will be equally applicable to the present species.

SOME COLEOPTEROUS ENEMIES OF THE GRAPE-VINE.

By F. H. Chittenden.

In the Report of the Nebraska State Horticultural Society for 1895 Mr. Lawrence Bruner gives a list of thirty-six species of Coleoptera affecting the grape-vine. Deducting three synonyms, this leaves a total of thirty-three species. Mr. Bruner has made no pretensions to a complete list of grape-vine insects, nor is it my intention to more than supplement his list by adding such species as I recall from personal observation, and such as are specifically mentioned in literature or in the records of this division as attacking the vine in this country.

The twig-pruner (*Elaphidion villosum* Fab.) is of common occurrence, in my experience, on grape. I have in mind at least two published statements of this food habit, viz, that by Professor Riley (Am. Ent., vol. III, p. 239), and my own (Pr. Ent. Soc. Wash., vol. III, p. 96).

Neoclytus erythrocephalus Fab. is recorded from grape (loc. cit., p. 97).

The red-legged flea-beetle (*Crepidodera rufipes* Linn.), attacks the opening leaf buds of grape, and is capable, if present in sufficient numbers, of very serious damage. During May of last year I observed this bud-destroying habit near Washington, and we have a divisional record of having received the same insect May 13, 1881, from Mr. Randall Morton, of Pittsburg, Pa., with the statement that the species was very injurious to the vine near there, by eating the buds. As this flea-beetle has lately been found to be very destructive under certain circumstances (see Insect Life, vol. v, pp. 334–342) to the peach, pear, plum, and apple, I take this occasion to add cherry to the list. It was observed last year, April 13, gnawing the undeveloped leaf buds of cherry saplings near Rosslyn, Va. A large number of young trees, chiefly pine and locust, had just been cleared away from this spot the previous spring. In this instance it is quite plain that the presence of the insects on the cherry was due to the absence of the favorite food tree of the species, the locust, in this locality.

Xyleborus dispar Fab., one of the "shot-borers," is known to injure the vine in Europe, and in this country doubtless has the same habit. I have beaten it from old vines near Washington early in April.

Anthaxia quercata Fab.—The larva, which resembles those of Chrysobothris, Dicerca, and other large Buprestidæ, was taken at Rosslyn, Va., from its pupal chamber in the old outer bark at the base of a living and evidently healthy wild grape-vine. At the time of its discovery, May 28, this larva was motionless, showing that transformation was about to begin. June 2 it became a pupa, and June 14 all parts save the elytra had become dark colored. On the following day the legs unfolded, but the elytra remained uncolored until the 16th, when the transformation was completed. The pupal stage, therefore, lasted fourteen days. Mr. C. H. Roberts has recorded the abundance of this species on grape-vine (Am. Ent., vol. v, p. 17) without, however, a conjecture of this as a larval food-plant, but his discovery of twenty two pairs *in copula* conclusively proves this, as also what Dr. Horn in his synopsis of the genus had surmised, that *quercata* and *cyanella* represent sexes of a single species. I have previously recorded chestnut as a food-plant of this species, and there is no doubt that it breeds also in oak (loc. cit., pp. 31, 217).

Lyctus opaculus Lec., one of the "powder-post" beetles I have previously referred to as breeding in grape stems infested with *Phymatodes amœnus* (Pr. Ent. Soc. Wash., vol. II, p. 393). There is also a divisional record of the occurrence of this species on grape. Specimens observed by me several years ago at Ithaca, N. Y., hibernated in the larval condition. The adults began issuing May 8, the species being present in all stages at that date.

Hypothenemus dissimilis Zimm.—I have also noted the occurrence of this species in grape stems (loc. cit.).

Finally, should be added three species of Cleridæ, all but the last of which have been reared from the vine by the writer. These are:

Elasmocerus terminatus Say, recorded from dead vines (Am. Ent., vol. VI, p. 154), and by Dr. J. Hamilton (Can. Ent., vol. XVIII, p. 28).

Chariessa pilosa Forst., mentioned by Mr. A. D. Hopkins as occurring in dead vines.

Ichnea laticornis Say, reared from the vine by Mr. W. Juelich (Bull. Bklyn. Ent. Soc., vol. III, p. 140). These species prey on cerambycid and other borers and are, therefore, to a certain extent beneficial.

Thus much from personal observation. The following notes have been prepared from data gleaned mainly from published notices and from the divisional record books and correspondence.

Of the dozen species of vine-chafers of the genus Anomala, two species, *A. lucicola* and *A. marginata*, are mentioned in Mr. Bruner's list of grape insects. At least two others, viz, *A. undulata* Mels. and *A. minuta* Burm., are destructive to the vine.

The species described and figured by Harris (Ins. Inj. to Veg., p. 34) as probably *A. varians* (a synonym of *undulata*) is evidently not this species, but *lucicola*. In LeBaron's Fourth Report (p. 89) *varians* is described and referred to as "the species so common on grape-vines in the West." May 14, 1888, we received specimens of *undulata* from a correspondent at Greenville, S. C., with the report that they were injuring grape, and April 7, 1879, from Dr. Charles Mohr, who stated that they were injuring blossoms of grape, apple, and pear at Grand Bay, Ala.

A. minuta Burm. is mentioned in volume I of INSECT LIFE (p. 220) as injurious in Louisiana vineyards. June 14 of the present year Mr. A. N. Caudell sent specimens from the experiment station at Stillwater, Okla., with the statement that they were ravaging grape, doing much damage by skeletonizing the foliage.

A. binotata Gyll. has been included in a list of grape species by Thomas (Sixth Rept. St. Ent. Ill., p. 105), but on what authority I do not know.

Hoplia callipyge Lec.—Specimens of this scarabæid were received during May, 1893, from two correspondents in Fresno County, California, the first reporting that they were found on roses and afterwards in his vineyard, as many as a hundred on a single vine; the second that they were doing great damage to the Muscat grape (see INSECT LIFE, vol. V, p. 343). In the Pacific Rural Press of May 17, 1890, *H. sackenii* Lec. is mentioned as injurious to the grape in the same district.

Haltica carinata Germ.—Mr. D. W. Coquillett furnished us some time ago with specimens of this flea-beetle from Los Angeles, Cal., with grape leaves injured by them, and mention of this species as an enemy of the grape has been made by Dr. G. H. Horn in his synopsis of the Halticini (Trans. Amer. Ent. Soc., vol. XVI, p. 223).

Gastroidea formosa Say is reported in the first volume of this journal (p. 385) as a vineyard pest in Arizona. It is destructive also to the cañaigre (*Rumex hymenosepalus*). An account of what is undoubtedly the same insect is given in Bulletin No. 9 of the Arizona Agricultural Experiment Station, the species receiving mention as the cañaigre beetle (*Gastroidea cæsia* Lec.). The American representatives of the genus Gastroidea are as yet imperfectly known, but *formosa*, according to Dr. J. Hamilton, is an introduced species, synonymous with the European *viridula* Deg.

Metachroma sp.—A correspondent at Brighton, Tex., sent us, May 28 of the present year, specimens of what is apparently an undescribed species allied to *M. suturale* Lec., with the statement that this insect has been playing havoc with this year's cuttings of the vine. During the heat of the day the beetles remained concealed in the curl of a leaf or under any convenient bit of rubbish near the base of the stem and toward evening and in the early morning come forth to feed.

Catorama sp.—During the year 1892 Mr. F. G. Schaupp sent us from Shovel Mount, Tex., specimens of an evidently undescribed species of Catorama, taken in May, in all its stages, from grape canes.

Artipus floridanus Horn, better known as a depredator on orange and other citrus trees, was received November 23, 1889, from Mr. J. M. Lever, of Waldo, Alachua County, Fla., with the accompanying information that it was doing much damage to grape leaves.

Ampeloglypter crenatus Lec. and *Madarus undulatus* Say, near relatives of the grape-cane gall curculio, Mr. Schwarz informs me, occur both on grape and on Ampelopsis.

Species which are known to affect Ampelopsis and other genera of the vine family will be found in time on the grape. Of such are *Ampeloglypter ater* Lec.

THE CURRANT STEM-GIRDLER.

(*Phyllœcus flaviventris* Fitch.)

By C. L. Marlatt.

The publication of an illustrated account of this insect in Insect Life (vol. VI, pp. 296–301) led to the recognition of damage due to it by Mr. Robert B. Treat, of Centerville, R. I., and the interest thus aroused has enabled me, with Mr. Treat's assistance, to complete the details of the life history of this insect which were hitherto lacking. Mr. Treat said of it in his letter of May 30, 1894, that he had noticed its work on currant bushes during the last two seasons, but had never before observed any indications of its presence in New England. At the date mentioned the adult insects were rather abundant among his currants, as evidenced by the frequency of the severing of the terminals, and he was good enough to collect a large series of these and transmit them to this office. One of them, showing the characteristic appearance of the severed twig, is illustrated at Fig. 42. The work had been recently done, as the tips nearly severed—completely so in two cases—were merely withered. The cutting to sever the tip extended nearly completely round the twig, and was from one to two inches below the tip. From the nature of the marks the work was evidently done with the mandibles.

The egg was found to be inserted in the green, succulent growth, from one-eighth to three-fourths of an inch below the cut, the point of insertion of the ovipositor being indicated exteriorly by a very minute brownish cut or mark in the bark (Fig. 42 *a*). By dissection the transparent, delicate egg was found embedded in the very heart of the pith (Fig. 42 *b*). It is elongate-oval, about a millimeter in length, whitish in color, delicate, and without any characteristic sculpturing (Fig. 42 *d*).

At the suggestion of the writer a large number of the severed twigs were marked by Mr. Treat, with the idea of following up the subsequent development of the insect. These were examined from time to time, and on the 5th of October a large number of marked twigs were sent to this office, and it was found that in every instance the eggs had failed to develop, and the twig had merely died back from the point of exci-

FIG. 42.—*Phyllœcus flaviventris*: *a*, egg puncture; *b*, same in section showing egg in pith—enlarged; *c*, severing of terminal by female; *d*, egg—greatly enlarged (original).

sion, half an inch or so, and was otherwise uninjured. The balance of the marked material was transmitted to me April 24 of the present year, and out of some fifteen twigs there was only one in which the egg had hatched and the larva gone successfully through its development. In the other cases, as with those previously examined, the egg had failed to hatch, or the larva had failed to survive long enough to do any noticeable work. The reason for this great mortality is not apparent, unless it be due to the fact that the cultivated currant, on account of difference in growth or greater luxuriance, is not as suitable to the insect as wild currants or allied plants, which may be presumed to have been its original food plants. This very general failure of development from the egg, if normal, will detract somewhat from the injurious character of the insect. The severing of the terminal twigs is, however, the principal damage after all, since the work of the larva, as will be indicated below, only causes the death of three or four inches more of the twig.

In the twig in which successful development had taken place, the larva had worked down from the tip some 3½ inches, eating out the entire pith and inner layer of wood, leaving only a very thin shell. The interior of the twig was densely packed with the larval excrements down to within three-fourths of an inch of the base of the burrow, where the larva had hibernated in a delicate cocoon. The cocoon is a little over one-half an inch long, and consists of a very slight silken lining

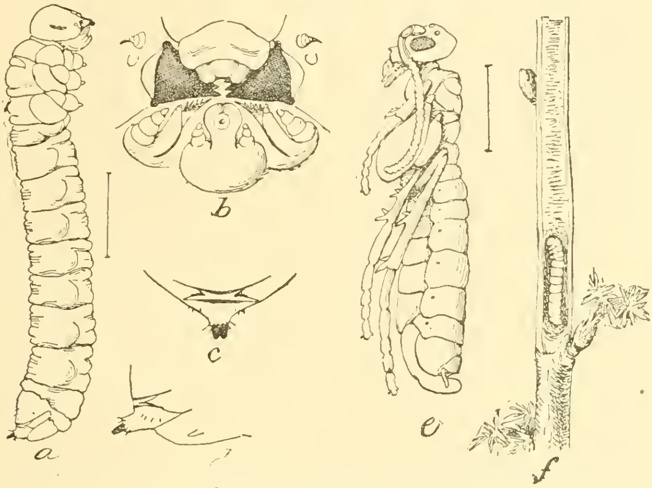

FIG. 43.—*Phyllœcus flaviventris*: *a*, larva; *b*, antennæ and mouth-parts of same; *c*, dorsal view of tip of abdomen; *d*, lateral view of same; *e*, pupa; *f*, larva in twig in hibernating cocoon. *a*, *e*, enlarged; *b*, *c*, *d*, greatly enlarged; *f*, natural size (original).

of a portion of the burrow. A section of the burrow, showing the cocoon and contained larva, is given in the accompanying illustration (Fig. 43 *f*).

The larva passes the winter practically unchanged in this cell, and at the time of examination had not transformed, although pupation was near at hand, as indicated by the fact that the compound eyes were already showing through the head. The larva is a little over half an inch long, and is creamy white in color, with the mandibles and labrum brown, darkest at tips, and the area back of the base of the mandibles, together with the tips of the antennæ, maxillæ, and horny tip of abdomen somewhat lighter brown. The peculiarities of structure of the larval mouth-parts, and the peculiarly spiny projection terminating the body, are indicated in the accompanying illustration (Fig 43 *b*, *c*, *d*).

Transformation to the pupa took place two or three days after the receipt of the specimen, and the general characteristics of this stage are sufficiently indicated in the illustration (Fig. 43 *e*). The pupa was preserved in alcohol, but the adults, from previous observations and rearings, issue, as indicated in the article cited at the outset, from the middle to the last of May. Arrangements have been made with Mr. Treat to continue the study of this insect, and particularly to determine whether the great mortality in the eggs, in last season's experience, may be relied on as a normal feature.

Three nearly full-grown larvæ of this insect in currant twigs were received August 10, 1892, from Mr. E. W. Claypole, Akron, Ohio. One of these, which was saved to rear the adult, spun up in August, indicating an early completion of larval growth and a larval dormancy of upward of nine months.

OBSERVATIONS ON CERTAIN THRIPIDÆ.

By Th. Pergande.

Thus far only two species belonging to the genus Heliothrips have been described.

The most common and destructive of these two species to the foliage of hothouse plants in general, both in Europe and in this country, was described by P. Fr. Bouché, in his Naturgeschichte der schädlichen und nützlichen Garten-Insekten, in 1833 (p. 42) under the name of *Thrips hæmorrhoidalis*. It is a rather stout, black species, with pale yellow legs, almost colorless wings, and the end of the abdomen red.

The other species, much less common, although it may be found in almost every hothouse, becomes sometimes also quite destructive to various kinds of plants, particularly the Dracænas. It was described by E. Heeger (Sitzungsb. d. mathem.-naturw. Klasse d. Wissensch., vol. XIV, 1854, p. 365) under the name of *Heliothrips dracænæ*. This is a yellowish-brown species with rather long and narrow white wings, which are ornamented with a brownish band across the basal third; two brownish spots or interrupted band beyond the middle and a spot near the apex.

Both were probably introduced with ornamental plants from the warmer regions of America, at least the first-named species, which is found upon wild and cultivated plants in Brazil.

HELIOTHRIPS CESTRI SP. NOV.

To these I have to add now two additional new species. One, which I shall call *Heliothrips cestri*, has been known to me since 1884, when specimens were presented to me by Mr. B. P. Mann, who discovered them infesting a plant of *Cestrum nocturnum*, brought from Massachusetts. About the same time it was also sent me by Prof. O. M. Reuter, Helsingfors, Finland.

In 1883 I discovered the same species in the conservatory of this Department to be extremely abundant, both on the upper and under sides of the leaves of a species of Amarillis. Some of the leaves were so badly infested that their entire surface became blistered and bright red, as if attacked by a peculiar fungus.

I have observed it also on quite a number of different kinds of hothouse plants, as *Richardia æthiopica*, *Ficus grandiflora* and *elastica*, Aralia, Gardenia, Phœnix, and different species of Dracæna; also on Hydrangea, Chrysanthemum, foreign grape-vines, cotton, and a number of weeds growing with some of the cultivated plants.

It appears from these observations that this species may gradually become as troublesome in hothouses as the other two species.

Heliothrips cestri sp. nov.

Length, 1.2^{mm}. General color black or dark brown; the end of the body more or less distinctly reddish. Head reddish, marked with a rather broad, dusky, median stripe and a shorter one behind each eye. Eyes dark brown. Ocelli reddish. Antennæ dark yellow, with apex of first, fourth and fifth and the remaining joints black. Prothorax generally a shade darker than the head, and marked with a still darker median and lateral stripe. Legs reddish-yellow; median and posterior femora and tip of tarsi blackish. Wings dusky, marked with a pale band near base, a rather indistinct band beyond the middle and frequently a pale apex, while the surface is clothed with minute whitish hairs, and the veins with stiff spines. Fringes dusky. Surface of body reticulated, coarsest on the abdomen. Third antennal joint almost as long as the two following joints combined; the fourth and fifth subequal in length, each of them scarcely longer than the second.

The larvæ are whitish, sometimes slightly greenish or yellowish, and the alimentary canal, when filled, more or less distinctly brownish; they are very dirty looking on account of a clear or brownish fluid, which they eject from the upturned anal segment. The eyes are small and brown.

HELIOTHRIPS FASCIATA SP. NOV.

A specimen of this handsome little species was sent to the Department of Agriculture by Mr. G. W. Harney, of Yuba County, Cal., with the statement that two of them were discovered by him in November, 1894, on a leaf of orange infested with *Aspidiotus aurantii.* This accidental occurrence of these specimens on the infested leaf makes it appear as though they might be preying upon the scales, which, however, I seriously doubt, since none of the other known species of this genus have shown carnivorous habits.

Heliothrips fasciata sp. nov.

Length, about 1^{mm}. General color, black. Head and thorax dark brown; the anterior margin of the prothorax and more or less of the mesothorax yellowish-brown. Eyes black. Ocelli clear, yellowish. Antennæ whitish; a broad band on joints 3 and 4, apex of the fifth and the remaining joints black. Legs black, with apex of femora, base and apex of tibiæ, and the tarsi, except the apex, yellow. Anterior wings blackish; their base and a broad band beyond the middle transparent white. Posterior wings faintly and uniformly yellowish. Fringes blackish. Head and thorax reticulated and furnished rather sparsely with short, slightly curved hairs.

Some short and stiff hairs, becoming more numerous toward the end of the body, may also be observed near the posterior lateral angle of the abdominal segment; one or two larger ones on segments 5 to 8 and a number of long bristles along the posterior margin of the ninth.

EUTHRIPS OCCIDENTALIS SP. NOV.

Specimens of this species were transmitted to the Department of Agriculture during June of 1881 by Mr. Alexander Craw, from Los Angeles, Cal., with the information that great numbers were infesting the underside of the young and tender leaves of one-year-old apricot trees, and that the constant irritation causes the leaves to become deformed. He stated that he had known these insects for years, but had not previously considered them particularly injurious.

During February, 1891, the same species was received from Mr. D. W. Coquillett, who observed them to be plentiful in the blossoms of orange trees. In July of the same year Mr. Coquillett informed the Department that this insect was damaging the leaves of potatoes in that locality, and that he had noticed it also on different kinds of weeds.

Up to the present time this species has been considered as being probably identical with *Thrips tritici* Fitch, which it closely resembles. A critical comparison, however, of the two forms proves the California insect to be a different species. The most marked differences, insignificant as they may appear, are the much larger eyes, shorter head, much longer terminal joint of the antennæ, and the stouter and more prominent bristles of the head, thorax, and wings of the Californian species.

Euthrips occidentalis sp. nov.

Length, 0.9 to 1.2^{mm}. General color, orange yellow, with the posterior margin of the abdominal segments broadly dusky or blackish. Eyes hairy, black. Ocelli reddish. Antennæ dusky, with base and tip of the joints paler. Wings yellowish, the spines and fringes blackish. Head twice as broad as long. Eyes very large, occupying about two-thirds or more of the sides of the head, and coarsely granulated. Head and pronotum transversely striated. Joints 3 and 6 of the antennæ longest and nearly subequal in length; the third with a short though distinct pedicel. Joints 2, 4, and 5 next in length, also subequal. The last two joints, usually termed the "stylus," are smallest, though the last is considerably longer than the penultimate one. Joints 2 to 5 bear each about six bristles around the apex and the sixth about the same number around the middle. Besides these bristles, there may be noticed a pair of stout, bluntly pointed, curved, sensorial spines, near the end of joints 3 and 4, originating from a rather large, membranous spot, similar to those organs in *Thrips tritici*.

THE ONION THRIPS.

(*Thrips tabaci* Lindeman.)

Limothrips tritici (Fitch) Pack., Second Ann. Rept. Insects Mass., pp. 5–8, 1872.
Thrips tabaci Lindeman, Schädl. Ins. d. Tabak in Bessarabien, pp. 51–76, 1888.
Limothrips allii Gillette, Bull. 24 Agr. Exp. Station Colorado, p. 15, 1893.
Thrips allii Gillette, Osborn and Mally, Bull. 27 Iowa Agr. Coll. Exp. Station, p. 139, 1895

The earliest record of the so-called "onion Thrips" which I have been able to find was published by Dr. A. S. Packard, in 1872 (Second

Ann. Rept. Insects Mass., pp. 5–8), under the name of *Limothrips tritici*, which, however, is neither a Limothrips nor *Thrips tritici* Fitch. Dr. Packard states that Mr. B. P. Ware, of Swampscott, Mass., had suffered a serious loss from the attacks of this insect; that he had noticed it on his onions for the last fifteen years, but that the damage in 1872 was greater than ever before, and that the evil appeared to be equally serious in other parts of Essex County, especially in Lynn, Salem, and parts of Danvers. He estimated that at least one-tenth of the crop of one season, amounting to $10,000, was destroyed by this new pest, in Essex County alone.

The next authentic record of a Thrips upon onion plants was on the island of Bermuda, and was published by Prof. A. E. Shipley, of Cambridge, England, in Bulletin 10 of Miscellaneous Information, Royal Gardens, 1887 (p. 18), with the remark, however, that it appeared to cause but little injury.

Two years later another account of the injurious work of the onion Thrips was published by Dr. Roland Thaxter (Ann. Rept. Conn. Agr. Exp. St. for 1889, p. 180) in the following words:

> The white blast of market onions is the most serious disease to which onions in the field have been subjected this year, and has been reported from numerous localities and observed in all the onion districts which have been visited. The injury gives the field a whitish appearance, which starts in one or more spots and spreads in all directions. The onions themselves become stunted in their growth, while the leaves are more or less completely dying, according to the severity of the attack; becoming water-soaked at the base if the weather be at all wet, inducing decay, and generally injuring the keeping quality of the bulbs.

In addition to the above I have seen several other references to what is without doubt this same species.

In the Annual Report of the Colorado Experiment Station for 1892 (p. 36) the following note from the pen of Mr. C. P. Gillette, station entomologist, appears: "The onion Thrips (*Thrips striata* Osb.?) was extremely abundant on the college grounds [Fort Collins] the past summer and fall, and has been reported as a pest at Greeley, Colo. Thousands of these Thrips were present on single onion tops in the college garden." In the report for 1893 (p. 55) this insect is again reported as exceedingly abundant at Fort Collins and Denver. In Bulletin 24 of the Colorado station, published the same year, a three-page account of this insect is given, including a description of the species, with illustrations. Mr. Gillette adds that should the species prove to be new, the name *Limothrips allii* be applied to it. Mention is here made also of an article on this subject by Mr. C. F. Baker, published in volume VII of the American Florist (p. 168).

Dr. J. A. Lintner, in his ninth New York Report, for 1892, (p. 445), mentions a Thrips from Kingston, Pa., attacking the leaves of cabbage and cauliflower in large numbers, which evidently also belongs to this species.

In the Annual Report of the New Jersey Agricultural College Experiment Station for 1893 (p. 441), Dr. J. B. Smith states that the onion

Thrips occurred that year on the leaves of onions in astonishing numbers, the result of their eating being visible in the form of small yellow spots, increasing in size until the tips of the leaves became yellow or brown, the whole stalk finally having a whitish appearance, very different from the usual dark green of a healthy onion plant.

In 1894 Messrs. Sirrine and Lowe, in Bulletin 83, new series, of the New York Agricultural Experiment Station (pp. 680–682), gave an account of the damage done by this insect to the leaves of cabbage, accompanied by a description and figures of the species.

Very recently the species has been treated by Messrs. Osborn and Mally, in Bulletin 27 of the Iowa Agricultural College Experiment Station for 1895 (pp. 139–142), under the name of the western onion Thrips (*Thrips allii* Gillette). To the list of food plants already mentioned are added squash, turnip, stone crop, heal-all, blanket flower, cinquefoil, Nasturtium, candytuft, four-o'clock, catnip, sweet clover, Rudbeckia, and mignonette.

The notes of the Department of Agriculture regarding this species show that it was received during 1889 and 1891 from Mr. Coquillett, from Los Angeles, Cal., where it was very injurious to the onions in that section of the State.

During 1892 a communication was received from Mr. R. D. Kline, of Streator, Lasalle County, Ill., complaining that this insect caused much damage to his onions.

In July, 1894, the same species was received from Mr. F. M. Webster, from Wooster, Ohio, with the report that it was making serious havoc in all onion fields in northern Ohio (see also INSECT LIFE, vol. VII, p. 206). In August of the same year it was again reported by Mr. Kline as being extremely abundant on all the onions in that neighborhood; that he used to grow five acres of them every year, but that he had to give it up on account of the extraordinary damage caused by them of late years. At the end of the same month Mr. Kline wrote again that they were also infesting his melons, remarking that they generally appear first on onions, next on cabbage, then on melons and cucumbers, and later on anything that may suit their taste.

In my own notes regarding this species I find that it was taken in the District of Columbia and in Virginia, from February till November, during the years 1882 to 1888, on the leaves of onion, cabbage, cucumber, and parsley, while in 1885 I received the species from Mr. L. Seifert, Segeberg, Holstein, Germany, with the statement that it was very destructive to the garden leek (*Allium porrum*).

Up to the present time I have considered this insect to be a new species, though, after carefully examining and comparing the determined European species in my collection with our American insect, I discovered it to be identical with *Thrips tabaci* Lind., specimens of which were kindly sent to me by Prof. K. Lindeman, at the time that he was studying this species, when it was causing much damage to the leaves of tobacco in Bessarabia, South Russia. A full account of its history, with description of the species, will be found in a pamphlet entitled Die schädlichsten Insekten des Tabak in Bessarabien (Moscow, 1888, pp. 51–76).

The fact of the occurrence of this species in Europe indicates, in my opinion, that it is not a native of this country, but that it has been imported from Europe, either with tops of green onions or on leaves of cabbage, infested parts of which were either brought ashore or thrown overboard, while the ships having such vegetables on board lay in our Eastern harbors. From such points of infection, after having secured a foothold, they gradually spread in all directions, following closely the trunk lines of the railroads, until they reached the Pacific Slope.

The species may be redescribed as follows:

Thrips tabaci Lindeman.

Female.—Length of body, 1 to 1.2^{mm}. Color, pale yellow, the thorax somewhat darker; sides of thorax and an elongated squarish spot on the meso-notum more or less distinctly dusky. Abdominal segments marked with a rather broad, darker, or lighter dusky band posteriorly. Eyes brown. Ocelli colorless, their inner margin more or less distinctly orange. Antennæ and legs pale dusky, with tip of tarsi somewhat darker. Wings faintly yellowish, their fringes and bristles dusky.

Antennæ 7-jointed. Joint 1 shortest and stoutest; the second slightly longer. Joints 3 to 5 are elongate-ovoid and subequal in length; the sixth is elongate-conical and longer than the others; the stylus is one-jointed. All are provided with a few stout bristles and the third and fourth in addition with two stout, blunt, curved, sensorial spines near the apex. Head about as broad as long, and transversely striated. Eyes hairy.

Prothorax longer than broad, slightly narrowed in front; its anterior and posterior angles rounded, and provided with two backward-directed diverging spines at each posterior angle; surface transversely striated. Spines and bristles of the abdomen similar to those of *Thrips tritici*. Legs rather long and slender, particularly the last pair. Wings densely covered with minute spines, and with stout spines or bristles along the veins and anterior margin, while the hairs of the fringes are slender and wavy.

Male.—This sex resembles the female in every respect, except that it is much smaller, narrower, and with the end of the body bluntly rounded. Its length is about 0.7^{mm}.

Larva: The mature larva is somewhat smaller than the female, and of a paler or darker yellow color, often with a greenish tint. Eyes reddish. Ocelli wanting. Legs pale dusky. Antennæ 6-jointed, short and stout. Joint 1 broader than long; the second about twice as long, stoutest and rounded at the apex. The third is longer than the second, pyriform and with a short but distinct pedicel, ornamented with, apparently six, rather shallow annulations; the fourth joint is almost as long as 2 and 3 combined, fusiform, and divided by about eight annulations; the fifth is very short, but indistinctly separated from the fourth, and much shorter than the last. All bear a few slender hairs. The thoracic and abdominal segments are ornamented with from six to eight transverse rows of closely set, minute, fleshy tubercles, while each of the abdominal segments in addition is provided with a lateral bristle, which gradually become longer and more slender toward the end of the body.

This species resembles in general appearance *Thrips striata* Osb., *T. tritici* Fitch, and *T. occidentalis* n. sp., but differs from all of them in the stylus of the antennæ, which is only 1-jointed. It belongs evidently to Walker's "Section 4, Neogami," and may form a new subgenus of Thrips.

AN IMPORTED LIBRARY PEST.

By E. A. Schwarz.

Nicobium (*Anobium*) *hirtum* Ill., of the coleopterous family Ptinidæ, is a native of southern Europe, where its larva has been occasionally found in libraries to burrow in the leather bindings and backs of old and little-used books, or in ancient documents written on parchment. The insect is, however, only locally abundant in Europe, so that it is not considered a serious library pest, and is not mentioned for this reason in most works on European economic entomology. In one way or another the insect has found its way to North America, but has always been regarded as a great rarity with us, since hitherto only a few specimens have been accidentally found in North Carolina, Georgia, and Florida. The following extracts from our correspondence prove, however, that this supposed rare insect is in reality far more abundant with us than is desirable. About three years ago Prof. H. A. Morgan, of Baton Rouge, sent to the Department for determination a specimen of this species which he had "bred from a book taken from our library, and in instances where books have remained undisturbed for a considerable time this insect has done considerable damage" (letter dated May 26, 1892). This happened at the Louisiana State library, but we are not aware that Professor Morgan has ever published anything on the subject. A more serious state of affairs was recently reported by Mr. C. M. Widman, S. J., librarian of St. Charles College at Grand Coteau, La., who sent us a lot of the larvæ, accompanied by the following letter, dated December 10, 1894:

Fig. 44.—*Nicobium hirtum*: adult beetle—enlarged (original).

Our case is this: We have a library of some eight or nine thousand volumes, some of them valuable ancient editions long out of print. A few insects were found, I remember, about twenty-five years ago, but as they seemed harmless no one paid much attention to them. Later on, about twelve years ago, they had made considerable progress, which we tried to check in different ways. The location of the library was changed twice or three times; the books were inspected, moved, and cleaned at least once a year, the damaged books being visited repeatedly almost page by page and worms taken out; corrosive sublimate in solution was dropped in to kill eggs, etc. But nothing has succeeded so far, and we see the time when we shall have to burn part of our books to save the other part. The worms attack especially old books with soft paper and paper bindings. If the books be thick, they generally do not advance deep, but spoil the first and last pages and the binding. Books with thick and solid paper are less exposed; but then they attack the back of the book, thus causing the leaves to fall out of the binding.

It would appear from this communication that this beetle has firmly established itself as a library pest at least in Louisiana, and we have no doubt that a careful search among the older libraries in the South will reveal its presence at other places. When and where it was originally introduced can not now be ascertained, Dr. LeConte's original specimen having been either collected by himself or sent to him previous to 1862.

In the more northern States the insect has never been found, and judging from the behavior of other Old World insects that have been introduced into the southern portion of North America, it is not likely that this Nicobium will spread northward. There is danger, however, that it may be imported again directly from Europe into the libraries of our more northern cities, and our librarians will do well upon purchasing ancient leather-bound works from Europe to examine them closely before incorporating them in the library.

In the library of the Department of Agriculture is a set of six folio volumes of Olivier's Histoire Naturelle des Insectes, published a century ago, the leather binding of which has been attacked by insects, several exit holes corresponding to the size of Nicobium while the remainder were evidently made by a smaller insect of about the size of *Sitodrepa panicea.* It is probable that these two ptinids were the species concerned in the damage.

The larva of *Nicobium hirtum* does not differ in general appearance from other ptinid larvæ, i. e., it closely resembles a "white grub" in miniature in shape and characteristic curvature of the body. It is covered with sparse but rather long hairs, while even a feeble magnifying glass will show numerous short, brownish spines, with which the larger portion of the dorsal surface is furnished. Although the legs are well developed, the larvæ are barely able to make use of them, and if shaken from the books they are utterly unable to climb back to the shelves.*

The general appearance of the beetle (Fig. 44) deserves a few words, since the presence of this pest in a library is liable to make itself known from specimens of the beetle being seen crawling about, more especially on the window panes. It is of elongate-oval, cylindrical form, between 3 and 4^{mm} (.12 to .16 inch) in length, its color rather light brown, but rendered grayish by a dense, short, and somewhat velvety pubescence. This pubescence, however, does not uniformly cover the elytra, but is here absent on two or three transverse bands of which the anterior is usually quite distinct, while the two posterior ones are less distinct, often confluent or broken up into spots. This peculiar arrangement of the pubescence, as well as the strongly punctate elytral striæ, render this species at once recognizable from all other beetles which are liable to occur in the rooms of a library. In addition to this short, appressed pubescence, the dorsal surface is furnished with moderately sparse, but rather long, erect hairs.

In the comparatively few instances where injury to books in our more northern libraries has been reported, the author of the mischief has

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* A very useful synoptic table of ptinid larvæ, including that of *Nicobium hirtum*, is published by Ed. Perris in his Larves de Coléoptères, page 248.

been (to omit here the white ants, roaches, and springtails) either *Sitodrepa panicea* * or *Ptinus fur*.

The imagos of these species have been frequently figured; regarding their larvæ it suffices to say that that of *Ptinus fur* (as well as other species of the same genus) is at once distinguished superficially from the larva of *Nicobium hirtum* by the complete absence of spines on the dorsal surface. The larva of *Sitodrepa panicea*, however, closely resembles that of Nicobium, but is much smaller and lacks the spines on the third thoracic segment.

Another dangerous library pest in the West Indies is *Anobium bibliothecarum*,† so named by Prof. Ph. Poey (Mem. sobre l'Hist. nat. de Cuba, vol. I, 1851, p. 228), some thirty years ago was very destructive to the libraries at Havana, Cuba. There can be but little doubt that the library pest on the island of Guadeloupe, described by L'Herminier,‡ must be referred to the same species. This insect appears to a native of the West Indies, and has never been found in North America, but if imported with old books or otherwise it may possibly propagate in the Southern States. It is of a black color, covered with an extremely fine, prostrate, grayish pubescence, and the wing-covers are not striate. This last character will at once distinguish it from all other Ptinidæ known to infest libraries.

In a large library these ptinid beetles are more difficult to deal with than one would expect. In the first instance their presence is easily overlooked until they have become very numerous, because they preferably infest the leather bindings of old volumes which are rarely disturbed on their shelves § and further because outward signs of their work are but little evident. Thus a careful and repeated overhauling of the books is necessary to ascertain even the extent of the infestation, although we are well aware that in a library containing many thousands of volumes even a single overhauling is a matter of considerable magnitude and expense. Then comes the difficulty in exterminating the larvæ since by no means all of them can be shaken from the volumes during the examination. All infested volumes should be placed in a separate, well-closed room, where they should be frequently examined or fumigated with bisulphide of carbon in a tight chest.

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* This includes the case reported by Mr. Scudder from the library of the Boston Athenæum (Proc. Bost. Soc. Nat. Hist., vol. x, pp. 13, 14. The scolytid beetle, *Hypothenemus eruditus*, which was found by Westwood in England injuring the pasteboard bindings of a book, has never been found in North America under similar circumstances, although what is supposed to be the same species is extremely abundant with us.

† Dr. LeConte suggested (Library Journ., vol. IV, 1879, p. 374) that this species should be referred to the genus Eupactus, and more recently Mr. A. Sallé (Ann. Soc. Ent. France, 1889, p. 418) places it in the genus Cathorama.

‡ Ann. Soc. Ent. France, vol. VI, 1837, pp. 499–502. The species is there named *Dermestes chinensis* but is evidently a ptinid (see Dr. H. A. Hagen's note in Library Journ., vol. IV, 1879, p. 374).

§ "Les livres et les dossiers sommeillant dans les bibliothèques" (Ed. Perris, Larves de Col., p. 246).

TWO DIPTEROUS INSECTS INJURIOUS TO CULTIVATED FLOWERS.

By D. W. Coquillett.

A DESTRUCTIVE LEAF-MINER ON THE CHRYSANTHEMUM.

Next to the rose, there are few flowers more widely cultivated and admired in this country than the chrysanthemum. So great, indeed, is its popularity that annual fairs are held in various localities devoted entirely to an exhibition of specimens of this queenly flower. Within quite recent years a pest has made its appearance which, if not destroyed early in its career, will severely disfigure if it does not succeed in killing the plants outright. Not only are the various kinds of chrysanthemums thus attacked, but cinerarias, eupatoriums, and tansy are also subject to its depredations. One grower, in transmitting specimens of the infested leaves to the Department, writes that he will be compelled to abandon the growing of these plants owing to the attacks of this pest.

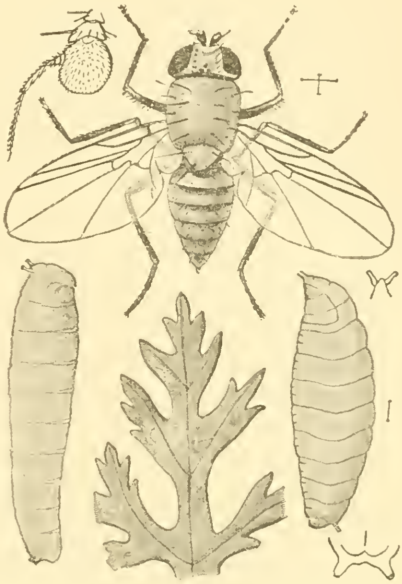

Fig. 45.—*Phytomyza chrysanthemi:* adult fly, above—enlarged; antenna of same, to left—more enlarged; leaf showing larval mines, below—natural size; larva, at left, pupa at right—both enlarged (original).

The latter when in the adult state is a small, black, two-winged fly, represented in the accompanying engraving (Fig. 45). The front of the head, the face, halteres, knees, and posterior margin of each segment of the abdomen are yellowish. The larva, which is of a pale yellowish color, with the mouth-parts black, forms long, discolored mines in the leaves, usually in the blade of the leaf, but sometimes in the petiole, and passes the pupa state within the mine. The species was described a few years ago under the name of *Phytomyza chrysanthemi*—by Mr. Kowarz.

The first specimens of this pest were received at this Department December 30, 1886, from Charles Anderson, of New York; these were still in their mines in the chrysanthemum leaves, with the exception of two of the adults, which had issued on the way. Others put in their appearance at intervals up to January 10, and on the 6th of the latter month two were observed to be still in the larva state.

A package of leaves of the Marguerite, or French daisy (*Chrysanthemum frutescens*), infested by this pest was received January 14, 1887, from the well-known horticulturist, Prof. Thomas Meehan, of Germantown, Pa.

Leaves of the same plant were also received February 28, 1890, from the greenhouse of James Read, Irvington, N. Y., and from these the adults were reared on the 5th of the following month. Quite a large series of chalcidid flies belonging to the genus Chrysocharis were also bred, but as the other members of this genus are almost without exception parasitic upon other chalcidid or Ichneumon flies, it is quite certain that the present specimens did not prey upon the leaf-miners. Their presence, however, is indicative of the very important fact that these miners have an enemy to contend with in the form of a small four-winged fly that has thus far escaped detection.

On March 27, 1890, leaves of what is apparently the same kind of plant were received from J. H. Ives, of Danbury, Conn. From these the adult phytomyzids issued from March 31 to April 3.

A second package of infested leaves of the marguerite and feverfew were received from Mr. Ives April 3, 1890, and in transmitting them the statement was made that he would be compelled to abandon the growing of these plants owing to the attacks of this pest. From these leaves the adults issued in large numbers April 5 to 14.

Still another package of infested leaves of the marguerite were received June 5, 1890, from John Akhurst, of Brooklyn, N. Y. Several of the adults had issued while on the way.

Our present knowledge of this insect would appear to indicate that it is indigenous to this country; specimens have been submitted to one of the best German authorities on this group of insects, Mr. Ferdinand Kowarz, and he was unable to identify it with any of the described European species. There is, of course, a possibility that it may exist in that country, and that we may have received it from that source. An allied European species, *Phytomyza affinis*, so closely resembles it that the one might easily be mistaken for the other, even by an expert. The fact that it has been reported in this country only along the Atlantic seaboard, and that, too, principally in greenhouses, is a further indication of its having been introduced.

The earliest record of the depredating of this pest upon cultivated plants appears to date from the month of October, 1886; during that month Dr. J. A. Lintner, State entomologist of New York, received a package of leaves of the marguerite infested with this insect, and in his Fourth Report, published two years later, an interesting account of it is given under the erroneous name of *Phytomyza lateralis*, the species, by some means not easily understood, having been wrongly determined by Baron Osten Sacken. In the American Florist for March 15, 1887, Mr. William Falconer published what is apparently the earliest account of this insect under the incorrect name of *Phytomyza affinis*.

Dr. Lintner gives some additional facts concerning this pest in his Seventh Report, correcting the erroneous identification published in the previous accounts.

The remedy employed by Mr. Falconer consists in simply pulling off and destroying the infested leaves as soon as the mines are discovered, and he reports that this method proved entirely effectual.

A CECIDOMYIID INJURIOUS TO THE GARDEN POPPY.

A somewhat extended search through the literature on this subject has failed to reveal a single recorded instance where a cecidomyiid of any kind has been bred in this country from any portion of the garden poppy. In Europe, however, two different species are known to attack it, both of them confining their depredations to the seed-pods, and it is somewhat curious to note that the larvæ of both of them are not infrequently found infesting the same pod. One of these species belongs to the genus Cecidomyia, while the other pertains to the closely related genus, Diplosis.

On July 7, 1893, Mrs. Celia Thaxter sent the Department a package of Iceland poppies (*Papaver nudicaule*) the stems of which were infested with pale, rose-colored cecidomyiid larvæ; these occurred in considerable numbers in the interior of the plants near the roots. The plants were from Mrs. Thaxter's famous garden on the Isles of Shoals, off the coast from Portsmouth, N. H.

In the breeding cages the adults began to issue July 15, and continued emerging up to the 22d of the same month. They belong to the genus Diplosis, and clearly represent a new species, which is duly characterized below. They differ in too many respects from the European species of Diplosis, which also infests the poppy, to be considered identical with it, in addition to the fact that they attack a different part of the plant. The kinds of poppies attacked by these two species are also different, the European species depredating upon *Papaver rhœas* and *P. dubium*, while the present species is thus far known to attack only *P. nudicaule*.

The fact that it is found to infest an introduced plant would seem to indicate that it likewise is a native of some foreign land and had been imported into this country with its food-plant, were it not for the further fact that with us this plant is almost without exception grown from the seed.

Diplosis caulicola n. sp.

Male.—Antennæ yellow, twice as long as the body, 15-jointed (or, counting each enlargement a joint, 28-jointed); the first two joints simple, each of the others with a globose basal and a long median enlargement, the latter constricted slightly before the middle, nearly twice as long as the slender portion on either side of it, the bulbous basal portion of the joint subequal in length to the slender portion in front of it; each enlargement bears a whorl of rather long bristly hairs, those on the upper side being of nearly the same length as those below. Head black. Thorax yellow, marked with three brown vittæ; scutellum yellow, its base brown. Abdomen wholly yellow; halteres and legs dusky yellow. Wings grayish hyaline, the veins yellow; first vein lying close to the costa, in which it terminates at three-sevenths of the length of the wing; second vein strongly curved toward its tip, ending considerably below the extreme apex of the wing; small cross vein straight and nearly on a line with the second vein; anterior fork of the third vein (the true fifth vein, since the third and fourth are absent), nearly twice as long as the posterior branch.

Female.—Same as the ♂ with these exceptions: Antennæ only one-fourth longer than the body, joints 3 to 14 subcylindrical, slightly constricted at the middle, considerably narrowed at the apex of each, this portion of the sixth joint equaling one-half of the thickened part of the joint, but on the fourteenth joint it is only one-eighth as long as the thickened part; each joint from 3 to 14 bears on the thickened portion a basal and an apical whorl of rather long bristly hairs.

Length, 1 to 1.8mm. Four males and fifteen females.

AN INJURIOUS PARASITE.

By L. O. Howard.

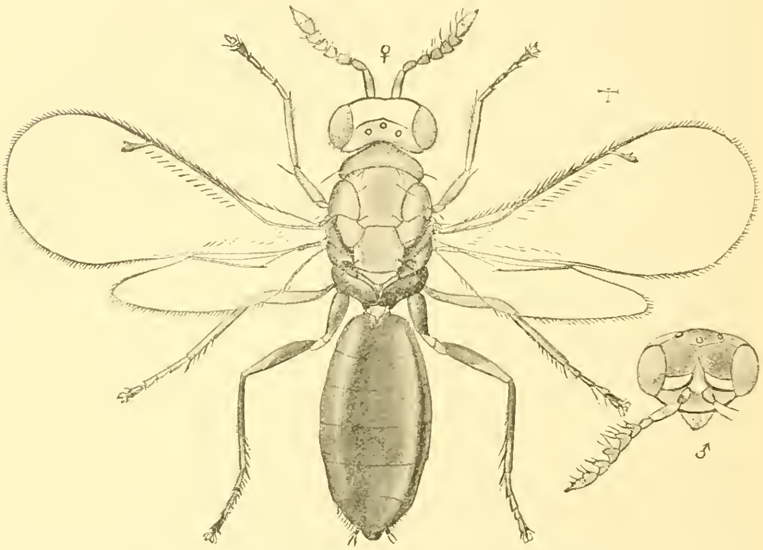

Fig. 46.—*Leucodesmia typica*: female, with head of male below at right—greatly enlarged (original).

It is a pity that the energetic parasites of the family Chalcididæ do not confine their attacks to injurious insects. The great majority of the species are parasitic upon injurious forms. Many, however, lay their eggs in beneficial insects, and thus become injurious species themselves. It is an example of this class which we shall describe in this note.

In 1879 Prof. J. H. Comstock called attention for the first time to the good which was occasionally done by the predaceous larva of a lepidopterous insect, which he described in the North American Entomologist as *Dakruma coccidivora*, by feeding upon our larger scale insects. The first specimens observed by Comstock were feeding upon the cottony maple scale (*Pulvinaria innumerabilis*) at Washington. So abundant were Dakruma larvæ in the District of Columbia in the season of 1879 that it is quite probable the freedom of the Washington maples from this destructive scale since that time has been due in large measure to this Dakruma. Later the insect was found to feed in a similar manner upon other large scale insects of the subfamily Lecaniinæ, and particularly upon the largest of our native species, *Lecanium tulipiferæ* Cook, which frequently occurs in enormous numbers upon the tulip tree and upon different species of Magnolia in the South.

The Dakruma larva, as is well known, leads a hidden existence. It works beneath the bodies of the scale insects, eating them out, one after another, from below. When the scales are crowded upon a twig or branch, the Dakruma larva passes from one to another without showing any indication of its presence. Where the scales are more scattered, and some little distance intervenes between them, the Dakruma larva still hides itself, traversing the open spaces within a delicate silken tube which it spins as it goes. It is thus protected from ordinary natural enemies, and no parasite has hitherto been known to affect it. It has not, however, escaped the notice of one of the omnipresent and apparently sharp-eyed chalcidids. There was brought me recently from the insectary a series of little parasites which had been reared, so the labels stated, from a mass of specimens of *Lecanium tulipiferæ* upon a Magnolia tree, which had been sent up from Florida by Mr. Hubbard. The labeler supposed that he had before him a new parasite of the Lecanium. A glance at the specimen, however, showed that the parasite belonged to the subfamily Elachistinæ, the species of which are, so far as we know, invariably parasitic upon lepidopterous larvæ. An examination of the specimens of Lecanium from which the parasites were supposed to have been reared was immediately made, and they were found, upon lifting them from the twig, to have been eaten out by the larva of the Dakruma, and from the Dakruma larva, not from the scale insects, came the little parasites.

This observation is of interest, in the first place, as indicating that the Dakruma larva, with all its care, has not succeeded in hiding itself from its natural enemies. In the second place, it emphasizes once more the necessity for the most careful consideration of all the circumstances in recording the host relations of parasitic insects, and forms perhaps a more striking example of this necessity than any of those mentioned by the writer in an article upon this subject published in INSECT LIFE (vol. IV, pp. 48, 49). In the third place, the observation is of systematic interest, since the insect reared forms the type of a new genus. Its characterization follows:

LEUCODESMIA n. gen.

Female: Resembles *Stenomesius* Westwood. Abdomen with a distinct, though very short, petiole; scutellum with two longitudinal impressed lines: posterior tibiæ with one short spur; prothorax subconical; wings broad. Head broad and well rounded, shrinking very considerably, however, in death. Ocelli forming a very obtuse-angled triangle, and bounded by a well defined impressed line. Eyes slightly hairy; facial depression narrow, deep; a rather broad, transverse, pearly-white band extending from facial depression to border of eye. This has the appearance of a structural character, and is probably generic in value, though it may be only specific. Bulb of antennæ distinctly separated from scape. Antenna as a whole clavate. Pedicel as long as broad, funicle joints 1 to 4 increasing slightly in length, considerably in breadth; club ovate, as long as two preceding funicle joints together and distinctly 3-jointed. Basal joint nearly as long as the other two joints together, the terminal very short, very thin, and pointed. Sclerites of notum of thorax as indicated in the figure. Metascutum with central longitudinal furrow widening anteriorly. Abdomen flattened, concave above, ovate in shape. Post-marginal vein of forewings longer than stigmal. Stigmal rather long, descending into the disc at an angle of about 45°. Club distinctly spurred.

Male: Resembles female, except that the abdomen is narrower, with subparallel sides. Stigmal club is larger, and the facial band is broader. The funicle joints of antennæ are prolonged above into rounded teeth, as indicated in the figure, the hairs on the funicle joints being considerably longer than on the corresponding joints of the female.

Leucodesmia typica n. sp.

Female: Length, 1.5^{mm}; expanse, 3.4^{mm}; greatest width of forewing, .42^{mm}. Head faintly shagreened, pronotum, mesoscutum and disk of mesoscutellum granulate, mesoscutum more coarsely than mesoscutellum; metanotum and abdomen smooth; mesopleura faintly shagreened. Head dusky yellow; face with a transverse pearly-white band bordered with jet black above and below, interrupted in the middle by the facial depression. Scape of antennæ yellowish, with a faint dusky band in the middle. Pedicel black, flagellum dusky yellow with black hairs. Thorax dusky yellow with tegulæ darker; metanotum black. Abdomen black. Front legs dusky, middle and hind legs nearly black, yellow at joints; tarsi yellowish.

Male: About the same size as the female; general color darker; head darker, with white transverse band of face broader. Basal half of bulb of antenna white, apical half dark, facial depression with a light center. Abdomen with a large yellow-brown or semitransparent spot at base.

Described from many male and female specimens reared from *Dakruma coccidivora*, preying upon *Lecanium tulipiferæ* collected at Crescent City, Fla. Issued at Washington April 11 and 12, 1895.

THE HORSE-RADISH FLEA-BEETLE.

(*Phyllotreta armoraciæ* Koch.)

By F. H. Chittenden.

Another injurious European insect has been introduced on this continent, and although its exact economic status can not yet be defined its advent among us should be regarded with distrust.

During August, 1893, the writer obtained from the withered leaves of a plant that grew in one of the numerous vacant lots within a quarter of a mile of the grounds of the Columbian Exposition a few specimens of a little flea-beetle of the genus Phyllotreta entirely different from any hitherto known to occur in North America. These specimens agree perfectly with Weise's description of *Phyllotreta armoraciæ* (Erichson, Naturg. Ins. Deutsch., vol. VI, p. 865), a well-known European species, originally described by Koch in 1803 (Ent. Heft, vol. II, p. 75) as *Haltica armoraciæ*, after its food-plant, the horse-radish, *Nasturtium* (*Cochlearia*) *armoracia*. It is probable that the plant on which the few specimens taken were observed was the horse-radish, although it was thought at the time to be Rumex. All of the Phyllotretas, so far as we know, breed on cruciferous plants, and the occurrence of these specimens on the supposed dock was regarded as purely accidental. Not more than a handful of the plants were seen. and these were in the midst of the true Rumex.

In appearance this Phyllotreta is quite distinct from any species belonging to our fauna, hence it is practically certain that it is of recent introduction. Most introduced species first obtain a foothold near the seaport where first imported, and from this point gradually extend inland. In this instance the introduction appears to have begun right in the heart of our country. It might have been imported with horse-radish, or with some potted ornamental Nasturtium, and it is not impossible that these plants were brought to this country expressly on account of, if not for exhibition at, the Columbian Exposition. It is more probable, however, that they were introduced at a somewhat earlier date.

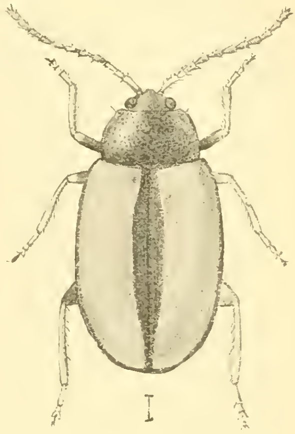

FIG. 47.—*Phyllotreta armoraciæ*: female—much enlarged (original).

In its native home this flea-beetle ranges through middle Europe. Mr. Schwarz has a series from Guttenberg, Iowa, collected in some numbers last year on horse-radish by Mr. Hugo Soltau. Guttenberg is on the Mississippi River, about 200 miles from Chicago. From the close proximity of other States to these points, it may be inferred that the species has already invaded Wisconsin and Indiana, and we shall expect soon to see this insect spread to Missouri and other States that border on the Mississippi below Iowa and perhaps also to southern Minnesota and Michigan.

Another European food-plant of *Ph. armoraciæ*, viz, *Nasturtium palustre*, or marsh cress, has been introduced in this country, but it is hardly probable that the insect will restrict itself to these plants, but will in time, as it becomes more at home in its new surroundings, gradually extend its list of food-plants as it extends its distribution.

In Europe *Ph. nemorum*, the turnip flea-beetle, and in the United States the striped or cabbage flea-beetle, *Ph. vittata*, do much damage to cruciferous crops. *Ph. sinuata*, common to Europe and North America, has similar habits, but has not yet attracted much attention by its ravages. The last two species have been treated at length in the Annual

Report of this Department for 1884 (pp. 301–308). In the West *Ph. pusilla* and *albionica** also do some damage.

None of the injurious species are restricted to any one food-plant, but attack freely all sorts of cruciferous vegetables, both cultivated and wild. As an example of food-habit it might be mentioned that *Ph. vittata* infests alike cabbage, turnip, radish, horse-radish, cresses, mustard, shepherd's purse, charlock, Lepidium, Matthiola, and Hesperis, and has even been said to attack the strawberry.

Ph. nemorum is in its larval state a leaf-miner, as is also *sinuata*, but *vittata* is subterranean in habit, and it would seem probable from the fact that the larval history of *armoraciæ* is unknown that it belongs to the latter class and breeds in the roots of its food-plants.

As has been said, and as may readily be seen by reference to the accompanying illustration (Fig. 47), *Ph. armoraciæ* is not likely to be confused with any other species of the genus. It is somewhat larger and broader than any American Phyllotreta. In form it is oval and strongly convex, and black in color. The first three antennal joints, the tips of the four anterior femora, the tibiæ and tarsi are reddish yellow. The elytra is very light yellowish or cream color, nearly white, with a very thin, black lateral margin and a broader sutural stripe, which is broadest at the middle and constricted at each end and extends from the base of the thorax to the tip of the elytra, where it joins the lateral line. The front is very finely, and the prothorax and elytra densely, punctate. In my specimens there is a sensitive pore from which proceeds a seta, located on the lateral margin just behind the anterior angle. In the male the fourth antennal joint is slightly thickened and longer than the fifth; in the female the fourth and fifth joints are equal. In length this species measures from 3 to 3.5^{mm}.

A NEW WHEAT PEST.

(*Sciara tritici* n. sp.)

By D. W. Coquillett.

From observations made both in this country and in Europe it appears that the larvæ of the different species of Sciara feed principally upon vegetable matter in a greater or less state of decay, their favorite haunts being beneath the loose dead bark of various kinds of trees, in the deserted burrows of wood-boring larvæ, in decaying wood, partially decayed galls, under excrements, in mushrooms, etc. In this country a single species is known to infest apples previously attacked by the larvæ of the Codling moth, and by burrowing through the partially decayed portion, to thereby hasten the decomposition of the more

**Ph. albionica* has been very generally confused in literature with *pusilla*, which was not separated as a distinct species until 1889. The latter is the commoner species.

solid parts. On pages 19 to 21 of his Seventh Annual Report as State Entomologist of Illinois. Prof. S. A. Forbes gives an interesting account of an undetermined species of Sciara, the larvæ of which feed upon the interior portion of newly planted kernels of corn, and also attack the roots and bulbs of various kinds of flowering plants.

Several reports of injury to growing potatoes by larvæ of this kind have also appeared from time to time, but beyond this, and the instances alluded to above, no other injury to cultivated plants by these larvæ in this country has come to our notice, although in France, as long ago as the year 1813, Olivier is reported to have reared three different species of Sciara from wheat. The writer has not been able to examine the original account of this rearing, but from the fact that none of the later authors have mentioned the names of the species

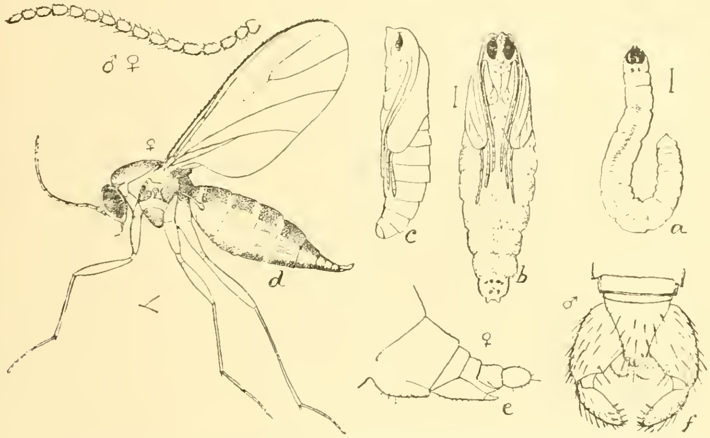

FIG. 48.—*Sciara tritici: a*, larva; *b*, newly formed pupa, from below; *c*, same later, from side; *d*, adult female—greatly enlarged; *e*, female genitalia; *f*, male genitalia—still more enlarged (original).

bred by Olivier, it is very probable that they were neither identified nor described in such a manner as to render their future recognition possible.

Observations made several years ago at the insectary of the Department indicate that even in our own country the larvæ of at least one species of Sciara are also destructive to young wheat plants. On March 17, 1885, a large number of adults issued from a jar containing plants of this kind that had attained a height of from 6 to 8 inches. They already indicated an unhealthy growth by a more or less yellowish appearance, and an examination of their roots revealed the fact that these had been severely injured by the larvæ, many of which were still present and were observed to feed upon the roots and interior of the stems both below the surface of the soil as well as in the interior of the stems a short distance above the surface. As many as eight larvæ were sometimes found in one of the stems, and they had also penetrated the kernels of wheat from which the plants sprang; many of the smaller rootlets had also been devoured, or more or less injured, by them.

The larva (Fig. 48 *a*) is of a milk-white color, with a prominent black head, and attains a length of about 6 millimeters. Pupation occurs in an oval cell lined with a few silken threads, the cells being formed at a depth of half an inch or less beneath the surface of the ground. The eggs are usually scattered on the ground, but are sometimes deposited in clusters of twenty or more; they are oval, polished, white, and measure about one-tenth of a millimeter in length.

This species belongs to the genus Sciara as restricted by the German entomologist Rübsaamen in his recent revision of the genera and species belonging to this group (Berliner Entomologische Zeitschrift, May, 1894, pp. 17–24). The present species differs from any of those heretofore described in several important particulars, notably in the coloring of the thorax and pleura: and in the belief that it is as yet undescribed, is duly characterized herewith:

Sciara tritici n. sp.

Male.—Antennæ two-thirds as long as the body, black, the first two joints fulvous; head black, the face fulvous; palpi brown. Thorax dorsally fulvous, the pleura brownish, marked on the lowest third with a whitish vitta, also with a whitish spot below the humerus. Abdomen reddish-brown, basal joints of hypopygium each bearing a stout macrochæta at the tip of its inner side, the apical joints bearing several short, claw-like processes on the apical third of the inner side and at the tip (Fig. 48). Legs testaceous, front coxæ two thirds as long as their femora. Wings iridescent, grayish hyaline, the veins brown excepting the fourth which is very faint, the forks more distinct but much less robust than the other veins; costal and first veins bearing microscopic spines on nearly their whole length, the second vein also spinose beyond the small cross-vein, the others bare: costa straight or gently convex on the basal half; first veins extending slightly beyond the middle of the wing, its last section half as long as the preceding; fourth vein forking far beyond the tip of the first, the distance about equaling four times the greatest width of the marginal cell; anterior fork of fourth vein seven-ninths as long as the preceding section of that vein forking at a distance from its base equal to slightly over twice the greatest width of the costal cell. Halteres yellow, the knob brownish.

Female.—Same as the ♂ except that the antennæ are only half as long as the body. The last joint of the ovipositor is slightly longer than wide.

Length, 1.8 to 2.5mm. Ten males and fifteen females.

NOTES ON PARIS GREEN.

By C. L. Marlatt.

Paris green is the most useful and valuable of the arsenicals used as insecticides. As is well known, its action is more rapid and effective than that of London purple, and having a definite chemical composition it ought not to be subject to variation in the amount of the active agent, arsenic. Its use as an insecticide has enormously extended of late years, and upward of 2,000 tons are annually employed in the United States, besides 400 tons in Canada. The chief difficulty in using Paris green is the readiness with which it settles to the bottom of the tank or reservoir of the spraying apparatus. This is because it is a rather coarse powder, very much less finely divided than London purple, which latter fact gives the purple a certain advantage.

A recent conversation with one of the leading manufacturers of Paris green has brought out the fact that this coarseness of grain and the accompanying difficulty in using Paris green in water suspension are quite unnecessary. It seems that the market has hitherto demanded a very dark-colored article, the lighter color having been deemed to indicate adulteration. It seems, however, that the darker color is simply due to the larger size of the crystals, the darkest green having the largest crystals. If the green were reduced to an impalpable powder, which would make it much more satisfactory as an insecticide, it would lose the intensity of its color and become whitish. This manufacturer tells me that for a number of years he was able practically to control the market, because he had discovered a means of crystallizing the green in unusually large particles, securing a very dark-colored product, although he was aware that for the use intended the product so obtained was much less valuable. Yet the darker green, with its accompanying larger-sized crystals, is more difficult to manufacture, and hence more expensive.

It seems, therefore, that all these years we have been using a poison which could have been had at less expense and in a much more satisfactory form.

Steps were therefore taken to secure a quantity of pulverized Paris green which was made in the ordinary way, except that it was reduced by the manufacturer to a nearly impalpable powder. The results were eminently satisfactory, and would have been more so if the pulverization had been carried to the fullest degree. This product remained in suspension three times as long as the ordinary Paris green, and the advantage of the fineness in division will undoubtedly be apparent in its use against insects.

It may be interesting to know the process of manufacture of this arsenical. Powdered white arsenic (arsenious oxide) is combined with sodium carbonate in a large vat of boiling water. A chemical change results, in which the sodium unites with the arsenic, forming sodium arsenite, and carbonic acid gas is given off. Sulphate of copper or blue vitriol is dissolved in another large vat, and is then combined in a still larger vat with the sodium arsenite already obtained. A precipitate of arsenite of copper forms on the commingling of the two liquids and sodium sulphate which remains in solution. Acetic acid is added to the mixture thus obtained and unites with the precipitate of arsenite of copper, forming an aceto-arsenite of copper, or more properly, a double salt of copper with arsenious acid and acetic acid. This is insoluble in water, and appears as a fine, green, crystalline product, which, when properly dried, is ready for the market.

Paris green, having a definite chemical composition, should be practically uniform in the percentage of arsenic. An excess of arsenic is, therefore, as much an indication of impurity as a deficiency. The great advantage in the use of Paris green comes from the fact of its insolubility in water. Wherever there is a great excess of arsenic this occurs in a free soluble form, and as it is a very decided source of danger to plants it is highly objectionable. It is a comparatively easy matter to increase the percentage of arsenic, and if the Paris green be improperly made it frequently happens that unchanged arsenious oxide occurs throughout the mixture in the form of small particles coated with the Paris green. and capable of being dissolved in water and exerting an injurious action on plants. This fact has been lost sight of in many of the analyses and regulations on the subject, as, for instance, in the laws of Louisiana bearing on this point. The law referred to requires the manufacturer or dealer to guarantee the percentage of arsenic claimed, and provides severe penalties for any sales of insecticides containing a less percentage of arsenic than is indicated on the official label. By the provisions of this law this arsenical is separated into two classes, one containing 50 per cent or more of arsenic, to be labeled "strictly pure." and the other containing less, to be labeled "impure." As a result of this and similar provisions Paris green was occasionally adulterated in the sense of being made to contain an excess of arsenic, this working no hardship to the manufacturer, since white arsenic costs only 3 or 4 cents per pound, while Paris green sells wholesale for 20 cents or more per pound. For mutual protection, now, however, the leading manufacturers of this article have combined to prevent adulterations, and as it now comes from original hands it may generally be relied on as being properly compounded. Out of sixteen analyses by experiment station chemists to which I have access the percentage of arsenious oxide in Paris green ranges from 53 to 63 per cent, the samples averaging 58 per cent, which is the proportion of arsenious oxide indicated by the chemical formula.

The last step in the process of manufacture of Paris green is the combination with acetic acid. What value this may have on the substance as an insecticide is not at once apparent, and at our request the manufacturer was good enough to make 100 pounds of arsenite of copper prepared from the sulphate of copper as above but omitting the acetic acid. This is not a crystalline product but an impalpable powder, and in this respect is far superior to any other powder insecticide known to me. It is much finer than London purple, and remains in suspension almost perfectly, not settling completely until after the lapse of twenty-four hours. It is the color of Paris green, but is not of as bright a tint. The Department Chemist reports that the arsenic in this compound is practically insoluble in water, but is soluble in acetic acid and would, therefore, likely yield to weak vegetable acids or other solvents, such as the gastric juices of insects. The percentage of arsenic is practically the same as that contained in Paris green. Experiments to be conducted this summer will demonstrate whether this substance can be used as a substitute for Paris green, to which it is very superior in the matter of fineness of division, and will cost about one-half less.

GENERAL NOTES.

THE CLASSIFICATION OF LEPIDOPTERA.

The absence of a rational classification of the order Lepidoptera, based upon the structural features of all parts of the body, instead of upon shape, size, mouth-parts, leg-armature, and wing-venation only, has always been a source of wonder to students. Of late the genitalia have been used in certain groups; but no systematic study of the structure of the order as a whole has been attempted by any lepidopterist. It is not strange that a broad and careful man like Prof. J. H. Comstock should have halted in dismay in the preparation of a text-book on entomology on reaching the point where it became necessary, in pursuance of his general plan, to introduce an analytical table separating the families of Lepidoptera. Perhaps Professor Comstock may have remembered an early experience, when, in 1879, he sent the same moth in succession to four different specialists in Lepidoptera. One determined it as a new genus of Tineina, another as a new genus of Tortricina, a third as a new genus of Pyralidæ, and a fourth as a new genus of Zygænidæ!

However this may be, Professor Comstock saw the necessity for a new classification, and in his admirable essay entitled "Evolution and Taxonomy," published in the Wilder Birthday Book, and reviewed on pages 272, 273 of volume VI of INSECT LIFE, he gives a tentative new classification of the Lepidoptera, based almost entirely upon wing-venation and the special structures by which the wings are held together. Although this classification is based practically upon but one element of the complex, it was reached only after profound study of the problem upon evolutional grounds, and it was published more as an illustrative record of the results obtained by his work than as a classification to be accepted and practically used. The author expressed his anticipation, however, that equally careful study of other elements would lead to the same result, and that the proposed classification would be strengthened thereby. The proposed classification was so revolutionary in its character that it united two families which had previously been placed nearly at opposite extremes of the old system, viz, the Micropterygidæ and the Hepialidæ, forming a suborder which he called the Jugatæ. It is very fitting that further study of other points should be undertaken by Mr. V. L. Kellogg, who has been associated with Professor Comstock at Stanford University. In a paper published in the Kansas University Quarterly for July, 1894, and reviewed on page 149 of this volume, he considered especially the clothing of the wings of Lepidoptera, and ascertained that the results of his observations confirmed in a broad and general way the taxonomic conclusions arrived at by Professor Comstock.

In the American Naturalist for March, 1895, Mr. Kellogg, briefly reviewing the whole matter, gives additional points of interest based upon the structure of the thorax, and his work in this direction is of the broadest interest, although it is but a beginning. He shows that here again the suborders Frenatæ and Jugatæ of Comstock are confirmed, and that in Micropteryx and Hepialus we have a generalized type of thorax approaching that of the Trichoptera, while in the other groups this portion of the body is more highly specialized, the mesonotum in particular being developed at the expense of the metanotum. His thoracic studies indicate that Hepialus is more specialized than Micropteryx, while among the Frenatæ the Tineina possess the greatest development of the metathorax, as had, by the way, already been pointed out by Brauer. In the Tineina, however, Mr. Kellogg finds that the shape of the sclerites differs greatly from that of the Jugatæ. Among the thoracic sclerites the so-called "patagia of the mesothorax" (more properly "tegulæ") have particularly attracted Mr. Kellogg's attention, and here again he finds these organs highly specialized, although varying greatly in degree and in direct relation with the power of flight, with the Frenatæ, while with the Jugatæ there is again an approach to the trichopterous form.

In a later paper (American Naturalist, June, 1895) Mr. Kellogg enters upon the consideration of the mouth-parts, and shows a very distinct correspondence between the very generalized mouth of Micropteryx and the equally generalized, although somewhat rudimentary, mouth of Hepialus, the parts of both differing strongly from the specialized mouth-parts of other Lepidoptera, thus still further helping to confirm the Comstockian suborder Jugatæ. Careful study of the mouth-parts of the Trichoptera shows considerable correspondence between the trichopterous and the jugate mouth, although his studies lead Mr. Kellogg to believe that the Jugatæ can not be looked upon as in any way lineal descendants of the Trichoptera. The affinity must be of the character of two dichotomously divided lines of descent. Incidentally to the main objects of the paper several interesting points are brought out, notably the conclusion that the maxillary lobe in Micropteryx which goes to make up the short proboscis is lacinia and not galea, as had been concluded by Walter in 1885; also that the lepidopterous mandibles figured by Savigny, Graber, Packard, Hyatt and Arms, Lang, and others are not mandibular remnants; and also that the thorn like projections figured by Burgess in his Anatomy of the Milkweed Butterfly and identified as rudimentary maxillary palpi are wrongly named.

This class of work is of a very high character, and Professor Comstock's paper, aside from the actual and great value of his researches, is of inestimable service as directing thought into so rich a field.

A SECONDARY EFFECT OF THE FLORIDA FREEZE.

In the last number of INSECT LIFE we referred to the destruction caused by the December and February freezes in Florida, and to the fact that innumerable insects were killed off by the same cold that killed many of the trees. Mr. Hubbard has found, as was quite to be expected, that wood-boring beetles are beginning to attack the trees which were seriously affected by the cold. They enter both the wood that is dead and that which, though enfeebled, is still living. Where they enter dead wood, says Mr. Hubbard in a letter to the Crescent City (Fla.) News, no attention need be paid to them; they will simply aid in trimming the trees hereafter. Unfortunately the enfeebled condition of the trees invites and permits the attacks of the borers in portions that are yet alive, and many, unless help be given them, will be killed to the ground, or at least below the bud.

To check the work of the beetles in living wood Mr. Hubbard recommends that a brad or small wire nail be driven into each hole, thus plugging the hole and preventing the insect from finishing its work or laying its eggs. In many cases the nail will reach and crush the beetle itself. Where the gallery is longer than the nail, a piece of pliable wire should be pushed in as far as it will go, and clipped off at the surface of the bark. In the present critical condition of the trees the use of powerful insecticides is not advisable, nor is it safe to coat the bark with any substance to repel the borers.

Several species of Scolytidæ are concerned in this injury to orange trees in Florida. Specimens of what Mr. Hubbard states to be the largest and most destructive have been sent to the Department, and prove to be *Platypus compositus* Say.

SPRAYING ON A LARGE SCALE.

Mr. W. R. Gunnis, of San Diego County, Cal., has been spraying his trees with kerosene emulsion on a large scale in the following manner: The apparatus is placed on the platform of a light wagon, and on the front end is a tank of a capacity of 100 gallons, filled with the emulsion. A small electro-vapor engine on the wagon operates a double-action, high pressure, cylinder pump, and to this eight lines of hose may be attached. The pump can be worked at a pressure of 200 pounds, rendering the spray fine and strong, and capable of reaching to the tops of the tallest trees where the hose is supported by ten-foot bamboo canes. Twenty-five or thirty acres of four-year old trees may be sprayed in one day with the labor of four men.

ANIMAL LIFE IN THERMAL SPRINGS.

In the Lincoln (Nebr.) Evening Call of April 6, 1895, Prof. Lawrence Bruner records under the above heading the receipt from Hon. John C. Hamm, of living larvæ captured by Mr. Hamm in a hot spring in Uinta

County, Wyo. The larvæ were found in a cup-shaped depression in the top of a small cone about 20 inches high, situated a few feet from a large sulphur mound or "dune," under which the boiling water could be heard rumbling. Through small apertures in the bottom of the cup hot water rose and overflowed the edges, and it was in this cup filled with hot water that the larvæ were found. The temperature of the water, Mr. Hamm states, was so hot he could not hold his hand in it, and he estimates that it was not more than twenty or thirty degrees below the boiling point. The larvæ belonged to the dipterous family Stratiomyiidæ.

It is to be regretted that the temperature in this case was not taken with a thermometer for comparison with previously recorded cases of this kind. Mr. Bruner cites the statement of a Mrs. Partz (Rept. U. S. Geol. Surv. for 1878, Pt. II, p. 358) who saw "in springs in Owens Valley, Cal., a spider-like animal and small red worms in water having a temperature of 124° F."

To this may be added Mr. H. G. Hubbard's statement in a letter published in the Canadian Entomologist or 1891 (p. 226), that in the Yellowstone National Park he saw a little Salda running about the edges of springs which were actually boiling. He also observed two species of Nebria living under pieces of geyserite "even on the sides of the cones of the largest spouting geysers, where they were liable to be washed away in a flood of boiling water." Prof. A. S. Packard (American Naturalist, 1882, p. 599), also records such a case, he having received from a Mr. Griffith the larva of a Stratiomyia found in a hot spring in Gunnison County, Colo. In this case the temperature of the water is stated to have been 157° F.

APPARENT SUCCESS OF ONE OF THE HESSIAN FLY PARASITE IMPORTATIONS.

In the last number of INSECT LIFE (p. 356) we published a figure of *Entedon epigonus*, the principal European parasite of the Hessian fly, and mentioned the attempts which Professor Riley had made in 1891 to introduce the species into the wheat fields of this country. One of the last acts performed by Professor Riley before leaving this office in May, 1894, was to send a batch of parasitized puparia of the Hessian fly, just received from Mr. Fred Enock, of London, to the farm of Mr. G. Morgan Eldredge, at Cecilton, Md. During May, 1895, wishing to ascertain whether or not this attempt had been successful, we sent Mr. William H. Ashmead to Cecilton to make careful observations. He found that the parasitized puparia had been placed upon the ground at the borders of a wheat field which appeared to be rather badly affected by the Hessian fly. The crop was harvested and the land plowed at the end of August and planted in winter oats, which at the time of Mr. Ashmead's visit were from four to six inches high. After harvest the wheat straw was stacked in the immediate vicinity of the place where the parasitized puparia were deposited, and a small quantity of winter wheat was sowed (during August), so that the Hessian fly might find an early place for oviposition, giving the parasites a good chance. Mr. Ashmead swept volunteer wheat in the immediate vicinity of the straw stack, and also swept the adjoining field, at that time in winter wheat. He was in the field but a single day, and among the lot of parasites which he took from his beating net, and which consisted mainly of one of our commonest American parasites of the Hessian fly, *Platygaster herrickii* Pack., was found a single male specimen of *Entedon epigonus.*

The presence of this single living specimen indicates that the parasite has established itself to a certain extent, and it is greatly to be hoped that subsequent visits will show it to be present in numbers. Mr. Enock, by the way, has written us that the figure of the male abdomen, published on page 356, is incorrect. It is too much drawn up posteriorly, and he sends us beautiful mounted slides to prove his point. The figure was drawn from dried specimens which were naturally somewhat shriveled, but it is valuable for comparison with dry mounts in the cabinet. As Mr. Enock expresses it, it appears as though the insect from which it was drawn had a severe case of colic.

CUTWORMS AND THE ARMY-WORM HABIT.

The close relationship of the ordinary army worm (*Leucania unipuncta*) to the cutworms has often been mentioned, as well as the fact that in years of comparative army worm scarcity this insect feeds by night like the ordinary cutworm and remains hidden in tufts of grass or under the surface of the ground during the day. There is, therefore, little to distinguish it from ordinary cutworms except the fact that it occasionally becomes extremely abundant and then is forced to travel in search of food, its great numbers making it conspicuous, and the rapidity with which available food is devoured forcing it to travel by day as well as by night. There is, therefore, no reason why, should any of the other cutworms become equally numerous, they should not take on the army-worm habit of traveling by day and exposing themselves to the attacks of natural enemies. In fact, several such instances have occurred.

In 1884 the black cutworm (*Noctua fennica*) appeared in enormous numbers in Michigan, northern Wisconsin, and parts of Canada, and assumed the army-worm habit. The present spring two other species, for some unexplained reason, hibernated in enormous numbers in many localities and were found to be marching like army worms, and, in fact, were sent to this office as genuine army worms. The most abundant of these was the Western striped cutworm (*Feltia herilis*) which has been frequently referred to in the Western papers during the spring of 1895, and of which we have received specimens with accounts of marching armies from Byrneville, Vevay, Mitchell, Pekin, and Oatsville, Ind.; Maysville, Russellville, and Scottville, Ky.; Jackson, Tenn., and Mexico, Mine la Motte, and St. Louis, Mo. Some accounts of serious damage by *Agrotis saucia*, the variegated cutworm, have also come from

California, while other species have been received from Baltimore, Md.; Glen Inglis, N. C.; Joy, Pa.; and New York and Chicago.

The ordinary cutworm remedies in such extraordinary cases must be largely abandoned and army-worm remedies substituted.

THE MEDITERRANEAN FLOUR MOTH IN NEW YORK.

It is strange, considering the ease with which the larvæ of *Ephestia kuehniella* may be carried in flour and grain, that it has not spread all over the United States. Down to the present spring it was known to occur in injurious numbers only in Ontario and California. Mr. W. G. Johnson, of Champaign, Ill., however, in the American Miller for May 1, 1895, records the receipt of specimens of this insect from a New York miller, with the statement that the mill had been obliged to shut down several times in order to clean out the elevator spouts and other machinery. The locality in New York is not given. It will pay all millers to use the most scrupulous cleanliness about their establishments, and to thoroughly steam or treat with bisulphide of carbon all bags, barrels, boxes, and second-hand machinery which may be brought into their mills. Mr. Johnson thinks that the substitution of metal for wooden spouts will also be a measure of great utility. The insect is a difficult one to fight, and the experience of Toronto and San Francisco millers should lead others engaged in this business in all parts of the country to keep a sharp lookout for the pest.

APPLES AND THE CODLING MOTH IN AUSTRALIA.

Probably influenced by the successful exportation of apples from the United States to England, Australian colonies are beginning a similar export. From various districts in South Australia many hundreds of cases of apples will be sent to the London Produce Depot in 1895, the expense of shipment amounting to about 8 shillings per case. Many districts in South Australia are still uninfested by the codling moth, but in spite of the existence of regulations forbidding the sale of affected fruits and the penalty of a fine not exceeding £50 for each offense, apples and pears, according to Mr. W. C. Grasby, of the Garden and Field (Adelaide), are freely sold at auction and in the markets and are distributed throughout the colony when they are badly infested by codling moth caterpillars. Recent fruit-growers' meetings have passed resolutions calling the attention of the minister of agriculture to this fact, and recommending that full publicity be given to the regulations forbidding the sale of affected fruit, after which the regulations should be strictly enforced.

THE GRAVE-DIGGER WASP AND ITS PARASITE.

On page 376 of our last volume, it may be remembered, we gave some notes from one of our correspondents on a digger-wasp that provisioned its nest with cutworms and a parasite which follows the latter after they have been buried.

We have recently received an interesting letter from Mr. William H. Crane, of Steele City, Nebr., in which he tells of a large prismatic-tinted black wasp locally known as the grave-digger which preys upon a green katydid. This wasp, we are informed, also has an enemy which pursues it as relentlessly as it does the katydid. One day our correspondent observed a wasp with a katydid and seemingly annoyed by something. Soon two flies not much larger than house flies, "with wings that stood out from their bodies like a dragon fly," were seen. Their motions were so swift that they were lost sight of repeatedly, but they had a habit of "standing still on the wing watching for an opportunity to deposit an egg on the wasp or his prey if he relinquished his vigils for an instant; but the wasp interrupted them, fluffing up his wings like a hen protecting her brood. Then one would approach from the rear and endeavor to deposit an egg at the base of the wasp's wing or on the back of its head. Once a fly succeeded in placing an egg on its victim's head, but it was promptly clawed off by the wasp." The fly in question is doubtless one of the Tachina flies, but we know of no record of any of these insects being parasitic on adult digger wasps.

MIGRATION OF THE GREAT PLAINS CRICKET.

The same correspondent mentioned in the preceding note writes us that he has seen an insect which he calls the army cricket marching in innumerable numbers, destroying everything green in their path. A swarm was seen on the Bear River on the boundary of Utah and Idaho. It was 10 miles in length and a quarter of a mile in width. "In front of this army," writes our correspondent, "the landscape was green, behind a brown waste. Large streams deflected their course, but small creeks they crossed with impunity, jumping in and swimming. They climbed the willows that grew over the brook and by their combined weight bent them over, thus bridging the stream. After the crickets had crossed, the willows appeared as if scorched by fire. These streams were filled with trout, and as the vanguard of the army plumped into the water they were pounced upon by the hungry fish, but when the tens of thousands followed, so as to almost dam the current, the gorged trout sought the deepest pools, feeling no doubt like the Hebrews after their feast of quails."

The insect referred to is undoubtedly the Great Plains cricket, *Anabrus simplex*, a species to which we have frequently had occasion to refer in past issues of the publications of this division.

NOTE ON THE CHICKEN TICK (ARGAS AMERICANUS PACK).

During the latter part of December of the past year we received specimens of the above-mentioned insect from Mr. C. H. T. Townsend, who found it infesting chickens at San Diego, Tex. It will be remembered that we published, on pages 267 and 348 of volume V of INSECT LIFE, some interesting correspondence on this species and its depredations on poultry in Kinney County, Tex. Early in the year 1894 we received specimens of the same creature from Mr. E. M. Ehrhorn, with accompanying information concerning its habits and its attacks on chickens and turkeys in the neighborhood of Merced, Cal.

Our correspondent writes that the eggs are laid in masses or clusters of from 30 to 100, the larger masses being probably laid by several individuals. They were found in the cracks of the walls of the chicken houses and between the cracks and boards of egg boxes. The large masses are laid in layers two or three deep, the eggs composing them not being firmly attached, so that they always separate when dropped in alcohol.

The eggs measure 0.6 to 0.8^{mm} in diameter; are spherical and highly polished with no sculpture visible. When received they were of a purplish-brown color.

The first and second stages of this species were always found attached to the chickens day and night.

The records of this division show that this same tick was received as long ago as November, 1884, from Mr. F. G. Schaupp, who reported that it had recently killed large numbers of chickens in Dimmit County, Tex., one farmer having lost thirty fowls from this source. He also stated that these ticks occur on trees, in cracks and under the bark, and it is evident that the chickens which roost in the trees convey the ticks from them to their coops and houses.

Mr. Ehrhorn reports perfect success in the use of creozozone against these little pests, which are instantly killed when sprayed with it.

SOME CHANGES IN NOMENCLATURE.

Since the publication of Henshaw's List of the Coleoptera of America North of Mexico, ten years ago, several changes in the nomenclature of certain Coleoptera of economic importance have been made, more particularly among introduced or cosmopolitan species. The results of recent studies of these forms have been made known in papers by Dr. John Hamilton in Entomologica Americana (vol. VI, pp. 41–44), and in the Transactions of the American Entomological Society (vol. XVI, 1889, vol. XXI, 1894), and by M. Fauvel in Revenue d'Entomologie (vol. VIII, 1889). The changes of nomenclature in the species common to Europe and North America have been adopted in the latest edition of Catalogus Coleopterorum Europæ, and have been inserted in the recently published Third Supplement to the Henshaw list.

The desirability of a more uniform system in our economic literature is apparent, and to facilitate the adoption of the present accepted nomenclature the following short list of some of the more important or common species has been prepared:

The 15-spotted ladybird (*Anatis 15-punctata* Ol.)=*A. ocellata* Linn.

The Australian ladybird (*Vedalia cardinalis* Muls.)=*Novius cardinalis*.

The square-necked grain beetle (*Silvanus cassiæ* and *S. quadricollis* of economic literature)=*Cathartus gemellatus* Duv.

Silvanus advena Waltl., also a grain beetle = *Cathartus advena*.

Anthrenus varius Fab., one of the cabinet beetles, is referred to *A. verbasci* Linn.

Ips fasciatus Oliv. = *I. 4-guttatus* Fab.

The cadelle (*Trogosita* [*Tenebrioides*] *mauritanica* Linn.) = *Tenebroides mauritanicus*.

Gibbium scotias Scop. = *G. psylloides* Czempinsk.

Xestobium tessellatum Fab. = *X. rufovillosum* DeG.

The cigarette beetle (*Lasioderma serricorne* Fab.) = *L. testaceum* Duft.

The "bark stripper" (*Phymatodes variabilis* Linn.) = *P. testaceus* Linn.

Rhagium lineatum Oliv., a short-horned pine-borer, is identical with the European *R. inquisitor* Linn.

Gastroidea formosa Say and *G. raphani* Herbst. = *G. viridula* DeG.

The two cottonwood leaf-beetles, *Lina* (*Plagiodera*) *scripta* Linn. and *tremulæ* Fab., belong to the genus Melasoma.

The strawberry root-borer, mentioned in economic literature as *Paria aterrima* and *P. 6-notata*, together with several other forms, have all been united under the one specific name *Typophorus canellus* Fab.

Colaspis tristis Ol., (of collections) an enemy of the rose, strawberry, blackberry, and other Rosaceæ, is identified as *Nodonota puncticollis* Say.

The elm leaf-beetle (*Galeruca xanthomelæna* Schr.) = *Galerucella luteola* Mull.

Systena blanda Mels. and *S. mitis* Lec., with their varieties are considered merely varieties of *S. tæniata* Say.

The pea weevil (*Bruchus pisi* Linn.) = *B. pisorum* Linn.

Bruchus scutellaris Fab., one of the cow-pea weevils, is referred to *B. chinensis* Linn.

The bean weevil (*Bruchus obsoletus* Say [Horn] and *B. fabæ* Riley) = *B. obtectus* Say.

The rice weevil (*C. oryzæ* Linn.) = *C. oryza* Linn. (See Amoen. Acad., vol. VI, p 395).

Calandra remotepunctata Gyll. is a synonym of *C. granaria* Linn.

Xyloterus bivittatus Kby. = *X. lineatus* Oliv.

The pear-blight beetle (*Xyleborus pyri* Peck.) = *X. dispar* Fab.

[F. H. C.]

A NEW FURNITURE PEST.

During the past winter Mrs. J. M. Hunter, of New York City, wrote us that the bottom of one of the drawers in her bureau was infested by some insect. From her description of the nature of the damage we inferred that the culprit was one of our species of Lyctus and advised her to soak the infested wood with kerosene or to apply corrosive sublimate. Subsequently Mrs. Hunter discovered that the bottom of a washstand in the same room was infested in the same way, and forwarded a minute fragment of the insect which she found protruding from one of the holes in the surface of the wood. This fragment was evidently a piece of the prothorax of an anobiid beetle, quite different from any Lyctus, and we concluded at first that it indicated the presence of one of the common European furniture-infesting anobiids, viz, *Anobium pertinax* (the well-known "death watch") or *A. striatum*, neither of which, strangely enough, has ever been recorded from North America. Mrs. Hunter found the bottom of her washstand entirely destroyed, and finally sent us one of the boards. Upon investigation we found within the board perfect, though dead (evidently killed by the kerosene), specimens of the beetle, which, to our surprise, proved to be our native *Xyletinus peltatus*. This species is common enough in our woods, boring in dead and dry twigs and branches of all sorts of trees, but it has never been reported before to infest furniture. The board in question was of tulip-tree wood, and plainly indicated that the beetles and their larvæ had been at work in it for several, if not many, generations. But it also showed another point, viz, that the working of the insect was exclusively done in the sap wood, and the portion consisting of heart wood had not been touched in the least. This is by no means a new observation (see Ed. Perris's Larves de Coléoptères, p. 246), but to our knowledge no one in this country has ever drawn attention to the rule that, for furniture of all kinds, only the heart wood should be used, never the sap wood, as a protection against the attacks of ptinid beetles, including our powder-post beetles (genus Lyctus).—E. A. S.

THE HOME OF THE CHINCH BUG.

In a recent article in INSECT LIFE (vol. VII, pp. 232–234), Mr. Marlatt states that the normal hibernating place of this insect is in the dense stools, or root-stocks, of certain wild grasses, and concludes that this hibernating habit "is the normal and ancient one of the species, the natural food-plant of which, before the advent of settlement and the growth of the cereals, must have been some of our native grasses." In this Mr. Marlatt is unquestionably correct, and I merely wish to point out that this habit of the chinch bug can still be studied to-day in the original and ancient habitat of the insect.

The unique appearance of the full-grown chinch bug, with its white wings and chalky white pubescence,* forcibly indicates that the insect is either a psammophilous or maritime species; and that it originally belonged to the latter class of insects is, in my opinion, fully borne out by its geographical distribution. It is abundant on the sandy dunes along the Atlantic Ocean, where I have traced it from Cape Florida to Atlantic City, N. J., and I have not the slightest doubt that it occurs along the coast much farther north. In Mr. Ashmead's and my own experience it is never found inland in Florida, though it abounds on the coast.

It is well known that even now the chinch bug does not occur west of the Rocky Mountains until we come to the Pacific Coast, and the meager records from California show that it is a strictly maritime species there, never having been found inland. Mr. Koebele had no trouble in finding it in large numbers on the shore near Alameda (see INSECT LIFE, vol. I, p. 26), and if proper search be made it will no doubt be found on any point of the California coast. Farther south, Professor Uhler records it (Proc. Cal. Acad. Sci. (2), vol. IV, p. 240) from Lower Purissima, which is on the east coast of Lower California. Of the localities in Guatemala recorded by Mr. Distant in Biologia

* The color of the specimens figured in the Report of the Commissioner of Agriculture for 1887 (Pl. I, figs. 4 to 7), is altogether too dark, they having been drawn from alcoholic specimens. Fresh, living specimens, except such as have been exposed to prolonged rainy weather, more or less closely resemble in coloration the specimens represented at figure 8.

Centrali-Americana, those I am able to find on the map are all on the coast. Extended cultivation of grain in Central America is of ancient date, and we should expect to find the chinch bug widely distributed there inland, but for the present the Volcano di Chiriqui, in Panama, is the only inland locality on record. The locality Tamaulipas, Mexico, is too indefinite to tell whether or not the specimens collected there came from the seashore, and the same holds true of the locality Cuba.

Various North American maritime plants and insects occur also on the sandy beaches of the Great Lakes or still inhabit the ancient shore line of the Cretaceous ocean west of the Mississippi Valley (see Dr. J. L. Le Conte's address in Proc. A. A. A. S., 1875, pp. 4, 5), but whether or not the chinch bug has been among them can not longer be ascertained in the absence of early records, although I believe that the assumption of its occurrence on the shores of Lake Erie previous to the time when it was generally distributed inland explains the doubtful points in Mr. Van Duzee's article on the occurrence of the chinch bug at Buffalo, N. Y. (Can. Ent., vol. XVIII, 1886, p. 219).

Furthermore, there are some other points which deserve to be mentioned in this connection: The appearance of the chinch bug in such prodigious numbers; its extreme power of destruction in the Western States, and its marked susceptibility to the influence of moist weather are in striking contrast with the behavior of all other insects which are truly native of these States; the apparently complete absence of parasitic insect enemies also strongly points to the fact that it is an introduced species, in this instance not from foreign countries but from our coast regions.

The actual proof that the chinch bug did not occur in former years in the Western States can not longer be given. From Professor Forbes's remarks (INSECT LIFE, vol. I, p. 249) it would appear that the insect was in the Mississippi Valley as early as 1823. Still the fact that Say, when in 1831 he described *Lygæus leucopterus* from a single specimen taken on the coast of Virginia, had never found the chinch bug in the West, although he had been a resident of southern Indiana for six years and had previously traveled extensively in what was then called Missouri Territory, shows at least that it was not generally distributed over the Western States. As far as the Eastern States are concerned, the early records,* fragmentary as they are, show that the chinch bug gradually spread inland from the coast regions of the Carolinas.

The hibernation of the chinch bug in its maritime home has been observed by me only at a single place, but the characteristic features of the sand dunes are so uniform all along our coast that the experience in one locality undoubtedly holds true for all. This particular locality is in the immediate vicinity of Fortress Monroe, Va., where for a number of years I have been in the habit of visiting on the first warm

*These have been collected by Mr. Howard (Ann. Rept. Dept. Agric. 1887 (1888), pp. 51-52).

Sunday in spring. The maritime flora and fauna are late to awake, and most of the insects peculiar to the seacoast can still be found in their winter quarters by the end of April. That on the naked rolling sand hills there is only a single place fit for insect hibernation must be apparent at the first glance, even to a tyro in entomology; unless they fly great distances they can hibernate only within or beneath the dense stools of grasses. By pulling out any good-sized stool and beating it out on the smooth surface of the sand or over a cloth, a multitude of various insects are sure to be found, and among them always plenty of chinch bugs. It may be added that these stools not only serve as winter quarters, but the chinch bugs also crawl into them during the day in summer time to protect themselves from the fierce rays of the sun.—E. A. S.

TRANSMISSION OF INFECTION BY FLIES.

At the annual conversazione of the Royal Society held May 1, 1895, says "Nature" for May 9, Mr. W. T. Burgess showed the results of experiments in connection with the transmission of infection by flies. Flies having been placed in momentary contact with a cultivation of *Bacillus prodigiosus* (or other suitable chromogenic organism) were allowed to escape into a large room. After some time they were recaptured and allowed to walk, for a few seconds, over slices of sterile potatoes, which were then incubated for a few days. The experiments showed that the flies' tracks on the potatoes were marked by vigorous growths of the chromogenic organism, even when the flies spent several hours in constant activity before they were recaptured. The use of pathogenic organisms in these experiments would be attended with obvious dangers, but the results obtained with harmless microbes indicated the constant risks to which flies expose us.

A REMEDY AGAINST FLEAS.

All persons who have lived in a house which has become infested with fleas in summer will know how these creatures inhabit the floor by preference, and how they will jump upon the legs and ankles of everyone who passes near them. Taking advantage of this fact, some years ago, when the lower floor of McGraw Hall of Cornell University was badly infested by fleas, which had come from animals temporarily kept there in confinement, Prof. S. H. Gage invented the following ingenious plan. He had the negro janitor put on a pair of rubber boots, and then tied sheets of sticky fly paper, with the sticky side outward, around the legs of the boots. The janitor was then told to patrol the lower floor for several hours a day. The result was gratifying and rather surprising. The sheets of fly paper soon became black with fleas and had to be changed at intervals, but by this means the building was almost completely rid of the pest, with a minimum of trouble to everyone except the janitor.

A NEW MANUAL OF ENTOMOLOGY.

There is no text-book on entomology in any language which contains so many points of excellence as does the recently published Manual for the Study of Insects, by Professor and Mrs. Comstock. English-speaking students are fortunate that such a work has been published in English, and American students are particularly fortunate that it is based upon forms which inhabit this country. It is a large work, comprising about 700 pages, and includes a more or less detailed consideration of insects and their near relatives, such as the spiders, mites, and scorpions. In all cases there are synoptical tables to families, and many of the commoner forms are figured and described. Particular attention is paid to habits and transformations, and species of economic importance are singled out for especial mention, remedies being given in many cases. The insects proper are divided into nineteen orders, and much original work upon classification is indicated. The greatest reform which the book makes is in the nomenclature of the wing veins of the insects of different orders. The veins have been homologized throughout all orders, and a uniform numerical nomenclature has been applied. Entomological students will in the future, as a direct result, be spared a large share of the trouble and annoyance which older workers have had through the extraordinary confusion which has hitherto existed in this direction. The work is most profusely illustrated, containing about 800 text illustrations in addition to 6 full-page plates. Most of the illustrations have been drawn and engraved especially for this work by Mrs. Comstock, the main exceptions being a series taken from the author's Government reports and certain diagrams of wing-venation which have been done by some of Professor Comstock's assistants.

AN INSTANCE OF INTELLIGENCE IN ANTS.

The January number of Revista Brasileira, a monthly magazine just started at Rio Janeiro, contains an interesting note upon the intelligence displayed by the so-called *saûba* ant (probably *Œcodoma cephalotes*). It seems to be the general opinion that these ants spare the coffee trees that grow about the ant-hills. They enjoy the shade afforded by these evergreen trees, whose roots penetrate their galleries, and hence endeavor to preserve them, despoiling only those which furnish them no protection. The writer of the note referred to witnessed near Rio an interesting exhibition of the intelligence of these insects. A "Rosinante" lodged in a stable built of boards was being daily defrauded of a portion of his rations by the saûbas. We quote from a translation from the Portuguese kindly sent us by Mr. J. C. Branner:

> No sooner was the corn put in the feed trough than the scouting ants announced the fact, and a line of workers was immediately established, and, penetrating by the cracks between the boards, they came out, each one loaded with a grain of corn, with which it descended on the outside. In this descent there was a reëntrant angle,

difficult to cross; a single worker stationed itself there and undertook to help the others over. It did this by taking part of the weight of the grain of corn and backing across ahead of its companion until it had got it in a safe place. After helping one it returned to meet another, and continued this apparently voluntary task as long as this systematic robbery lasted.

CICADA CHIMNEYS—CONTRADICTORY TESTIMONY.

In a note upon page 276 of the current volume of INSECT LIFE we reviewed Mr. Benjamin Lander's theory as to the reason for "chimney-building" by the pupa of the periodical Cicada. Recent correspondence with Mr. Lander, and with Mr. J. G. Barlow, of Cadet, Mo., has elicited some further observations made by these gentlemen, which are so diverse in character as to leave the question as far from solution as ever.

The earlier supposition that these chimneys are built only upon low ground has been shown by Lintner to be unjustified, and seems to be further controverted by the observations of Mr. Lander, who has found them in great numbers on top of the Palisades of the Hudson, and by those of Mr. Barlow, who writes that he has found them mostly on a high ridge. Mr. Barlow also agrees with Mr. Lander in stating that the chimneys occur in numbers where the undergrowth of saplings, etc., is thick, thus contradicting another suggestion referred to in our former note, that the chimneys are built to afford the Cicada pupa an eminence upon which to crawl while shedding its skin and unfolding its wings.

Mr. Lander's observations tend to show that the chimneys are built only where the soil is thin, covering a layer of rock or it may be a stratum of sand too light to burrow in. Mr. Barlow, on the other hand, reports finding the chimneys plentifully where the soil "was of reasonable depth, with a foot or more of clay, then gravel below."

Mr. Lander's theory of the chimneys is, in brief, as we understand it, that owing to unusual warmth, either of the weather, as was the case in March, 1894, or perhaps of forest fires, such Cicada pupæ as are near the surface of the ground are aroused to activity early in the season. "It does not seem unlikely," he then says, "that the wonderful intelligence of these marvelous creatures * * * would impel them to build closed extensions to their short burrows as a protection from the premature heat * * * and possibly to shut out injurious intruders during the incidentally lengthened period they would have to wait for full development over that of those who would later open their deeper shafts, unroofed, at the surface of the ground." But both the objects thus attributed by Mr. Lander to the Cicadas in building their chimneys are apparently contradicted by the observations of Mr. Barlow, who says, "I have seen the most of them where there was a layer of dead leaves completely covering the chimneys from sight."

These observations are so contradictory that it seems to us no definite theory can yet be formulated as to the purpose served by the chimneys.

Since the above was written another theory on the same subject has been propounded by Dr. E. G. Love (Jour. N. Y. Micros. Soc., April, 1895). Having found the chimneys in soil of "great depth" and "not especially exposed," Dr. Love does not agree with Mr. Lander that the larvæ, under the influence of unusual heat, come to the surface before the proper time for their final transformation, and construct these huts as a protection against too great heat and possible enemies. He thinks that pupal changes may be in progress during a portion of the time the insect is making its way to the surface. The time required for the larvæ to reach the surface would vary, of course, with the depth from which they started, the nature of the soil tunneled, and the directness of the line followed. "In any case," says Dr. Love, "some of the larvæ would miscalculate the time required, and reach the surface before they were prepared to assume the imago condition, and this number would be greater when the conditions united to favor a short passage. * * * Thus it is that the insects sometimes find themselves exposed to the upper air before the proper time for their final transformation, and are compelled to seek some temporary shelter. This is often found under sticks or stones which may be near, but more frequently they construct the huts as extensions of the tunnels."

It will be seen that Dr. Love practically agrees with Mr. Lander in considering the chimneys places of temporary shelter while the insect is undergoing its final transformation. But, while Mr. Lander thinks the larva is stirred to activity by unusual warmth, Dr. Love thinks that, at the expiration of the seventeen years, it is prompted by a natural instinct to seek the surface; a journey the length of which it has no power of calculating, and hence sometimes reaches the surface of the ground prematurely. For protection it then simply extends its burrow in the form of a chimney.

A HORN-FLY TRAP.

The Manitoba Free Press for November 1, 1894, gives a short description of a fly-trap for use against the horn fly, which is so ingenious and so simple that it deserves to be made known more widely.

The device is described as a structure 6 feet high and 4 feet wide, fitting closely in a stable door. On the outer side is hung a curtain, while the inner side, next to the doorway, is composed of broom corn extending from the top downward and from each side toward the center, so that the cow in going through is brushed over every part of the body, while the elastic broom corn, springing back into place, prevents the flies from following her into the stable. The roof of the structure is of wire netting, in which is a trap which the flies can enter but can not leave. In use the cow is driven into the pen, the curtain let down behind her, and as she passes into the stable the broom-corn brush sweeps off the flies, which by a shake of the curtain are sent up into the trap. The editor of the Canadian Live-Stock Journal, according to the Press account, saw twenty-eight cows put through this contrivance in twenty-eight minutes, including the placing of the device at three barn doors.

THE BUFFALO GNAT.

In volume II of INSECT LIFE (pp. 7–11) was published a report of a trip to investigate buffalo gnats, which was written by Mr. Marlatt. His investigation resulted in finding that the buffalo gnats about Frierson's Mill, La., were largely due to the occurrence of a great raft of logs in the Bayou Pierre which was formed in 1872–73. The raft furnished excellent breeding places for the larvæ, and dammed the stream to a certain extent, causing the flooding of the adjacent lowland, furnishing additional foothold for larvæ and also driving the adults to the higher land every spring. The raft originated in an attempt of the United States Government to close Tone's Bayou, which connects Bayou Pierre with the Red River, and to confine the water of Red River to its own channel. From the outlook in 1889 it seemed that unless Bayou Pierre were cleaned out, at an expense of some $25,000, the gnat would continue to be a great nuisance. The present spring Mr. L. S. Frierson has written that for the first time since 1889 there were no buffalo gnats. He further stated that last year for the first time the water almost ceased to run through Bayou Pierre, and became so stagnant in and about the raft of logs that a green scum was formed upon the surface. The nuisance has thus corrected itself without the apparently necessary removal of the log raft or dam.

A NEWLY IMPORTED SCALE INSECT.

When Mr. Koebele stopped at Hawaii on his second Australian mission, he collected among other things a new species of Pulvinaria, which occurred on guava. This, with other material, he sent to Mr. Maskell, who in 1892 described the species in the Transactions of the New Zealand Institute (p. 223) as *Pulvinaria psidii*. The adult female of this insect is yellow or yellowish brown, sometimes with a greenish tinge, and secretes an ovisac consisting of a mass of dry, cotton-like wax, which is often accompanied by a black fungus. Correspondence during the past two or three years with persons in Hawaii, especially Mr. William G. Wait, of Kailaua, N. Kona, Hawaii, indicates that this insect does a great deal of damage to coffee plantations in the Sandwich Islands.

In June, 1894, specimens of a Pulvinaria were received from Mr. Samuel B. Parish, of San Bernardino, Cal., which he stated had recently appeared on his plum trees, infesting the leaves and to some extent the branches and immature fruit. Up to that time he had found it only upon a few trees of the wild goose variety, which were scattered among other plums of American and Japanese races. He found only old trees infested, the younger ones being free. The affected trees bore a sickly appearance, and the fruit was inclined to drop. Specimens sent at that time were so old and disintegrated that specific determination was impossible. The present season, however (May, 1895), Mr. Parish sends us additional material, consisting of sound females and eggs, from which we are able to determine the species as Maskell's *Pulvinaria psidii.* We have not been able to ascertain the date and manner of its introduction into California. The species was possibly introduced from the Sandwich Islands, or possibly also from Japan on Japanese plums. At all events, Mr. Wait's account of the damage done by this insect to guava plantations in Hawaii shows that it is a dangerous species, and efforts should be made to stamp it out at once at San Bernardino.

HOW HEMIPTERA FEED.

There seems to be a very general misapprehension of the manner in which the hemipterous insect draws up nourishment from animals or plants. The popular conception that the plant or the larva or other animal preyed upon is actually punctured by the beak, or, in other words, that the beak, meaning the labium with inclosed setæ, is thrust for a greater or less distance into the tissue, is certainly erroneous. Observations on the habits of our predaceous Hemiptera, together with an examination of the structure of the labium itself, indicate that the latter never enters the food, but that the puncture is made entirely with the setæ applied together to form a lancet, and that the juices are drawn up by suction through the labium or beak, which is merely applied closely to the exterior surface.

If a predaceous hemipteron be noticed in the act of sucking the juices from some lepidopterous larva it will be seen that the latter is suspended from, or is seemingly attached to, the very extremity of the beak. Plants also, infested with aphides or larger Hemiptera, do not exhibit the numerous large punctures which would result if the beak were bodily inserted. The Cicada larva, for instance, which possesses a very large and robust beak, and which attaches itself to a fixed portion of a root for a very long period, leaves no visible sign of puncture other than a slight discoloration, which results from the entrance and irritation of the almost microscopic setæ.

If observations on this point were wanting, the structure of the labium itself would at once indicate that it could not be employed as a piercing organ. The labium of all hemipterous insects, so far as I have examined them, is clothed to and on the very tip with hairs, usually very strong and numerous, projecting anteriorly, which would make the piercing of any hard substance quite impossible, without tearing off and rupturing the hairs; and what is more, the beak is rarely very sharply pointed. This holds true even of the predaceous Reduviidæ, the water bugs, and the animal parasites. In the case of the black reduviid, *Melanolestes picipes* H. S., which often severely stings collectors, the beak is very strongly clothed to the very tip with long, coarse bristles. The same is true of *Acanthia lectularia.* In Belostoma the beak is quite smooth, hard, tapering, and nearly hairless, a very few scattering but rather long hairs occurring near the tip, so that apparently it would not be impossible for it to be used as a piercing organ. Experiments with a living specimen indicate, however, that the general conclusions advanced hold also with this insect. The setæ are thrust a quarter of an inch or more against or into any object presented, but no effort whatever is made to puncture with the beak.—C. L. M.

BIRDS AND BARK-LICE.

As a general thing birds have not been considered to possess any economic importance as destroyers of bark-lice. There is a South African bird, called the white eye (*Zosterops capensis*), which has been frequently recorded as preying upon the large Lecaniinæ, but we are not familiar with instances of similar work on the part of North American birds. Mr. R. Newstead, in the April, 1895, number of the Entomologist's Monthly Magazine, publishes some facts of this kind. In nine stomachs of the blue tit and long-tailed tit he found numerous specimens of *Aspidiotus zonatus* and *Asterodiaspis quercicola* and a few of *Mytilaspis pomorum*. He has also seen, with the aid of field-glasses, the tree-creeper (*Certhia familiaris*) collecting *Mytilaspis pomorum* during winter and spring.

STAINING THE WINGS OF INSECTS.

In No. 4 of Volume I of the Biological Review of Ontario, Dr. H. W. Hill gives the following method, devised at the request of Dr. Brodie, of staining the veins in the wings of certain insects:

Place the whole insect in a strong alcoholic solution of fuchsin and allow it to remain there for forty-eight hours. Then transfer the insect to water with a pair of fine forceps and wash it until no more color comes away, changing the water if necessary. While the washed insect floats in clear water slip a microscope slide under it, raise the slide, holding the insect on it with a fine needle, separate the wings from the body with a fine scalpel and remove the body. With a drop or two of clear water on the slide float the wings into any desired position, keeping them flat and unwrinkled, taking care to have no bubbles under them. Remove any excess of water with blotting paper and allow the wings to dry. Then place a drop of thick Canada balsam near them and heat the slide over a spirit or gas flame. Tilt the slide so that the now liquefied balsam flows over the wings; lower a cover-glass gently into position, and allow the preparation to cool. On examination the veins will be found red, the depth of the coloring varying with the length of time of staining, the thickness of the veins, etc. The color is well retained, so far as has been tried, and successful photographs have been made.

NOTES FROM CORRESPONDENCE.

A new Grain-moth Parasite.—Mr. John G. Jack, of Jamaica Plain, Mass., sends us a series of *Bracon* (*Habrobracon*) *honestor* Say, which he has reared in considerable numbers from the common little Indian-meal moth, *Plodia interpunctella*.

Florida Orange Scales in Ceylon.—Mr. Albert Koebele, writing from Kandy, Ceylon, January 5, 1895, informs us that he has found there orange trees badly infested with *Mytilaspis citricola* and *M. glorerii*, the two well-known orange pests of Florida. We knew that *citricola* probably came from China, but that *M. glorerii* is an oriental species is new.

The Horn Fly in New Jersey.—Mr. I. W. Nicholson, of Camden, N. J., writes that the horn fly appeared in that place on May 10 this year, but was not prevented by the cold weather from coming in large numbers since that date. Last year was the first time he had observed this insect upon mules. It appeared at that time in large patches while the animals were in pasture.

Communistic Cocoons of the Apple-tree Tent-caterpillar.—Miss Allie C. Simonds, of Fayetteville, Ark., writes us that she raised larvæ of *Clisiocampa americana* from the eggs, and that when they began to spin up she observed that instead of spinning individual cocoons several would spin large, irregular cocoons in common. One of these cocoons which she opened contained seven or eight chrysalides crowded in together, without any separating partitions.

The Horn Fly in Texas.—Mr. Victor A. Noregaard, veterinary inspector of the Bureau of Animal Industry, at Alice, Tex., writes that the horn fly is there by the millions, and is a terrible nuisance to the cattle, causing large sores, especially on the shoulders, affording an entrance for the screw worm. The flies light on the cattle the very moment they come out of the dipping vat, and half an hour later they are as thick on them as before they went through the dip.

The Convergent Ladybird injuring Cañaigre.—Prof. F. L. Washburn writes from Corvallis, Oreg., that *Hippodamia convergens*, which he has seen feeding in numbers on the leaves of sugar beet, has also badly eaten the leaves of some cañaigre growing on the grounds of the experiment station at Corvallis. The ladybird seems to have a decided liking for the leaves of this plant, which have a taste like sorrel. A lampyrid, *Podabrus comes*, has also been observed to feed upon cañaigre, though in smaller numbers than *Hippodamia convergens.*

Sow-bugs in a Well.—Mr. George B. King, of Lawrence, Mass., writes that a well belonging to Mr. N. N. S. Tompkins, and situated in a woodshed, was fouled by the decaying bodies of great numbers of sow-bugs of the genus Porcellio. The shed naturally contained large quantities of chips of decaying bark and wood, so that it was an admirable place for the breeding of the Porcellios. They got into the well by accidentally falling in or by crawling down the stone facings. The well was cleaned out, the decaying wood taken away, the stone wall relaid, and the shed floor covered with Portland cement, with perfect success. Mr. J. E. Benedict, of the Smithsonian Institution, to whom the specimens were referred, found two species among them, *Porcellio rathkei* and *P. scaber*.

The "Fringed Anthomyian" injuring Wax Beans.—Under date of May 31, Mr. L. H. Reed sends from Plainfield, Wis., specimens of the so-called "fringed anthomyian" (*Phorbia fusciceps* Zett.) with the information that this species is ruining a field of wax beans. The maggots attack the plants before they appear above ground and are found in the stems after the plant has reached a height of about two inches. This species is identical with the seed-corn maggot (*Anthomyia zeæ* Riley), and in addition to injuring beans and corn, attacks also cabbages, radishes, onions, hedge mustard, and has even been known to feed on the eggs of locusts.

The American Locust in Illinois.—Mr. John C. Andrus writes us that *Schistocerca americana* was very abundant during the fall of 1894 in the vicinity of Manchester, stripping corn of leaves and silk, especially when adjoining meadow lands. Orchards, particularly apple and cherry trees, where adjoining meadows, were also stripped of leaves. The full-grown specimens ate the hardening kernels of corn in the fall and were noticed to feed upon bits of leather, and would roughen the handles of hoes and other agricultural implements left for a day in the field. Butcher birds captured full-grown specimens and impaled them upon the thorns of Osage orange. Young pigs and turkeys were observed to feed upon them with avidity.

The Leaf-footed Plant-bug damaging Peaches.—The leaf-footed plant-bug (*Leptoglossus phyllopus*), which occasionally does considerable damage in orange groves, was found last year, as we have already shown in the pages of INSECT LIFE, damaging plums in Texas. The present spring, as reported by Mr. F. E. Cunningham, it has been found puncturing half-grown peaches in the neighborhood of Brunswick, Ga. The normal food of this insect, as we have elsewhere shown, is a large thistle. Upon this plant it breeds, and when it occurs in injurious numbers in an orchard search should always be made for the normal food-plant, which should thereafter be watched and the young bugs destroyed by spraying with kerosene emulsion.

Mauritian Sugar-cane Coccidæ.—Miss Ormerod sends us some specimens of Coccidæ from the Oriental Estates Company in Mauritius. One proves to be the original *Icerya sacchari* of Signoret (synonym of *Icerya seychellarum* Westwood), the species which Dr. Icery reported as seriously damaging sugar-cane in Mauritius many years ago. On the lands of the Oriental Estates Company it occurred upon guava and not upon sugar-cane. Upon sugar-cane, however, was found another coccid, which proves to be a species, probably new, of the genus Westwoodia. This latter insect lives upon the roots of sugar-cane, and does serious damage. Is it possible that in the different handlings between Mauritius and Washington the labels have become changed and that the Westwoodia belongs on the guava and the Icerya on sugar-cane?

Leaf-beetle Injury to Orchard and Nut Trees in Florida.—A little leaf-beetle, *Metachroma luridum* Ol., related to the strawberry root-borers, has this spring been reported from two localities in western Florida as injurious to nut and fruit-bearing trees. Mr. A. Faye, of Faye, Walton County, reported injury to pecan trees, a grove of several hundred trees being all more or less blackened, as if blighted. Mr. S. S. Harvey, of Quintette, Escambia County, reported damage last year to chestnut, on the young sprouts and bloom. The present year, before the chestnuts put out leaves, they began on the buds of pear, cutting the stems of many leaves. They also did considerable damage to the fruit of early peaches, to the apricot, Japan walnut, and pecan. One entire grove of pecans was affected.

A destructive Scale Insect new to the United States.—Our agent, Mr. Townsend, at Brownsville, Tex., has just found a mealy bug new to the United States in *Dactylopius virgatus*, said by Mr. Cockerell to be the most pestilential of Jamaican Coccidæ. Mr. Townsend found it upon "Jacobo" cactus. In Jamaica the species is nearly omnivorous and cotton is one of its food-plants.

Further Damage by Cryptorhynchus lapathi.—Mr. E. V. Wilcox, of Cambridge, Mass., sent to this division during June specimens of the large curculionid, *Cryptorhynchus lapathi*, in the larval and beetle states, with the statement that the larvæ were present in large numbers in certain willows in that locality. The larva, our correspondent states, bores between the bark and the wood, the burrow being made in the growing wood and bark, usually in an horizontal plane about the stem and branches.

Spread of another imported Snout-beetle.—The same correspondent sent with the bark and wood infested with *Cryptorhynchus lapathi* a single specimen of an imported otiorhynchid beetle, *Barypithes* (*Exomias*) *pellucidus* Boh. The former species, as we announced in the last number of INSECT LIFE (p. 360), has recently been recognized in the suburbs of Boston, but the latter has not hitherto been found outside of the neighborhood of New York City, where it was first taken in 1886. *B. pellucidus* is said to be very common in the environs of Paris, France, at the base of the cultivated strawberry.

ERRATA.

Page 100, tenth line from bottom, for "1882," read: 1892.
Page 120, fifth line of second paragraph, for "ust," read: just.
Page 224, line 4, for "*Pseudacacia robinia*," read: *Robinia pseudacacia*.
Page 279, second line of fourth paragraph, for "*scabies*," read: *scabiei*.

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Assistant Entomologists: C. L. Marlatt, Th. Pergande, F. H. Chittenden.
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U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

GENERAL INDEX

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1888-1895.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., *July 20, 1896.*

Sir: I have the honor to transmit herewith the manuscript of a General Index to *Insect Life*, the periodical bulletin of this Division, seven volumes of which were published between July, 1888, and July, 1895. Each volume as published contained an index, but there has been a decided demand from working entomologists for a combination index to the seven volumes. The very great number of short articles and notes of general interest to which entomologists have frequently to refer renders this comprehensive index most desirable, and in response to this demand it has been prepared. I respectfully recommend that it be printed as an unnumbered publication of this Division.

Respectfully,

L. O. Howard,
Entomologist.

Hon. J. Sterling Morton,
Secretary of Agriculture.

PREFACE.

With the discontinuance of the publication of *Insect Life* by executive order in 1895, the preparation of a combination index for office use was begun. The work was assigned to Mr. F. H. Chittenden, by whom and under whose supervision it has been completed. It has been found so useful to entomological workers in this Department that it is published in order to make it available to entomologists in general.

The basis of the General Index is naturally upon the separate indices of the several volumes. Several persons, however, were engaged upon these separate indices, and after the conclusion of Volume III a somewhat different system was introduced. As a consequence it was found necessary to largely rewrite the indices of Volumes I, II, and III, and many alterations have been made in the course of the work. Valueless items, such as were formerly classified by the addition of "mm," meaning "mere mention," have been discarded and many omitted references have been added. The nomenclature has been altered to conform with the latest accepted opinions of specialists, and when several items refer to the same subject these have been placed under one head, in order to bring the Index into as small space as is consistent with clearness. In its final arrangement one noticeable change has been effected, which it is hoped will commend its usefulness by facilitating the work of specialists and others engaged in reviewing the literature of topics which may have been mentioned in *Insect Life*. This consists in the arrangement of the different items under each subject, species of insect, or other catchword, according to date of publication, by volume and page, instead of alphabetically, as was formerly done.

The following abbreviations are used:

Abs., abstract; *art.*, article; *bull.*, bulletin; *descr.*, description; *m.*, mention; *n. g.*, new genus; *n. sp.*, new species; *ref.*, reference; *rem.*, remarks; *rept.*, report; *rev.*, review; *sp.*, species of; *spp.*, plural do.; *var.*, variety.

The abbreviation "art." appended to an item indicates that the species or other subject indexed forms the text of a comprehensive account or article, and the dash (–) placed between the first and last page of the article denotes its length.

"Ref." signifies that a reference is given to a work which is being noticed or reviewed in which the species or other subject is treated.

It is believed that by means of these insertions the reader in search of a general account of an insect or other subject will be saved much time, being able to see at a glance and select the more important accounts.

What has been said applies to the General Index. A word of explanation is due in regard to the Plant Index. The aim has been to itemize the more important food plants of an insect, and unimportant mention of a food plant is not as a rule recognized, since such items are practically of no value and would increase the size of the Index far beyond its present dimensions without a corresponding increase in its usefulness. Thus "bean" is not indexed every time that injury by the bean weevil is referred to, nor "hop" whenever the hop louse is mentioned, but the reader is referred to the General Index where full lists of references are given. Reviews and other notices of works are indexed under the subjects treated of and not under the name of the authors. References to agricultural experiment stations are entered under the general heading "Experiment Stations" and not under authors or States.

L. O. Howard.

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