VIOLET LEAVES, SHOWING INJURY BY THE GREENHOUSE LEAF-TYER—NATURAL SIZE.

(From photograph by P. H. Dorsett.)

BULLETIN No. 27.—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

SOME INSECTS

INJURIOUS TO

THE VIOLET, ROSE, AND OTHER ORNAMENTAL PLANTS.

A COLLECTION OF ARTICLES DEALING WITH
INSECTS OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY F. H. CHITTENDEN,

ASSISTANT ENTOMOLOGIST.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., April 2, 1901.

SIR: I have the honor to submit herewith manuscript of a paper entitled Some Insects Injurious to the Violet, Rose, and Other Ornamental Plants, which has been prepared with admirable care and thoroughness by Mr. F. H. Chittenden, of this Division. The subject is one which has engaged Mr. Chittenden's attention for some time, and the investigation was necessitated by a very general complaint of damages by insects from growers of hothouse plants. The general subject is one which has not heretofore been treated, and the work is unquestionably needed. I recommend its publication as Bulletin No. 27, new series, of this Division.

Respectfully,

L. O. HOWARD, *Entomologist.*

Hon. JAMES WILSON,
Secretary of Agriculture.

PREFACE.

Within the past three years insect injury to violets grown under glass has been very pronounced and has been the occasion of considerable correspondence and investigation in this Division and of experiment in the line of remedial treatment, conducted chiefly by the Division of Vegetable Physiology and Pathology of this Department. Messrs. A. F. Woods and P. H. Dorsett, of that Division, were in charge of this work, and the latter gentleman, who is also a practical florist, has furnished much material for the investigations conducted at this office. The insects which have been the occasion of the principal injury and which have received the larger share of attention in the present bulletin are five in number: (1) The caterpillar of a small moth, which we have called the greenhouse leaf-tyer; (2) the larva of a hymenopteron, which will be called the violet sawfly; (3) a plant-louse undescribed at the time work was begun on this class of insects and known to violet growers as the black or brown aphis or "black fly;" (4) the common "red spider," and (5) a small maggot called by florists the "gall fly." Several instances of injury by the larva of the moth above mentioned, to violets and other greenhouse plants, have been published; and the red spider is altogether too well known as a pest everywhere. None of these species has been at all fully treated biologically and economically in any of the publications in which they have hitherto been considered, and none has been figured in Departmental publications with the exception of the gall fly, which was described specifically in an earlier bulletin of this series. Numerous other insects have been observed upon violets in recent years, and some have been sent in by correspondents, particulars concerning which will be given. Certain common greenhouse pests other than those which will receive special mention, such as white grubs, wireworms, and sow-bugs, are occasionally troublesome to violets. Several species of cutworms have been observed from time to time attacking violets, and these will be considered with such other insects as have been recorded in our Divisional notes and in literature as occurring on this genus of plants.

Several other species of greenhouse pests, notably such as infest the buds and blossoms of roses, have been conspicuous in recent years, and certain of the more interesting of these will be duly considered in accordance with their injuriousness. Prominent among these are little caterpillars known as rose leaf-tyers, rose gall flies (minute maggots, similar to those which attack violets), bud-worms, etc.

It was found impossible to complete certain of the studies planned and begun in 1898, owing to the scarcity of material (about Washington) the following years, but it is believed advisable not to further delay publication, as it is impossible to foretell when sufficient material will be available for our purposes.

Since the writer is not a special student of Lepidoptera he has preferred to use in the present work the lepidopterous genera in Smith's Catalogue rather than to adopt those recently proposed by certain European systematists, among whom is Sir G. F. Hampson, who has been for some time engaged upon the Pyralidæ. By so doing he believes that a certain degree of unnecessary confusion will be avoided, as it is by no means certain that the new generic arrangement of the European lepidopterists will be generally adopted in toto by Americans; and, until this matter has received the attention which is its due on the part of our students of this order, the old genera will be retained.

Mr. B. T. Galloway, Director of Plant Industry, has discussed some of the principal insect pests of the violet in a little handbook, published in 1899, on the subject of growing and marketing violets for profit, and entitled "Commercial Violet Culture." The question of violet insects with the remedies to be employed against them is considered on pages 190–215 of that publication.

In the present bulletin all of the text figures designated as original have been drawn by Miss Lillie Sullivan, under the writer's personal supervision, and for the most part from selected fresh material.

F. H. C.

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SOME INSECTS INJURIOUS TO THE VIOLET, ROSE AND OTHER ORNAMENTAL PLANTS.

THE GREENHOUSE LEAF-TYER.

(*Phlyctænia rubigalis* Guen.)

One of the most troublesome of all known enemies of violets and other ornamental plants when once it obtains foothold in a conservatory is the greenhouse leaf-tyer, the larva of a small moth, now known as *Phlyctænia rubigalis* Gn., but formerly as *P. ferrugalis* Hbn.

Until within recent years only a few instances of injury by this species had come to our knowledge or been brought to public notice. During the past four years, however, its depredations have attracted attention in widely separated localities, and it is evident that this insect has now become established as a pest more than periodically injurious. As such it is entitled to somewhat extended notice. The greenhouse leaf-tyer, as its name would suggest, is more particularly annoying to ornamental plants grown in greenhouses; but its injuries do not cease here, since the larvæ work also in the field—celery, beets, cabbage, and tobacco, among crop plants, being most often affected.

NATURE OF INJURY.

The usual manner of work of the larva is upon the underside of a leaf. A fair specimen of larval injury to violets is shown in Plate I, which is reproduced from a photograph. The leaves figured were eaten out in holes on the under surface, leaving the upper epidermis intact, and this is the manner of injury to many other plants. Some plants, however, are eaten entirely through and some are skeletonized. Occasionally larvæ, when numerous, feed upon the upper surfaces of the leaves, but this is exceptional. The normal habit of the larva in feeding is to fasten together two contiguous leaves, to curl over the edge of a single leaf upon which it may be feeding, or to spin about itself a thin, filmy web within which to feed.

In close confinement a few larvæ will in a very short time devour and destroy their food plant. In one experiment in rearing this species at this office, larvæ completely destroyed a large pot of violets in ten days.

DESCRIPTION OF THE SPECIES.

The moth which produces the greenhouse leaf-tyer is a member of the family Pyraustidæ, superfamily Pyralidina, and was first recognized and described from this country in 1854 (Guenée, Deltoïdes et Pyralites, p. 398). It is an inconspicuous little pale reddish-brown species with a wing expanse of about three-fourths of an inch. The fore-wings are light clay brown in color, suffused with a slightly darker reddish or ochreous brown, the serrate blackish lines with which they are ornamented forming the pattern shown in the accompanying illustration (fig. 1, *a*). The hind-wings are gray, becoming light brownish toward the termen, and with two discal spots, the costal one prominent. Both wings are bordered with a row of small well-defined black dots.

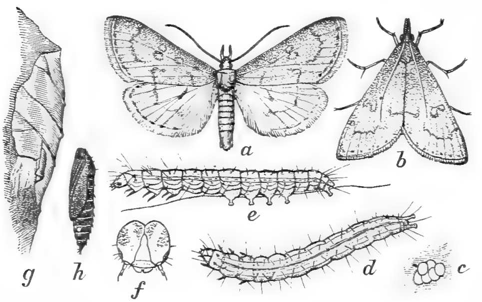

FIG. 1.—*Phlyctænia rubigalis*: *a*, moth; *b*, same in natural position at rest; *c*, egg mass; *d*, larva from above; *e*, same from side; *f*, head of same; *g*, pupa case; *h*, chrysalis—*a*, *b*, *d*, *e*, *g*, *h*, one-half larger than natural size; *c*, twice natural size; *f*, more enlarged (original).

The description of the moth by Mr. A. R. Grote, which appeared in 1877 under the name of *Botis harveyana* (Can. Ent., vol. IX, p. 104), is copied herewith for the further identification of the species:

A small species more slender than *communis*,[1] with pale, brown primaries, the exterior line fine, blackish, obsoletely denticulate, rather suddenly drawn in at vein 2, thence back again and angulate before the margin. Outer spot large, annulate. Inner spot obsolete. Before the fringes, which are faintly interlined with pale and are discolorous, there is a distinct sinus of dark points. Hind-wings paler than primaries, washed outwardly with the same brown as primaries, with a distinct discal dot and median line. Beneath more ochreous, with the discal dots double on hind-wings; a common exterior line; on the primaries the veins are partially darker marked; terminal points very distinct and continuous. Head, palpi, and thorax above pale-brown, beneath concolorous with under surface of wings glistening.

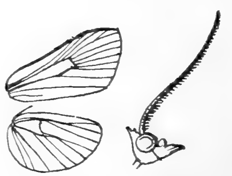

FIG. 2.—*Pionea ferrugalis*: wing venation of moth at left; side view of head at right—enlarged (after Hampson).

Dimensions: Fore-wings, 17–20 mm; hind-wings, 14.5–17 mm; length of body, 7.5–10 mm.

The venation and the shape of the head and antennæ is about as in *P. ferrugalis* shown in figure 2.

The moth bears a strong superficial resemblance to the common

[1] Presumably *Botis communis* Grt. (Can. Ent., v. VIII, p. 99=*Loxostege similalis* Gn.

garden webworm, *Loxostege* (*Phlyctænodes*) *similalis* Guen., but may be distinguished by the characters above given. That there need be no confusion of identity an illustration of this latter is also introduced for comparison (fig. 3).

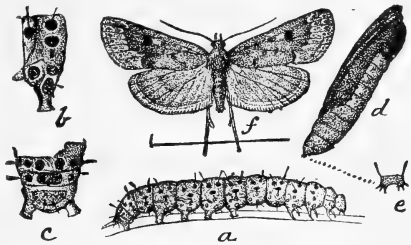

FIG. 3.—*Loxostege similalis:* *a*, larva; *b*, side view of middle segment of larva; *c*, dorsal view anal segment of larva; *d*, pupa; *e*, cremaster of pupa; *f*, moth—*a*,*f*, somewhat enlarged; *d*, twice natural size; *b*, *c*, *e*, more enlarged (from Riley in Ann. Rept. Dept. Agr., 1885).

NOMENCLATURE AND SYNONYMY.

Since the original description of Guenée in 1854 (l. c.) which appeared under the genus Scopula, the species has been described under the names *Botys oblunalis* Led. (Wien. Ent. Monatschrift, 1863, pp. 372, 469), as well as *Botis harveyana* Grt., and assigned to various other genera among which are Margaritia, Phlyctænia, Pyrausta, and Pionea.

In domestic lists and current literature this species has usually been mentioned as *Phlyctænia ferrugalis* Hbn., but it is at present catalogued by Sir G. F. Hampson (Proc. Zool. Soc. London, Feb. 21, 1899, p. 242) as *Pionea rubigalis* Guen. According to the usage of American systematists this species appears to belong rightfully to Hapalia *Hbn.*, a genus which was proposed, though not described, as early as 1827, or twenty-seven years before Guenée's genus Pionea.

Phlyctænia rubigalis is, according to Hampson, native to North America and distinct from the Old World, and nearly cosmopolite *ferrugalis* Hbn.,[1] with which it has until very recently been confounded.

DISTRIBUTION OF THE SPECIES.

Grote's types of *Botis harveyana* were from New York and Texas. In the National Museum are specimens bearing capture labels of Illinois, 1876, and St. Louis, Mo., 1878. Published records and specimens now in the National collection are in evidence to show that the known distribution, though not cosmopolitan, is very wide, covering nearly our entire country from Canada to the Gulf States and from the Atlantic to the Pacific. The following are the known localities:

Toronto, Canada; Wading River, L. I.; Albany (Lintner), Poughkeepsie, Highlands, New York City, and Ithaca, in New York; Libonia, Pa.; New Jersey—throughout the State (J. B. Smith); Lakeland, Kensington, and Garrett Park, Md.; Tennallytown and Brook-

[1] This latter species is recorded from central and southern Europe, Great Britain and Ireland, Western Asia, India, Ceylon, Burma, Japan, Afghanistan, western and southern Africa.

land, D. C.; Louisa County, Va.; Harpers Ferry, W. Va.; Wooster and elsewhere in Ohio; Indiana; Pekin, Urbana, (Forbes and Hart), Chicago, and central parts of Illinois; Kalamazoo, Mich.; North Carolina; Texas (Belfrage); Key West, Fla.; St. Louis, and central part of Missouri; Alameda (A. Koebele) and Los Angeles (Coquillett), Cal.

The fact of this species being so well established as a greenhouse pest and preferring indoor life to that of the field, is at least strongly suggestive of exotic and even tropical origin. From the above list of localities it will be seen that it occurs from semi-tropical portions of Florida through the Lower and Upper Austral life zones to what is at present considered Transition. For a species of its habits there is no reason why it should not become established, at least in greenhouses, still farther north in colder latitudes.

THE EGG AND OVIPOSITION.

Eggs are deposited singly or in masses of from two to nine or more; when laid in groups the different eggs composing it overlap as shown in the illustration (fig. 1, *c*). Many such groups may sometimes be found under a single leaf.

The egg.—The egg is scale-like in appearance; when first laid, clear grayish white in color, and so nearly translucent as to show the color of the surface, e. g., the green of a leaf, upon which it is deposited; the exterior surface shining glassy and iridescent; flattened upon the surface of deposition; convex above and somewhat variable in outline but usually broadly ovate. The surface is rather strongly and rather finely rugose, irregularly subreticulate. The average length is about 0.8^{mm} and the width 0.65^{mm}.

THE LARVA AND PUPA.

The full-grown larva.—The larva when full grown presents the appearance indicated by *e* and *d* of figure 1. It is green or greenish yellow in color and somewhat translucent; the head is whitish and rather faintly spotted with small purplish spots (fig. 1, *f*), and the first thoracic segment is marked on each side by a small but conspicuous round black dot. Along the dorsum the green ground color of the body shows as a narrow, rather conspicuous median green line, and on each side of this is a double line of white. The legs show on their outer surface two little round black dots and the prolegs are rather long and prominent. The surface is very sparsely hairy. The mature larva, when extended at full length in natural feeding position, is nine or ten times as long as wide, measuring about three-fourths of an inch (18–20^{mm}) in length and only about a twelfth of an inch in width (2^{mm}).

The pupa.—The pupa is dark, shining brown, and bears along its dorsal surface conspicuous hairs, as shown in the illustration (fig. 1) at *h*. It measures about three-eighths of an inch in length (7.5^{mm}).

Owing to the fact that the identity of this species with the closely related European *Phlyctœnia ferrugalis* Hbn., which has been very carefully studied and described in detail in its several stages by the Rev. William Buckler in The Entomologist's Monthly Magazine for February, 1878 (pp. 200–204), was not for a moment doubted, no effort was made to watch the various molts or to make detailed descriptions of the larvæ while these could be obtained in fresh condition for the purpose. When the specific distinctness of the two species was recognized on receipt of the publication of Sir G. F. Hampson, previously cited, it was not possible, owing to the lateness of the season, to secure sufficient material for rearing.

The development of the embryo in the egg has been observed by Buckler in the case of the European species, and probably this does not differ much in the case of our own species. He states that the margin of the egg on the seventh or eighth day "becomes rounded or raised, and, like the rest of the upper surface, a little convex; the shell then is seen to be minutely pitted, and through it the whitish, wax-like, opaque, faint form of the larva coiled round can be just discerned; on the ninth day it shows more distinctly, and on the tenth the head can be plainly seen as a black spot on the margin; the shell is pearly and glistening; and after this the larva hatches in a few hours."

LITERATURE OF THE SPECIES.

The first notice that the writer finds which bears upon the biology of this insect was published in 1890 in the form of abstracts from correspondence in Insect Life (Vol. II, p. 277), further mention of which will be made under the heading of "Divisional Records of Injury." The species is there referred to *Botis harveyana* Grote.

In 1893 Mr. G. C. Davis gave a short popular account of this moth, with original illustrations of its different stages, in Bulletin No. 102 of the State Agricultural College of Michigan (pp. 28, 29).

In his report on the insect injuries in Maryland in 1897, Prof. W. G. Johnson mentions the finding of the larva injuring the young and tender lower leaves of tobacco in a hotbed at the Maryland Agricultural Experiment Station (Bul. 9, n. s., Div. Ent., p. 83; Bul. 57, Md. Agl. Expt. Sta., p. 7). They were noticed in abundance from July 1, and most numerous July 13. In the Florists' Exchange for October 23 of the same year, Mr. P. H. Dorsett, of this Department, gives a few notes on this moth and its injuries to the leaves of violets, illustrated with a half-tone reproduction of a photograph of the insect, natural size, in its different stages and its work.

It should be added that Mr. Dorsett met with this insect also at Poughkeepsie and Highlands, N. Y., and he informs the writer that it was troublesome in greenhouses there and elsewhere along the Hudson River valley.

The same year Mr. James S. Hine published a very good three-page account of this species, with original observations upon its life history, in the Columbus Horticultural Journal (reprint, dated September 28, 1897, pp. 1–4).

In the edition of the Weekly Florists' Review, of Chicago, Ill., for March 3, 1898, the writer published a short preliminary account of this insect in answer to the inquiry of a correspondent of the Review, who requested a reply through the columns of that periodical.

Under the heading *Phlyctænia ferrugalis* Mr. Galloway mentions this species on pages 214 and 215 of his work "Commercial Violet Culture," published in 1899, giving a half-tone illustration of the insect and its injury, from photographs of the same.

This species was included in a list of the principal injurious insects of the year 1899, with brief mention of reported injury to violets in Maryland and Virginia and to other greenhouse plants in New York and Canada, in the Yearbook of the United States Department of Agriculture for 1899 (1900), page 746.

It has also received brief mention under the name of the chrysanthemum leaf-skeletonizer in a paper entitled Insects Infesting Carnations, by F. A. Sirrine, published in the American Florist for March 3, 1900 (Vol. XV, p. 912). Chrysanthemums were stated to be subject to attack particularly when roses were grown in the same house.

In Bulletin No. 60 of the University of Illinois Agricultural Experiment Station, also published in 1900, Messrs. Forbes and Hart have a short article on this species (pp. 453, 454), which was found attacking beets at Urbana and near Pekin, Ill.

In a recent publication by Dr. James Fletcher (Transactions Royal Society of Canada, Vol. V, second series, 1899–1900, p. 228) mention is made of this leaf-tyer in connection with its occurrence in Canada upon the leaves of roses in greenhouses. It was reported to have done very serious damage three years previous to the time of publication, necessitating the entire cleaning out of a large house of choice roses. In the same writer's report, as entomologist and botanist to the Canada department of agriculture, central experiment farm, for 1899 (1899), pages 179, 180, and in the Report of the Entomological Society of Ontario, for 1899 (1900), page 110, more detailed accounts of this same attack are given, with notes.

Mr. Davis has called this insect the celery borer, from the habit of the larva of boring into celery stems; but this habit is evidently an exceptional one, as it is normally a leaf-feeder, and, although its habits vary, it usually joins together the leaves of the plant upon which it feeds. It appears to feed by preference also upon the terminal leaves of most plants and upon such plants as are growing in dark or protected situations. As the species is omnivorous and, so far as observed, a pest chiefly in greenhouses, the writer some time ago proposed the name of greenhouse leaf-tyer, a cognomen which has already been adopted.

DIVISIONAL RECORDS OF INJURY.

What is probably the first rearing of this species is that of June, 1888, in the laboratory of this office. The 23d of that month Mr. Theo. Pergande found larvæ and pupæ in one of the conservatories connected with this Department. They had done much damage to a number of small plants of the nodding thistle, *Carduus* [*Alfredia*] *cernuus*, a European plant sparingly introduced about some cities in the Eastern United States. These larvæ had completely skeletonized the plants, causing them to dry up. From this lot moths were reared June 28. On September 14 of the same year were received larvæ and pupæ from Mr. E. S. Miller, Wading River, Queens County, N. Y., with the statement that the larvæ were doing much injury to all kinds of "soft-wooded" greenhouse plants (Insect Life, Vol. II, p. 277).

The writer's first experience with this species was on July 7, 1893, when it was observed in all stages in a conservatory at the World's Columbian Exposition at Jackson Park, Chicago. One of the exhibitors in the Horticultural Building showed the writer specimens of the moth, and stated that it was very injurious to dried apples from Missouri and Idaho. A personal visit to the building resulted in the discovery that the dried apples were, in reality, injured by the Indian-meal moth (*Plodia interpunctella* Hbn.); but by striking some of the ornamental plants in the conservatory with a cane the moths of this leaf-tyer were induced to fly up and were captured. A careful search of the plants upon which the moths were most frequently noticed led to the finding of the larvæ. The plants mostly attacked were the wandering jew (*Tradescantia zebrina*), ground ivy (*Nepeta glechoma*), and geranium, the last being least affected. It was noticed that the larvæ fed chiefly upon the terminal leaves, and, for the most part, on the under surface. They were surrounded usually by a slight silken web, and where two leaves were in contiguity they were often fastened together with the silk, and sometimes a single leaf would be folded. Unfortunately, observations were not carried on as intended, owing to the fact that the exhibitors having charge of the conservatory evidently became suspicious of the frequent visits of a "Government official," and, no doubt, fearing that publicity might be given of the facts in the case, kept a sharp lookout for insects of every kind, and destroyed every insect in sight. Mention is made of this fact because it resulted in a test of a good but somewhat tedious remedy. August 7 only a single moth could be found and no larvæ. Soon after the writer's first visit in July the attendants trimmed the infested plants and they were afterwards trimmed as often as the larvæ showed themselves. As already stated, the larvæ affect more especially the terminal leaves of these particular plants, and these were destroyed after being cut off, presumably by being crushed under foot. One of the attendants stated that the plants had also been dosed with a strong tobacco wash, which probably affected such larvæ as might have remained on the plants.

July 23, 1897, Mr. F. C. Pratt found numerous individuals of the moths as well as larvæ on celery at Brookland, D. C. An average of about three pupæ were found spun up in the leaves at the tops of all the young plants, and when the plants were brushed with a stick or by hand the moths "rose up in clouds." The owner of the place where the insects were at work stated that this species had been a most troublesome pest the previous year; its habit of feeding upon the tops of the celery greatly lessened its market value. It was his first year in celery raising in that locality, and he had conceived the idea that it would not be profitable to raise that crop there. In succeeding years, however, there was a decided decrease in the numbers of this leaf-tyer. When the place was visited by the writer in 1899 and in 1900 the insects were comparatively rare.

During January and February, 1898, this species was the subject of correspondence between this Division, the Florists' Review, of Chicago, Ill., and Mr. Robert Mearns, a florist, of Toronto, Canada. The latter sent specimens in all stages, with the report that this insect was doing much damage to plant life in the greenhouses of some of the florists in that city. The florists were very anxious to learn of an effective remedy for the pest. Larvæ were particularly destructive to heliotrope, wallflower, violet, and geranium.

April 28, specimens of the moth and pupa of the greenhouse leaf-tyer were sent to this office by Mr. S. S. Wilson, Libonia, Franklin County, Pa., with the statement that the larva was very injurious to greenhouse plants, such as geraniums and dahlias. From this lot one moth was obtained April 30. May 17, the same gentleman made another sending of material and, in response to inquiry, furnished a list of the plants affected in his greenhouses. This list includes Ageratum, geranium, German ivy, Kenilworth ivy, ground ivy, dahlia, Justicea, chrysanthemums, *Cineraria hybrida*, anemone, cabbage, Matricaria, Passifloras, Plumbago, Ruellia, Tydæa, daisy, Lobelia, *Veronica imperialis*, Lantana and Deutzia. Larvæ were first noticed at that place about the 1st of January, in 1898, on Ageratum in a hot place in one of the greenhouses, and next upon geraniums. At the time of this writing it was feared that if their ravages were not checked they would eat all the near-by plants. It was noticed that they had a special fondness for forming their cocoon-like pupal cases on *Anemone japonica*.

May 14, 1898, Mr. Pratt called the writer's attention to the great numbers of the moths of this species that were present in a large field of rhubarb at Tennallytown, D. C. When the field was visited again on the 17th it was found that this was by far the most abundant species of moth then present in that locality. They began hovering about the plants before sundown, often several individuals being in sight at one time. A considerable proportion alighted upon the rhubarb leaves and immediately crawled to the lower surface and disappeared when not molested, while others alighted upon clover and weeds in the same field.

Again the following year moths were observed in the same fields and elsewhere early in the season, but careful search failed to reveal any larvæ. The only wild plant from which the species has been reared here is hedge mustard (*Sisymbrium officinale*). Imagos issued June 10–17.

Attack upon field crops and weeds, aside from celery, is not so obvious as in the greenhouse, the larvæ being distributed here and there in such manner that they can do little harm. Hence it follows that larvæ are rather rarely found out of doors, though the abundance of the moths show that they undoubtedly are present and often in some number, on a great variety of crop plants and weeds.

Later in the season of 1899 the species when sought for was rarely found. Mr. Dorsett was able to obtain only three larvæ from his violet greenhouse, and search by the writer in several beds of celery failed to be productive of many individuals.

November 15, 1899, Hon. G. W. Koiner, Richmond, Va., sent specimens of this species, among others, that were depredating on violet beds in Louisa County of that State.

January 12, 1900, Mr. Franklin Sherman, jr., wrote that this species was breeding at Ithaca, N. Y., on a great variety of plants, and had made itself quite a serious pest in the forcing houses during that winter.

In a letter of the same date Dr. James Fletcher reported attack by this species in greenhouses in Canada.

The foregoing mention includes only such plants as the larvæ have been found to select for themselves. In confinement, larvæ, after devouring the potted plants upon which the eggs had been deposited, were fed with bean leaves, which happened to be the most available plants on which to feed them at the time. It appears probable that larvæ would thrive on almost any succulent vegetation, with perhaps the exception of conifers.

In addition to the plants above mentioned, there is a Divisional record of this moth having been reared from some species of ragweed or pigweed (Ambrosia) from central Illinois.

HABITS OF THE LARVA.

Soon after hatching, the larva begins feeding, at first cutting little patches of parenchyma from the under surface of the leaves, leaving the upper epidermis intact, as shown in the illustration of an affected violet plant in Plate I. A few days later it usually seeks concealment by drawing together by means of its fine silken webbing portions of a leaf or of two leaves that happen to be contiguous.

The terminal leaves of such creeping plants as the wandering jew appear most subject to attack, while the lower leaves of taller plants are most injured. As in the case of many other greenhouse insects, the larvæ prefer secluded places, and plants growing in shady locations are most affected.

When full grown the larva prepares for pupation in different ways. Sometimes it will spin up between two leaves, but more often rolls up a pupa case at the edge of a leaf, if the leaf be large, cutting a slit usually on one or both sides before drawing the leaf over itself. The interior it lines with a thin silken membrane, and within the cocoon thus formed changes to pupa. In figure 1, *g*, a pupal case showing slit on one side is illustrated.

Individuals that were observed in May would be feeding one day and the next would form their pupa case and the same or the next day would transform.

HABITS OF THE MOTH.

As has already been stated, the moths fly just before sundown. Indoors they rest during the daytime on the lower surface of the leaves of their food plants and other low-growing plants and doubtless remain thus for many hours at a time unless disturbed. When disturbed they fly only a very short distance before they alight and at once seek the underside of a leaf again. They fly low and if along the ground they alight only to again fly up until the underside of a leaf is found. In these habits they resemble many other moths that could be mentioned. The position taken by the moth when at rest on the under surface of a leaf is shown in figure 1, *b*.

DEVELOPMENT AND GENERATIONS.

It will be noted, in Buckler's account of the development of the egg of the European *Phlyctænia ferrugalis*, that hatching took place on the tenth day. With our native leaf-tyer, eggs that were found on rolled violets in a rearing jar in which moths had been placed May 11, and which were presumably laid on that date, hatched May 23, or in twelve days.

The oldest larvæ of this lot attained full growth and began crawling about the rearing jar, June 10; on the 11th began spinning, and on the following day had pupated, thus giving twenty days as the duration of the larval stage. The individuals which developed into pupæ June 12, transformed to imago June 19, giving seven days as the duration of the pupal period for this time of the year. The weather averaged about normal, the temperature being 75–86° F.

The duration of the first generation observed was therefore thirty-nine days.

There is little doubt that in confinement a generation of this species is produced which issues in April and May. The writer, therefore, feels justified in considering the first generation reared at this office as the second indoor one. Of the development of the first generation, then, nothing can be said.

A larva from the hypothetical first generation was observed to begin the construction of its pupal case May 13, on the following day it spun up and over night changed to pupa, the imago issuing during the night of May 23, the duration of the pupal period for this individual having been nine days. A second individual went through this process in the same time, beginning to spin up May 16, completing its work the following day, being found as pupa next day and issuing as adult on the 27th; the weather was cool. In hot August weather the pupal condition consumed seven days.

The midsummer generation, as observed at this office, may be passed in thirty-four days; or, we may say, in about five weeks. The egg state required but five days, and this with the pupa seven, leaves twenty-two days or about three weeks for the larval period.

In an exceptionally low temperature in which a midwinter generation was reared under artificial conditions, neither that of a conservatory nor the field, where the temperature varied from 42° to 62° F., eggs laid January 19 hatched thirty-four days later, or in about five weeks. The larval period was prolonged about two weeks, and the imagoes, which laid the eggs in this experiment lived, some of them, a month, and one for six weeks.

The larva has been traced through its molts by Mr. Hine, at Columbus, Ohio (l. c.). In greenhouses he found that the larva makes its first molt in eight days after hatching, and at intervals of about five days thereafter, having four molts in all, the duration of the last stage—that is, after the fourth molt—being about eight days. The duration of these molts in a close conservatory in hot weather would, of course be a day or two less.

Two and probably more generations are unquestionably produced annually in the open, and in hothouses a still greater number. At least four are indicated for the average indoor temperature of a conservatory.

On this head, Mr. Hines says: "It is evident that at least five generations are produced in the interval between the middle of September and the middle of the following May, or the time during which most commercial greenhouses are in operation."

Divisional records and those of captures show that moths have been taken out of doors as early as April in central Illinois and central Missouri, and in May in the District. Moths have been reared under more or less unnatural conditions, but similar to what are experienced in greenhouses in every month throughout the year.

LIST OF FOOD PLANTS.

The known host plants of this species may be summarized as follows: Celery, cabbage, beets, and tobacco, among crop plants; and of greenhouse and other ornamental plants, Ageratum, geranium, ground ivy (*Nepeta glechoma*), German and Kenilworth ivy, violet, heliotrope, wall flower, wandering Jew (*Tradescantia zebrina*), dahlia, daisy, Justicea, chrysanthemum, carnation, Cineraria, begonia, abutilon, roses, pelargonium, anemone, nasturtium, moonvine, Swainsonia, Genista, Plumbago, Matricaria, Passiflora, Ruellia, Tydæa, Lobelia, Veronica, Lantana, Deutzia, nodding thistle (Carduus), and ornamental Ambrosia. Of weeds it has been observed on hedge mustard (*Sisymbrium officinale*) and ragweed (Ambrosia).

SUMMARY OF THE LIFE HISTORY.

The life history of the insect is now practically known, and the summary which follows is fairly complete. This species occurs out of doors, where it sometimes does considerable damage to celery, but aside from this its injuries are confined, for the most part, to plants in conservatories.

The moth lays its scale-like white eggs on the plant which is to serve as the food for its larvæ. The eggs hatch in from five days to about three weeks, according to temperature.

The larva, soon after it is hatched, usually conceals itself or begins the process of doing so by drawing together, by means of its white silken web, a portion of a leaf, or it thus joins two contiguous leaves and feeds upon their lower surface. The work of the larvæ has been most noticeable in secluded situations, and, on most plants, upon the terminal leaves, which they eat full of holes. They work chiefly at night, and by day rest in the same location; here also they transform to pupæ or chrysalides, and subsequently to the imago or moth state. Occasionally, at least, perhaps in the case of the hibernating generation out of doors, the larvæ seek more protected locations for their transformations.

Hibernation either begins in the larval state and ends toward the approach of warm spring weather with the pupa, or is passed in the pupal condition. In warm indoor temperatures there is no definite hibernating period.

The larval period varies also, according to the temperature at the time of tranformation, from an observed minimum of about three weeks to perhaps five weeks, and the pupal period from one to probably two weeks.

NATURAL ENEMIES.

A single parasite of this species has been observed, the only natural enemy that appears to be known for it. Among a lot of larvæ from Libonia, Pa., a cocoon was found May 19, which gave the imago May 27. It was identified by Mr. Ashmead as a species of Synetæris, an ichneumonid genus related to Limneria.

REMEDIES.

Hand-picking.—The greenhouse leaf-tyer can be controlled in greenhouses by hand-picking or trimming away and destroying all infested leaves or other portions of plants as often as they are detected. This has been successfully practiced in a number of cases, one of which has already been mentioned, but it is somewhat laborious. Mr. Wilson wrote in regard to this species that he entirely rid his greenhouse of it one season by hand-picking.

Attracting moths to lights.—Another method of checking the increase of the species is by attracting the moths to lights placed in the greenhouses at night. This method is in practice by at least one of our correspondents, who reports that it affords some relief. Lights to be most successful should be placed over vessels of water on which a thin scum of kerosene is floating.

In any case a careful lookout should be kept for this and other insects which injure the plant by eating its leaves.

Arsenical spray.—Paris green or other arsenical would, if applied at the outset of the attack, effect the destruction of the larvæ, but it has not been ascertained by practical experience whether or not such a spray would destroy the more mature larvæ. Owing to their more or less protected manner of working, it would probably not do so effectually. An underspraying is, of course, a necessity.

This and hand methods are about the only remedies applicable to celery beds and elsewhere out-of-doors. An objection to the use of Paris green on violets and some other greenhouse plants is that the plants have to be syringed every few days for protection against the so-called "red spider," and this would wash away the arsenite. Another is that a poisonous wash could not be used when the plants are in bloom. It might also injure the foliage of certain tender plants. It is better to use some remedy that will at the same time destroy other insects with which the greenhouse may be affected.

Tobacco as a greenhouse fumigant.—The most widely useful insecticide for greenhouse fumigation is tobacco in its various forms. In many instances it is without doubt the cheapest and safest insecticide to use against certain greenhouse insects, particularly plant-lice. Its effectiveness, however, under the best conditions is not great, as it requires repeated use at short intervals. Moreover, it may cause serious injury to some plants. On the other hand, tobacco may prove injurious to the foliage and flowers of certain plants such as violets, by bringing on epidemics of "spot." Tobacco is also useless against scale insects in general and mealy bugs.

Hydrocyanic-acid gas treatment.—At present the most satisfactory manner of dealing with this and similar pests is by means of hydrocyanic-acid gas which has been developed as a medium for the fumigation of insect-infested greenhouse plants by the Division of Vegetable Physiology and Pathology of this Department, having been used under the direction of Mr. A. F. Woods in 1894, and later by Mr. Woods and by Mr. P. H. Dorsett. Detailed directions for its use were given by these two gentlemen in Circular No. 37, 2d Ser., of this Division, from which publication the directions which follow on the hydrocyanic-acid-gas method have been largely transcribed.

This remedy has proved particularly effective against the present species on violets and against aphides on similar greenhouse flowers, and has the advantage of being useful against all other insects except the so-called red spider, which it does not entirely destroy, but it can not yet be safely used for the fumigation of certain other plants owing to the danger of bleaching and otherwise injuring them; hence it will be wise, before undertaking fumigation on a large scale on other plants which will be mentioned, to first try this remedy experimentally on a few plants and in a small way.

THE HYDROCYANIC-ACID-GAS METHOD OF FUMIGATING GREENHOUSES AND COLD FRAMES.

Hydrocyanic-acid gas, since its introduction by the Division of Entomology in 1886 as a remedy against scale insects of the orange, has proved of great value as an insecticide. Previous to our experiments early in 1895, though it had been occasionally tried in greenhouses, hydrocyanic acid was not recommended on account of its injurious effects upon plants. As a result of a series of careful experiments we found that, as a rule, plants were less injured by a short exposure to a relatively large amount of gas than they were by a long exposure to a relatively small amount. On the other hand, a strong dose for a short time was the most effective in killing insects. Different species and varieties of plants, however, were found to vary remarkably in their power of withstanding the poison. This in many cases appeared to depend upon the open or closed condition of the breathing pores, as well as upon peculiarities of the cell contents. Fumigation an hour or two after sundown, with the temperature as low as practicable, was found to give the best results. In each case the proper amount of gas to use and the length of exposure must be determined by experiment. It is impossible at present to give a general rule applicable to all plants in all stages of development. When the conditions are once determined they must be strictly followed to insure the greatest success. Methods of experimenting will be described in the latter part of this circular. The quantity of gas in each case is always given in terms of the potassium cyanide from which it is made, and on a basis of a cubic foot of space, as will be explained more in detail further on. The cyanide, as well as the gas made from it, is exceedingly poisonous, and both must be used with the greatest care.

CROPS AND PESTS ON WHICH THE GAS HAS BEEN SUCCESSFULLY USED.

Ferns.—For *Davallia mooreana* infested with a scale insect (*Chionaspis* sp.), 0.075 gram of 98 per cent potassium cyanide should be used for each cubic foot of space to be fumigated, not deducting the space occupied by the plants. Length of exposure, twenty minutes.

One hundred and fifty to two hundred plants with fronds in all stages of development have been thus treated two or three times each year for the past four years with no injury to the plants and almost complete destruction of the insect. They were treated fifty at a time in a fumigating box (fig. 4.), described later.

Adiantum cuneatum and *A. Ballii* have been tried on a small scale and were not injured by the treatment.

Coleus.—"Golden Bedder," "Verschaffeltii," "Shylock," and others. 24,000 plants in pots, badly infested with the "white-tailed" mealy bug (*Orthezia insignis*). The house contained 15,587 cubic feet of space. Treated at the rate of one-tenth of a gram of 98 per cent cyanide of potash per cubic foot of space for twenty minutes, one hour after dark. Orthezia all killed and plants not injured in the least. All

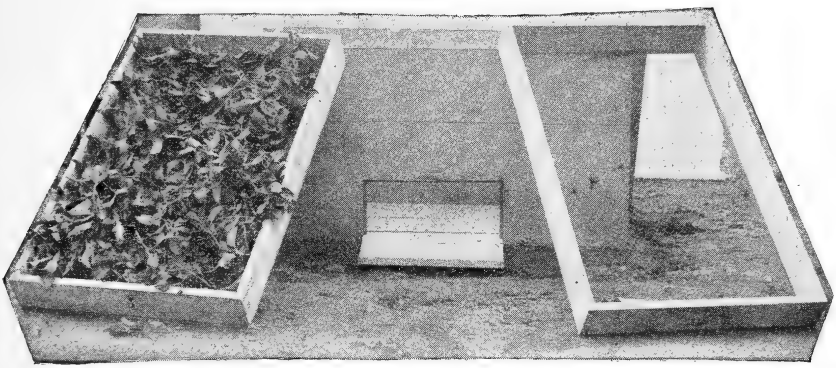

FIG. 4.—Fumigating box showing trays and coleus cuttings (from Woods and Dorsett).

other means of destroying the Orthezia had been tried without effect. Large numbers of the common mealy bug were also killed by this treatment; but it was not nearly so effective as for the "white-tailed" mealy bug. All coleus cuttings made by the United States Propagating Gardens for the past two years have been fumigated before being prepared for the cutting bed (see fig. 4).

Double English violets.—"Marie Louise," "Lady Campbell," and others. For plant-lice and general fumigation fifteen-hundredths of a gram of 98 per cent cyanide of potash for each cubic foot of space is required. The exposure, if made according to directions, will not hurt the plants in any stage of growth. The gas has been used on a large scale in fumigating violets for the past three years with the greatest success, only a few treatments during the season being required. Leaf-eating larvæ, slugs, millipedes, cutworms, etc., when exposed are killed as well as plant-lice. Red spiders, however, are not entirely eradicated by the treatment. The foliage of single violets like California and Princess of Wales are sometimes slightly injured by the stronger dose of gas. A weaker dose (one-tenth of a gram potassium cyanide per cubic foot) should be used when they are to be treated.

Other plants.—Other plants on which the gas has been tried on a small scale indicate that it may probably have quite a wide range of usefulness.[1]

Roses.—"Perle des jardins," "Mermet," and "Bride." The young growth on roses is particularly sensitive and has been more or less injured in all our experiments.

Carnations.—Scott, Garfield, Meteor, and McGowan will stand one-tenth of a gram of 98 per cent cyanide per cubic foot of space for 15 minutes without material injury. This will kill about 90 per cent of the plant-lice, but will not kill thrips. The use of the gas for carnations needs to be more carefully investigated before it is recommended. The same is true of chrysanthemums, on which it has been tried with only partial success, the young growth being very sensitive.

Grapes under glass.—The gas has been used with success in New Zealand [2] for mealy bugs (*Dactylopius adonidum* L.) at the rate of one-third of an ounce 98 per cent cyanide to 100 cubic feet. This is equivalent to nine-hundredths gram per cubic foot. The gas is liberated after dark and left in till next morning, when thorough ventilation is given. It largely escapes, however, during the night. The treatment is said not to injure the plants in the least.

Tomatoes.—Dr. Jabez Fisher, in "American Gardening" (Oct. 29, 1898), reports using the gas for "white fly" (*Aleyrodes* sp.) on tomatoes. The gas from one ounce of pure cyanide of potassium for each 1,000 cubic feet left in the house over night killed all the insects without injury to the plants. This method has not yet proved successful with us in any case, but it should nevertheless receive careful trial by other experimenters.

CUBIC CONTENTS OF THE HOUSE.[3]

In all cases where fumigation with this gas is to be followed it is necessary to first determine accurately the cubic contents of each house. The determination of the cubic contents of the house, while in itself a comparatively simple problem, has, in the eyes of many growers, difficulties which they are not willing to undertake. The cubic contents can be determined by a comparatively simple mathematical calculation, but perhaps the easiest way is by a method recently described by the writer in the Florists' Exchange [Vol. II, no. 5]. This method involves nothing more difficult than the mere counting of a number of squares, and from an examination of the accompanying illustration [fig. 5] the simplicity of the method will become apparent. Procure from a stationery store or art supply store some cross-section paper, such as represented in the figure. In this particular case squares of three sizes are shown, the largest being one-half inch, the next one-fourth inch, and the smallest one-sixteenth inch square. The one-fourth inch squares may represent feet. Now determine the dimensions of the house—that is, the length, width, height to ridge, and height on sides, and make a sketch as shown, each square or one-fourth inch representing 1 square foot. This particular house, it will be seen, is 18 feet (18 squares) wide, 12 feet to the ridge, 6½ feet high at the back, and 4½ feet high in front.

The ridge stands 5 feet from the back wall, as shown in the sketch. After the lines are drawn, simply count the squares inclosed, and the number of squares will be the number of square feet. The parts of squares, that is, where a line divides a square, can be easily determined by counting the smallest squares, or by the eye, and by adding these fractions of squares together the number of whole squares may be readily found. After the number of square feet is obtained it is only necessary

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[1] The gas has been used on the following plants at the rate of one-tenth gram of cyanide per cubic foot of space for twenty minutes without injury. Further experiment, however, is necessary before the treatment can be recommended for these: *Alocasia Macrorhiza variegata; Anthurium crystallinum; Areca lutescens; Aralia filicifolia; Adiantum cuneatum; Adiantum Ballii; Campylobotrys refulgens; Cissus discolor; Crotons* (in variety); *Cichorium intybus; Diffenbachia Lenmanii; Ficus elastica; Fuchsias* (in variety); *Jacaranda mimosæfolia; Marantas* (in variety); *Nymphæa candidissima,* and *odorata rosea; Pontederia crassipes; Pandanus veitchii; Phrynium variegatum; Phyllotænium Lindenii; Panax Victoriæ; Stenanthium Lindenii.*

[2] Fourth Report, Dept. of Agr., New Zealand. 1896. Pp. 141–143.

[3] The method described is quoted from B. T. Galloway's Book on Violet Culture.

to multiply this by the length of the house in feet and the result will be the cubic contents. For example, supposing the house in question is 100 feet long, it contains $150\frac{1}{2}$ squares or square feet, and $150\frac{1}{2}$ multiplied by 100 equals 15,050 cubic feet. The whole operation requires less time than it takes to describe it and will apply, of course, to a house of any shape or size. It may be added that if the cross-section

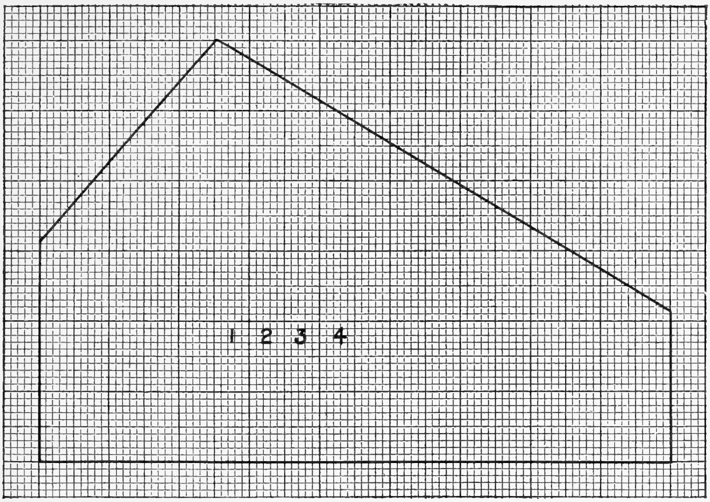

FIG. 5.—Diagram illustrating method of determining cubic contents of greenhouses (after Galloway).

paper can not be obtained readily the sections or squares can be laid off with a rule and lead pencil and practically the same results obtained. In any event, it is only necessary to get an accurate outline drawing of the section of the house, and by projecting this over squares as indicated the number of square feet in the section can be readily determined.

SELECTING A TIME TO FUMIGATE.

Care should be taken to select a night when the houses can be ventilated the required time without injury to the plants and when there is little or no wind.

PREPARATION OF THE HOUSE FOR FUMIGATION.

On account of the very poisonous nature of the gas, it is necessary to arrange a number of ventilators, the more the better, so that they can be easily opened from the outside. It would be very dangerous to enter the house while it contains the gas. All broken glass should be replaced and holes stopped up; a thoroughly wet piece of newspaper will close a crack effectually or take the place of a broken glass if necessary. It is best not to permit the gas to get into fire pits or engine rooms; these should be cut off from the space to be fumigated.

In case of a large range of houses opening into each other it is best to separate them into several sections, by tacking up building paper or oiled cloth, so that each section may be fumigated separately and at different times. The work may thus be done with greater ease and care, and with less danger to the plants. When all the larger cracks and openings have been stopped up, if the house is quite old or loose it is well to wet the roof on the outside just before fumigating. The water will fill the cracks between the glass and will assist in making the roof tight.

METHOD OF MAKING THE GAS.

The materials required are 98 per cent cyanide of potash, best secured in 5 or 10 pound cans at 35 to 40 cents a pound, and commercial sulphuric acid at 3 to 4 cents a pound.

For an ordinary house or frame, good vessels for liberating the gas are $1\frac{1}{2}$ or 2 gallon earthen jars of as small diameter as possible, so as to insure the immersion of the cyanide of potash when it is dropped into the acid. One jar should be used to about every 50 feet in length of such houses as described, in order that the gas may be quickly distributed when set free. When the jars are placed in position the next step is to arrange to lower the paper bags containing the desired amount of cyanide into the jars, from the outside. This is best done by passing a cord through a hook or screw-eye attached to the roof over each jar in such a manner that when the string or strings are loosened from the outside the bags of cyanide will be lowered into their respective jars, as shown in fig. 6. When the strings are ready, divide the amount of cyanide to be used into parts corresponding to the number of jars. Do each part up in a couple of thicknesses of ordinary newspaper and put in ordinary brown paper bags, and attach the bags to the strings, as shown in fig. 6. While the jars are empty test the arrangement to see if it works satisfactorily. After each bag

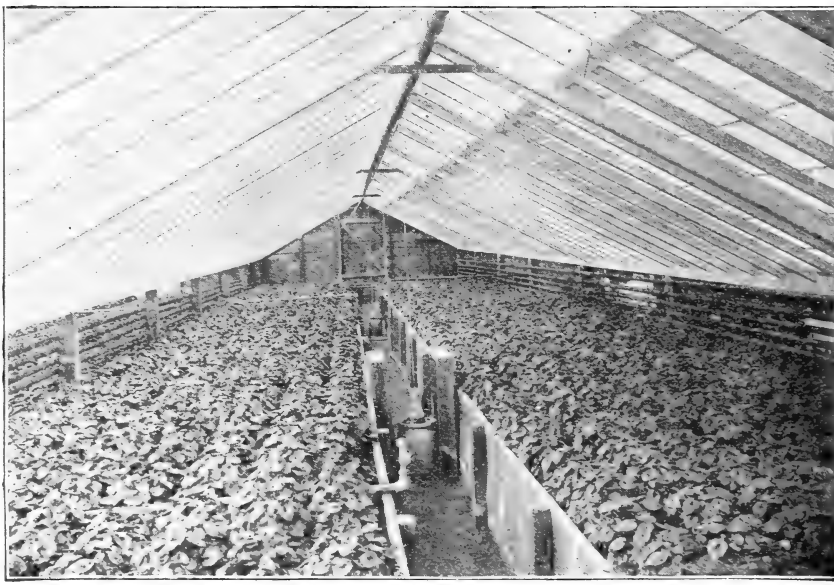

Fig. 6.—Violet house prepared for fumigation (from Woods & Dorsett).

is suspended in place, the other end of the string securely fastened where it can be reached from the outside, and the arrangement tested, move the suspended bags to one side, so they will be out of the way while putting the water and acid in the jars. When this is done, pour into each jar an amount of water about equal to the bulk of the potassium cyanide in the bag. Eight ounces of cyanide will require about half a pint of water. The sulphuric acid should then be poured in until steam rises from the water. This would require for a pint of water about a pint and a half of acid. It is not necessary, however, to measure the acid, as the evolution of steam indicates when the right amount has been poured in. Always put the water in first and then pour in the acid. As soon as this is done place the bags over their respective jars. In order to prevent injury to foliage in case it is very near the jars, it is a good plan to surround each jar by some protection. A section cut from a roll of building paper is effective. The paper naturally rolls into a tube and is very convenient for this purpose. The pieces may be laid together and tied when not in use, so that they will keep their shape. When all is ready, go out quickly, close the door, and carefully loosen the strings, allowing the bags to settle into the acid. The gas will very soon be given off and fill every portion of the house. It is colorless and smells and tastes like peach pits. A little of it is harmless, but too much will cause death. A small quantity will leak out of the house; avoid positions where it can be smelled. The time of exposure should be reckoned from the lowering of the cyanide into the jars. When the proper time has elapsed, varying for different plants, as previously stated, quickly open the ventilators from the outside, so that the gas can escape as rapidly as possible. It will all be gone from a large house, such as described in this circular, in half or three-quarters of an hour, and the ventilators can then be closed if necessary. Next morning the material left in the jars should be emptied into a hole and buried. It is nothing but sulphate of potash, sulphuric acid, and water, having a little hydrocyanic-acid gas in solution. The latter will soon disappear, and the sulphuric acid will unite with lime in the soil, forming gypsum.

FUMIGATING BOXES.

For the purpose of experimenting and where only a few hundred plants are to be treated, a tight box may be made of 30 to 50 cubic feet capacity. The box should be as nearly air-tight as possible, with a removable cover and a small door at the bottom for introducing the cyanide of potash into the bowl containing water and sulphuric acid, as shown in fig. 4.

The wire trays as shown in the same illustration are used in fumigating cuttings of coleus or other plants. When desired the trays can be removed and pot plants set in the box and given such fumigation as desired. To prevent injury to the plants they should be so set that the foliage does not come within 18 inches of the bowl near the small door. When the plants are arranged the top is put on securely and a little water is poured into the bowl, and then sulphuric acid is added till steam is formed. The necessary amount of cyanide wrapped in a small piece of newspaper is then dropped into the bowl and the little door quickly closed. When the desired length of time has elapsed take off the cover and open the door and retire, so as not to breathe the gas. In a few minutes the gas will have sufficiently escaped so that the plants may be taken out and others treated in the same way. Injury (if there is any) to the plants may not show for two or three days, so in the case of experimenting, conclusions should not be hastily drawn. The box may be used in the daytime if the work is done in a cool place. For experimental purposes and treating plants on a small scale, a small greenhouse containing 1,000 cubic feet, or less, is better than a box, as the results obtained with it are more reliable, and there is less danger of injury to the foliage.

CONDENSED DIRECTIONS.

(1) Carefully determine the cubic contents of the house and the amount of cyanide of potash to use.

(2) Make the house as tight as possible.

(3) Arrange so that the ventilators can be opened from the outside.

(4) Place the jars and strings in position.

(5) After dark attach the bags containing the cyanide to strings, as described, and find if they work correctly.

(6) Hang the bags to one side and put water and acid into the jars; arrange protection and put the bags in place again.

(7) When all is ready lower the bags into the jars by loosening the strings from outside.

(8) After the proper exposure open the ventilators from outside, leaving them open from thirty to forty-five minutes before entering the house.

(9) Next morning bury contents of the jars.

CAUTION.

It should be remembered that hydrocyanic-acid gas is one of the deadliest poisons known, fatal to human beings and plants as well as to insects.

Greenhouses which are within 50 to 75 feet of dwellings should not be fumigated unless the windows and doors of the latter on the side next to the greenhouse can be closed during the operation.

The bag containing the cyanide should not be permitted to drop into the jar until the operator has left the house.

It is essential that the exact proportion of cyanide be used at the rate designated for each cubic foot of space and that the exposure should not exceed the limit ascertained by experiments as appropriate to the plants to be fumigated. A greater strength of gas or a longer exposure than specified is apt to result in injury to the plants.

It is best to use this method at first experimentally on a small scale before attempting the fumigation of an entire greenhouse, and a preliminary test should always be made in case plants of a species or variety not previously fumigated are to be treated.

Concerning the possibility of hydrocyanic-acid gas forming a deposit upon any of the substances with which it might be brought in contact in its ordinary use as a fumigant, either in greenhouses or in buildings infested by indoor insects, Dr. H. W. Wiley, chemist of the Department of Agriculture, states that there is no possibility whatever of such a contingency, unless the gas comes in contact with some alkaline body, such as soda or potash, with which it would form a salt. The soluble cyanides are extremely poisonous, and if this gas were to act upon lye, or any similar alkaline body, a certain amount of cyanide would be produced. In a dry room, in the absence of alkaline bodies, there could not be any possible danger of a poisonous body being formed.

THE VIOLET SAWFLY.

(*Emphytus canadensis* Kby.)

RECENT INJURY.

October 19, 1897, Mr. Dorsett brought to this office specimens of the larvæ of this sawfly with the information that they were injuring violets in his greenhouses at Garrett Park, Md. He had experienced great trouble with this pest and stated that Mr. Joseph Markle, of Rhinebeck, N. Y., was similarly annoyed by its presence on greenhouse violets. Later Mr. W. G. Saltford, of Poughkeepsie, N. Y., sent specimens of the larvæ to this office, and Mr. B. T. Galloway, of this Department, also submitted for identification another lot of larvæ from Garrett Park, Md. From material received from Mr. Dorsett the adult was reared, and from the bred lot a number of observations on the development of the species were made and will be here recorded.

January 12, 1900, Dr. James Fletcher reported attack by the larvæ of this insect during the previous year in the extensive violet houses of Mr. J. H. Dunlop, of Toronto. He stated also that it was a common pest at Ottawa on pansies and some species of violet.

DESCRIPTION OF THE SPECIES.

The female sawfly may be recognized with the aid of the accompanying illustrations—figure 7, *a*, representing the insect with wings expanded and three times the natural size, figure 8, *e*, showing the same with wings folded and natural size, on a violet leaf—and Cresson's translation of Provancher's description (Tr. Am. Ent. Soc., Vol. VIII, p. 38):

"♀.—Length, 0.22 inch; black; head transverse, angular, as broad as the thorax, punctured, with a furrow on each side behind the ocelli; antennæ moderate; palpi, tegulæ, legs, with trochanters and tips of the coxæ, dull yellowish-white; posterior femora except base, tips of their tibiæ, with their tarsi, black or deep brown; abdomen entirely black, short and stout; wings hyaline, nervures brown, the costa and stigma deep brown."

The flies reared at Washington differ slightly from the above description, as did those reared by Dr. Dyar, in having the fore and middle tarsi darker toward the apex. Some of the veins and stigma are very dark brown and others are black.

Measurement of the material at hand gives an average of 12.5^{mm} wing expanse and 6.5^{mm} total length of body.

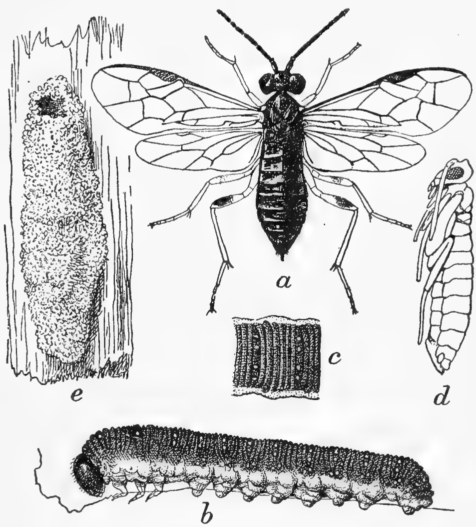

FIG. 7.—*Emphytus canadensis*—*a*, female sawfly; *b*, larva; *c*, abdominal segments of larva from above; *d*, pupa; *e*, cocoon—all except *c* four times enlarged (original).

THE EGG AND OVIPOSITION.

The individual fly which issued April 18 was placed in a jar with a potted violet plant, and was soon running about on the leaves with vibrating antennæ and active jaws and ligula, apparently feeding freely and making frequent attempts to insert her ovipositor in the leaves. This she was unable to accomplish with many of the older leaves, nearly all of the eggs found having been inserted in the tenderer leafage. Oviposition and the subsequent escape of the young larva from the place of deposit is not unlike that of the common pear slug, *Eriocampoides limacina* Retz., with the process reversed, the egg being inserted from the upper side of the leaf and the larva escaping on the under surface. The ovipositor is thrust through from above to the lower epidermis, which is left intact, the nidus thus formed with its contained egg appearing as a blister on the lower surface.

The egg.—The egg is soft and delicate, and when dissected out appears to be rather variable in shape, but the normal outline seems to be elliptical oval, those deposited on the outer surface being inclined to reniform and narrowed at one end. It is somewhat flattened on its lower surface. Its length is nearly twice the width, the color limpid whitish, surface moderately polished, with no apparent sculpture. Eggs that were measured two or three days after deposition were about 0.7^{mm} in length and a little over half that in width; some, however, were much shorter in proportion to the width. The membrane of the epidermis protecting the egg on the lower surface of the leaf, although thin, does not permit a good view of the egg within. There is little doubt, however, that the eggs of this species, like those of other sawflies of similar habits, increase in size soon after they are laid, by the absorption of nutriment through their membranous skins from the vegetable juices which surround them.

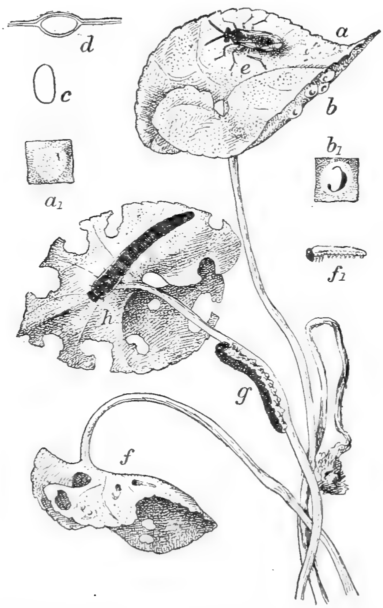

FIG. 8.—*Emphytus canadensis*—Violet leaves showing nature of attack and the following: *a*, egg cells on upper surface of leaf; a_1, an egg cell magnified; *b*, cells after escape of larvæ; b_1, one of same magnified; *c*, egg from above; *d*, egg *in situ* from side; *e*, female at rest on leaf; *f*, newly hatched larvæ on leaf; f_1, same enlarged; *g*, active stage of larva; *h*, full-grown larva feeding. *a, b, e, f, g, h*, natural size; a_1, b_1, *c*, *d*, f_1, more enlarged (original).

Eggs are laid singly, but it could not be ascertained whether only one or two are deposited normally on a leaf at one time, although many are often found on a single leaf. These may be deposited by different females or by the same individual on different visits.

In figure 8 the egg cells with the slits made by the female in oviposition are shown on the upper surface of the leaf at *a*, natural size, and much enlarged at a^1. The under surface of the cells on the lower surface of the leaf are shown natural size at *b*, and enlarged at b^1. These illustrate the method of escape of the young larva from the egg The egg is shown much enlarged in outline at *c* and in section *in sit* at *d*.

DESCRIPTIONS OF THE LARVA AND PUPA.

The loss of the material under observation through failure of the eggs to hatch prevented detailed descriptions of the various stages.

The newly-hatched larva.—The larva when first hatched presents the appearance shown in figure 8. At *f* is shown at the right a larva natural size crawling on a leaf, and, at the left, one in the curled-up position which it assumes when disturbed. At f^1 it is shown, lateral view, enlarged; the color is light slaty, and the head, it will be seen, is proportionately larger and the legs longer than in its more mature stage; its length is about 2.5^{mm}. At g of the same figure, the penultimate stage, which appears to be the most active, is shown from the side resting quietly on a leaf stalk.

The full-grown larva.—A mature larva is illustrated at h of figure 8, feeding upon the under surface of an injured violet leaf. It is here represented in its largest state. After ceasing to feed it begins to contract, and assumes more of the appearance of figure 7, *b*, which represents the larva in its most characteristic form. The general color of the larva, as it approaches maturity, is dark dull olive or slate above with a bluish tinge. It is rather conspicuously marked with minute white tubercular spots, arranged in transverse rows of four dorsal and two lateral on each side, as shown in the illustrations, but these disappear in the contracted final stage and can hardly be detected in preserved specimens. The ventral surface is pale-gray, also with a bluish tinge.

The length of the mature larva as it lies extended on a leaf just before the last molt previous to the final prepupal stage is about 15^{mm}. When fully extended it measures 18^{mm}, and in its contracted state just prior to pupation it is only about 8.5^{mm} in length.

A larva that came under observation May 6 will well illustrate the changes of color just prior to and after molting. Immediately before this molt, which occurred at 11.15 a. m., the general color of the dorsal surface had become very dark, nearly black; a few minutes after molting it was very light, nearly uniform leaden gray, the ventral surface but slightly lighter, the head being now light pearl gray, with the black eyes showing prominently. When next seen, about five hours later, the general color had turned to glaucous blue. Next morning, when this larva was again examined, the color had not changed appreciably, except that it was a little darker and duller. The color undergoes but little change from this time till the contracted stage is assumed.

Dr. Dyar's technical description of the mature larva is appended:

Head rounded, normal, dull black, slightly slaty; eye and mouth black, the sutures around clypeus pale; some short pale hairs; width, 1.4^{mm}. Body of nearly equal width, slightly largest at anterior end; thoracic feet small, abdominal ones well developed, present on joints 6 to 13 (22 feet). Segments 6-annulate, rather sharply so, and about as distinct as the segmental incisures. Color slaty black dorsally, not shining, smooth, the dorsal vessel showing darker; below the spiracles olive gray. Thoracic feet pale. On each segment, on second annulet, a transverse row of minute white points, with a second one on first annulet stigmatally; a few less conspicuous ones on subventral ridge.

Final stage.—Head blackish above, pale below; eye in a black spot; mouth brown; antennæ and palpi pointed, minutely brown-ringed; width, 1.4^{mm}. Body entirely dark olive-gray, rather bluish, slaty, the segments neatly 6-annulate, not shining, evenly minutely granular. Feet transparent, spiracles in paler areas. No white points or tubercles.

The pupa.—The pupa is sufficiently shown at figure 7, *d*. It measures about 7.5^{mm} in length and is nearly white in color, the eyes turning darker as it approaches the time for final transformation.

The change to pupa in the confinement of our rearing jars took place in the pith of sunflower stems placed there for the purpose. A cocoon is shown at figure 7, *e*.

DISTRIBUTION.

Little can at present be said of the distribution of this species. Like the majority of sawflies, it is most abundant in the North, but has undoubtedly been disseminated by commerce in shipments of violets and pansies from one place to another. Its occurrence has not been noted out-of-doors in the vicinity of the District of Columbia to the writer's knowledge, and it would therefore seem probable that it is a comparatively recent introduction, if we may use the term in speaking of a native species being established in new localities. The known distribution embraces Plattsburg, Rhinebeck, and Poughkeepsie, N. Y.; Garrett Park, Md., Toronto and Ottawa, Canada.

It is not a little singular that a northern species of insect as this seems certainly to be should become acclimatized in greenhouses as far south as the District, since it is a well-established fact that a very large proportion of the insects that lead an indoor life are of tropical origin.

HISTORY OF THE SPECIES.

This species was first described in the year 1878 by the Abbé L. Provancher as *Emphytus pallipes*, a name preoccupied by Spinola for a European species of this genus. Kirby's description of *E. canadensis* appeared in 1882 (List Hymen. Brit. Mus., Vol. I, p. 204). There are several accounts bearing on the biology of this species. One is by Dr. H. G. Dyar, of the U. S. National Museum, published in 1894 in the Canadian Entomologist, in which he describes the larva in the last two stages and gives some brief notes on its habits and occurrence on cultivated pansies at Plattsburg, N. Y. In the Florists' Exchange for August 7, 1897, Mr. B. T. Galloway published a short article on this insect under the title of "Injury to Violet plants," the species being identified as "an undetermined sawfly." Brief mention is made of the larva and its manner of work, the article being devoted mainly to methods of control. The nature of injury by the larva is illustrated. This article was republished in American Gardening for August 21 of the same year. In Fauna Ottawaensis Hymenoptera Phytophagica, an article by Mr. W. H. Harrington, published in volume VII, Ottawa Naturalist, and consisting of a list of the Phytophagic Hymenoptera taken in the neighborhood of Ottawa, Canada, the following appears concerning this species: "Eight females. May 8, June 9. Violets and pansies."

In his annual report as Dominion entomologist of Canada for 1898 (p. 169), Dr. Fletcher briefly mentions considerable injury that was done in beds of violets at Toronto, Ontario, reported to him by Mr. J. Dunlop, a florist of that city. He states that complaints of this false caterpillar have occasionally been noticed in the past to foliage of pansies (*Viola tricolor*, varieties), but that no great injury had previously been recorded.

Brief notice of Mr. Pratt's rearing of this species in 1899 from violets received from Rhinebeck, N. Y., was recorded in the proceedings of the Entomological Society of Washington (Vol. IV, p. 302).

During the fall of 1899 Mr. Galloway published in his book entitled "Commercial Violet Culture" a short account of this insect, without, however, mentioning the species scientifically.

The same year Dr. Fletcher again mentioned this species somewhat briefly in connection with injury to pansies and violets at Toronto, Canada (Transactions Royal Society of Canada, Vol. V, second series, 1899–1900, p. 228).

BIBLIOGRAPHICAL LIST.

The bibliography of this species is moderately extensive. A list of articles arranged in order of publication is appended for convenience of reference:

L. Provancher, Naturaliste Canadien, vol. X, p. 66, 1878.
E. T. Cresson, Trans. Amer. Entom. Soc., vol. VIII, p. 38, 1880.
W. F. Kirby, List Hymen. Brit. Mus., vol. L, p. 204, n. 49, 1882.
L. Provancher, Faun. Entom. Canada. Hymen., p. 192, 1883.
W. H. Harrington, Ottawa Naturalist, vol. VII, p. 122, Nov., 1893.
H. G. Dyar, Canadian Entomologist, vol. XXVI, p. 185–6, 1894.
B. T. Galloway, Florists' Exchange, vol. IX, p. 720, Aug. 7, 1897; Am. Gardening, vol. XVIII, p. 585, Aug. 21, 1897.
James Fletcher, Rept. Entom. & Bot. Expt. Farms Dom. Canada for 1898, p. 169, 1899.
[F. C. Pratt]. Proc. Entom. Soc. Wash., vol. IV, p. 302, 1899.
B. T. Galloway, Commercial Violet Culture, New York, 1899.
James Fletcher, Trans. Roy. Soc. Canada, vol. V, 2nd ser., 1899–'00, p. 228.

MANNER OF WORK—HABITS OF THE LARVÆ.

The larvæ, while very young, feed on all parts of a leaf by cutting out little holes from the lower surface, and later, when more mature, eating along the edge of the leaf. Occasionally, at least, they nibble the flower stalk and destroy the flower, as shown in the illustration (fig. 8). An idea of their injuriousness may be had when it is said that the potted plant on which the larvæ were first kept began to wither and die during the third week of April, necessitating the removal of as many large larvæ as could be found to prevent the entire destruction of the plant. The second plant was injured in like manner, and the next two or three colonies completely stripped the first plant of leaves. A third plant was also defoliated. In a few instances larvæ attacked the stems, in one case eating them off nearly to the roots.

Injury by the larger larvæ is much worse, the younger ones appearing to confine attack to cutting small holes here and there in the leaf.

The punctures made by the females in oviposition and the holes made by the larvæ in escaping from the nidus in the leaf also cause injury, particularly when the eggs are deposited in a bunch, as shown in the illustration (fig. 8, *a*, *b*). The tip of the leaf withered and nearly died as a result of this attack.

The younger larvæ have the habit of resting during the daytime, usually in a curved position like the letter J. When disturbed even slightly, they promptly curl up spirally, after the manner of many Tenthredinids, and drop from the plants to the earth below. All of the youngest larvæ that have come under observation rest thus on the lower surface of the leaves, and are never curled spirally when upon the leaf. The more mature larvæ may be found during the daytime extended lengthwise on the leaves and more particularly along the stems near the ground, but sometimes in other positions, with their heads usually pointed upward but often downward. In this position they are afforded sufficient concealment on fresh plants to readily escape notice. On such plants, except when occurring in great numbers, they are eminently successful in eluding observation at nearly any time. For example, only one or two of the nearly grown larvæ in a lot of upward of a dozen on a small plant were to be seen at one time, the others being securely hidden from view.

Of the first two broods reared—using the word not in the same sense as generation, but as the progeny of one female—it was quite noticeable that the larvæ did not in any case desert the plant on which they had hatched until they were mature or very nearly so.

Injury is most apparent late in May and early in June, and almost entirely to plants grown under glass, being particularly noticeable, upon plants growing in shaded locations, such as are to be found in greenhouses, under gutters, where the plants grow ranker. In some cases injury appears to be confined to such locations. In the greenhouse, according to Mr. Galloway, "seldom more than two of the worms are found at one time on the same plant. Two, however, are enough, as they will riddle a half-grown plant in a week."

Mr. Dorsett's experience with this species goes to show that it is quite persistent in the greenhouse, and difficult to dislodge after it has obtained a foothold, in this respect ranking with several other species, such as the "red spider" and the aphides, which are not, like the sawfly, limited to any one genus of host plants. In spite of frequent and systematic fumigation and careful watchfulness in his greenhouse, this species continues to be seen, although in small numbers, at intervals every year. This is the more remarkable in that the species has practically become an indoor one so far as we know, and the individuals found from time to time are therefore evidently survivors of the original lot first introduced in a previous year.

The length of life of the mature sawfly is only a matter of three or four days. It was noticed of the adults that were transferred to new quarters for oviposition, when first issued, that they died in this time. One that was found just casting off its last pupal skin June 10 was isolated on a potted violet on the 11th, was observed living as late as noon of June 13, and was found dead and dry on the morning of the 15th. It had evidently lived an active life of only three or four days.

PARTHENOGENESIS.

The material received in October, 1897, was taken in charge by Mr. Pratt and confined with potted violets, surrounded by a glass cylinder, resting upon a base containing sand, which was kept moderately moist, as the plants did not require a very great degree of moisture. Upon this sand there was placed a stem of sunflower, containing pith, and in this the larvæ constructed their cocoons. The first adult was observed March 17, 1898, its appearance being nearly coincident with the blooming of its host plant; a second and third appeared about April 7, a fourth April 18, and a fifth was found May 2. All of the imagoes reared were females.

April 7 the writer noticed young sawfly larvæ feeding on the leaves of the plants used in these observations. This was prior to the appearance of any except the first issuing adult, and is proof conclusive of parthenogenesis in this species—a not unusual occurrence in Tenthredinidæ, but more commonly met with in certain other families of Hymenoptera, and particularly well known in Cynipidæ.[1]

April 16 at least two new broods of the larvæ were observed, the progeny of the females that were found dead April 9, and yet another brood was obtained from the female which issued late in April, furnishing still further evidence of parthenogenesis.

All of the flies reared in May and June were females. A portion were placed with two pots of violets, but not carefully watched, as it was not deemed necessary to do so with this generation, it being the intention merely to note from the time of first egg-laying to the issuance of the first fly of the next generation, and then to follow this last closely, to obtain all stages of the midsummer generation. Only a few larvæ hatched, and it was then found that the plants were dying from

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[1] Parthenogenesis in the Tenthredinid genus Emphytus has been recognized by the distinguished zoologist, C. Th. E. von Siebold. In Entomologische Nachrichten (Vol. X, p. 95), published in 1884, he records the fact that eggs laid by virgin females produced males in the European species *Emphytus cinctus* L. and *E. viennensis* Schr.

"red spider" attack. It is almost certain that this same red spider had killed the sawfly eggs or at least prevented their development.

DEVELOPMENT.

The first of the larval offspring of the female found March 17 attained mature growth and deserted the plant on which it had fed May 3. In the absence of more accurate information we may assume that this female issued about March 14, and that eggs were deposited during the next three days. It may be assumed also that the egg stage was at this season about eighteen days, which would leave an active larval period of about four and a half weeks.

From eggs that were deposited by a fly which was confined alone with a violet plant April 19, the first larva hatched May 1, giving as the duration of the egg state for this period, which was colder than normal, twelve days.

From May 4 until about the 10th or later the other larvæ of this brood, about a dozen in number, deserted the plant and crawled about on the glass cylinder confining them.

May 25 the first fly of this brood was found to have issued, having passed the entire cycle from egg to imago in about ten weeks.

The first larval molts of the first spring generation were not observed. A number of mature larvæ were isolated and observations made from the time of the penultimate molt to the issuance of the adult.

No. 1 molted April 21 and afterwards, and transformed to pupa May 25.

No. 2 molted April 22, also afterwards, and transformed to pupa May 26.

Nos. 3 and 4 molted May 10, and had assumed the contracted form by May 21. May 25 both transformed to pupa, and to imago May 31.

No. 5 molted May 6, began May 9 to bore into the pith of a stem supplied for the purpose of pupation, and in the course of an hour had obtained entrance and closed the aperture with the comminuted bits of pith produced by its boring. May 14 a portion of pith was removed that further transformation might be observed. Pupation ensued May 25 and the adult appeared June 1. The last fly observed issued June 11.

These periods, if so we may term them for present convenience, are of course variable according to atmospheric conditions—heat or cold, humidity or dryness—and are probably also subject to individual variation in the larval stage. Approximately, we may say that the penultimate larval molt in the first spring brood takes place about five weeks from the time of pupation, the final larval molt occurring about eighteen or twenty days later than this. The duration of the final contracted larval stage could not definitely be determined, as it is gradual and hence it is difficult, if not impossible, to determine where the penultimate larval stage ends and the final stage begins. Of this, however, we are certain, that there is an inactive period, or at least what we may consider such, although neither larva nor pupa is truly quiescent, of at least two weeks during which the larva remains in its pupal cell.

The entire cycle from the date of laying of the eggs to the issuance of the first adult was between eight and ten weeks.

From the above data the approximate life cycle for the first spring generation may be deduced as follows:

	Days.
Egg period, from laying to hatching	12–18
Active, feeding stage of larva	24–31
Inactive or nonfeeding larval stage	14
Pupal stage	6– 7
Entire life cycle	56–70

NATURAL ENEMIES.

As only a single lot of this species was used in rearing, no parasites were developed. In one instance, however, an adult fly, not yet mature, was found to have succumbed to mites and it has already been stated that eggs were destroyed by red spiders. No larvæ died as far as noticed, although the first generation was exposed to a temperature which was below freezing out-of-doors and not much higher in the rearing jar, which stood near an open window in an unheated room.

REMEDIES.

The violet sawfly is amenable to the same remedies that have been found most useful against the greenhouse leaf-tyer in greenhouses. Hand-picking of the larvæ has been employed with some success by Mr. Dorsett and others, but is too slow to be entirely satisfactory and the larvæ are difficult to discover. Extract of tobacco diluted at the rate of 1 part extract to 30 parts of water was also effective when applied as a spray, but florists are opposed to the use of tobacco on violets owing to its tendency to weaken the plants and to bring on the condition known as "spot." The main reliance at present is in the hydrocyanic-acid-gas treatment, as described in the foregoing article on the greenhouse leaf-tyer.

THE TWO-SPOTTED RED SPIDER.

(*Tetranychus bimaculatus* Harvey.)

Perhaps the most troublesome of greenhouse pests, everything considered, are minute reddish spider-like creatures known popularly as "red spiders." They often do very considerable damage in flower and vegetable gardens, but in greenhouses they attain their greatest destructiveness, and are particularly injurious to violets and roses, as well as to a great variety of other plants.

Until within the year 1900 the common red spider most often occurring in greenhouses was technically designated as *Tetranychus telarius* Linn., a name which has been rather indiscriminately applied to all species of red spiders, both in America and abroad.

Red spiders are not true insects, in fact not even spiders, but are, more properly speaking, spinning mites. Since, however, they are almost universally known as red spiders, this term is retained for present purposes.

As the word "mite" indicates, these insects are extremely minute, and when they occur in ordinary numbers are not apt to be noticed unless leaves are carefully scrutinized. Attention, however, is certain to be drawn to them when they become excessively numerous, as frequently happens in neglected greenhouses or out of doors during droughts in summer.

Red spiders spin threads, but do not, like true spiders, utilize them for climbing or descending from a height. The threads spun are extremely fine and scarcely perceptible to the unaided eye, but a web of threads is frequently so dense as to form a tissue plainly visible at a little distance. Webs are usually constructed upon the lower sides of leaves, and attached here and there to projecting hairs, veins, or the edges of the leaves. Within the webs thus formed the mites feed in their different stages, and the eggs are laid from which the young develop.

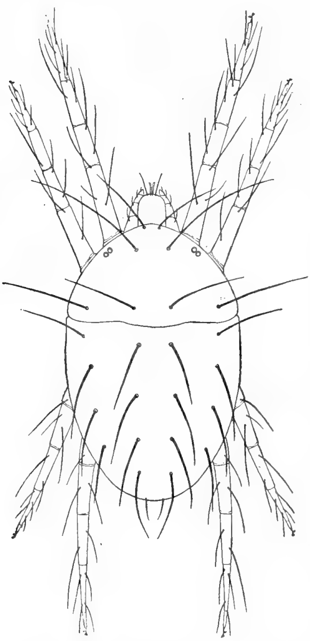

Fig. 9.—*Tetranychus bimaculatus:* adult—enlarged (from Banks).

Fig. 10.—*Tetranychus bimaculatus:* palpus—enlarged (from Banks).

Fig. 11.—*Tetranychus bimaculatus:* claws—enlarged (from Banks).

The general appearance of the red spider under consideration, which is now known as *Tetranychus bimaculatus* Harv. as it looked under a microscope, is well shown in figure 9. At figure 10 a greatly enlarged palpus of the same species is illustrated, and figure 11 shows the claws similarly enlarged.

The length of full-grown individuals, including the palpus, is from 0.4 to 0.6 ^{mm} and the width 0.25 to 0.30 ^{mm}, the thickness being 0.17

to 0.20^{mm}. The form is broadly oval, the width greatest in the anterior third of the body, back of the eyes, where the sides are somewhat distended. The general color of the adults is reddish, usually more or less tinged with yellowish or orange, and most specimens have a dark spot on each side, due to the food contents of the body, from which the scientific name *bimaculatus* (two-spotted) has been derived.

Careful study of different individuals as they occur on garden vegetables and horticultural and other plants grown out of doors with those taken in greenhouses shows no appreciable differences. According to Mr. Banks, however, specimens taken in Florida on Datura and at Washington, D. C., on violets are red, while those from Orono, Me., and those from the District of Columbia on squash and peaches, and those on rose from Idaho, are greenish with more or less dark markings.

The eggs are extremely minute, spherical, of variable diameter, glassy, and are scattered and loosely attached about the webs.

The young are of somewhat similar appearance to the adults, but differ in having only three pairs of legs.

DISTRIBUTION.

If, as seems probable, *Tetranychus cucumeris* or some other species described by Boisduval (Entom. Horticole) is identical with the present species of red spider, it is quite likely that it is of foreign origin and introduced into the United States, which is true of a very large proportion of greenhouse and other indoor insects.

The two-spotted red spider is well distributed through the eastern United States, and has been identified as occurring in localities as far west as Idaho. A list of localities from which the species has been reported includes Orono, Me.; Ithaca and New York City, N. Y.; Westgrove, Pa.; Washington, D. C.; Tremont, Pekin, and Bloomington, Ill.; Punta Gorda, Key Largo, Galloway, and Eustis, Fla.; Charleston, S. C.; Auburn, Ala.; and Weiser, Idaho.

RECENT INJURIES.

During the past two years we have received complaints of this species from various sources, as follows:

June 9, 1899, from Mr. H. M. Simons, who reported its occurrence on snap beans grown at Charleston, S. C. The species was stated to have literally overrun and totally destroyed the beans where discovered. It had not been seen in previous years, and it was noticed that the season had been very dry.

July 6 the occurrence of this red spider was reported by Mr. F. S. Earle on cowpea and beans at Auburn, Ala.

May 8, 1900, it was concerned in injury to raspberry at Bloomington, Ill., and reported to this office by Mr. J. L. Lampe, jr.

August 2, 1900, its occurrence on *Apios tuberosa* was reported by the late Thomas A. Williams, of this Department.

Violets and carnations were seriously injured during the last two years in the District of Columbia, and we received in a letter dated March 19, 1901, information concerning general destructiveness by this species to strawberry in the vicinity to Galloway, Polk County, Fla. Our correspondent, Mr. E. G. Gardner, stated that the mites were always found on the underside of the leaves.

IDENTITY OF THE SPECIES; LITERATURE.

The subject of the specific identifications of the different species of red spiders which occur in this country, of which there are 11 distinct forms described, together with the characteristics which distinguish them, and other information of more or less technical import, has been already made public in a paper entitled "The Red Spiders of the United States," by Mr. Nathan Banks, published on pages 65–77 of Technical Series No. 8 of this Division.

Tetranychus bimaculatus was first described by the late Prof. F. L. Harvey in 1893 (Annual Report Maine State College Agr. Exp. Station, Part IV, pp. 133–144, pl. 3). This account includes valuable notes on the insect's habits and injuries, a tabulated list of host plants, extracts from correspondence, and a consideration of remedies, besides technical descriptions of the different stages of the species.

In Galloway's Commercial Violet Culture, already quoted, considerable space is devoted to a consideration of this specise, mentioned as "red spider" (pp. 190–198), particular attention being given to remedial treatment based upon years of experience with it as it occurs on violets grown under glass.

The above-mentioned publications have been freely used in the preparation of the present article.

The species has been treated from the standpoint of an enemy of sugar beets, with brief mention of its occurrence on hemp near Tremont and Pekin, Ill., in 1899 and 1900, on pages 406 and 407 of Bulletin No. 60 of the University of Illinois Agricultural Experiment Station, by Messrs. Forbes and Hart.

FOOD PLANTS AND NATURE OF INJURY.

The two-spotted red spider is inclined to be omnivorous, attacking a wide range of both glabrous and hirsute plants belonging to several families. It is present in greenhouses throughout the year, and appears to be able at all times to be destructive if permitted to propagate. Few plants are, in fact, free from the attack of this red spider, and it is present in most greenhouses. When only a few mites are present, the plants seldom show any external evidences of injury, but as they increase in number the leaves gradually turn paler and yellowish in color and become stunted, and soon the whole plant succumbs unless the proper remedies are applied. Cuttings or young rooted plants are particularly subject to serious injury, and this is especially true in the spring. At this time the mites multiply rapidly, and unless plants are carefully watched they are apt to become so badly infested that it is only with extreme difficulty that they can be restored to their normal growing condition.

The mites injure the plants by suction, and when they occur in numbers, which they almost assuredly will do when plants are neglected, the vitality of the plants is slowly but surely reduced by the loss of their juices, and in time all of their functions are more or less deranged.

In cases of severe attack, millions of red spiders can be found upon the foliage of plants, and the webs, which are rarely observable at ordinary times, sometimes stretch from plant to plant, and the mites may be seen passing rapidly over them and congregating in swarms.

The following list of food plants has been compiled from Professor Harvey's article previously mentioned (l. c., p. 142): Clematis, mignonette, pink, Indian mallow (*Abutilon* spp.), Pelargonium, Canary bird (*Tropæolium peregrinum*), beans, rose, apricot, Cuphea, Godelia, Fuchsia, Passiflora, cucumber, muskmelon, Manettia, Bouvardia, feverfew, Mimulus, slipper flower (*Calceolaria* spp.), Thunbergia, verbena, sage, heliotrope, cypress-vine, moon-flower, morning glory, tomato, pepino (*Solanum muricatum*), eggplant, pepper, wedding bell (*Brugmansia arborea*), castor oil plant, hop, calla, Boston smilax, and Easter lily.

Violets and roses are particularly troubled by this species of red spider, more especially, as might readily be inferred from what has already been said, when these plants are grown under glass. Peaches have been injured by the curling of their leaves; squash, corn, cowpea, raspberry, *Apios tuberosa*, strawberry, beets, hemp, and watermelon have also been reported to be attacked.

REMEDIES.

Red spiders are resistant to fumigation either with tobacco or hydrocyanic-acid gas, and only a portion of these creatures are usually killed by the ordinary use of the gas in greenhouses. They are stupefied for a time, but eventually recover. They are, however, extremely sensitive to sulphur, applied either dry or as a wash or in connection with other poisons, and to soap.

Flowers of sulphur, mixed with water at the rate of an ounce to a gallon and sprayed over infested plants, is of great value in the eradication of this pest; or the sulphur may be combined with a strong soapsuds. For the application of this spray a force pump with spraying nozzle is of course a necessity.

Kerosene emulsion and whale-oil and other soap solutions are also valuable, and the addition of the sulphur increases their effectiveness; but these washes are too strong for some plants and are apt to injure them.

For the particular red spider in question, as it occurs in greenhouses, particularly on plants that are liable to injury by the use of sulphur, such as violets, no other remedy is used by florists generally than frequent syringing or spraying with water or with a solution of neutral soap. Both have been extensively used by Mr. Galloway in growing violets, from whose experience the following instructions have been gathered:

Neutral soaps, such as castile soaps, are particularly valuable for use upon cuttings affected with red spider, and the best results have been obtained in using such at the rate of a 5-cent cake to 6 or 7 gallons of water. The soap is shaved with a small plane, dissolved in about a gallon of hot water, and then sufficient cold water is added to make the quantity desired. Five gallons are sufficient for the treatment of three or four cuttings of violets, and other plants are in proportion. It is customary to allow the soap to remain on the plants two or three hours, and then thoroughly syringe with clear water, repeating this treatment two or three times until the spiders and their eggs have been destroyed. Used in this way, the soap has little if any deleterious effect upon most greenhouse plants.

It is unsafe to use strong soaps, such as potash, whale-oil, or fish-oil soaps, as they are apt to injure delicate plants and are of no more value as insecticides than those of a neutral nature.

Tobacco water is of some use for the same purpose, but can not be recommended for violets owing to the tendency which tobacco has to weaken the foliage and induce "spot."

Spraying with water is usually practiced from two to three times a week during the growing season, and by a little practice and experiment with a fine spray nozzle or tip the operator will soon be able to ascertain the proper degree of force to use. A pressure of about 25 pounds has proved most effective against this red spider. Care should be exercised to wash off the spiders and at the same time not to drench the beds. When it is necessary to spray during the winter time work should be done on a bright day in order that the plants may dry off in a few hours.

Spraying apparatus.—For several years the want has been felt by florists of a spraying apparatus that would be perfectly satisfactory for use in greenhouses, and that could be purchased at a moderate price. Such a sprayer has been devised by Mr. Galloway, and the illustration here presented (fig. 12) shows its general appearance. It will be seen that it is an ordinary hand syringe fitted with a Vermorel nozzle and provided with a separate intake attachment.

To change the syringe to a sprayer a cap (fig. 13, *c*) with a larger opening is put on in place of the usual one, and into it is screwed the Vermorel nozzle. The nozzle proper (fig. 13, *n*) necessarily has a very small orifice, and to fill the syringe through this would require too much time; hence a larger opening is made (fig. 13, *o*), and into this a ball valve is fitted (fig. 13, *b*). This latter is so arranged that when the handle of the syringe is drawn up the liquid is drawn in through the opening, and when forced down the ball valve closes the intake and the liquid issues from the nozzle in the form of a mist-like spray.

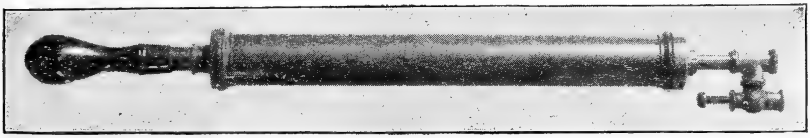

FIG. 12.—Hand sprayer, complete (from Galloway).

This syringe, with its attachments, will be found valuable also for whitewashing benches, shading glass, and other purposes. The syringe under consideration was devised for the application of fungicides, but it may be used for insecticides also and for the application of water to plants; but for the syringing of plants with water, where this is

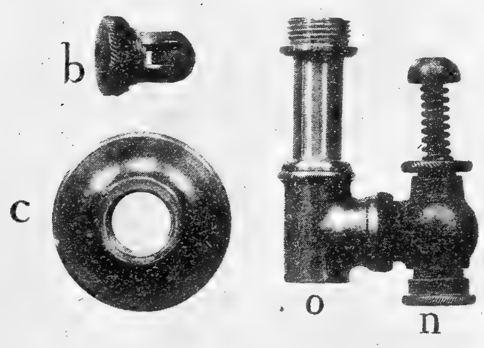

FIG. 13.—Parts of hand sprayer: *c*, cap; *n*, nozzle; *o*, opening closed by ball valve; *b*, ball valve (from Galloway).

practiced on a large scale, still another apparatus has been devised in the shape of a tip and nozzle of the form illustrated in figure 14. The nozzle consists of a casting turned to the desired length and flattened at the end, as shown. Through the flattened end a narrow slit is made, and it is important that the slit or opening be absolutely true throughout, so that the water, when it issues, will be broken up into streams. It will sometimes be found necessary to file the tips as they come from the factory to produce the desired results.

The spray tip proper is attached to a brass fitting, which in turn screws onto the end of a three-quarter-inch hose. The apparatus is very effective for spraying roses, as it readily serves to keep the leaves in a thoroughly healthy condition, and at the same time wets the beds but little. It is also very useful for violets, as with a pressure of 35 to 40 pounds the leaves of the plant can be readily turned over and thoroughly washed without soaking the crowns and the bed. In spraying some plants, particularly violets, it has been found advantageous to use a lance 18 inches long, made of a piece of one-half-inch brass pipe. This increases the reach, and enables the operator to place the water to better advantage on plants which under ordinary

FIG. 14.—Tip and greenhouse nozzle, complete (from Galloway).

conditions would be beyond arm's length. The apparatus can be made for 50 cents, and will be found a useful instrument wherever there is sufficient water pressure to insure a proper amount of force. (Circ. 17, Division of Vegetable Physiology and Pathology.)

THE BLACK OR BROWN APHIS OF VIOLETS.

(*Rhopalosiphum violæ* Perg.)

Until within five or six years from the present time one of the most troublesome insects upon greenhouse violets in the vicinity of the District of Columbia, as well as elsewhere, was a plant-louse known to florists as the "green fly" or "green aphis." Some time in the spring of

VIOLETS SHOWING INJURY BY PLANT-LICE.

1893 (or '4) Messrs. Galloway and Dorsett, at that time jointly concerned in the propagation of violets at Garrett Park, Md., noticed for the first time a darker species of plant-louse in their greenhouses, which in time practically displaced the other form and has become the most injurious violet pest of this vicinity and in other localities where it has been introduced. The matter was not immediately brought to the attention of any specialist in the Aphididæ and the species was not identified until recently, even generically. What is with little doubt the same insect is now known to be widely distributed in our violet-growing regions, being generally recognized by the trade under the rather inappropriate name of "black aphis" or "black fly," by which cognomens it has received mention in recent years in various floral journals. Regarding its rank as a pest, Mr. George Saltford, a prominent violet grower of Rhinebeck, N. Y., says: "It is the greatest scourge of the violet grower to-day." (The Florists' Exchange for December 10, 1898.)

NATURE OF INJURY.

These plant-lice are to be found in greatest numbers at the crown of the violet plant, in the petioles and on the under side of the leaves, and they accomplish considerable injury by entering the young opening buds and inserting their haustella, or sucking tubes, through the overlapping petals. When the petals unfold they are seen to be distorted and bleached where they have been injured, these spots showing greenish-white, and in some cases almost pure white. The flowers also are dwarfed and distorted, the stems are nearly always shorter than is normal, and the flowers altogether present a weak, sickly, and unsightly appearance when contrasted with healthy blooms. Injury is apt to be very disastrous unless the aphides are destroyed in some manner. In the accompanying illustration (Plate II) normal violets are shown below, and a small bunch of flowers injured by this aphis are illustrated above.

This species of aphis has not been under continued observation, and hence we have no very full notes regarding its development. Winged forms were noticed in March, April, and May, and again during the first two weeks of November.

DESCRIPTIVE.

As the species was apparently undescribed, a description was drawn up by Mr. Th. Pergande and published in the Canadian Entomologist of February, 1900 (Vol. XXXII, pp. 29, 30). The grower of violets will readily distinguish this from the green aphides which affect his plants, with the aid of the accompanying illustration (fig. 15). The winged female, shown at *a*, is of attractive appearance. She has a dark cherry or purplish brown body, clear wings with the veins strongly and conspicuously clouded with dull black, as figured. The tail is short and inconspicuous; the nectaries are clavate, reaching to the tip of the abdomen. The species is somewhat remarkable on account of the inconstancy of the wing venation. Certain of the terminal veins are often wanting, as illustrated at *b*. The apterous or wingless female, shown at *c*, and the last stage of the nymph, (*d*), are of similar general color to the winged form, but usually paler.

The length of the body and head together is about $\frac{1}{12}$ of an inch (nearly 2^{mm}) and the wing expanse about $\frac{1}{4}$ of an inch (5–6^{mm}).

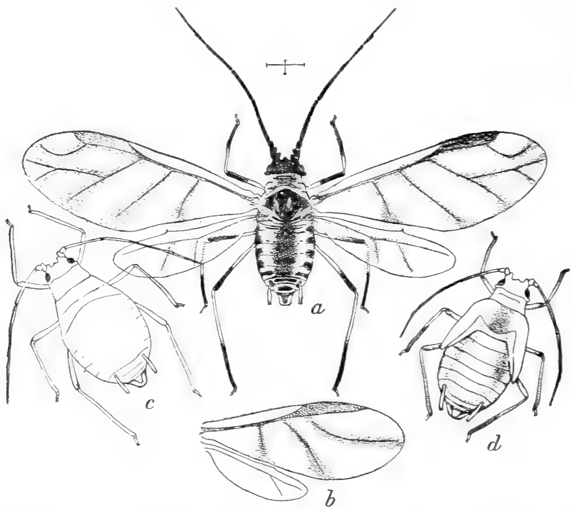

FIG. 15.—*Rhopalosiphum violæ:* *a*, winged female; *b*, wing of same, showing aberrant venation; *c*, wingless (agamic) female; *d*, nymph—all much enlarged (original).

DISTRIBUTION.

This plant-louse is of doubtful nativity. The fact that it appears to confine its attack to plants grown indoors would indicate a tropical and therefore foreign origin; but as the species has been described from this country, and is not known elsewhere, it will have to be considered native until we learn to the contrary. The present distribution includes the following localities, the list being necessarily small on account of the newness of this insect as a pest: Toronto, Canada; Poughkeepsie, Rochester, and Cornwall-on-Hudson, N. Y.; Newton Center, Mass.; Providence, R. I.; Garrett Park, Waverly, Brooklyn, and elsewhere in Maryland; District of Columbia; Gordonsville, Va.

DIVISIONAL RECORDS OF INJURY.

In August, 1898, Mr. Dorsett visited Mr. Theodore Diedrich at Anacostia, D. C., and ascertained from that gentleman that this species had done immense injury to violet blossoms, the cash estimate of his losses being placed at \$1,000 to \$1,200 for that year.

During the following autumn correspondence was received from Mrs. J. Sampson, Gordonsville, Va., regarding the occurrence of this species in her violet beds, this being the most troublesome violet pest in that locality.

November 19 of the same year Mr. W. D. Philbrick, Newton Center, Mass., wrote that this species, specimens of which were received, was present in his violet beds, and that they are usually noticed to be quite plentiful when the plants are first brought in under glass in the fall from the field where they are grown in the summer. This species, he reports, is most abundant on the petals of the flowers.

The following day Messrs. Thomas De Voy & Son, Poughkeepsie, N. Y., sent specimens with the information that these insects appeared in their violet houses during the summer of 1897, and that they were introduced through the purchase of plants from elsewhere. They gave considerable trouble that season, and the following year they occurred in vast numbers. Of their occurrence our correspondents wrote:

> The increase of these terrible pests is not owing to neglect on our part; we have fought them constantly from propagating beds down to the present time, using tobacco smoke, soap water, and tobacco dust. These remedies hold them in check somewhat if constantly applied, but the insects appear to breed by the million in a single warm day or night. Several of the growers in this vicinity are troubled like ourselves with this pest, and it is beginning to alarm us, for it seems impossible to eradicate them from houses once infested.

December 12 Mr. John G. Bahret, Poughkeepsie, N. Y., sent specimens obtained from a neighboring greenhouse. His own greenhouse was free of the pest, but he had heard much talk concerning its great damage in his vicinity. The cold weather at the time of writing appeared to have had considerable effect upon the little pests, as they were not found in abundance.

February 27, 1899, Mr. W. V. V. Powers, Cornwall-on-Hudson, N.Y., sent specimens of the adult, taken on hothouse violets at that place.

No further complaints of injuries by this species were received in 1899 until October 18, when Dr. James Fletcher wrote that it was reported to be doing a good deal of harm to violets grown under glass by one of the principal growers of Toronto, Canada. The prominence which was given to this plant-louse in short notes and letters published in various florists' periodicals during the year 1898 led to its general identification in many greenhouses, and our correspondent was aware of the fact that the species was of serious importance in many of the large greenhouses of the United States, including those of Rochester, N. Y.

February 10, 1900, Miss Frances Roberts, Providence, R. I., sent specimens, reporting the species injurious to violets in that city. The beds of the greenhouse were stated to be in ideal condition and the violets were planted September 15, and, though given the best of careful attention as to air, light, and water, our correspondent succeeded in obtaining nothing but "green" violets.

LITERATURE.

In addition to the technical paper by Mr. Pergande previously noted, several notes and extracts from correspondence have made their appearance in different florists' journals during the past two years in which the species has been studied from the practical side. It has also received consideration in Mr. Galloway's "Commercial Violet Culture," where it is discussed with the so-called green aphis, on pages 198–208. The chapter referred to is devoted principally to the use of the hydrocyanic-acid gas method of treatment for these aphides and has less to do with their biology, although the nature of injury is described somewhat in detail.

In the Transactions of the Royal Society of Canada (Vol. V, second series, 1899–1900, p. 228), Dr. James Fletcher states that this pest had caused much damage to violets during "the past winter," and that it had made its first appearance in Canada about 1897; and, in his "Report of the Entomologist and Botanist for 1899" (1900, pp. 177–178), he has given an account of injury in a large florist's establishment in Toronto. The loss was estimated at $1,000. Reference to the same matter is given in the Report of the Entomological Society of Ontario for 1899 (1900, p. 110).

Prof. W. G. Johnson briefly noted injury to violets in Maryland during the season of 1900 (Bul. 26, new series, p. 81); also in the American Agriculturist for December 29, 1900, and elsewhere he has furnished some notes on the treatment of a greenhouse in Maryland affected by this plant-louse. One of the owners in this case stated that a single demonstration of this method was worth to him at least $250 that season.

REMEDIES.

Hydrocyanic-acid gas alone is a sufficient remedy for this species. A spray of neutral soap or of water will also kill the insect. These remedies are treated in previous pages. Concerning the gas treatment, it should be said that it is due to the ravages of this plant-louse in the vicinity of the District of Columbia more than to anything else, perhaps, that the hydrocyanic-acid gas method of treatment was brought to its present state of perfection as a method of controlling insects infesting plants grown under glass. Until the adoption of this means of fumigation, tobacco, which has been in use as a greenhouse insecticide, or, more properly speaking, repellent, for upward of a century, was the remedy most relied upon. The danger of using tobacco in violet greenhouses is treated somewhat at length in an article entitled "Combating Aphis on Violets," published by Mr. Galloway in American Gardening for November 6, 1897 (Vol. XVIII, p. 758), from which the following is quoted:

> Aphides, especially the black ones, were once the most serious pests with which we had to contend. Since we have adopted the hydrocyanic-acid gas treatment, however, * * * we have had no serious trouble. So important do we consider this matter of being able to use this gas that we shall plant in the future throughout the entire season in such a way that the plants may be fumigated at any time.
>
> We abandoned tobacco entirely some time ago, as we found by experience that, no matter how used, it would tend to weaken the foliage and make it more subject not only to "spot," but to other diseases as well. * * * When tobacco is used, either as smoke, dust, stems, or extract, it seems to in a measure check the vital functions of the leaf, the little cells of which temporarily lose their vitality and their ability to resist outside influences. Here is the opportunity the fungus needs, and it at once takes advantage of it by sending a thin, thread-like growth into the cells. Once the tissue is entered, the fungus continues to grow until the plant is able to check it of its own accord. The spot then turns white, but when conditions are again favorable the fungus will start anew, and the spot will be found soft, greenish, and watery, etc.

THE VIOLET "GALL FLY."

(*Diplosis violicola* Coq.)

Violets and roses are subject to the attack of different forms of minute larvæ or maggots, the young of what are known to florists as gall flies—minute two-winged flies or gnats of the family Cecidomyiidæ. Three species are of importance as enemies of these plants, and there are doubtless others, but these three are the only ones that have obtained marked recognition by their injuries in recent years; until recently, indeed, they were not recognized as distinct from others of their kind. They have been given more or less study by the writer and by some others, and, when it was made manifest that they were undescribed through special study by Mr. D. W. Coquillett, of this office, all of the notes and manuscripts which had accumulated at that time were turned over to him, and the results were embodied in two somewhat technical articles, with full descriptions, in Bulletin No. 22 of the present series.

DESCRIPTION.

The larva or maggot, which is usually found folded up in the leaf of a violet in such a manner as to bring the upper surfaces together in what has been termed a gall, is a minute, legless creature of a whitish or yellowish color. The general appearance of one of these larvæ is shown in figure 16 at *d*, *e* representing its breastbone.

The parent gall fly is a minute, slender and delicate two-winged fly, measuring about one-twentieth of an inch in length. It has long and slender legs and antennæ, the latter 14-jointed and surrounded by two whorls of bristly hairs on joints 3 to 13, inclusive.

The general appearance of the female is shown in figure 16 at *a*, much enlarged, the segments of the antennæ being shown still more enlarged at *b*. The genitalia or sexual organs of the male are illustrated, also greatly enlarged, at *c*.

DISTRIBUTION.

It seems probable that this species, like others found in greenhouses, and in habitations, storehouses, and indoors generally, has been introduced from abroad; and it is perhaps tropical, at least in origin. The present known distribution includes the following localities: Washington, D. C.; Richmond and Gordonsville, Va.; Nyack, Tappan, and Cornwall-on-the-Hudson, N. Y.

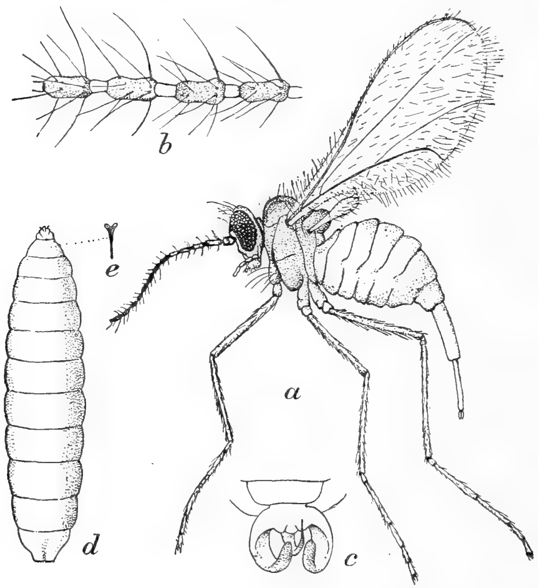

FIG. 16.—*Diplosis violicola*: *a*, female fly; *b*, female antennal joints; *c*, male genitalia; *d*, larva; *e*, breastbone of larva—*a*, *b*, much enlarged; *c*, *d*, *e*, more enlarged (from Coquillett).

This species first attracted attention in 1896, when it was noticed by Mr. Dorsett on sweet violets in the vicinity of Washington, D. C. One of our correspondents, Mr. W. V. V. Powers, writing under date of January 27, 1899, stated that he had noticed this insect three years earlier, and although he could not feel certain that there was any connection between the appearance of this pest and the introduction of the so-styled California violet, it was noticed that they both appeared the same year in his vicinity, Cornwall-on-the-Hudson, N. Y.

NATURE OF INJURY.

The maggots, as previously stated, conceal themselves in folds of the young, growing leaves, causing a distortion or curling into irregu-

LEAVES OF VIOLETS, SHOWING INJURY BY "GALL-FLY" LARVÆ—NATURAL SIZE.

(From photograph by P. H. Dorsett.)

lar shapes, such as are shown in the illustration (Plate III), having somewhat the semblance of a gall, which name has been rather generally applied to them by florists. After the formation of the "gall," what is known as wet rot is apt to set in and destroy the leaves. This has the ultimate effect of dwarfing the plants and of arresting the development of the flower buds.

From the frequency with which maggots resembling those found on the leaves of violets are found in the soil in violet houses, it has been thought that the insects live both in the soil and upon the leaves. It has been thought, also, that this pest is more apt to make its appearance in greenhouses where proper attention has not been paid to the mixing of the soil and to drainage, and that manures of some kinds favor its development. It seems probable, however, in the light of more technical knowledge of the subject that the larvæ found in soil are in nearly every case those of Mycetophilidæ, and probably of different species of Sciara, several forms of which occur in greenhouses, of which some are reported to be injurious while some are scavengers. One of these species known as the fickle midge will be treated farther on in the present publication.

LITERATURE OF THE SPECIES.

What appears to be the first account that can be with positiveness attributed to this species of "gall fly" was published in the Florists' Exchange (Dec. 19, 1896, p. 1132), by Mr. Dorsett. At that time it was not known that this species was different from the so-called gall flies of roses. The account in question is a short one, and is illustrated by a half-tone reproduction of a photograph showing injury to violet leaves by the larvæ. In the same publication (issue of December 3, 1898), Mr. W. Davison wrote of the occurrence of this species at Nyack, N. Y., and in The American Florist for January 21, 1899, Dr. L. O. Howard gave a brief summary of what was then known concerning the insect. In Mr. Galloway's "Commercial Violet Culture," published the same year, this species is considered on pages 211–214, injuries by the larvæ to the flowers of violet being illustrated.

The aim of the present article is to present in concise, summarized form most of the facts which have already been made public in the articles above quoted.

REMEDIES.

Hydrocyanic acid gas does not appear to have been tested against the violet gall fly, or if it has been used we have no published account of the fact. There is no reason to believe that it would be less effective than when employed against aphides and other insects. Its use is, therefore, suggested. It does not seem practical to pick the leaves, because in such cases the crowns are permanently injured and flowering is checked. Mr. Galloway suggests the use of air-slaked lime, thrown into the crowns and allowed to reach the soil. If with this the best cultural conditions possible are maintained, such as good ventilation and a frequent stirring of the soil, injury might be greatly lessened. The free use of Buhach, or Persian insect powder, at the time when the mature gall flies are seen flying about the greenhouses and upon the windows, would also be of considerable value in lessening their numbers.

THE VARIEGATED CUTWORM.

(*Peridroma saucia* Huebn.)

Of all violet pests, other than those which have already received special mention in this publication, cutworms of several species as well as allied caterpillars of moths belonging to the same family, the Noctuidæ, and some related families, are most conspicuous. It is seldom that greenhouses are entirely free from them, and the constant vigilance of the florist must frequently be exercised to keep them under control. The leaves of violets are particularly subject to cutworm attack in the spring, after the new plants have been set out.

The cutworms in houses may be produced from eggs laid by moths which have flown in at open doors or windows, but more frequently they are carried indoors with the soil in the fall, and they are most apt to occur in beds in which grass has been permitted to grow, as well as in houses immediately surrounded by dense growths of rank grass and weeds. The reason for this is that a very considerable percentage of the cutworms which attack violets feed normally upon grasses or weeds and it is upon these plants that the moths usually lay their eggs.

Cutworms, as is well known, are most voracious feeders, and in a short time are capable of doing much damage to such small plants as violets. Frequently they cut down whole plants of these and similar ornamental flowers.

What makes these insects difficult to deal with is their nocturnal habit, their presence being seldom detected in the daytime, save by their work, unless during cloudy weather or in secluded dark places.

A common insect met with in recent years on violet and a number of other plants grown under glass is the variegated cutworm (*Peridroma saucia*). It is usually abundant nearly everywhere, and to be found in fields and gardens, pasture land, vineyards, and orchards, as well as in greenhouses. It is one of the best known of our numerous cutworms, one of the most destructive, and appears to be the particular species most often found on ornamental and other plants growing under glass in conservatories as well as in cold-frames. During the season of 1900 it was very destructive over a wide extent of territory, but most conspicuous by its injuries in the Pacific States. Owing to its destructiveness that season, it received considerable attention at this office as well as elsewhere, and will be given more extended notice in a future bulletin.

DESCRIPTIVE.

The moth which produces this cutworm is a rather large species of the family Noctuidæ. The fore-wings are pale, grayish brown, tinged with reddish and shaded about the middle and toward the outer margin with darker brown, the pattern being variable, but more or less like the form illustrated in figure 17, *a*. The ground color of the hind-wings is iridescent or pearly white, strongly shaded about the margins with shining, light brown, the veins being of the same color and

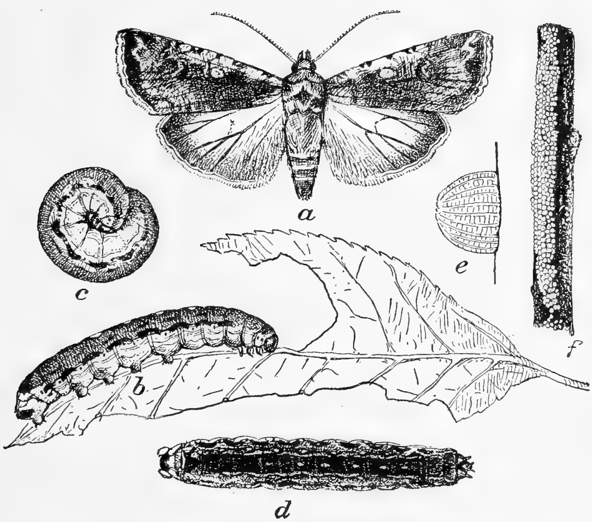

FIG. 17.—*Peridroma saucia: a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard).

strongly marked. The wing-expanse is about an inch and three-quarters, and the length of the body three-fourths of an inch.

The eggs are deposited in regular masses and often in rows of seven or eight or to the number of sixty or more, preferably it appears, along the twigs of certain fruit trees since egg-masses are often found in such locations. An egg is shown in profile, very much enlarged, at figure 17, *e*, and an egg-mass deposited on a twig at *f*.

The larva.—The larva is very variable, but can usually be distinguished by a row of from four to six yellow rounded spots which occur along the back at the middle of the anterior portion of the body, extending usually from the second to the fifth or seventh segment, as shown in the illustration at *b* and *d; d* shows a dark form, while a lighter form, coiled in the position which the larva assumes when disturbed, is illustrated at *c*. Still lighter larvæ occur.

The pupa presents no obvious characters for description. The color is dark brown at maturity, and the tip of the body ends in a pair of minute spines.

DISTRIBUTION.

Peridroma saucia is cosmopolitan and very widely distributed over Europe, Asia, North Africa, and North and South America. In the United States it is injurious practically throughout the arable region.

During the season of 1900 injury was particularly severe in Washington and Oregon, and was reported also in Texas, Missouri, Kansas, West Virginia, Illinois, and California.

RECENT INJURY IN GREENHOUSES.

Injury in greenhouses has been reported during the past six years to roses and carnation plants near New York City, to carnations at New London, Conn., to cultivated violets at Campbell, Va., and to violets also at Charlottesville, Va. At the last place it was noticed that larvæ ate blossoms as well as leaves.

A list of ornamental plants which have been noted to be affected by this cutworm includes violets, pansies, carnations, roses, smilax, sweet pea, hollyhock, sunflower, and chrysanthemums.

Mr. M. V. Slingerland, in writing of this species and its injuries, in 1895 (Bul. 104, Cornell Univ. Agric. Exp. Sta., p. 581), says:

> It would climb up the flower stalks in the evening, and, upon reaching the blossom, would firmly grasp the stalk just below with its prolegs, and then reach out as far as possible onto the petals and eat them down to the base; the outer portion of the petals which it could not reach usually dropped to the ground, often to be eaten by cutworms just coming from their day retreats. One cutworm would thus quickly damage these beautiful blossoms, and frequently two or three of them would completely destroy a whole blossom in a single night.

ON THE LIFE HISTORY OF THE SPECIES.

Considerable has been ascertained in regard to the life history of this species. In fact, we know much more about it than of most cutworms, but published accounts are somewhat conflicting, showing great variability in the life economy of the species not entirely traceable to different environment.

During recent investigations larvæ have frequently been taken during the winter when they have come out to feed on warm days. This, however, is no indication that the species does not also hibernate as a moth and also as pupa, as surmised by Slingerland and others. Egg masses that were found late in the year hatched during the latter days of October. Enough has been learned also to show that an indefinite number of generations can be produced indoors. At this office we have kept larvæ feeding during October and November and have secured eggs in numbers during the first two weeks of January.

Dr. Riley was doubtless right when he remarked (Rep. Comm. Agric. 1884, p. 298) that his St. Louis notes on the biology of this species "indicate at least two annual generations, with a possibility of three." The climate in the District of Columbia and vicinity is much the same, and the writer feels positive that at least two generations and a smaller third generation are normally produced.

Attack begins as with most cutworms, with larvæ which survive the winter in April and May, and may continue practically without cessation until the latter days of August. The third generation is too small and makes its appearance too late to cause much trouble.

REMEDIES.

After what has been said in the introductory chapter concerning the factors which conduce to the injury of violets by cutworms, it is obvious that one of the first requisites in our efforts at controlling these pests is to avoid for use in the greenhouse soil that has grown up in grasses or weeds that may contain cutworms. To avoid this all that is necessary is to select the soil in the spring and pile it up for use in the fall. In the interim, if no vegetation grows upon the piles, the cutworms will all leave them and thus the soil will be free. This holds true to a certain extent also of some species of white grubs and wireworms, as well as some other insects. If the use of fresh soil is necessary, it should be sterilized by subjecting it to heat. It is advisable also to keep the beds as free as possible from grasses, and not to permit a rank growth of grasses or weeds to accumulate in the immediate vicinity of greenhouses and to keep the houses as tightly closed as possible, especially at dusk and at night, at the time when these moths fly about looking for suitable places for oviposition.

Careful growers keep this insect in subjection in ordinary cases by closely watching for the first evidence of attack and then searching for the insects and destroying them. During the daytime it is not difficult to find them just beneath the surface of the earth about the stems of the plants which they have attacked during the night. By digging in the soil the insects can be discovered without much trouble, and can then be destroyed.

Where fumigation is practiced many cutworms are destroyed, but for plants grown out of doors and in frames if the insects become numerous it may be found necessary to use other than mechanical methods. For this purpose poisoned baits, the standard remedies for cutworms, are the best. Green bait is prepared by spraying a patch of clover or some succulent weed with paris green, one pound to about 150 gallons of water, mowing it close to the ground, and spreading it while fresh about the plants to be protected.

Another bait, known as the bran-arsenic mash, is also valuable for the same purpose, and is prepared by combining one part by weight of white arsenic, one of sugar or a like quantity of molasses, with six of bran, and enough water to form a mash. This is distributed in the same manner as the green bait. Before setting out plants in fields which experience has demonstrated are apt to be infested with cutworms, or in new ground which has been in grass and is therefore liable to contain these insects, it is advisable to use one or the other of these baits.

THE SPOTTED CUTWORM.

(*Noctua c-nigrum* Linn.)

The spotted cutworm, which is also known as the corn cutworm, is one of the best known species of this group occurring in our country. Like the preceding it appears to be an introduced form, and is common to America, Europe, and Asia. It was found depredating on violets in the late fall of 1899 and 1900 in different portions of Virginia; and other complaints of injuries during the latter year have been received from Indiana, where it was injuring early cabbage and tomatoes; from Connecticut, where it had assumed the army-worm habit, and was eating a great variety of herbage, including many cultivated plants, and in Ohio, where it was reported by Professor Webster as injurious in wheat fields in March. It was one of the common species in Maryland during the past year, and in all seasons ranks with the foremost noxious cutworms over considerable territory.

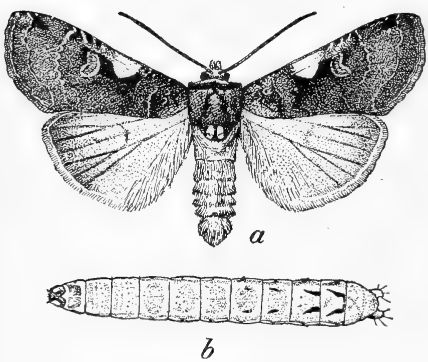

FIG. 18.—*Noctua c-nigrum:* *a*, moth; *b*, larva—somewhat enlarged (original).

DESCRIPTIVE.

The moth.—The adult of this species of cutworm is a rather attractive and well-marked species. It has brown fore-wings, tinged with reddish in light individuals and purplish in darker ones. The anterior portion of the fore-wings is marked as shown in the illustration. (Fig. 18, *a*.) The reniform spot is partially suffused laterally, and at a distance of about one-third between it and the thorax is a larger triangular gray spot; back of this, and approaching the reniform, are two black, velvety spots, and there is another one on the anterior margin, near the tip. The collar is pronounced and of a gray color; the thorax is brown and the abdomen dull gray, a little darker than the hind-wings, which are sometimes strongly infuscated on the outer margins and moderately distinctly veined. The illustration represents a male.

The egg.—The eggs may be laid singly in rows, or in compact layers, sometimes to the number of 200 or more, and when first deposited are nearly transparent, showing the green of the leaf beneath. They are nearly hemispherical in form, and strongly ribbed like many of the Noctuidæ. In consistency they are firm and elastic; each egg is about 9^{mm} in diameter, or a little more than a third of an inch.

The larva.—The young larva, when first hatched, has been described as about 0.04 of an inch (1^{mm}) in length, nearly white in color, and thickly covered with black pilosities. From these pilosities proceed black hairs, which also ornament the head and thoracic shield. The remaining molts have been described as follows by Prof. A. J. Cook (Report Michigan Experiment Station, 1890, p. 108):

After the first molt they were four millimeters (one tenth of an inch) long. A few were still white with eight pilosities to each ring and otherwise as before, while most were now plainly striped with green and white. There is a dorsal white line and two others near together on each side just above the spiracles. The pilosities are less distinct, the hairs white, and the head or under side is white or greenish-white. After the second molt they are one centimeter, or four-tenths of an inch, long. They are now lined with white, and dirty white, or light gray. A wide white stripe on each side contains the brown spiracles in its upper margin, a narrower white stripe extends along the back, while one still narrower divides the distance between the dorsal and lateral stripe about equally. The head and under surface are dirty white. In some specimens the gray is quite darkened by minute black spots, and the lateral stripes are pinkish. The hairs and tubercles bearing them are still more obscure, and as in the previous stages extend all around the body. After the next, or fourth molt, the length is nearly or quite two centimeters. The general appearance is as in the last stage except that the white lines are less clearly defined, while the gray lines are more thickly set with dark olivaceous specks which really make a dark line just above the spiracles.

The mature larva is illustrated at figure 18, *b*. In this stage it measures, when fully extended, about one and one-half inches, and five-sixteenths of a millimeter in width. It is usually an inconspicuous gray or brown in color, sometimes whitish, with strong green or olive-brown tints, and the last three or four, and sometimes all, of the abdominal segments are marked with diverging, velvet-black lines, as shown in the figure.

The pupa is of the usual mahogany brown color of most Noctuid pupæ and measures about three-fourths of an inch in length and one-fourth in diameter. The anal segment terminates in two outwardly curved spines on each side of which there are two shorter curved spines or bristles, and on the ventral surface, just above the insertion of the larger spines, are two similar, still shorter, curved processes.

DISTRIBUTION.

This species is common to North America, northeastern Europe, and northern Asia, and is probably not indigenous to our country, but was introduced many years ago, as has been known to collectors for a considerable period, and was perhaps brought from the mother country in soil about nursery stock or potted plants.

The list of localities which we are at present able to furnish is scarcely indicative of the insect's range. The following are definitely known: Schenectady, N. Y.; New Jersey, common throughout the State (Smith); Storrs, Conn.; Washington, D. C.; Marshall Hall, Cabin John, and Bennings, Md.; Richmond and Poindexter, Va.; Dayton, Ohio (Pilate); Kentland and Chesterton, Ind.; Urbana, Sheldon, and elsewhere in Illinois; Stratmann, Mo.; Volga, S. Dak. (Truman); Montana; Washington, and Oregon.

There are specimens in the National Museum, identified as this species, from Kadiak and Popof islands, Alaska, and we have larvæ, identified as this same species from Savannah, Ga. There is nothing to indicate, however, that the species is established in Alaska; in short, nothing is more likely than that the insect was transported from farther south on the coast—for example, from Washington or Oregon; and the Georgia locality is also doubtful.

With so short a list of definite localities, it is practically impossible to define the insect's geographical limits. The list alone would indicate an exclusively Upper Austral distribution, but the probabilities are that this cutworm inhabits also Transition and perhaps Lower Austral territory. A perusal of all available lists of moths might add somewhat to our knowledge. The species affords a striking example of how little we know of the distribution of some of our most common and destructive species, since this insect is to be classified with the most pernicious of its kind.

RECENT INJURY.

Recent experience with this species of cutworm begins with November 15, 1899, when Hon. G. W. Koiner, Richmond, Va., sent specimens among others, that were depredating on violet beds in Louisa County of that State. The moths issued February 1, 1900.

April 2, 1900, and later this cutworm was taken, together with others, feeding on chickweed (*Stellaria media*) in a garden near Cabin John, Md. At Marshall Hall, Md., where it was found a few days later, it was the most abundant species of cutworm. From this material the moths began issuing May 10. The period of the pupal stage was found to be about four weeks—April 20 to May 18.

May 15 Mr. F. G. Dickinson, Chesterton, Ind., sent larvæ of this species, with the statement that it was one of the cutworms found there attacking early cabbage and tomatoes. He said that it was impossible to get early plants of these crops started there owing to the ravages of cutworms. The garden had not been in grass for fifteen years, but still about half of the plants were destroyed by these insects.

In early August the spotted cutworm assumed the army-worm habit in at least one locality. August 6, Prof. B. F. Koons, of the Connecticut Agricultural College at Storrs, Conn., sent a number of living cutworms of this species with the accompanying information that they first attracted his attention in a large meadow, where they were tumbling into the water of a ditch, being particularly abundant along its border, where they fed upon weeds, ferns, golden-rod, and other plants, not cutting them, however, but eating the lower foliage. They were traveling like the army worm in considerable numbers, and not feeding upon oats or grasses, but upon netted-veined leaves. They riddled a small plot of rhubarb on the hillside near the meadow, filling the leaves full of holes, and attacked also the fruit of tomato near by. They were found also in great numbers coiled about the roots of weeds and in rubbish at their bases, and they were as abundant along the borders of the ditch as our correspondent had ever seen the true army worm, *Leucania unipuncta*. The moths of this lot, which may be considered the second generation of larvæ, began issuing about the middle of August. The pupal stage during hot weather was fifteen days.

This is the third instance known to the writer of this species assuming the habit of traveling in armies. On page 135 of the Third Report of the United States Entomological Commission, Dr. Howard states that in his investigations of the true army worm (in Illinois and Indiana) in 1881 this species was accompanied by large numbers of the spotted cutworm in the proportion of about one of the cutworms to five of the army worms. During the same year Mr. Coquillett observed this cutworm in Illinois associated with the army worm in the proportion of one of the former to eight or ten of the latter (Eleventh Report State Entomologist of Illinois, 1882, p. 51).

December 6, 1900, Mr. G. W. Morris, Poindexter, Va., sent specimens of this cutworm with report that they were devouring violets upon his place, eating both blooms and leaves of the plants.

Brief mention of the occurrence of this larva on violets in September and October in Illinois has been made by Messrs. Forbes and Hart (Bul. 60, Univ. of Ill. Agric. Exp. Sta., 1900, p. 451).

A note on the extreme abundance of this species in many localities along the north shore of Lake Ontario, where it was injurious to all kinds of garden and root crops, was given by Dr. James Fletcher in an article published in the Thirty-first Annual Report of the Entomological Society of Ontario for 1900 (1901 p. 68). The generation of larvæ found during July was in the year 1900—the one that did most harm. It seemed to take the place in Ontario of the variegated cutworm, which was injurious in the West.

LIFE HISTORY AND HABITS.

The European food plants which have been recorded for this species include Rumex (dock or sorrel), *Stellaria media* (chickweed), Primula (primrose), Thalictrum (meadow rue), *Epilobium palustre*, Myosotis, Verbascum, and Lamium.

Chickweed, in the writer's experience, is the favorite food of this as well as some other cutworms. Violets are quite subject to attack, as are also cabbage and tomato, ferns, goldenrod, rhubarb, Lobelia, Helianthus, chicory (*Cichorium intybus*), currant, celery, corn, grasses, and clover. The fruit of tomato is sometimes injured. Young larvæ devour their own eggshells, and a larva has been seen to feed upon the egg pods of locusts.

The species frequently assumes the climbing, and, less often, what is known as the army-worm habit.

It seems probable, from what the writer has been able to learn from experience and inquiry, that the larvæ are rather partial to the foliage of some fruit trees, since they are so frequently found in orchards, but the climbing habit has been noticed only in a few localities.

The life history of this species has never been fully traced, but, from the observations of Messrs. Coquillett, French, and Forbes in Illinois, it is evidently two-brooded, at least in the northern portion of that state. The imagos of the first generation appear in May and early June, and those of the second late in July and in August. It is proved beyond peradventure that hibernation takes place in the larval condition; probably only in this stage and not as pupa or moth. As an example of development in midsummer, Professor Forbes states (Sixteenth Report State Entom. Ill., 1890, p. 86) that ten larvæ, taken from cabbage July 16, entered the earth for pupation July 25 and emerged as adults August 15 to 19, these individuals having remained in the earth from twenty-one to twenty-five days. Forbes has observed that this species rarely appears at electric lights, an observation that is borne out by the writer's experience also.

Injury by this cutworm appears to be done chiefly by the hibernated or spring generation, the larvæ doing little if any appreciable damage in the autumn. In Illinois larvæ are said not to be particularly troublesome after the first part of May. Larvæ have been observed in the fields in and near the District of Columbia late in November and have been kept feeding in rearing cages out of doors exposed to the weather as late as January, in which respect this cutworm resembles *Peridroma saucia*, also a European importation.

NATURAL ENEMIES.

This cutworm being one of several species which sometimes rest during the day under stones, it is at such times sought out by parasitic insects for the deposition of their eggs.

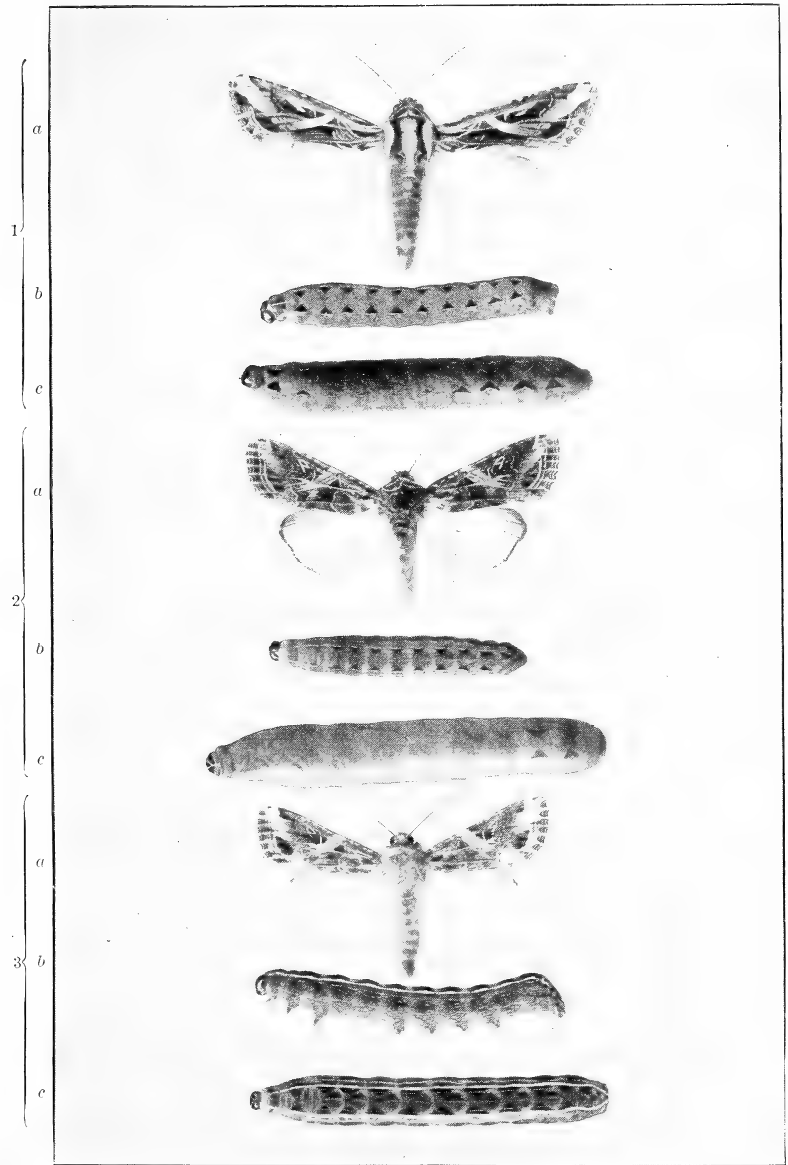

Fig. 1.—*Prodenia commelinæ: a*, moth; *b*, penultimate stage of larva from above; *c*, mature larva from side.
Fig. 2.—*P. ornithogalli: a*, moth; *b*, penultimate stage of larva from above; *c*, mature larva from side.
Fig. 3.—*P. endiopta: a*, moth; *b*, larva from side; *c*, larva from above—all slightly enlarged (original).

Ichneumon comes Cr. was reared from the pupa of this cutworm June 5, the host having transformed to pupa May 7, 1900. Locality, Marshall Hall, Md.

Apanteles sp. (near *glomeratus*) has been bred from a larva of this moth in about 60 individuals. April 7 the host larva was found dead and the parasites spun up in a white flocculent mass of cocoons, measuring a little less than an inch in diameter and half an inch in thickness. From this mass the adult parasites issued April 23.

REMEDIES.

The spotted cutworm is amenable to the same remedies prescribed for use against the variegated cutworm treated in preceding pages.

THE COMMELINA OWLET MOTH.

(*Prodenia commelinæ* S. & A.)

A conspicuously marked caterpillar that preys upon violets is produced by a moth which Smith and Abbot described over a century ago under the name of *Phalæna commelinæ*. Comparatively little is known of its food habits, but what has been learned shows that it is inclined to be omnivorous, as it has been found to be destructive to the foliage of sweet potato and cotton, and to attack asparagus and raspberry among cultivated plants. It is one of three species of Prodenia which inhabit the Central Atlantic States, but are more numerous in the Gulf States.

In their more northern range these larvæ appear to be more diurnal than most cutworms, and are frequently to be found in shady places in the afternoon feeding in free exposure upon their food plants. Their normal habit is evidently crepuscular and they are rather peculiarly solitary, and perhaps for these reasons they attract little attention on account of injuries. The genus, however, is well known on account of the striking colors of the larvæ as well as of the mature insects or moths.

DESCRIPTIVE.

The moth.—The adult of this species may readily be distinguished from its two more common congeners, which are here considered, by its greater wing-expanse, darker colors, and less complicated markings. The color of the fore-wings is, in fresh specimens, moderately dark rich brown, velvety in the darkest portions, where it is variegated with black in transverse lines, paler purplish brown, and dull yellow and ochreous. The pattern formed is illustrated at figure 20, *a* and figure 1 of Plate IV. The thorax is similarly colored, as is also the head, and the abdomen is paler, more uniform, grayish brown. It is rather wide and tapers strongly toward the tip. The hind-wings are pale pearl-gray with a strong violet iridescence, which is visible also on the lower surface. The wing-expanse is about $1\frac{3}{4}$ to 2 inches ($45–50^{mm}$) and the length of the body is about nine-tenths of an inch (23^{mm}).

The eggs of this species, or for that matter of the genus Prodenia, do not appear to have been described. From preserved specimens, however, of an empty egg mass it is obvious that they are nearly duplicates of Laphygma in appearance, the mass itself being covered with gray hairs as in the latter genus.

The larva.—The general color of the larva is a peculiar olive or greenish brown, more or less variable, finely lined with dark gray and brown, and this as well as other species of the genus which will be discussed are all ornamented on the upper surface with a double row of triangular, velvety-black, sometimes greenish, spots, which give them a striking appearance. The larvæ are in fact so peculiarly marked that it is not at all difficult to separate this genus from any other common genus of the same family occurring in the Eastern States. The larva of this species may be distinguished in all stages, except the final stage, by the greater number of these dorsal black spots and the lack of striation so visible in the other two. The body is cylindrical and smooth; the head is small and polished black or dark brown in front, shading off into lighter brown at the posterior end and at the sides, with the frontal triangle margined with white. The thoracic plate is dull brown or blackish with the piliferous spots and median line dull yellowish, and the second thoracic segment has two usually large, deep-black dorsal spots. The dorsum is also marked with a median row of small yellow dots. The stigmata are black with pale centers, the thoracic legs brown, the abdominal legs dark green externally, and the hooklets dark brown; inflated larvæ are rather dark reddish-brown.

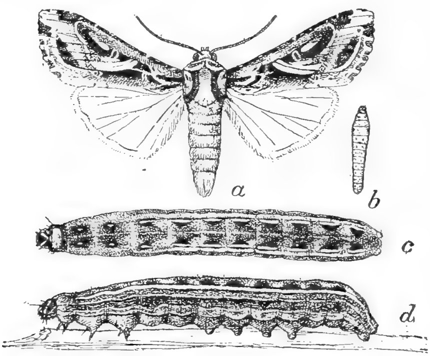

FIG. 19.—*Prodenia commelinæ:* *a*, moth; *b*, young larva; *c*, mature larva, dorsal view; *d*, same, lateral view—all slightly enlarged (original).

The length is between one and one-half and one and three-fourths inches ($38–45^{mm}$), the diameter $10–12^{mm}$.

Technical descriptions of the various stages of the larvæ have been kindly drawn up by Dr. H. G. Dyar, and are appended.

The mature larva of a well-marked form is shown at figure 19, *c* and *d*, a young larva being illustrated by *b*.

LARVAL STAGES OF PRODENIA COMMELINÆ.

Stage I.—Head rounded, bilobed, shining brown-black; clypeus moderate; mouth slightly projecting; antennæ small, normal; width, 0.3^{mm}. Body slightly enlarged at joints 3-4, and 12, cylindrical, normal, the feet small, equal, thoracic ones black. Whitish; a red-brown lateral patch on joints 5 and 11, with faint traces about tubercle iv on joints 6 to 8 of red-brown. Cervical shield distinct, transverse, slightly excavate behind, with the leg shields and tubercles brown-black. Tubercles distinct, rounded, moderate, normal. Anal shield small, brown-black.

Stage II.—Head rounded, bilobed, about as high as wide, greenish testaceous; width, 0.5^{mm}. Body shaped as before, but the shields and plates scarcely cornified, obscure, concolorous; tubercles minute, setæ small. Green. the dark brown patches on joints 5 and 11 large, covering the spiracle and a small rounded subdorsal one on joint 3. Numerous longitudinal white lines consisting of dorsal, subdorsal (upper and lower), lateral, substigmatal (upper and lower); feet all pale.

Stage III.—Head rounded, wider than high, slightly bilobed, the lobes full in front, the clypeus reaching two-thirds to the vertex; greenish testaceous, a brown patch before on each lobe; width, 0.8^{mm}. Body shaped and colored as before, the region between the lower subdorsal and substigmatal lines reddish and containing traces of a supra-stigmatal white line; subventer slightly reddish.

Stage IV.—Head as before, shining brownish testaceous, clypeus rather high, two-thirds, ocelli large, black; width, 1.3^{mm}. Body cylindrical, enlarged at joints 3–5 and tapering to the head, enlarged also dorsally at joint 12. Feet moderate, equal. Shields and tubercles obsolescent, setæ minute except at the extremities. Green; dorsal line narrow, white, obscure; lower subdorsal rather broad, distinct, white, shaded with orange, angled on the hump on joint 12; the two substigmatal lines parallel, waved, subconfluent by mottlings, forming a broad, sharply edged band centered with brown and shaded with orange in spots. Other lines broken, dotted, confused with strigæ. Dark brown subdorsal patch on joint 3 and lateral ones on joints 5 and 11 as before. Body more or less mottled with brown between the strigæ. Concolorous cervical shield cut by three white lines; thoracic feet brown; abdominal ones green, brown shielded.

Stage V.—Head as before, shining brown, reticulate with darker on the sides, the same dark color shading the clypeus, labrum, and edges of the pale paraclypeal pieces; width, 2 to 2.2^{mm}. Body as before, the enlargements less marked. Green, densely mottled reticulate with brown and whitish dots, the lines obsolescent, lost in the mottlings, except the lower subdorsal, which persists as a series of white dashes on the centers of joints 3 to 12, each dash forming the lower edge of a triangular brown-black patch, those of joints 3 and 12 the largest, the central ones smaller and sometimes not developed. A lateral patch on joints 5 and 11. Upper subventral line indicated, narrow, waved, reddish. Dorsal line indicated, distinct on joints 2 and 3. Cervical shield olivaceous brown with three pale lines; anal plate concolorous; feet greenish; slight irregular black dottings on joint 13 dorsally.

Stage VI.—Head broad, rounded, bilobed, clypeus large, reaching over two-thirds to the vertex; brown, marked as before, the reticulations not prominent; not retracted in joint 2; width, 3^{mm}. Body cylindrical, normal, gently enlarged at joints 3 to 5 and 12, tapering only at joints 2 and 13; feet moderate, normal. Densely and finely mottled with brown and whitish, the marks as before but somewhat more defined. Subdorsal velvety black triangular patches, usually subequal on joints 3 to 12, edged below by a yellow-white line, becoming a dot on joint 4, or the central ones smaller or absent, but those on joints 3, 11, and 12 persistent. Other lines obsolete or represented by traces except the dorsal on joints 2 and 3, which is narrow, pale. Cervical shield olivaceous with dorsal line only or traces of the pale subdorsal also; anal plate small, olivaceous. Black dottings of joint 13 absent in faintly marked examples. Spiracles black; feet greenish. Tubercle iv on joint 5 above the middle of the spiracle, on joints 6 to 8 above the lower angle, on 9 and 10 below the middle, on 11 halfway to tubercle v, on 12 at the lower angle of the spiracle.—[H. G. DYAR.]

The pupa is of the customary Noctuid color, mahogany brown, and is of robust form, measuring about five-eighths of an inch (16^{mm}) in length, and a little more than one-fifth of an inch (5^{mm}) in width. No characters are apparent, from a casual glance, to distinguish this genus from allied ones. The anal extremity terminates in two small divaricating processes, a character of many Noctuid pupæ.

DISTRIBUTION.

This species of Prodenia, as previously stated, is the rarest of the three common eastern forms, and although we have received material identified as *P. commelinæ* from Ashby, Mass., and it is recorded by Dr. J. B. Smith from that State, our list of definite localities appears to indicate that it is Lower Austral, and not so well established in the Upper Austral region as the other two species under discussion.

At the present writing we can furnish only the following short list of localities: "Massachusetts"; District of Columbia; Charlottesville and Colonial Beach, Va.; St. Louis, Mo.; Illinois; Macon, Ga.; Alabama; Lake City, Fla.; and Texas.

THE QUESTION OF NOMENCLATURE.

A glance at the synonymy furnished for the genus Prodenia by Dr. Smith in his catalogue of the Noctuidæ, published as Bulletin No. 44 of the United States National Museum (p. 169), is sufficient to show that considerable confusion exists in published accounts as to the identity of the different species. According to Smith the "wheat cutworm" mentioned and discussed by the late Dr. Riley in his First Missouri Report (pp. 87, 88), and which he again mentions and figures (as moth) in his Third Report (p. 113, fig. 48, *b*), is *ornithogalli* and not *commelinæ*, by which both this figure and *c* of the same illustration are designated.

This subject is discussed on page 43 of volume II of Papilio, as also in the Index to the Missouri Reports (p. 56).

DIVISIONAL RECORDS OF OCCURRENCES.

During recent years this species has been reported as injurious only in 1898. November 10 of that year we received from Mrs. H. B. Boone, Charlottesville, Va., specimens of the larva found feeding upon violets grown in beds at that place; but there is an earlier record of injury during the same year. This is by Mr. A. L. Quaintance, and was published in the Farmer and Fruit Grower of October 8, 1898, and it is evident from this account that the species is coming to the fore as a garden pest, at least in the South. The account in question relates to damage to the foliage of sweet potato by the larva of this Noctuid "throughout the State" of Florida. Reports had come in from various localities indicating that the species was widespread in its occurence there. During feeding, the young were noticed to congregate more or less on the under surface of the leaves and to eat through to the epidermis of the upper surface. With increased growth large holes were eaten entirely through the leaves, and a leaf would in some cases be completely devoured except some of the larger veins.

There are among office records two of the earlier occurrences of this species, one at St. Louis, Mo., where this species was stated to be feeding in its larval state upon the leaves of apple and peach, but in confinement only, and another dated May 13, 1884, of the receipt of specimens from Ashby, Mass., where the larva was stated to have done much damage to the buds of grape, and apple and other fruit trees; but as the moths reared are not to be found among our Prodenias, it is fair to presume that the person who identified the species may have been at fault. In short, there is nothing to show that this or other species of the genus ever assume the climbing habit, as is the case with the spotted cutworm, *Noctua c-nigrum*, which somewhat resembles Prodenia in the pattern of the markings of the dorsal surface. There is also a record of the larva identified as *P. commelinæ* eating holes into the leaves of raspberry, May 30, 1879, at Ithaca, N. Y., but it is not stated that this occurred in the field. Larvæ of this species have several times been taken on grass by the writer and others in the District of Columbia.

PUBLISHED RECORDS.

Smith and Abbot's description appeared in the year 1797 in Natural History of the Rarer Lepidopterous Insects of Georgia (Vol. II, p. 189, Plate XCV). The specific name was derived from the insect's food plant, *Commelina communis* Linn. We quote the original description and remarks:

Ph. *Noctua* spirilinguis cristata, alis deflexis: primoribus fusco-nebulosis litura diffracta maculaque ad apicem flavescentibus posticis albidis.

Feeds on Wild Comfrey (*Commelina communis*), Hickory, Groundpeas, etc. It went into the ground August 19, and the fly came out the 10th of September. This moth, though found also in Virginia, is not very common.

The illustration furnished of the moth is quite recognizable, but that of the larva might serve about equally well for *ornithogalli* or *eudiopta*, our other common species.

Smith and Abbot gave this species the name of Commelina or wild-comfrey owlet moth, and the first name we may retain for lack of a better one, since another plant, *Cynoglossum virginicum*, is the one recognized by present-day botanists as wild comfrey.

In Glover's "Manuscript Notes from My Journal" (p. 60), two references are made to *Prodenia commelinæ* in his own earlier accounts in Patent Office Reports for the years 1854 and 1855, respectively, but these accounts can not be referred to the species in question with any degree of certainty. Mention has been made by the writer in Bulletin No. 10 (new series, p. 60) of the occurrence of this species on asparagus at Colonial Beach, Va., in August.

NATURAL ENEMIES.

The habit of this larva of crawling distances in exposed situations, as, for example, across roads and sidewalks, together with its bright and conspicuous colors and large size, would seem to render it peculiarly subject to the attack of natural enemies, but as yet only one of these has been observed.

There is in the National Museum a specimen of the larva which bears upon the thoracic segments eggs of a Tachina fly, deposited in the usual manner transversely upon the dorsum. The adult was not reared, and no Tachina fly appears to be recorded as attacking this or other species of the genus.

Several times during rearing experiments larvæ that had just been taken from the field were observed to be dying of a fungous or bacterial disease, evidently the same one that is so prevalent with *Plusia brassicæ*, the cabbage looper, and similar species.

REMEDIES.

It has been reported by Mr. Quaintance (l. c.) that this species was successfully treated at the Florida experiment station with a spray of 1 ounce of Paris green to 10 gallons of water, with the addition of 1 or 2 ounces of quicklime.

Other remedies, such as poisoned baits and the like, are valuable. See account of variegated cutworm.

THE COTTON CUTWORM.

(*Prodenia ornithogalli* Guen.)

The most abundant and destructive, and consequently the best known, of the three species of Prodenia under discussion has been called the cotton cutworm, *Prodenia ornithogalli* Gn. Larvæ were found in considerable numbers on violet at Garrett Park, Md., during October, 1898, and were taken at intervals, although in much decreased numbers, during the following year; but in 1900 larvæ reappeared in numbers, in some cases occurring indoors as well as in the fields. The moths also returned in their customary abundance to the electric lights, where in ordinary autumn weather they are among our commonest Noctuids.

This species, like the preceding, is a general feeder, and has been noted to attack cotton bolls and the fruit of tomato in the same manner as does the cotton boll worm. In short, it has what is termed the boll-worm habit.

DESCRIPTIVE.

The moth.—The moth of this species can readily be distinguished from *commelinæ* by the much more complicated pattern of the fore-wings, its smaller size, and less iridescent hind-wings. The thorax lacks the two longitudinal stripes seen in *commelinæ.* There is a submarginal vein of the hind-wings which shows very distinctly, and all the veins of the hind-wings, particularly the inner ones toward the abdomen, are more distinctly marked than in the preceding species. The average wing expanse is a little less than one and one-half inches (36^{mm}), and the length of the body is about seven-eighths of an inch (22^{mm}). One individual of this species taken recently measures a little less than $1\frac{3}{4}$ inches. There is considerable variability in the depth of coloration, fresh specimens being as dark as *commelinæ*, but soon fading. The general appearance of the moth of this species is shown at figure 2, *a* of Plate IV.

In the year 1875 Dr. Leon. F. Harvey described this species (Bul. Buff. Soc. Nat. Sci., Vol. II, pp. 274, 275) under the name *lineatella*, but Dr. Smith's recent studies show that this name is antedated by Guenée's *ornithogalli.* The latter description appeared in 1852 (Spec. Gen. Noct., Vol. I, p. 163).

P. flavimedia Harv. (which is now recognized as the *c* of the Missouri figure above referred to) in like manner becomes *eudiopta* Gn.

It has several times been described in print, but a thoroughly satisfactory comparative description has not appeared.

Technical descriptions of several of the stages of the larva drawn up by Dr. Dyar are appended:

LARVAL STAGES OF PRODENIA ORNITHOGALLI.

Stage I.—Similar to *commelinæ.* Whitish, the head, tubercles, and shields black. The newly hatched larva is unspotted, but toward the end of the stage the body becomes faintly green from the food with faint subdorsal, dorsal, and stigmatal white lines, a red lateral patch on joint 5, and a diffuse streak on joints 11 and 12. Head rounded, slightly bilobed, polished black; mouth squarely projecting. Cervical shield small, black, transverse, slightly pointed centrally in front. Tubercles small, black, normal, no subprimaries; ia to iib of thorax all separate, iia minute. Anal plate and leg-shields black.

Stage II.—Head rounded, slightly bilobed, clypeus high; shining translucent light brown with a reddish shade at the vertex; ocelli black. Body gently enlarged at joints 3 to 5 and 12, rather robust, normal. Green, slightly tinged with reddish especially dorsally posteriorly; a rounded, elevate, red-brown spot laterally on joint 5 and a shade on joints 11 and 12. Dorsal line white, upper subdorsal faint, lower distinct; a fainter lateral line and two parallel fine ones below the spiracle. Tubercles black, distinct, normal. Cervical shield brown, cut by whitish lines; anal shield small, dusky. Feet normal with dusky plates.

Stage III.—Head as in the next stage, pale brown, the paraclypeus pale. Body greenish, with lines as in *commelinæ*, but more numerous, consisting of dorsal, subdorsal (upper and lower), lateral (upper and lower), suprastigmatal, substigmatal (upper and lower); a black subdorsal spot on joint 3, and a large elevated lateral one on joint 5. Substigmatal line, hump of joint 12 and subventer faintly shaded in vinous. Feet all pale.

Stage IV.—Head rounded, wider than high, slightly bilobed, the lobes full in front, the clypeus reaching two-thirds to the vertex, brownish testaceous, subreticulate, the paraclypeus pale. Body normal, gently enlarged at joints 3–5, and 12, rather robust; feet small, normal. Shields membranous, tubercles and setæ minute. Green, shaded with vinous brown, especially on dorsal line and subventrally. Dorsal line white, narrow, spotted with vinous shading; upper subdorsal narrow, lower broad, both white, the latter angled on the hump of joint 12; a black spot between them on joint 3. Lateral line narrow, white, with a fainter line above it; a faint suprastigmatal white line; substigmatal lines parallel, narrow, white, waved, joined into a sharp-edged band by vinous shading. Subventer faintly vinous shaded, white dotted. A square lateral black patch on joint 5. Concolorous cervical shield cut by three white lines. Feet plates brown.

Stage V.—Head as before, shining dark brown, paler on the sides, paraclypeal pieces contrastingly pale. Body as before, the enlargements less marked. Shaded with brown and vinous, obscuring the ground color, sparsely white strigose between the lines. Lines distinct generally. Dorsal line narrow, broken, vinous edged, obscure; upper subdorsal likewise narrow and reduced; lower subdorsal broad, distinct, edged above by segmentary brown patches, fainter than but similar to the one on joint 3; upper and lower lateral lines broken, mottled, but not obscured; suprastigmatal line fine and broken; subventral line narrow, waved, centered by red about as before. Cervical shield and anal plate brown, trisected in white. Feet brownish. Lateral patch on joint 5 brown-black, distinct.

Stage VI.—Head broad, rounded, bilobed, clypeus large, reaching over two-thirds to the vertex; brown, dark on the face, cut by the pale contrasting paraclypeal pieces. Body cylindrical, normal, shaped as in *commelinæ*. Densely and finely mottled with whitish dots on a brown ground, the marks as before but better defined. Dorsal line diffuse, red, obscurely pale centered; subdorsal distinct, broad, yellowish white, faint on joint 2, surmounted by a row of triangular brown spots on joints 3–13, cut pulverulently by the broken upper subdorsal and separated by pale intersegmental shades. Lateral area on joints 5–12 marked by upper and lower lateral lines, the lower broader but both subconfluent by mottlings with each other and the lower subdorsal, scarcely developed on joints 2–4 or 13. A faint suprastigmatal mottled and broken line. Substigmatal band, broad, red, white dotted, edged by the narrow lines; subventer white dotted. Shields and plates pale brown, the cervical faintly trisected by white; spiracles black. A brown patch on joint 5 between the lower lateral line and spiracle. Tubercular formula as in *commelinæ*. [H. G. Dyar.]

From the description which has been given of the larva of *commelinæ* in treating of that species, enough has been said to show that the principal difference between these two species consists in the greater striation of *ornithogalli* and in the fact that the dorsal velvety spots are many of them lost in the last two molts. The question of the separation of these three forms of larvæ can best be expressed in tabular form as follows:

Ground color gray, closely streaked with fine, very irregularly undulating lines.
  Upper line of latero-dorsal stripe always interrupted, usually yellow, the lower line faint or absent.
    Longitudinal stripes not strongly marked .... *commelinæ.*
Ground color similar.
  Upper line of latero-dorsal stripe, usually more or less continuous, often white or very pale yellow, lower line distinct, though narrow. *ornithogalli.*
Ground color darker, and all stripes and other markings more pronounced and more beautiful, but the arrangement is little, if at all, different. *eudiopta.*

The penultimate stage of the larva of *ornithogalli* is shown at figure 2, *b*, of Plate IV, and the final stage at *c* of the same figure. The length of the mature larva is from one and one-half to one and three-fourths inches and five-sixteenths of an inch is the width (of inflated specimens). It should be added that the figures presented of this larva are not as good as could be desired partly on account of their imperfect inflation.

DISTRIBUTION.

According to specimens in the National Museum, Divisional records of occurrence, and such few published records as have been consulted, it is obvious that this species is widely distributed through the Upper and Lower Austral life zones from Massachusetts and New York southward to Texas and westward to California. In New Jersey it is credited by Smith as occurring "throughout the State," and the New York locality is recorded by Harvey. Its occurrence in the latter state, however, does not appear to be noted in any of the fifteen Annual Reports of Doctors Lintner and Felt that have appeared to date, and as no definite locality in that State or in Massachusetts has been specified it would seem that the species is rare so far north, if, indeed, it occurs there at all in the larval condition. The same holds good for Minnesota, where the moth has been captured. This species is evidently one of several comparatively well known Lower Austral forms of moths which are able during the summer and autumn to extend their range, principally by flight, well into the Upper Austral region, where occasionally, as happened in 1889, numbers succumb during severe winters.

The list of localities which will be given, though short, may serve as a basis for additions which will indicate more clearly the range of this insect: New York; New Jersey; Lancaster, Pa.; Berwyn, Cabin John, Garrett Park, Md.; Tennallytown and Brookland, D. C.; Dayton, Ohio (Pilate); Lafayette, Ind.; St. Anthony Park (Lugger), Tensas Parish, Ashwood, La.; Holly Springs, Miss.; Archer, Fla.; Gainesville, Tex.; Lawrence, Clay County, Kans.; Fountain, Okla.; St. Francis County, Ark.; Savannah, Griffin, Ga.; Raleigh, N. C., and California.

RECENT OCCURRENCE.

This species has come under observation quite frequently during the past three years through the occurrence of larvæ upon cultivated and other plants. Prior to this date and during 1898 the moths were quite frequently seen at electric lights, particularly during autumn, but in 1899 there was a considerable diminution in their numbers, as has been related elsewhere, while in 1900 the moths returned to lights in numbers approximating their former and normal abundance.

During 1898 several larvæ were brought to the office at different times in late August and early September by Mr. P. H. Dorsett found feeding upon violets at Garrett Park, Md., and were also taken by the writer upon potted violets on the Department grounds. A larva which was nearly full grown September 6, 1898, and which entered the ground a day or two later, issued as moth October 16. From larvæ obtained from the same source September 29 moths were obtained November 10. A larva received on greenhouse violets October 14 issued as a moth in a warm room January 7, 1899.

During 1899 this larva was met with on only two occasions, early in September, when the species was found feeding upon the hogweed, *Amaranthus retroflexus*, on the Department grounds. A moth from this lot was reared September 27, 1899.

October 7 three larvæ were taken by Mr. Pratt on asparagus in the District of Columbia.

June 11, 1900, Mr. T. C. Knoop, Fountain, Okla., sent larvæ of this species with report that they were injurious to garden plants, and especially to cabbage. They were noticed in great numbers in the evening, and were seldom found during the day. They were stated to have destroyed several thousand plants on our correspondent's farm, necessitating much replanting.

July 1 a larva taken on tomato at Cabin John, Md., was one-fourth grown. At the end of a week it was three-fourths grown. The moth issued July 28. July 9 a larva was observed attacking cucumber at Cabin John, Md.

Larvæ were subsequently taken about Washington, D. C., at intervals in late September and in October, on tomato and on morning glory, moths from which issued as late as the latter days of November.

October 13 Mr. H. Walter McWilliams, Griffin, Ga., sent the larva with report that these "worms" were destroying ruta-baga turnips, field-pea vines, rape, and everything belonging to the cabbage and pea families of plants. The specimen received bore numerous eggs of a Tachina fly on the head and thorax.

EARLY DIVISIONAL RECORDS.

Our office notes concerning this species begin with the date August 27, 1881, when we received larvæ taken at Savannah, Ga. March 10, 1882, we received from Mr. Albert Koebele, Archer, Fla., a larva taken in a cotton field.

Eggs obtained from a moth of this species taken in the District of Columbia August 22 hatched on the 25th.

June 30, 1885, a larva was received from Mr. J. H. Ragsdale, Gainesville, Tex., where it was found feeding on cotton.

May 1, 1888, we received a lot of larvæ from Mr. F. M. Webster, at that time at Ashwood, La., found depredating on corn and cabbage.

The lower leaves of corn were first attacked, and then the "worms" fed on the tender unfolded leaves higher up.

June 30 of the same year Mr. Webster again sent the larvæ of this species from Lafayette, Ind., where it was also found feeding on corn.

October 28, 1890, we received the larva from Mr. F. W. Mally, Holly Springs, Miss., where it was found feeding on cotton.

June 6, 1896, we received the larvæ from Prof. F. H. Snow, Lawrence, Kans., with the report that they were destroying late-planted corn in Clay County of that State, eating both leaves and stalk down to the ground.

We have also obtained the larva from Raleigh, N. C., reported on cottonwood.

Some of the above facts have been briefly repeated by Mr. Webster in Bulletin 45 of the Ohio Agricultural Experiment Station (p. 187).

ECONOMIC LITERATURE.

This species has received comparatively little attention in economic literature. In the Tenth Report of the State Entomologist of Illinois (p. 139), Mr. John Marten makes mention of the feeding of the caterpiller on salsify. This note, however, was based upon observations made in confinement, and there is no evidence to show that the insect sought the salsify from choice.

In Insect Life (Vol. II, p. 382) Mr. F. M. Webster notes the occurrence of full-grown larvæ at Lafayette, Ind., October 29, 1888. In the same publication (Vol. III, p. 149) Mr. Webster states that the larvæ were observed in considerable numbers in April, 1888, in Tensas Parish, La., depredating upon young corn. They were also observed the same month riddling the leaves of cabbage in gardens, as also in St. Francis County, Ark., ravaging fields of potatoes, eating every vestige of a leaf from them. June 26, of the same year, young larvæ were observed at Lafayette, Ind., feeding upon the parenchyma of leaves of wheat, and a few days later upon cabbage. Still later they were feeding upon the foliage of late-planted corn.

In Bulletin 24 (o. s.) of this Division (p. 24) Mr. F. W. Mally notices the occurrence of the larva on cotton and states that it enters nearly grown bolls, feeding on their contents in much the same manner as the boll worm. Mr. Ashmead also noticed this species feeding upon cotton bolls and records the fact that it had been observed attacking young cotton plants as they appeared above ground, acres being sometimes destroyed and having to be reset to secure a good crop. The pupal stage was ascertained to be between twelve and thirteen days in August in Mississippi (Insect Life, Vol. VII, pp. 324, 325).

The occurrence of this cutworm upon asparagus at Berwyn, Md., and in the District of Columbia, in August and September, 1896, has been recorded by the writer (Bul. 10, new series, p. 60)

This is one of the common caterpillars in Illinois beet fields, according to Messrs. Forbes and Hart (Bul. 60, Univ. Ill. Agric. Exp. Sta., 1900, pp. 496–497), being found most abundantly in the caterpillar state in July and August.

FOOD AND OTHER HABITS.

A list of larval food plants has been compiled by Messrs. Forbes and Hart which includes besides cotton, beets, corn, wheat, cabbage, potato, asparagus, salsify, peach, and raspberry. To this list may now be added the foliage of violets, asparagus, cucumber, tomato, morning glory, turnips, pea, rape, ruta-baga, pigweed, cottonwood, and grasses. It seems probable that many more plants will be added in course of time. Injury has also been noted to the bolls of cotton and fruit of tomato.

Our knowledge of the life history of this cutworm is so limited that little can be said about it. What we know, however, applies about equally well to the other two species under consideration.

The moth does not appear to have been captured or reared earlier than July 28 in the District of Columbia. In cold rooms in confinement moths have bred out at intervals during the winter, and one was present in our rearing jars, and active when stimulated, February 2. It is evident that moths develop in the field as early as the last week of July and irregularly from that time, according to the state of the temperature.

The species is credited with being double-brooded, and of this there can be no possible doubt. It is more probable, however, that three generations are produced in the District of Columbia and farther South.

When fully matured the larvæ enter the earth to a very moderate depth, according to the writer's observation, and form, at least for the last generation or hibernating pupa, a tolerably compact, serviceable cocoon, moderately lined with silk and outwardly covered with sand or earth. The winter, according to Riley, is passed generally in the larval stage, but sometimes also as pupa or imago. Recent observations do not uphold this theory, since the climatic conditions are much the same in Missouri as in the District of Columbia and vicinity. In the latter locality larvæ have never been found hibernating, and it is probable that the pupæ would pass the winter under suitable conditions, but the imago often hatches out, as previously stated, at times during the winter, and it does not seem probable that all of the individuals which issue in cold weather survive cold spells.

NATURAL ENEMIES.

Mention has already been made of a Tachina fly parasite of the larva.

Limneria sp.—A larva was brought to this office June 13, 1899, by Mr. T. A. Keleher, who found it feeding upon tomato. It was at this time only about one-fourth grown, and it was somewhat surprising to find that a parasite issued from it in a few days and spun up its cocoon June 18. The adult parasite issued June 26.

Copidosoma truncatella Dalm.—A Prodenia larva of this species found on tomato September 20, 1900, was noticed to be infested with this minute Chalcidid, which issued later.

REMEDIES.

The remedies are the same as for the variegated cutworm and similar species.

THE EUDIOPTA OWLET MOTH.

(*Prodenia eudiopta* Guen.)

The moth of this species, until recently labeled in collections *Prodenia flavimedia* Harv., is nearly as often met with in the District of Columbia as the two preceding species, but until the past year the larva does not appear to have been so often observed attacking useful plants. It has not yet been identified with attack upon violet, but since it is so closely related to the other two Prodenias, and especially to *ornithogalli* Guen., from which indeed it can sometimes be separated only with difficulty, it may appropriately be considered in connection with the other two forms mentioned. During the year 1900 larvæ were several times taken on tomato, into the fruit of which they sometimes bore after the manner of the boll worm.

DESCRIPTIVE.

The moth.—The closeness with which this species approximates *ornithogalli* is such that it leads to the suspicion that they may be only dimorphic forms of the same species, a matter which could perhaps be satisfactorily determined one way or the other by rearing from the egg, an experiment which we hope to perform the coming season. The differences, indeed, are much less striking than are those of the two common forms of *Laphygma frugiperda.* The most striking character is the brighter coloration of the fore-wings, the ground color of which is more or less ochreous. The body is lighter, with an ochreous tint particularly marked at the tufted extremity. The apex of the fore-wing is well marked with whitish, as is also a little area about the tornus. The oblique band which crosses the fore-wings from near the middle of the costa toward the tornus is wider and pale yellowish, and the space between this and the dorsum is variegated pale brown. The size is about the same as *ornithogalli.*

This moth is shown at figure 3, *a*, of Plate IV.

As to the validity of this species it may not be out of place to quote the language of Professor Riley in discussing these three species.

Speaking of "*Prodenia commelinæ*" (=*ornithogalli*), he wrote (Papilio, Vol. II, p. 43):

With the well-known varieties of *Laphygma frugiperda* in mind, I have been particularly interested for a good many years in breeding this Prodenia, and I record here my belief, which will be the accepted belief in the future, that *flavimedia* and *lineatella* are one species not distinct from *ornithogalli* Guen. The larvæ, so far as I have bred material, are extremely variable and not separable, and the same may be said of the mature insects. They are more readily separable from the typical *commelinæ*, though doubts even as to their specific distinctness from it are justifiable.

In case *ornithogalli* and *eudiopta* should prove to be varieties, the former name would take precedence, as it was described first, although in the same publication.

The larva.—The general color of the larva of this species in its last stage is much darker than that of the two forms previously mentioned, the triangular spots in most individuals being velvet-black. The dorsal line is reddish-brown; the latero-dorsal stripe is bright canary-yellow, its upper fourth or third and lower sixth or eighth forming distinctly separable stripes within the main stripe, and inclosing a third duller stripe streaked longitudinally with undulating olive-brown; the lateral or stigmatal stripe just below this is a little narrower, and so closely streaked with black as to appear uniformly black except under a magnifier. The latero-ventral stripe is of about the same width as the lateral. It is light yellowish-brown dorsally, and darker brown below, mottled with white. The ventral surface of the body is olive-brown, greenish-olive medially, mottled with white.

The difference between the larva of this species and that of *ornithogalli* may perhaps prove to be of a varietal nature only.

The length of the larva (inflated) when fully matured is about one inch and three quarters (45 mm), and the width a little over a fourth of an inch (7–8 mm). An illustration of the larva, dorsal view, is given in the last object figured in Plate IV (fig. 3, *c*), the object above it (*b*) showing the lateral view of the penultimate stage.

DISTRIBUTION.

The distribution of this species appears to be the same as for the preceding, any difference that may exist, so far as our records go, being accountable for the fact that this form is liable to be confused with *ornithogalli* by those not perfectly familiar with both, as well as by the somewhat greater scarcity of the present species. In New Jersey *eudiopta* is credited by Smith with the same distribution as *ornithogalli*. It is common in the District of Columbia, and the moth is frequently taken at lights. It has also been reported at this office from St. Elmo and Falls Church, Va.; Kirkwood, Mo.; Texas and California, and it has been recorded from Massachusetts, New York, Dayton, Ohio (Pilate), and Nebraska.

RECENT OBSERVATIONS.

In recent observations this species has come under notice as follows:

July 20, 1899, a larva was taken feeding on the leaves of pokeweed, *Phytolacca decandra*, growing in the Department Insectary. This larva ceased feeding and entered the earth July 23, the moth issuing August 6.

August 10, 1900, Mr. Nathan Banks brought larvæ of this species from Falls Church, Va., less than one-fourth grown, feeding upon tomato. They fed most voraciously in confinement, and in three days had completed growth, entering the earth on the 13th and 14th of August, the adults issuing August 29.

August 16 Mr. Pratt brought a larva found at St. Elmo, Va., boring into tomato. As was to be expected, this individual was very much paler than normal, and the triangular dorsal spots were also pale and inconspicuous. This larva at once bored into a tomato when provided with one.

Larvæ were subsequently found and reared to moths on tomatoes growing in the District of Columbia. One of the larvæ kept under observation entered the earth August 31, and the imago issued September 15. Moths were obtained at lights in the city as late as the 31st of October.

Nothing can be found by the writer at the present time, in all the literature which has been consulted, concerning the biology of this species, and the same is true of our Divisional notes.

The larvæ, like those of the preceding species, have frequently been observed crawling about the grounds of the Department of Agriculture and elsewhere in the vicinity of the District of Columbia, and we have one record of the larva feeding on turnip, one of its feeding upon "bushberry," and another of attack on castor-oil plant.

REMEDIES.

For a consideration of the remedial treatment to be observed in the case of attack by this species the reader is referred to the article on the variegated cutworm.

THE FALL ARMY WORM.

(*Laphygma frugiperda* S. & A.)

The first occurrence of the fall army worm or "grass worm" on violets that appears to be recorded in our notebooks is dated August 9, 1897, when we received from Miss Louise Morris, Athens, Ga., the report that the species was injuring violets at that place, and that there were thousands of the caterpillars in the grass near by. The following month we received larvæ from Garrett Park, Md., where they were found on greenhouse violets.

As it is evident that this species has a fondness for violets among greenhouse plants, growers would do well to keep a lookout for it in times of its abundance on grasses and other outdoor plants.

A general account of this insect, with illustrations of the larva, pupa, and imago, was given on pages 78–85 of Bulletin No. 23 of the present series; and, as a more detailed account of it will shortly be published, further mention may be omitted for the present.

The remedies applicable to this species are the same as for the variegated cutworm, at least as far as the occurrence of the fall army worm in greenhouses is concerned. A consideration of remedies to be used when this species is destructive in the field was given in the bulletin cited.

WHITE GRUBS.

Several other common greenhouse pests besides those which have already received special mention are often injurious to various plants grown under glass, and are occasionally troublesome to violets by attacking their roots. Among these are white grubs and wireworms. Complaints of both forms of insects have recently been made, but unfortunately the species concerned in the injury have in no case been identified, it being a difficult matter to rear these insects from material which has gone through the mails, principally because they need the best of care and attention, and require as well a considerable period for their development, extending in some cases over a period of three years. Nearly every florist is familiar with white grubs, but he may not know that there are several hundred different forms of these creatures, each representing a different species of the family Scarabæidæ or Lamellicorns. Fortunately only a small portion of the white grubs are of prime importance economically, the remainder not attacking living plants. The destructive forms subsist upon roots under sod and about weeds and various cultivated plants, and most of these, the typical white grubs, belong to the genus Lachnosterna. They are brought into greenhouses in pots of earth, and occasionally in manure, but as a rule the species which breed in decomposing matter, such as manures, are much less destructive than the species of Lachnosterna. The different species can be distinguished from one another only by careful study, and for practical purposes it will not be necessary to consider this subject in detail in the present bulletin.

The species of white grub shown in the accompanying illustration, (fig. 20), may be taken as a type of this class of insects. The grub itself, illustrated at *e*, is of large size, of soft consistency, and white or slightly yellowish in color. The body is wrinkled, covered sparsely with fine hairs, and the head is brownish and armed with strong mandibles.

This, as well as other grubs of the same class, habitually rest in the curved posture illustrated. The parent beetle, shown at *a*, is a large species, dark shining brown in color, and, like others of its kind, familiar to nearly everyone from its habit of flying into lighted rooms in late spring and early summer, where it buzzes and bumps about upon the ceilings until it drops sprawling to the floor. The antennæ or feelers are jointed and terminate in a club composed of seven leaf-like plates, folded closely together when the beetle is resting and expanding somewhat like a fan when the insect is active. The club of the male antennæ is usually considerably longer than that of the female. The form figured, *Lachnosterna arcuata*, is a Southern one, and common in a climate like that of the District of Columbia, Here these creatures occur from about the middle of April into June, being most abundant in May; hence the name of May beetles. Farther north they are more abundant in June, and are there called June beetles. They are familiar objects at electric lights in most cities.

The life history of a white grub of the genus Lachnosterna may be given in general terms as follows: The sexes pair soon after their first

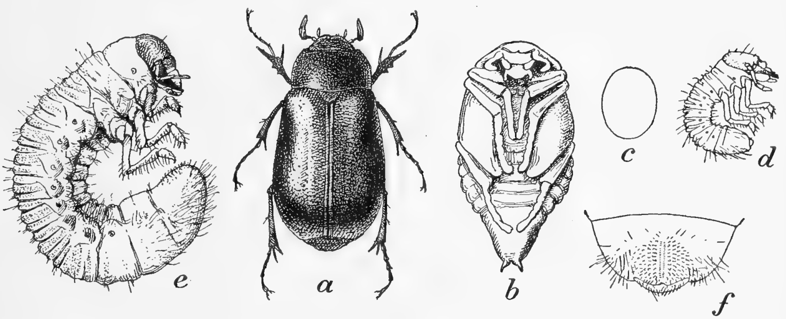

FIG. 20.—*Lachnosterna arcuata: a*, beetle; *b*, pupa; *c*, egg; *d*, newly-hatched larva; *e*, mature larva; *f*, anal segment of same from below. *a, b, e*, enlarged one-fourth; *c, d, f*, more enlarged (author's illustration).

appearance, whether in April or later in May or June. The females enter the earth and there deposit singly their rather large whitish or gray-colored eggs, one of which is shown in outline at *c* of the figure, each in a separate cell, and usually at a depth of from 2 to 4 inches. The grubs hatch and feed upon the roots of grasses and similar plants—first upon rootlets, and afterwards on larger roots—living in the earth, and slowly increasing in size for a period of two or three years. Transformation to pupa in a normal outdoor condition usually occurs from about the middle of June to September of the second or third year after hatching, the beetles developing in August or September of the same year. These remain in the earthen cells in which the pupal transformation took place until winter has passed, sometimes at a depth of a foot or a foot and a half below the surface, where protection from cold and frost is obtained.

Hibernation may occur in two stages of the larva and occasionally in a third, as well as in the beetle state, and some variation as regards the insect's life economy is to be expected in the higher temperature of a greenhouse.

White grubs are preyed upon by a host of natural enemies, including other insects, parasitic and rapacious, birds, mammals, and Batrachians. In the last class toads are the most efficient, and they are sometimes utilized for the purpose of destroying insects in greenhouses.

REMEDIES.

The habit of white grubs of passing the greater part of their existence underground and at a considerable depth renders it a matter of difficulty to reach them with insecticides. Against some forms bisulphide of carbon, kerosene emulsion, and poisoned baits have been used with some success. For use in greenhouses the best remedy, everything considered, is the poisoned baits. Of these, one of the best is the bran-arsenic mash, which has been mentioned in connection with remedies used against cutworms. In addition to the use of this mash, it is always advisable to pursue the cleanest of cultural methods, the same as has been advised against cutworms, which includes the avoidance of fresh soil which might contain these creatures, the keeping down of all grasses in the immediate vicinity of greenhouses, and particularly in the soil in the greenhouse itself. The use of fertilizers is also advisable, as it enables plants to resist insect attack at the roots.

Sterilizing the soil by means of heat or steam is also of value.

As manures are frequently infested by white grubs, and some of these are at times troublesome, it is well to exclude such forms as experience has shown contain an excess of these creatures—as, for example, horse manure. They can be identified readily by disintegrating the material, and chickens and other fowls could be utilized in destroying them before the manure is used in the greenhouses.

WHITE GRUB OF THE GREEN JUNE BEETLE.

(*Allorhina nitida* Linn.)

Complaints are frequently received from correspondents of injury by the larvæ of this species, but in most cases there are reasons to believe that the damage is really done by cutworms or some other insects, and the white grubs, on account of their large size and their habit of crawling about on the surface of the ground, are blamed for the misdemeanors of the other species.

An instance which was probably of this character was reported to this office November 21, 1898, by Mr. W. E. Pray, Kinkora, N. J., who sent specimens with report that this "grub-worm" was troublesome in his violet houses. The larvæ were first noticed soon after the plants had been put in bed, and at this time they seemed to do very little if any harm, but the ground was described as being "kept well cultivated for two inches deep by their movements." As the plants grew the larvæ were stated to begin to feed upon the fibrous roots, and were so doing at the time of writing. They were also stated to devour the outside petals of the flowers which rested upon the ground and very frequently ate into the hearts of the flowers, rendering them unfit for shipment. Specimens of violets showing the alleged work of this species were received with the white grubs. A great number of the flowers were described as having been destroyed, and a remedy was requested.

From the nature of the description of the injury there seems to be little doubt that cutworms were the authors of the damage in the case above cited.

WIREWORMS.

The term wireworm is applied to numerous forms of elongate wire-like creatures, the larvæ of snapping beetles or "snap-bugs," beetles of the family Elateridæ. Many of these species are injurious to culivated crops and are often troublesome in greenhouses to plants of various kinds, including violets. As with white grubs, however, and for the same reasons, the exact species causing this form of injury to violets have not been determined.

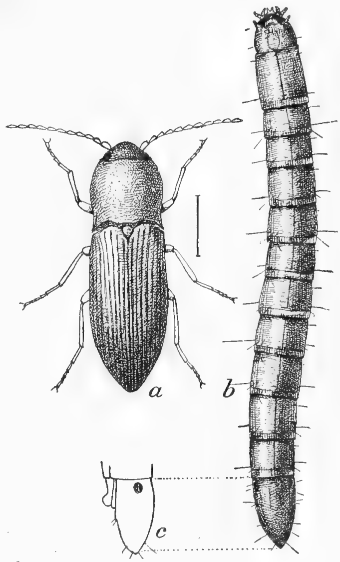

FIG. 21.—*Agriotes mancus*: *a*, beetle; *b*, larva; *c*, anal segment of larva in profile—about 4 times natural size (original).

The writer has in mind one complaint made of the ravages of wireworms to violets at Arlington, Md., reported to this office November 25, 1898, by Mr. James K. Marks, jr., who stated that the insects were giving a great deal of trouble, a remedy being desired.

A common form of wireworm in the field and one that has been identified as occurring also in greenhouses is the species figured herewith, known scientifically as *Agriotes mancus* and popularly as the wheat wireworm. It was received during April, 1898, from Mr. Milan C. Moulton, York Corner, Me., with report that it was injurious in a greenhouse there, cucumbers being attacked when no other plants were in the house. In the illustration (fig. 21) *a* represents the beetle, four times natural size; *b* the larva or wireworm, and *c* the anal segment of the same in profile.

A large proportion of these wireworms are shiny yellow in color, and the present form is no exception, while many of the adults, like the species figured, are brown and covered with close brown or yellowish pubescence.

The life history of injurious subterranean species is in some respects similar to that of white grubs, the beetles being among the earliest spring arrivals, occurring in April and May, flying rapidly in the heat of the day.

The eggs are deposited by preference in moist places grown up with grassy vegetation, weeds, or corn, and the larvæ upon hatching feed, like the white grubs, upon the roots, developing slowly and requiring about the same period for the perfection of the life cycle—about two or three years. Like the white grubs, also, the wireworms transform to pupæ in autumn, and change to the beetle form takes place before winter, the beetles usually remaining in a quiescent state until their emergence the following spring.

In the warmer temperature of the greenhouse this life cycle might vary somewhat from the normal cycle out of doors.

REMEDIES.

Owing to the extremely hardy character of the larvæ, indicated by the hard, firm texture which has given them the name of wireworms, as well as to their subterranean nature, these insects are even more difficult to treat satisfactorily than the white grubs.

Of direct applications, poisons are of little value, but salt in large quantity has been used by some persons with success for many years, and has been reported to be one of the most effective applications that can be made. Strong brine, it should be stated, must be used with caution, as it sometimes destroys certain forms of plant life.

Different forms of salty fertilizers are also said to be of value, both as stimulants to the affected plants and as insecticides. Among these are kainit and nitrate of soda.

The sterilization of the soil, clean cultivation, and poisoned baits are also indicated, the same as for white grubs. In fact, where remedial measures are in use against either cutworms or white grubs, they apply about equally well to wireworms.

One of the best forms of bait to be used consists of slices of potatoes or other vegetables poisoned in the same manner as advised in the consideration of the variegated cutworm.

MISCELLANEOUS INSECTS INJURIOUS TO VIOLETS.

A perusal of available literature shows some additions to be made to the list of the different species of insects which have been treated in preceding pages in connection with their attack upon the violet, and some insects are also mentioned in the files of this office, which have not been recorded as attacking this plant.

"*Green Aphis.*"—Two and probably more species of aphides affecting violets are known to growers, but only two have been identified specifically. These are the plum plant-louse, *Myzus mahaleb* Fonsc., which was treated on pages 52–59, Bulletin 7 of the present series, and *Rhopalosiphum dianthi* Schrank. The first of these was received November 19, 1898, from Mr. W. D. Philbrick, Newton Center, Mass., who stated that these plant-lice were usually noticed to be quite plentiful when the violet plants were first brought in under glass in the fall from the field where they are grown in the summer. This form is usually found on the underside of the large old leaves near the ground. During January and February, 1899, specimens were received from Mr. F. B. Boone, Charlottesville, Va., found on violets grown under glass. May 2, of the same year, Mr. Galloway brought specimens which were present upon violets, Scrophularia and *Capsella bursa-pastoris*, at his place.

A comparison of the nature of injury by the green aphides which attack violet and the brown or black aphis is made by Mr. A. F. Woods in a statement that the latter produces a marked stunting of the plants, while the former does little injury outside of distorting the flowers (Bul. 19, Div. Veg. Phys. and Path., p. 24, 1900).

Rhopalosiphum dianthi Schrank. was received November 21, 1898, from Mr. W. C. Pray, Kinkora, N. J., who sent two apterous specimens found upon violets at his place. These plant-lice were described as causing the flowers to turn white in spots by suction of the juices from the parts affected.

The "syringing," or, more properly speaking, spraying, to which violet plants are subjected two or three times a week to keep them free from "red spider," also serves to suppress or to at least keep down the number of aphides, and it is perhaps this remedy more than anything which has held in abeyance the so-called green aphides of violets.

A scale insect on violets.—A scale insect known as *Dactylopius virgatus* is on record as attacking violets (Insect Life, Vol. V, p. 247).

Butterfly caterpillars.—A considerable number of butterflies of the genus Argynnis subsist in the larval condition on wild violets, which is their normal food plant, and these and related species which attack wild violets are liable at any time to attack cultivated plants. Among related species which have similar habits is *Melitæa editha* Boisd.

The variegated fritillary (*Euptoieta claudia* Cram.).—One of this group of butterflies, the Nymphalinæ, is the species above mentioned. July 2, 1900, we received a number of caterpillars of this species from Mr. Willie A. Toole, Baraboo, Wis., with report that they were found on young pansies and were numerous enough to cause some damage. Writing again October 27 our correspondent stated that this species was very plentiful during the year, more so than in the preceding season, and expressed the opinion that if it continued to increase as it had done it might become a serious pest. During the past season the butterflies paid in part for what injury the caterpillars had accomplished, in the fertilization of the pansies—bumblebees, the insects which usually bring about this result, having been unusually scarce.

FIG. 22.—*Euptoieta claudia:* *a*, mature butterfly; *b*, caterpillar; *c*, pupa—all natural size (original).

A full account of this species has been given by Dr. S. H. Scudder in his "Butterflies of the Eastern United States and Canada" (Vol. I, pp. 519–527) where the different stages are fully described and figured, and other obtainable facts are detailed. The life history, however, is still somewhat incomplete. A shorter account is given in Dr. W. J. Holland's "Butterfly Book" (pp. 99, 100).

This butterfly varies in the depth of markings as well as in size, the wing expanse being from an inch and three-fourths to two inches and three-fourths. The upper surface is dull ferruginous or pale brown, shaded on the inner moiety with darker brown, and beautifully marked, lined, and spotted with black, forming a pattern more or less like that depicted in the illustration at *a*.

The caterpillar (*b*) is of cylindrical form, reddish or yellowish red in color, and marked with two brown lateral bands and a series of zigzag white interrupted lines upon the back. There are six rows of short, black, branching spines upon the body. The first thoracic segment bears a pair of these spines nearly twice as long as the remainder.

The chrysalis or pupa is nearly white in color, marked with dark brown and black spots, the dorsal surface being ornamented with golden tubercles arranged in rows. Altogether it is a most beautiful object. It is illustrated at *c*.

This species has a wide distribution, extending from Long Island and Connecticut southward, and westward from Virginia over practically the entire continent and into South America, where conditions favor its development.

It is recorded to feed upon the passion flower.

Oligia grata Hbn.—December 6, 1900, Mr. G. W. Morris, Poindexter, Va., wrote that this species of Noctuid was concerned in injury, with the spotted cutworm (*Noctua c-nigrum*), to violets grown in his vicinity. Both blooms and leaves of the plants were eaten.

The red-banded leaf-roller (*Lophoderus triferana* Walk.)—This species was reared from larvæ found feeding upon violets in the District of Columbia, August 13, 1897. It is a common species of the family Tortricidæ, and infests, besides numerous field and garden crops and fruit trees, rose, chrysanthemum, Lobelia, honeysuckle, and some other ornamental plants.

Unknown Tortricid.—November 7, 1898, we received injured specimens of a small Tortricid larva from Mr. H. B. Boone, Charlottesville, Va., with the statement that the species was troublesome to violets at that place. A remedy was requested to expel them from the beds in which they were lodged.

A leaf-miner on violets.—During September, 1885, a few larvæ of a leaf-miner were noticed on violets in Virginia near the District of Columbia. The larva was obviously coleopterous and evidently belonged to the family Chrysomelidæ, subfamily Halticini. It mined a large blotch on the upper side of the leaves. Unfortunately the species was not reared.

The yellow bear (*Spilosoma virginica* Fab.)—The yellow bear is of very common occurrence in greenhouses but fortunately for the florist it is more abundant in the field, orchard, garden, and vineyard, and as it does not appear to prefer any particular greenhouse plant, attack is usually so distributed that injury is not felt if careful watch be kept for the appearance of these larvæ so that they may be promptly destroyed.

June 27, 1900, Mr. Dorsett reported this species as occurring on violets in his greenhouse at Garrett Park, Md. A number of specimens were brought to the writer from which the moths began issuing

July 19. On the same date we obtained moths from larvæ received during June from Mr. J. H. Heard, Montreal, Ga., where they were found attacking cabbage. August 8 another lot of larvæ were received from Mr. Dorsett. It was also observed on two earlier occasions in July in 1898 and 1899.

Arctia nais Dru. (?)—Specimens of the larvæ of what were believed to belong to this Bombycid moth were received November 10, 1898, from Mrs. H. B. Boone, Charlottesville, Va., with report that they had been found in violet beds at that place.

Injury to violets by myriapods, sow-bugs, etc.—Different species of myriapods, or thousand-legged worms, and sow-bugs or wood-lice have been reported as occasioning injury to cultivated violets.

The myriapods are not positively known to be the cause of original damage to plant life, but it is not impossible that they assist in injury after the plant has become weakened by the attacks of true insects, such as cutworms and other caterpillars. Myriapods are scavengers by nature, and the product of damp and neglected soil containing an excess of decomposed vegetable matter or soil humus.

Two species have recently been identified in connection with injury to violets, and determined by Mr. O. F. Cook, of this department, as *Orthomorpha gracilis* (C. L.) Koch, a form found in troublesome numbers in and about the District of Columbia, and *Campodes flavicornis* (C. L.) Koch. The latter was reported January 14, 1901, by Mr. James K. Marks, jr., Arlington, Md., to be found in the ground about violet plants, which seem to die as soon as these thousand-legged worms congregate about them. It was stated that these creatures ate the small white roots of the plants.

In the American Florist for December 14, 1893 (Vol. IX, p. 448), the late Dr. C. V. Riley published a short letter in answer to correspondence concerning the occurrence of a myriapod identified as of the genus Julus said to be injuring violets, locality not stated.

A common species of sow-bug, *Armadillidium armadillo* Linn., occurring in the District of Columbia and vicinity. has been reported to do occasional damage to violets.

A species of sow-bug was received at this Department in 1890 from New Orleans, La., with the statement that it was destructive to the flowers of violets and pansies at that place and the present year, March 26, 1901, Miss N. L. Horlbeck reported injury to violets at Charleston, S. C.

Sow-bugs or pill-bugs, as they are also called, are not true insects, but crustaceans, but as they as well as the myriapods are classed by florists and the public generally with true insects, they may properly receive passing mention in this connection.

Injury by sow-bugs is apt to be exaggerated in many instances, still these creatures are often troublesome in greenhouses and in similar locations. Ordinarily they can be kept in check by poisoned baits, the same as those used against cutworms, or still better by distributing about the places which they infest slices of potatoes or other vegetables that have been dipped in a solution of Paris green prepared at the rate of about 1 pound to 100 gallons or a little less of water.

Aphodius granarius Linn.—March 15, 1901, Mr. A. F. Woods showed the writer specimens of this common dung beetle with report that it occurred in great abundance in a violet house at Takoma Park, D. C. He stated that in a small corner of the house hundreds of thousands of the beetles could be seen crawling and tumbling over each other. So far as we know, this dung beetle agrees with others of its kind in being innoxious. There is, however, a recorded instance of reported injury, that by Prof. C. H. Fernald (Bul. 1, Hatch Experiment Station, Mass. Agric. College, p. 3). Specimens of the beetles were received from Lancaster, Mass., with the statement that they had been found destroying seed corn in the ground before it had sprouted. This is one of our commonest dung beetles, and its occurrence in the violet house was, of course, due to the presence of manure in which the species breeds. It has been surmised that from the known habit of this species feeding in part on fragments of undigested grain that it might, under favoring conditions, transfer its attentions to seed corn in the hill, but this seems somewhat doubtful.

ROSE BUD-WORMS AND LEAF-TYERS.

Among the many insect pests which the florist has to combat in the cultivation of roses grown under glass are several small species of bud-worms and leaf-tyers, the larvæ of moths of the family Tortricidæ. Of these some of the most important will be considered.

THE ROSE BUD-WORM.

(*Penthina nimbatana* Clem.)

RECENT INJURY.

During the past summer the attention of the writer was called to the work of the larva of *Penthina nimbatana* Clem. on hothouse roses through Messrs. Erwin F. Smith and P. H. Dorsett, of this Department. July 8 word was first received of injuries to roses in the greenhouses belonging to Mr. Alexander Garden at Anacostia, D. C. The insect was in the larval condition when received, July 11, and remained so, feeding until July 13, when one or two showed signs of approaching transformation. The roses were being injured by the work of the larva on the foliage, buds, and flowers, the buds especially suffering.

Rose appears to be the only known food plant of this larva, and heretofore, it appears, it has never been recorded as attacking any portion of the plant other than the leaves. In our Divisional notes, however, there is a record of the rearing of the moth, December 22, 1896, from larvæ found December 15 folding leaves and injuring buds of roses in a hothouse in the District.

PUBLISHED RECORDS.

The first record that the writer finds of the food habits of this species was published in 1881, a note by Mr. D. W. Coquillett of four lines, descriptive of the larva and its food plant, wild rose, *Rosa blanda* (Tenth Rept. State Entom. Ill., 1881, p. 153).

Mr. C. H. Fernald in his Catalogue of the Tortricidæ of North America, published in May of the following year (Trans. Amer. Ent. Soc., Vol. X, p. 31), mentions rose as a food plant. In the same year, 1882, Mr. Coquillett, in comparing the larva of this species with that of *Cacœcia rosaceana* Harr. (11th Rept. State Entom. of Ill., p. 12), states that they are utterly indistinguishable from each other in certain individuals, and makes the further remark that *nimbatana* was reared by him only from *Rosa blanda.* "It binds three or more of the terminal leaflets together for a habitation, and there appears to be only one brood produced in one season."

The next year the same writer gives a brief description of the larva in Papilio (Vol. III, p. 101). Larvæ "were taken the first week in June; they pupated a few days later, and the imagos issued June 20 and 21."

During the same year the late Dr. J. A. Lintner published a note on injuries by this species to rose plants in greenhouses (Count. Gent. Mar. 1, 1883, p. 169). This note was in response to inquiry from a correspondent, "D. J. G.," Scarsdale, Westchester County, N. Y., dated February 7 of that year.

In his Fourth Report as Entomologist of the State of New York (1888, pp. 213–215), Dr. Lintner gives a more extended account of this species, with illustrations of the moth.

DESCRIPTION AND DISTRIBUTION.

The parent insect is a small moth of the family Tortricidae. It is shown in the accompanying illustration (fig. 23, *a*). The general color is brownish gray, the outer portion of the fore-wings and the under surface of the hind-wings being lightest. The inner portion of the fore-wings is dark brown in color, mottled with white, black, and light purple spots, the prevailing pattern being about as indicated in the figure. The wing expanse is about five-eighths of an inch (16^{mm}), and the length of the body is about half as long.

This species has a rather wide distribution, as the following list of localities, based for the most part on outdoor occurrences, shows:

Maine; Massachusetts; Albany, Scarsdale, and elsewhere in New York; Pennsylvania; District of Columbia; Woodstock and elsewhere in Illinois; Wisconsin.

THE LARVA AND PUPA.

The earliest stages of this species do not appear to have been studied. The full-grown larva is shown at *b* of figure 23. The head and cervical shield are shining dark blackish brown, verging to black in the outer portions, the three pairs of forelegs and two lateral marks on the first thoracic segment are dull black. The remainder of the body is rather bright, clear apple green in color, which means that the spiracles, except on the first thoracic segment, the piliferous warts, and the anal plate are all concolorous. The length of the mature larva when fully extended is a little less than five-eighths of an inch ($14–15^{mm}$).

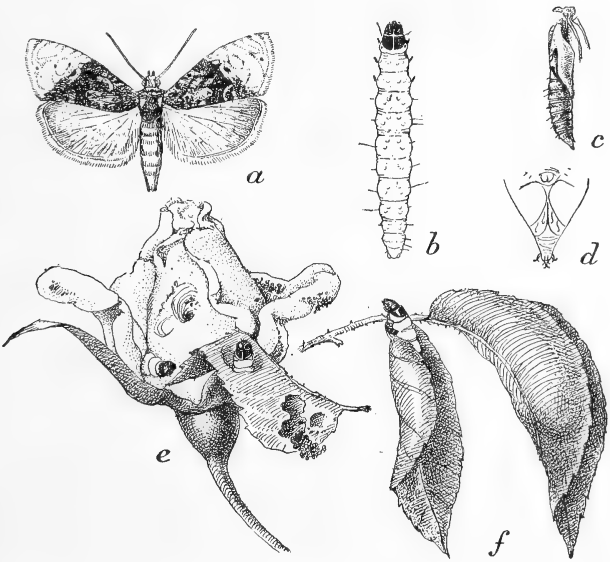

FIG. 23.—*Penthina nimbatana*—*a*, moth; *b*, larva; *c*, empty chrysalis skin; *d*, terminal segment of pupa; *e*, rosebud, showing larva at work; *f*, leaves folded by larvæ—all twice natural size, except *d*, which is greatly enlarged (original).

At *c* and *d* of the illustration the pupa is shown, *c* representing the empty chrysalis skin after the escape of the larva, and *d* showing the character of the anal segment. The length is nearly three-eighths of an inch (8^{mm}), and the color is light brown.

At *e* of the figure the manner of work of the larva on an unopened rosebud is illustrated, and at *f* two leaves are figured as folded by the larva. The leaves of the rose are joined together after the manner of the larvæ of this group of insects by silken threads and the larva lives within the case thus made, feeding upon the leaves of which it is composed, and later leaving it to attack others.

LIFE HISTORY.

The life economy of this rose pest has not been fully investigated. The parent moth, according to Lintner, who has observed the species in New York State, and from whose writings (l. c.) the following account of the life history is in the main compiled, appears in ordinary seasons in the vicinity of Albany about the middle of April. Its eggs are laid at night and presumably on the terminal leaves of rose bushes when they are pushing out from the buds. The caterpillar or larva, after hatching, begins by binding together the margins or surfaces of a folded leaf. With an increase of size the leaf, partly eaten and opened out by its rapid growth, is abandoned for another, or the larva selects two contiguous leaves and fastens them together. This habitation in turn, with the more advanced growth of the creature, is deserted for still more ample quarters, which it finds among several of the terminal leaves or in the unopened buds, as has been shown by recent observation in the District of Columbia.

Larval growth is rapid and at each successive molt the papillæ or piliferous warts and the hairs proceeding from them become more conspicuous. By the end of May the larvæ have attained full maturity, cease feeding, and are then believed to drop to the ground to undergo their final transformations among the dead leaves. The reason for this belief is that the pupæ have never been found among the folded or fastened leaves on the rose bushes.

The period of pupation is about nine or ten days. The moth of the first generation has been observed abroad at Albany as early as June 2. Eggs are laid for a second generation and the new operations of the caterpillars are soon to be seen and are extended into July. Dr. Lintner expresses the opinion that there is possibly a second generation,[1] since the transformations among insects of this class are quite rapid and several generations are of common occurrence in many species. The latest date recorded near Albany was July 25.

The fact of our rearing this insect to the adult from larvæ taken in December would seem to indicate that there may be three, or perhaps even four, distinct generations developed each year, under glass at least, in a climate like that of the District of Columbia.

As the name of rose leaf-tyer is preoccupied by *Penthina cyanana*, which will presently receive mention, rose bud-worm is proposed as a suitable appellation for this insect.

A PARASITIC ENEMY.

One larva received from Anacostia was seen to be parasitized, the parasites being noticed in the larval condition from July 11 to 13. The adult parasites began to issue July 15 and were identified by Mr. Ashmead as *Eulophus cyriades* Walk., a Chalcidid fly.

[1] In speaking of the different generations, Lintner mentioned the first appearing moths as one brood, and the first generation hatched during a year (which the writer considers the first generation) as a second brood, and the second generation as the third brood.

REMEDIES.

This species is amenable to the same remedies as the greenhouse leaf-tyer, considered in the initial article of this bulletin.

The presence of the caterpillars on roses is so obvious as to be easily detected, and all that is necessary in many cases when they are found in the leaves is to crush them between the thumb and forefinger. If the greenhouse is not fumigated the only remedy after the caterpillars have attacked the buds is to cut off the buds and burn them, or destroy them by crushing under foot.

Owing to the concealed manner of life of the larva it is doubtful if insecticides would be of much value when the insect is found on roses in gardens, hence hand methods must be resorted to.

The larvæ of a number of other moths, mostly Tortricidæ, attack roses in much the same manner as the rose bud-worm. Some of the best known of these may be briefly mentioned.

THE ROSE LEAF-TYER.

(*Penthina cyanana* Murtf.)

A species closely related to *Penthina nimbatana* is *P. cyanana*, which was described by Miss Murtfeldt in 1880 (Amer. Ent., Vol. III, pp. 14–15). The habits of this species do not appear to differ materially from those of *P. nimbatana*. It is more abundant on roses growing in the open, but according to Mr. G. C. Davis it also attacks roses in greenhouses. Of its injuries at Kirkwood, Mo., Miss Murtfeldt wrote that it was occasionally so abundant as to devour or mar fully 20 per cent of the rosebuds, especially of white or light-colored varieties.

Among the notebook records of the Division of Entomology this is stated to have been found by the late Dr. Riley in injurious numbers on his roses at Washington during the summer of 1879. July 6 of the next year he received rosebuds containing larvæ, which were reared to the adult, from Mr. Henry Plumb, Pleasanton, Kans.

This species was found at work on roses at Alexandria, Va., by Mr. T. A. Keleher, of this office, in July, the imago issuing in the middle of that month.

The recorded distribution of this species comprises portions of the states of Missouri, Kansas, Pennsylvania, and Michigan, and to this list may be added the District of Columbia.

As in manner of life all these rose pests are similar, the remedies to be applied are the same.

THE OBLIQUE-BANDED LEAF-ROLLER.

(*Cacœcia rosaceana* Harr.)

One of the most important of the leaf-rollers, from the economic point of view, if we consider its injuries to all its food plants, is

Cacœcia rosaceana. This is a well-known enemy of all sorts of fruit crops of the family Rosaceæ, as well as of several other orders, and is treated in most popular works on agricultural entomology.

Specimens of pupæ and adults of this species were received from Mr. S. S. Wilson, Libonia, Pa., with the statement made in an accompanying letter dated May 3, 1898, that it was received by him in a shipment of roses from a firm in Ohio, and that, on examining the roses, larvæ and chrysalides were found, and many of the leaves of the plants were eaten away.

THE ROSE LEAF-FOLDER.

(*Cacœcia rosana* Linn.)

This is an introduced species which attacks roses, but is not, so far as the writer is aware, particularly troublesome, at least in greenhouses. It is very likely to become injurious, however, at any time. It is figured and described as an enemy of currants by Messrs. Comstock and Slingerland (Bul. XXIII, Cornell Univ. Expt. Sta., pp. 119–121), and has been stated by Dr. Lugger to attack also the apple, wild rose, raspberry, hazel, hawthorn, and gooseberry (Fourth Annl. Rept. Entom. State Expt. Sta. Univ. Minn., 1899, p. 228).

OTHER LEAF-ROLLERS.

A short notice of injuries by the fruit-tree leaf-roller, *Cacœcia argyrospila* Walk., to the buds of roses in greenhouses was published in Insect Life (Vol. III, p. 19).

To this list must still be added, as species that are known to attack roses, and are hence likely at any time to invade the greenhouse and assume the bud-destroying habit, several other Tortricids, among which may be mentioned the grape-berry moth, *Eudemis botrana* Schiff., *Platynota flavedana* Clem., *Tortrix albicomana* Clem., *Cenopsis pettitana* Rob., and *reticulatana* Clem., as also *Lophoderus triferana* Walk., elsewhere noted as a violet insect.

FULLER'S ROSE BEETLE.

(*Aramigus fulleri* Horn.)

Various greenhouse plants, and roses in particular, are often severely injured and destroyed, unless remedial measures are adopted, by a moderate-sized, obscure, brown or gray snout-beetle, commonly known as Fuller's rose beetle, *Aramigus fulleri* Horn. Prior to the year 1874 this species does not appear to have been recognized; in short, its technical description was not published until the Centennial year. At about that time and soon afterwards, as well as at intervals later, it has attracted considerable attention on account of its ravages on roses, camellias, geraniums, and other ornamental plants in different portions of the country, particularly in the Eastern States, and more especially in New Jersey, New York, and Massachusetts. During the last two years this species has been troublesome to roses and carnations, especially in portions of New York and Wisconsin, and in lemon groves in California as well as in Hawaii.

This insect is destructive in both of its active stages, doing most damage as a larva, when it lives in the soil and feeds upon the roots of its food plants, the beetle practically confining itself to the foliage, flowers, and buds of the plants which it attacks. Although preeminently a greenhouse pest in California, particularly in the southern portion, groves of orange and lemon as well as other trees sometimes suffer much injury.

DESCRIPTIVE.

The beetle.—The adult of this insect is one of the so-called scarred snout-beetles (of the family Otiorhynchidæ), and was given its specific name in honor of the late A. S. Fuller. It measures from a quarter to nearly three-eighths of an inch in length, and is of the form shown in figure 24 at *c* and *d*. The snout is quite short and scarred at the sides of the mandibles. The head is white, and the abdomen is ovoid. The color is dark dirty brown, and the entire body, including the legs, is lightly covered with gray or pale-brown scales. On each side of the elytra there is a whitish diagonal line.

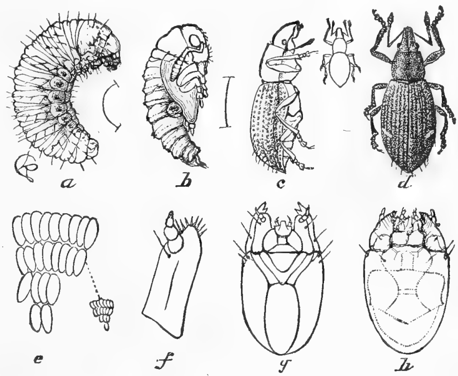

FIG. 24.—*Aramigus fulleri:* *a*, larva; *b*, pupa; *c*, beetle, outline side view; *d*, same, dorsal view, the outline between them showing natural size; *e*, eggs enlarged and natural size; *f*, left maxilla with palpus; *g*, lower side of head of larva; *h*, upper side of same enlarged (from Riley).

The egg.—An egg mass is shown in the illustration at *e*, greatly enlarged, the natural size being indicated at the right side. An individual egg measures about 0.9^{mm} in length and about one-quarter that in width. It is smooth, soft, and of a pale translucent yellow. The normal form is ellipsoidal, but great variability occurs from the close compression of the eggs, as they are deposited in rows.

The larva is shown in the illustration at *a*. It measures about 8^{mm} in length, is milky white in color; is destitute of organs of locomotion, and when in resting position is arched usually about as shown.

At *f* the left maxilla of the larva with its palpus is shown; *g* illustrates the under side of the head, and *h* represents the upper side, these last three figures being much magnified.

The pupa is about 7^{mm} in length, and of the same milky white color as the larva. It is shown, side view, in the illustration at *b*.

DISTRIBUTION.

At the time this species was described in 1876 (Rhynchophora of America North of Mexico, pp. 94, 95) it was known to have a wide distribution, stated to be "from New Jersey to Montana." At the present time it is known to occur from Maine to California, and has been reported at various times as being destructive in greenhouses in a large number of states. The habit it has of feeding in the larval state in the earth about greenhouse plants makes it peculiarly susceptible to transportation with the plants from one locality to another, and it is quite remarkable that it does not cause more destruction than is reported.

The first observed specimen of this insect appears to have been received by Mr. A. S. Fuller from Montana, and as the only other species of the genus Aramigus is American, it seems probable that, in spite of the fact that the insect lives almost exclusively indoors, it is native to America, although probably of neotropical origin. It was probably introduced from Mexico.

A list of localities follows: Bucksport, Me.; Cambridge, Boston, Worcester, Mass.; New York, Rochester, Little Falls, Poughkeepsie, Albany, Long Island, N. Y.; Madison, Summit, Jersey City, Union County, N. J.; Baraboo, Wis.; Mt. Airy, Griffin, Ga.; Sandwich, Ill.; Montana; National City, San Francisco, San Diego, Los Angeles, Fullerton, Cal.; Brantford, Stewarton, Ottawa, Canada, and Hawaii.

Concerning the distribution and periodicity of attack of this species, Mr. Schwarz of this office has pointed out (Proc. Ent. Soc. Washington, Vol. III, p. 145) that the insect does not occur so far as we know out of doors, either in Montana or in neighboring states farther south, although it is known to live outdoors in California.

If it could be proved that it lived in Montana originally, we have a case of rapid diffusion eastward analogous to that of the Colorado potato beetle, the weevil having spread to the Eastern States only a few years after that Chrysomelid. There is this difference, however, that the latter became disseminated mainly by flight, and the former, a wingless insect, through the agency of man.

RECENT INJURY.

March 15, 1900, Mr. Willie A. Toole, Baraboo, Wis., sent specimens of the larva of this beetle with the information that the insect was very troublesome in greenhouses around the roots of rose-scented geranium. They first eat the fine roots and then the larger ones, and when they get through with the plant there is nothing left of the roots but a few stubs. They appeared to prefer geranium to any other plant growing in houses there, and they always came under observation in winter. The species was kept in check to a considerable extent by turning the plants out of their pots and picking out such grubs as could be seen and killing them, and by digging up and picking out the grubs from the dirt in the benches.

Mr. C. L. Marlatt of this office informed the writer that this species caused injury in lemon groves near San Diego, Cal., during July, 1900, and that in that portion of the country it is known as an occasional pest, having been established there for a number of years.

A similar report of injury in the same locality was received from Mr. G. P. Hall, April 19, 1899.

OCCURRENCE IN THE HAWAIIAN ISLANDS.

During February, 1901, we received specimens of this species from Mr. Albert Koebele, at present stationed at Honolulu, H. I., with notes upon its habits. These specimens have been compared with authentically determined *Aramigus fulleri* by the writer, as well as by Mr. Schwarz and Mr. Charles Fuchs, and there is no doubt of their identity. It seems that the species is known in Hawaii as the Olinda bug, and has been described by Mr. V. R. Perkins as *Pandamorus olindæ*. Some notes are furnished by Mr. Koebele, which bear upon the insect's life economy. Its presence has been frequently noticed upon trees as well as upon Hilo grass. Many trees of Java plum recently planted have been seen by Mr. Koebele with every leaf eaten off, and some have died from the effects of the beetle and Hilo grass combined. The insect appears to be most numerous along the border of forests, and is found from the seashore as high up as 5,000 feet elevation. Seven years prior to the date of writing the beetle was seen from Paia, where it was destructive to roses and garden plants generally. Our correspondent believes that it must have been present on the islands long before it became prominent as a pest, and he as well as Mr. Schwarz, the writer, and some others are inclined to the belief that it is an introduction from Mexico—Mr. Koebele believes probably from Acapulco, but does not state reasons.

Larvæ have been found under stones, and in large numbers also in galls produced by Tortricidæ.

HISTORY AND LITERATURE OF THE SPECIES.

Fuller's rose beetle appears to have been first brought to notice as a pest in the year 1879, when Peter Henderson published a four-column illustrated article concerning it in the "Gardeners' Monthly" for March of that year (pp. 86, 87).

This species furnishes an interesting example, analogous to that of the so-called black aphis of the violet, of how long an insect can do extensive damage before public attention is drawn to its ravages or even to its identification. In Mr. Henderson's article he states that by correspondence with rose growers in six different states, and from personal observations, he had been forced to the conclusion that, in a large majority of cases where cultivation of roses during the winter proved unprofitable, the trouble was traceable alone to the ravages of this rose beetle. Owing to the small size and inconspicuous appearance of the beetle, and its habit of shunning the daylight and concealing itself under the leaves, as well as to the subterranean habits of its larva, its presence is not apt to be noticed by any except the most observing, or by persons who have had experience with it. The account in question includes, besides mention of injury by this species at Madison and elsewhere in New Jersey in the vicinity of New York City, a letter from Dr. Riley giving in condensed form what was known at that time concerning the insect's history, classification, distribution, and biology.

This article was followed by a more extensive one by Dr. Riley in the same publication for October (pp. 310, 311), republished from the Scientific American of August 30, 1879 (p. 129), these last two accounts including the illustration used in the present article. All of this matter was brought together in Dr. Riley's report as Entomologist for the Department of Agriculture for 1878 (Nov., 1879, pp. 255–257), technical descriptions of the immature stages being added. Injury at that time was most noticeable to roses and camellias. In the Report of this Department for the following year (pp. 250, 251) Professor Comstock furnished a few notes on the destructive occurrence of this insect at San Diego, Cal., in 1879, adding some unrecorded food plants and making mention of a wireworm found preying upon the larvæ.

An interval of four years elapsed before injury by this species was again noticed, at least so far as published records go. In November, 1883, we received complaint from Worcester, Mass., of injury to Azalea and Cissus (Report Dept. Agric. 1884, p. 414).

In December, 1884, injury was complained of to Dr. Lintner by extensive rose growers at Poughkeepsie (2d Report State Entom. N. Y., 1885, pp. 142–144). Dr. Lintner states that this species was first brought to his notice in 1874 because of injury to camellias and other foliage in conservatories at Albany, N. Y. The same writer had an article in the Country Gentleman of February 3, 1887, based upon injuries of this rose beetle at Bucksport, Me.

In 1889 Mr. Coquillett reported this species to be injurious in Los Angeles County, Cal., where it was mistaken for the plum curculio. It was very destructive at that time to the foliage of oak, camellias, palms (*Washingtonia filifera*), *Canna indica*, and several other plants.

The following year a short account of this species and its occurrence in California was given in the Annual Report of the State Board of

Horticulture of California for 1889 (1890, pp. 227, 228). An account by Dr. James Fletcher, in his report as entomologist and botanist of the Dominion of Canada, 1889 (1890, pp. 88–90), appeared at about the same time. Injury was noted at Stewarton and Ottawa, Canada, roses having been much injured. Begonias and lilies were also attacked. Dr. Fletcher also published an account, with original illustrations, in the report of the Entomological Society of Ontario for 1890 (1891, pp. 62–64).

In the year 1894 Mr. John G. Jack (Trans. Mass. Horticultural Soc. for 1894, p. 147) mentioned this species in connection with injury to primroses in the vicinity of Boston, Mass.

Brief mention of injury to carnations is given by Mr. F. A. Sirrine in the American Florist for March 3, 1900 (p. 913). Damage was noticed at Little Falls, N. Y., in October of 1899, and followed the removal of roses from the greenhouse in which the carnations grew.

There are several other notices of this species in addition to those which have been mentioned, but a few of these are not accessible, and others add little to our knowledge of the insect or its habits.

DIVISIONAL RECORDS.

Of reports of injuries other than those that have been already cited, the following are on record in the office, each communication which will be mentioned having been accompanied by specimens:

December 5, 1879, information was received from Mr. E. J. Wickson, San Francisco, Cal., of injuries by this species in orchards and gardens.

November 30, 1883, Dr. C. W. Minot, Worcester, Mass., wrote that this insect was found in greenhouses, and that its favorite food plant was Azalea; but Cissus and "inch plant" were also attacked. It was noticed by our correspondent that the beetles were to be found during the middle of the day perched as high as possible on the plants which they infest, and that they seek concealment upon the slightest disturbance. They fed upon the new shoots and tender leaves, and when a plant was permitted to stand alone they would frequently trim off the new shoots as fast as these appeared. The beetles disappeared about the first of January, a new brood replacing them in the spring.

December 31, 1889, Mr. A. W. Orr, Sandwich, Ill., wrote that the beetles were doing great havoc in greenhouses; they were described as gorging themselves and then crawling to the axils of the leaves or branches.

June 13, 1890, Mr. J. N. Harris, Griffin, Ga., stated that the beetles ate rose leaves and those of cape jessamine, stripping the bushes in a short time.

September 26, 1892, Messrs. George R. Hinde & Co. wrote that this species was becoming a pest at Fullerton, Orange County, Cal., by eating the foliage of young nursery trees of the citrus group; the beetles were found on apricot, pear, and other trees, and attack on persimmon was noticed. Our correspondents observed that the beetles concealed themselves behind or between the leaves, or in other retired places, and when disturbed suddenly dropped to the ground and feigned death to escape observation, which they were easily able to do, owing to their color bearing so close a resemblance to the dry soil.

September 10, 1896, a communication was received from Mr. David A. Horton, National City, Cal., that the insect was depredating on orange in that vicinity.

SUMMARY OF FOOD AND OTHER HABITS.

In addition to roses this species, as has been previously related in treating of its recorded history, feeds upon geranium, Hibiscus, Dracæna, orange, lemon, cape jessamine (Gardenia), Java plum, Achyranthes, Abutilon, Plumbago, Azalea, "Cissus," "inch-plant," carnations, Begonias, lilies, primrose, Hilo grass, oak, camellia, palms, and canna. Tea roses appear to be particularly susceptible to attack, and geranium seems to be preferred next after roses. The beetles are of nocturnal habit, feeding so far as known only after dusk. During the day they are generally quiet, resting in more or less concealment under or among the leaves of their food plants or clinging to the twigs or smaller branches in such positions as not to be readily observed. They are quite active at night and feed voraciously. When disturbed they "play 'possum," after the manner of many other Coleoptera, and particularly beetles of the same family, by dropping to the ground and drawing their legs and antennæ tightly to their bodies. As they often remain motionless for a considerable time and as their color is so very similar to that of the earth about their food plants they readily escape notice. They feed principally upon the leaves, but their greatest injury is accomplished by severing the leaves more than by the quantity of foliage consumed.

The life history of the insect as worked out at this office several years ago is approximately as follows:

The eggs are deposited in flattened batches consisting of several contiguous rows, each batch containing from ten to sixty eggs. The female, as in another species of the same family, which has been treated in earlier bulletins (see account of *Epicærus imbricatus* in Bulletin 19, pp. 62–67), has the habit of secreting her eggs by thrusting them between the loose bark and the stem, especially at the base just above the ground. In upward of twenty batches examined the eggs were found to have been thus concealed, either between the loose bark, as described, or in some similar crevice. More rarely they are deposited upon the ground between the earth and the main stem of the plant, and the eggs adhere so firmly together, and to the place of deposit, that they are not so easily seen and are also with extreme difficulty detached. The eggs observed required about a month to hatch.

The newly hatched larva, which is pale yellowish in color with light brown mouth-parts, is quite active, and upon hatching burrows immediately into the ground, where it soon acquires a bluish hue.

The larval period does not appear to have been ascertained, but it is with little doubt at least one month, and perhaps two or three more, this stage being passed entirely in the ground, where the pupa state is also assumed. As this species lives by preference, at least in most of the United States, under glass, there can be no great regularity in the duration of the periods of transformation. The insect may, in fact, be found in all stages during the winter and early spring months, injury appearing to be most noticeable in December.

NATURAL ENEMIES.

A single carnivorous insect appears to have been recorded as preying upon the larvæ of this beetle, this observation having been made in the rearing cages at this Department in 1878. The insect was a wireworm, the larva of a click-beetle, and was somewhat doubtfully referred to *Drasterius amabilis* Lec.

Toads are frequently found in greenhouses, and sometimes are purposely put in such places to prey upon destructive insects. They are known to feed upon insects related to this rose beetle, and probably feed upon the species in question.

Natural enemies that have been observed by Mr. Koebele in Hawaii include the mina bird and mongoose.

METHODS OF CONTROL.

The beetles are so long-lived and hardy that it is difficult, if not impossible, to destroy them by the use of ordinary insecticides, even hydrocyanic-acid gas being practically powerless against them used at a strength that would not kill the plants affected. The remedy which has found most favor is to search for and destroy the beetles, and a good time for this work is during the months of November and December, when the beetles may often be found congregated upon the plants. By persistently following this method the insect has been practically exterminated in many greenhouses which it formerly infested. By killing the beetles the number of larvæ will of course be lessened. Plants showing severe injury should be pulled out and the soil about them searched for the larvæ; or the larvæ may be killed by means of the bisulphide of carbon applied to the soil about the roots of the affected plants. It should be inserted by means of a metal syringe, a few drops here and there about the roots being sufficient to destroy the insects. Kerosene emulsion applied in a similar manner and in larger quantity will also kill larvæ, and the use of tobacco waste in liberal quantities about the roots of the plants is advisable, as it acts both as an insecticide and a fertilizer.

We may also take advantage of the wingless condition of this beetle by surrounding the trunks of rose bushes and of the different species of ornamental plants attacked by it with cotton bands, such as are in use against canker-worms and similar species. The bands should be applied before the beetles have found their way to the plants or after jarring the beetles from them.

A CALIFORNIA FLOWER BEETLE INJURIOUS TO ROSES.

During the past summer a species of flower beetle, known as *Hoplia callipyge* Lec., and native to California has been observed by Mr. Schwarz to be very destructive to roses at Fresno, Cal., and vicinity. From that gentleman we have also received specimens of the work of the insect, which show that it is capable of quite serious injury to flowers, but is hardly such a pest as the rose-chafer, *Macrodactylus subspinosus*, of the East. It is quite probable since injury by this species of Hoplia to roses has not been given much attention by entomologists in available early reports and bulletins, that injury was not noticed until recently but is on the increase, and will probably continue to multiply and spread, since most insects which feed upon wild roses, when they acquire a taste for cultivated ones, prefer the latter.

This species was recorded in volume V of Insect Life (p. 343) to be doing much damage to the young fruit buds and blossoms of the Muscat grape in vineyards in Fresno County, Cal. The insect was recognized as a yearly visitor, appearing in spring, and up to the time of writing, May 17, 1893, was known only as an enemy of rose leaves, doing much damage to the young buds. The beetles were said to be very numerous, in some vineyards as many as hundreds to a single vine; in one case about three acres were completely stripped of buds. The beetles were also present on rosebushes about dwellings.

A second correspondent in the same county wrote of similar injury to roses and to grapes at about the same time, a fact which has been briefly mentioned on page 386 of volume VII of the same publication.

This Hoplia is one of twelve described species, all of similar size, resembling each other more or less closely. They are oblong flattened beetles, with the body more or less completely covered with flat scales.

H. callipyge (figure 25) belongs to a group in which the posterior claws are not cleft, and in which the anterior angles of the thorax are obtuse, and the hairs are long on the thorax, elytra, and pygidium. It is rather dark brown above and incompletely covered with much lighter grayish brown scales on the elytra. The under surface and pygidium are densely coated with small, pale grayish, brilliantly iridescent scales. The legs are reddish and sparsely covered on the femora with similar scales.

The length is a litte less than three-sixteenths of an inch (7-9^{mm}).

The males, as frequently happens in this genus, differ from the females considerably in appearance. They are usually smaller and so much darker as to look like distinct species. The color of the male is quite dark brown, and the scales are less evident than in the female.

This species appears to be restricted to California, and to be most abundant in the southern portion of that State. The list of localities from which we have received this species or reports of its occurrence includes Los Angeles, Selma, Placer County, Fresno, Kern County, Lake Tahoe, and Sacramento.

Some interesting observations upon this species were made by Mr. Schwarz, who communicated a portion of them to the writer. It appears from his statement that roses are most badly injured, from half a dozen to a hundred individuals occurring on a single flower. The insect is rather generally known in California as rose bug, and even as the rose-chafer, being mistaken by some for the Eastern rose-feeding Macrodactylus. A singular and unaccountable fact is that the beetles are very strongly attracted to white and other light-colored roses, such as yellow and pink ones, and to light reds, but the dark reds, are, according to observation, entirely exempt from attack. The beetles bore into and through the roses, completely destroying them. The flowers of the Calla lily are always destroyed, the beetles occurring on them by hundreds. It seems that there is something about this plant—whether the petals or the long yellow spadix—that is poisonous to the beetles, and they die and collect with other insects in decaying masses in the deep calyx of these flowers. Whether or not in this condition they furnish nourishment for the plant remains to be ascertained. The flowers of magnolia, olive, and of various native plants, of which there are not many in the grape-growing regions, are also attacked, the list including late-blooming willows, lupines, and Eschscholtzias. As a rule, this species of Hoplia occurs too late, at least in the neighborhood of Fresno, to do much injury to the flowers of grape, and the same is true of orange. In fact, on the latter plant, it is possible that the beetles are of some benefit in reducing the surplus of blooms and thus improving the fruiting. Figs, it might be mentioned, because they have no flowers are exempt from attack.

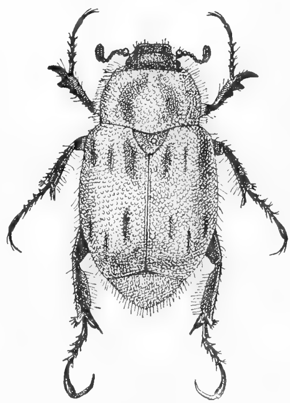

FIG. 25.—*Hoplia callipyge:* female—four times natural size (original).

No damage by this species in the larval stage has been observed, and it seems probable that although the insects may attack the roots and rootlets of growing vegetation, that they subsist mainly upon that which is dying or decayed, and, to a certain extent, also upon soil humus, which contains an excess of decomposing vegetable matter. In this respect it is probable that it resembles the habits of our Eastern rose-chafer, *Macrodactylus subspinosus*, although the habits of this latter are not perfectly known. Mr. Schwarz observed that in spite of the frequent plowing to which the ground is subjected about Fresno, that it has little effect upon the emergence of the beetles, presumably because they pass through their transformations so deeply in the soil that the plow does not reach them. Where the ground is not plowed it may often be found fairly honeycombed where the beetles have made their exit. The beetles have been observed to crawl back into these holes, presumably for oviposition, and this seems to be a natural habit. Unfortunately, the pressure of other work at the time these observations were made prevented Mr. Schwarz from continuing his investigations.

REMEDIES.

Until we learn more of the life history of this species we can only suggest observations of the same line of remedial and preventive treatment prescribed in the case of the rose-chafer in Circular No. 11, second series, of this office.

THE ROSE CURCULIO.

(*Rhynchites bicolor* Fab.)

May 16, 1900, Mr. Thomas Redmayne, Washington, Nevada County, Cal., wrote of the depredations of this species, specimens of which he sent. He stated that the curculio appears about the middle of May, or as soon as warm weather sets in, and confines its injuries to rose bushes, puncturing the flower buds; and that, even when occurring in small numbers, these beetles are able to destroy an entire crop of flowers in a small garden, as in fact they had done for the last two years on our correspondent's place. When cool weather sets in, about September, they disappear.

Hand-picking was resorted to, but without avail, for no matter if every beetle seen was destroyed about the same number could be found next day.

It was noticed that the beetles had the habit, in common with many other curculios, of dropping to the ground when disturbed, and they were captured by placing a hand under them very cautiously and catching them as they dropped.

The species was first noticed in that section about five years previous to the date of writing, no one having seen them earlier. The insect was known by the name of the rose curculio.

This curculio has been known for some time to live upon wild roses, and as early as 1889 was stated to feed upon both rose and raspberry (James Cassidy, Bul. 6, Colo. State Agl. College Exp. Station, p. 18).

June 2, 1891, Mr. Arthur Boyle, Santa Fe, N. Mex., sent specimens of this beetle with report that it was proving very injurious to roses in that vicinity, where it had not been known as a pest before. The beetles were stated to be frequently caught with their long snouts buried deep in the rosebuds, and they seemed also to cut the stem or otherwise injure the bud at the thin portion of the stalk below the calyx. The bud afterwards dropped and died (Insect Life, Vol. IV, p. 137). In volume VII of the same publication (p. 211) this species is stated by Prof. T. D. A. Cockerell to be very troublesome at Santa Fe, N. Mex., by eating holes into buds and bud-stalks of roses, as well as the expanded petals.

July 30, 1897, we received specimens from Dr. E. V. Wilcox with the statement that the beetles bore holes into rosebuds and are much complained of at Bozeman and Missoula, Mont.

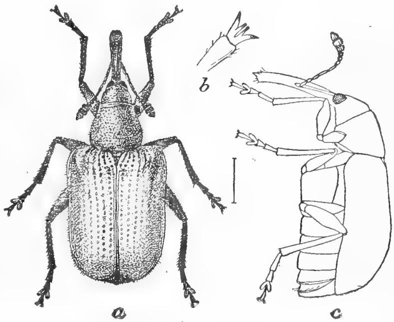

FIG. 26.—*Rhynchites bicolor:* *a*, female beetle; *b*, claw; *c*, female in outline from side; *a*, *c*, enlarged; *b*, more enlarged (original).

This species is also stated to be very common and destructive to roses in Minnesota, destroying both flower-buds and flowers and depositing eggs in the fruit in which the young mature (Lugger, 5th Annual Report Entom. of Minn. for 1899, p. 180).

In the report of Mr. Alexander Craw as Quarantine Officer and Entomologist to the State Board of Horticulture of California for 1893–'94 (p. 86), mention is made of this species, with the statement that it is frequently found on ripe blackberries and raspberries, puncturing the fruit with its beak and causing it to decay.

The rose curculio is one of the Rhynchophora typical of the family Rhynchitidæ, and may readily be known by its red thorax and elytra and black ventral surface, snout, and legs. In eastern specimens the colors are as indicated, but westward, in Colorado, specimens are found in which the greater part of the head is red, including most of the antennæ and the legs. The form of the insect is well illustrated at figure 26. The rostrum, or snout, it will be noticed, is very long—nearly a third the length of the entire body, and the antennæ are slender, with a well-marked three-jointed club. The length, exclusive of the snout, is a little less than a fourth of an inch (5—6 mm.).

This species is well distributed from the Atlantic to the Pacific, and is found more abundantly northward. A list of localities in which it is known, verified in great part by specimens in the National Museum, includes the following: Buffalo, Ithaca, and New York, N. Y.; New Jersey, "common throughout the State" (Smith); Pittsburg and vicinity, Pa.; Washington, D. C.; Tennessee; Missouri; Minnesota; Wisconsin; Iowa City, Iowa; Cheyenne, and National Park, Wyo.; University, N. Dak.; American Fork Canon, and City Canon, Utah; Santa Fe, N. Mex.; Pocatello, Idaho; Montana; eastern Washington; Oregon; San Francisco, San Mateo, San Diego, Los Angeles, Los Gatos, and San Jose, Cal.; Hamilton, Ontario, Can.; Moosejaw, Assa, N. W. T.; Victoria, Vancouver Island, North Bend, and New Westminster, British Columbia.

Hand-picking and jarring the beetles from the infested plants is all that is necessary in ordinary cases of attack. When the insects occur on other plants than canes bearing berries, or on roses soon to be picked, they can be destroyed in the usual manner by spraying with Paris green at the rate of about a pound to 150 gallons of water.

MISCELLANEOUS INSECTS INJURIOUS TO ROSES.

Roses have been quite subject to insect injury during the last few years, and some of the species which have been particularly destructive or troublesome are worthy of special mention. The rose aphides of the two commoner species have been abundant, and some complaint has been made of the rose-chafer.

Short notes on some interesting instances of attack follow.

The bristly rose worm (*Cladius pectinicornis* Fourcr.)—Numerous complaints of injury reached this office throughout the month of June and the early portion of July, 1900, from residents of the District of Columbia. In most instances the larvæ were seen and all proved to be this insect. Injury was also noticed by the writer generally throughout the District wherever roses were grown and in neighboring portions of Maryland. In fact the species was more troublesome this year than ever before. Mrs. Flora W. Patterson, Assistant Pathologist of this Department, who furnished larvæ for identification, stated that the roses most affected were La France, General Jacqueminot, a few pink varieties hardy to the District, and some red roses recently imported from Holland.

It was noticed on June 27 that larvæ had attained full growth and were rapidly disappearing from the plants.

A rose beetle, Trichius piger Fab.—An individual of this species which is illustrated by figure 27, was sent to this office June 27, 1900, by Mr. Ernest G. Asmus, a rose grower at West Hoboken, N. J., who reported that it was doing much injury to greenhouse roses, and especially to the variety known as the Bride. The beetles burrow into the center of the roses, destroy the flowers completely, and also eat the foliage.

Some interesting observations have been made concerning the habit of this ubiquitous flower beetle by Mr. James G. Needham (Amer. Nat., Vol. XXXIV, p. 365). He observed it in the flowers of *Iris versicolor* in New York State. The channeled sepals seeming to offer a favorite place for an afternoon nap, several beetles were found undoubtedly asleep. After repeatedly tickling two of a beetle's feet, it stretched itself like a lazy boy awakening. Although the beetle is not ill adapted by its size for visiting these flowers, it does not seem to pass from flower to flower, and therefore is not an important agent in pollen distribution. Upon reaching an Iris flower it is seemingly habitually deceived as to the point of entrance and endeavors for some time to effect ingress at its center between the branches of the cleft style. After clambering in and out of the central cleft repeatedly the proper entrance is at length stumbled upon. The stupidity of the species is summed up in the statement that if the beetle were seeking pollen it might, had it wit enough, obtain plenty of it by entering the other side up.

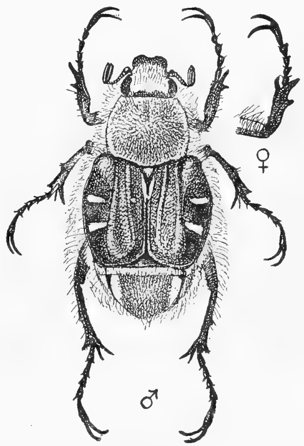

FIG. 27.—*Trichius piger:* male beetle, with female foreleg at right enlarged (original).

The oak pruner (*Elaphidion villosum* Fab.).—November 8, 1900, we received from Mr. F. A. Marlatt, from Manhattan, Kans., a package of stems of roses, evidently sweet-brier rose (*Rosa rubiginosa*), that had been amputated by this species, some of the larvæ being present in the infested twigs. The oak pruner has been treated somewhat at length in Bulletin No. 18 of the present series (pp. 35–40).

The tobacco bud-worm (*Heliothis* [*Chloridia*] *rhexiæ* S. & A.).—August 4, 1900, the writer observed larvæ of this species feeding upon cultivated roses at Marshall Hall, Md. Larvæ entered the earth on the 13th and 14th, and the first moth appeared August 25, twelve days later. This species was described by Smith and Abbot in 1797 (Nat. Hist. Lep. Ins. Georgia, Vol. II, p. 199) under the name of *Phalæna rhexiæ*, the specific name having been given it on account of one of its food plants, *Rhexia virginica.* Even at that early date the larva was known to attack tobacco, and was, in fact, called the "tobacco-bud-worm" by the authors mentioned. It was said to attack the bud and blossom, and to be "very pernicious in Virginia and other places, as it destroys the main shoot." Colored figures are given of the moth, larva, and pupa.

A short popular account of this insect, with figure, is given on pages 14 and 15 of Farmers' Bulletin No. 120.

THE MORNING-GLORY LEAF-CUTTER.

(*Loxostege obliteralis* Walk.)

Few of our ornamental garden plants suffer so universally from the attacks of insects as does the morning-glory (*Ipomœa purpurea* et al.). The more common forms of injury are shown on the leaves in the shape of numerous more or less rounded holes, the work of various species of tortoise beetles (particulary species of Coptocycla), and on the edges of the leaves, where little semicircular or semioblong oval pieces are cut out by leaf-cutting bees (*Megachile* spp.). Another form of attack is that which will presently be described, the work of the larva of *Loxostege obliteralis* Walk. (*Phlyctænodes obliteralis* of Hampson's Revision), no account of which appears to have been hitherto published.

During the years 1898 and 1899 Messrs. T. A. Keleher and W. S. Canatsey, of this office, reported injury to cultivated morning-glory in the District of Columbia, and the former gentleman, who devoted considerable time to the gathering of larvæ in different localities, reported injury also to spearmint and plum. The material secured, together with observations which were conducted in previous years by Mr. Theo. Pergande, also of this office, and other information obtained by correspondence with Prof. E. E. Bogue, makes it possible to give a fairly complete account of the insect's life history and habits.

The larva is remarkable not only on account of its great beauty but also from its curious and evidently characteristic habit of gnawing the petioles or leafstalks on the upper side near the leaf in such a manner that only a small portion of the skin and fiber on the under side remains. The leaf hangs downward and gradually wilts and becomes dry, the larva apparently preferring drying leaves as food to fresh ones. The larvæ secrete themselves in the wilting leaves either by drawing together or folding over small leaves, or rolling over the edges of larger ones. In the shelter thus formed they remain during the day, coming forth to feed toward dusk.

When the larvæ appear in any abundance their work is quite apparent, the vines appearing very unsightly where the leaves, partially cut off, die and turn brown. They cut large holes in the leaves, which sometimes present the appearance shown in the illustration at *f*.

DESCRIPTIVE.

The egg.—The egg resembles that of *Phlyctænia rubigalis*, previously described in this bulletin. It is scale-like, clear, grayish white when first deposited, so nearly translucent and so flat as to show through it the green of the leaf upon which it is deposited. It is shining, glassy, iridescent, the surface finely granulated and rugose. The outline is tolerably variable—a broad oval, nearly round. The length is about 0.7^{mm} and the width 0.6^{mm}.

The eggs are deposited in rather regular overlapping masses of from three to twenty, a portion of a mass often showing a hexagonal arrangement inclosing one egg. The favorite place of oviposition is on the lower surface of a leaf.

The larva.—The larva when first hatched is clear, grayish white in color, and the markings of maturity show but faintly, being few in number, totally unlike those of the full-grown individual. After feeding, the green of the leaf shows plainly through the outer integument. A half-grown larva is shown in the illustration at *b*.

The moth.—This species is a member of the superfamily Pyralidina, family Pyraustidae, and has recently been placed in the genus Phlyctænodes *Guen*, (Hampson, Pr. Zool. Soc. Lond., 1899, p. 208) though still catalogued under Loxostege in our latest list (Smith's List Lepid. Boreal Amer., 1891). The earliest description attributed to the species is by Francis Walker (Catalogue Lepidopterous Ins. Coll. Brit. Mus., part XVII, p. 399), who gave it the name *Isopteryx* (?) *obliteralis*. The type locality is "United States," the date of description, 1859.

The moth is of moderate size and may be recognized by the aid of the accompanying figure (fig. 28, *a*). The general color is described by Grote & Robinson, who gave a detailed characterization of the female under the name of *Botys marculenta* from Pennsylvania (Trans. Amer. Entom. Soc., vol. I, p. 23, 1867), as pale ochre-yellow. It is very pale, corresponding rather closely to, though lighter than, the "cream buff" of Ridgway's Nomenclature. The darker brownish markings are described as obsolete, and though rather faint or suffused in some places the pattern is usually quite constant though moderately variable in distinctness. In the paler individuals the lighter portions of the wings are translucent and more or less strongly iridescent. The lower surface of the wings is more strongly iridescent. In dark individuals, the marginal bands of the wings are sometimes very broad and heavy. The expanse of the fore-wings is about seven-eighths of an inch ($21–23^{mm}$). The body of the female is rather stout, and measures with the head about half the wing expanse.

The moth although nocturnal in habit is quite active when the least disturbed, and flies off with a quick darting motion.

The larva.—The larva is of unusual beauty. The general color when full grown is rather pale yellowish green, variegated with deeper green and with numerous very large and more or less rounded and polished somewhat rugose black spots, arranged as shown in the illustration (fig. 28, *b*). The head is a brighter yellow with orange mottling, as is also the cervical shield or anterior portion of the first thoracic segment, the posterior portion being green. The head and two thoracic segments, with two pairs of legs, are shown at *d*, lateral view. The dorsal surface is darker yellowish and green, the dorsal line being conspicuous dark green. It is bordered each side by yellow, which extends to the rows of black piliferous warts. Each wart is surrounded more or less irregularly with grayish yellow and bears a yellowish brown hair. The second and third thoracic segments are tinged with blue, particularly about the warts. Altogether the coloring, together with the piliferous spots, impart to the larva a somewhat more striped appearance than the illustration shows. The lateral line is wide and very pale yellow. Ventral surface pale green, the legs pale yellow. Surface moderately hairy, the hairs proceeding from the black warts at the anterior portion of the body being light

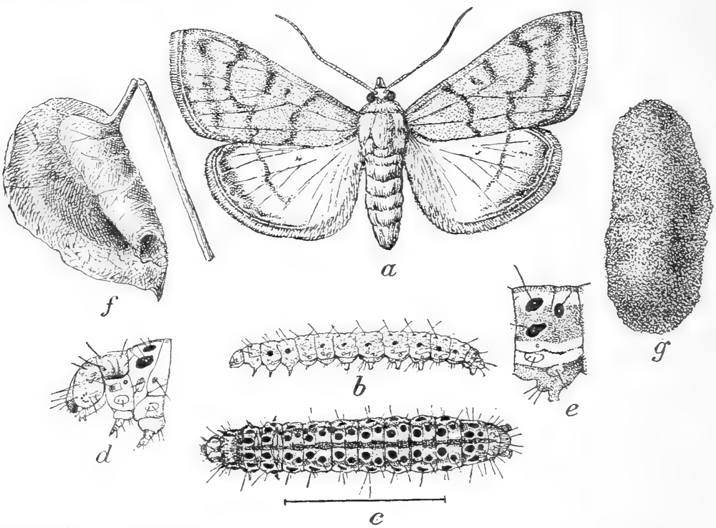

FIG. 28.—*Loxostege obliteralis: a.* female moth; *b*, penultimate stage of larva; *c*, last stage of larva; *d*, head and thoracic segments of same from side; *e*, third abdominal segment; *f*, work of larva; *g*, cocoon of hibernating individuals—*a*, $2\frac{1}{2}$ times natural size; *b*, *c*, *g*, 2 times; *d*, *e*, more enlarged; *f*, natural size (original).

brown, those from the posterior portion darker brown. The last segment bears no black spots, but is quite hairy. One of the abdominal segments is shown, lateral view, at *e*. The form is cylindrical and the folds of each segment are pronounced. The length is about six or seven times the width. The figure shows the larva in the somewhat contracted position assumed when at rest. Length when fully mature, $18–20^{mm}$; width, $2.7–3^{mm}$.

When the larvæ are full fed and have been for half a day or more without fresh food the ground color becomes almost uniform light yellow. At this period the striated effect is much diminished, although the black spots become more conspicuous, each one now showing a fine light ring about the insertion of the hairs.

The earlier stages differ in their paler color, the youngest larvæ being nearly white, and in having a much smaller percentage of the piliferous tubercular spots black. Only the lateral row is black, and of these the first thoracic and first abdominal are pale, the hairs being also pale, nearly white. The two pairs of thoracic spots are larger than the others, a character which is more pronounced in the earlier stages than in the antepenultimate. The penultimate stage of the larva is shown from the side at *b*.

The cocoon.—Transformation to pupa takes place in a cocoon, which, with the first generation, is often formed on the surface of the earth, sometimes attached to the dried leaves upon which it has fed. The cocoons of the second generation appear always to be formed normally beneath the earth's surface. The outer surface of the cocoon is covered with sand or earth, giving the appearance represented in the illustration at *g*. Such a cocoon divested of the outer grains of earth, which may be brushed off with a soft camel's hair pencil, measures about half an inch long and a fourth of an inch in diameter. Soon after forming its cocoon the larva becomes contracted to about half or a little less than half its length when fully extended when feeding.

The larvæ during the daytime are unusually sluggish as compared with other Pyralids, such as the grape leaf-folder (*Desmia funeralis*) and are not easily disturbed.

DISTRIBUTION.

The known localities for this species indicate a wide distribution, and it is probable that it is common from Canada to Mexico. The available list of localities includes the following: Washington and Georgetown, D. C.; Cabin John, Md.; Alexandria, Va., and Stillwater, Okla., from all of which specimens have been received. Grote and Robinson's type or types were from Pennsylvania. Lintner records Albany, N. Y., (vicinity); Smith, New Brunswick, N. J., and in the National Museum are specimens from Maine, North Carolina, Kansas, Texas, and Arizona.

DIVISIONAL RECORDS OF ATTACK.

The Divisional records begin with a note made by Mr. Pergande, August 21, 1884, when larvæ were found upon morning-glory in the District. In 1888 Mr. Pergande again observed this species in the District during July and August, feeding on sunflower and dahlia. It was also observed that year by Prof. W. B. Barrows on morning-glory.

Writing under date of July 4, 1896, Professor Bogue stated that he had reared this species (specimens of which were sent) from common morning-glory at Stillwater, Okla. Larvæ were observed to feed at night and to cut the petioles of the leaves upon which they were feeding in the manner previously described.

During August, 1898, Mr. Canatsey reported injury to cultivated morning-glory at Georgetown, D. C., which upon the receipt of specimens proved to be due to this species.

During the second and third weeks of the following June Mr. Keleher brought numbers of the larvæ, which from their peculiar coloration and markings are readily distinguishable, found on spearmint (*Mentha spicata*) growing in this city. Captures were made mostly toward dark, and larvæ were sometimes found at large upon the leaves, but more often in rolled-up leaves. Larvæ were also taken on morning-glory in the same neighborhood, but appeared to prefer mint. Later specimens were found by Mr. Keleher, July 5, feeding on the leaves of a young plum tree, and still later, up to September 28, larvæ were brought by him to this office found on morning-glory in this city and Alexandria, Va. July 8 the writer observed this species at work in a bed of cultivated peppermint (*Mentha piperita*) at Cabin John, Md.; August 21 he found larvæ feeding upon the rough hogweed (*Amaranthus retroflexus*) on the Department grounds; October 2 larvæ were observed on the same plant at Marshall Hall, Md., the leaves of which they cut in the same manner as the more useful plants. Morning-glory growing in the immediate vicinity was not noticed to be attacked.

LIFE HISTORY.

Moths that were placed in confinement, in the same manner as other species that have thus been successfully treated, failed to deposit eggs, and this stage was unfortunately missed.

From the lot of larvæ taken in August, 1884, moths began to issue May 28 of the following year, continuing till June 5.

The 1888 lot gave out moths February 11, 25, and March 9. This lot was evidently kept in an overheated room, which will account for what must be considered the premature appearance of the adults.

The larvæ taken in August, 1898, fed freely upon leaves of morning glory, with which they were confined, becoming full grown toward the end of that month. August 30 one of these formed its cocoon, in which it remained as larva until May 4 of the following year, when it transformed to pupa. The imago issued May 25, other moths continuing to issue until June 3.

The quiescent stage of the larva had thus lasted a little over eight months, and the pupal stage had lasted three weeks.

The remaining larvæ ceased feeding by September 8.

The first moth from the larvæ obtained in 1899, during June, was found to have issued early, June 5, the remainder issuing a few days afterwards. That there is considerable variation in the time of issuance was shown that year by our rearings, moths being present in our rearing jars as late as August 6.

According to Professor Bogue's observations, moths, evidently of the second generation, emerged from pupæ in about ten days after the larvæ transformed. One of the larvæ captured in 1899 became full fed July 8, entered the earth the following day, and issued as moth July 22. Assuming the pupal stage to have lasted ten days, three days were passed by the larva in inaction.

It is obvious from the above that we have two well-marked generations and there is evidence also of a third generation, of few individuals. Although the earliest appearance of the moths in the field was not noted, it is fairly certain that they begin to issue from the pupæ of the over-wintered larvæ during the latter half of May and continue into June, depositing their eggs at this time for the first new generation, the moths of which appear during the last week of July and the first week of August. From the larvæ of the second generation cocoons were obtained August 14. In other words, larvæ had reached full growth early in the second week of August, and one lot had already entered the earth and spun up by the end of the second week. It has already been shown that larvæ of the second generation pass the winter in their cocoons, form the pupal condition in May, and about ten days after transforming issue as adults. There is evidence that a very small percentage of these, however, issue late in August and lay eggs for a small third generation, the larvæ of which have been observed by Mr. Keleher and the writer at the end of September and during the first week of October.

From the observed food plants it is obvious that we may expect attack in the future on several other plants. The present list includes morning glory, spearmint, peppermint, plum, sunflower, dahlia, and hogweed, plants of different botanical families.

NATURAL ENEMIES.

From the first generation of this insect a number of individuals of a parasitic Dipteron of the family Tachinidæ were reared, all of which evidently came from the cocoons. The species was referred to Mr. Coquillett, who identified it as *Hypostena floridensis* Towns. Flies issued during the last week of July. This species, as its name shows, occurs in the South. Its known distribution extends from the White Mountains of New Hampshire to Jamaica, W. I. It has previously been recorded as a parasite of *Blastobasis nubilella* Zell. and *Schizocera ebena* Nort.

A nymph of the spined soldier-bug (*Podisus spinosus* Dall.) was observed by Mr. Keleher in the act of attacking a full-grown larva of this species the last week of September.

REMEDIES.

The earlier stages of this insect can doubtless be reached by a spray of Paris green or other arsenical, as to a certain extent also the latter stages, when the larvæ poke their heads forth from their sheltered homes in search of food. The presence of the larvæ as they approach maturity and cut the leaves of their host plants may be readily detected, and at this time hand-picking is all that is necessary.

THE FICKLE MIDGE.

(*Sciara inconstans* Fitch.)

Some insect inhabitants of the greenhouse that have attracted attention in very recent years are the larvæ or maggots of certain species of midges or gnats belonging to the families Cecidomyiidæ and Mycetophilidæ. The larvæ of three species of the former family attack roses and violets, and one of them has been discussed in former pages of this bulletin on account of its injuries. A large proportion of the Mycetophilidæ belong to Sciara, a genus of considerable extent, whose larvæ are believed to be for the most part scavengers, feeding upon decaying vegetable matter of different kinds, including fungus growths, whence the name of "fungus gnats" which has been applied to the family. Some of these larvæ live in vegetable mold, under the bark of trees, in putrefying vegetables, in manure, and some attack roots and sprouting seeds in greenhouses, and one of these, *Sciara inconstans* Fitch, the subject of the present paper, has recently been reported by various persons as being quite troublesome.

The subject of injuries by this species is a matter for future investigation, as there is a possibility that it agrees with other Sciaras in being a scavenger, and is, perhaps, in some cases attracted to the injured plants observed from the formation of fungus and other growths on them. It is to be regretted that the subject was not investigated earlier.

DESCRIPTIVE.

The adult of this insect is a minute two-winged fly or fungus gnat. Like others of the group to which they belong, these flies are exceedingly delicate, with moderately slender bodies, long slender legs, small heads, and rounded, moderately prominent eyes. The female of this species is shown in the illustration (fig. 29) at *c*. It may readily be distinguished from the male shown at *a* by its larger size, more robust abdomen when gravid, eyes somewhat smaller in proportion to its size, and particularly by the last abdominal segments. A side view of the tip of the abdomen of the female is shown at *f*, the maxillary palpus at *e*, and an enlarged section of the antennæ at *d*. At *b* is shown the peculiar structure of the external organs of the male. The general color of the body and legs is pale brownish yellow, with darker brown thorax, and black head. The wings are still lighter and lightly infuscated. The wing expanse is about one-fourth of an inch ($5.5–7^{mm}$), and the length of the body half that ($3–3.5^{mm}$).

The eggs are unknown, but they are probably like those of related species, white in color and of oblong shape and exceedingly minute.

The larva, shown at *h*, is a delicate threadlike creature, milk-white in color, with a distinct minute jet-black head. The average length is between 6 and 7^{mm}, the length being about eight or nine times the width, the latter being about 0.8 or 0.9^{mm}.

The pupa shown in the illustration at *g*, ventral view, is free (differing from the pupa of other Diptera in not being incased within its old larval skin). The length is about 3.5^{mm}, which is about three or four times the width. The color is pale yellowish, with darker wing-pads, and still darker head. The antennæ and legs are folded down between the wing-pads, as shown in the illustration.

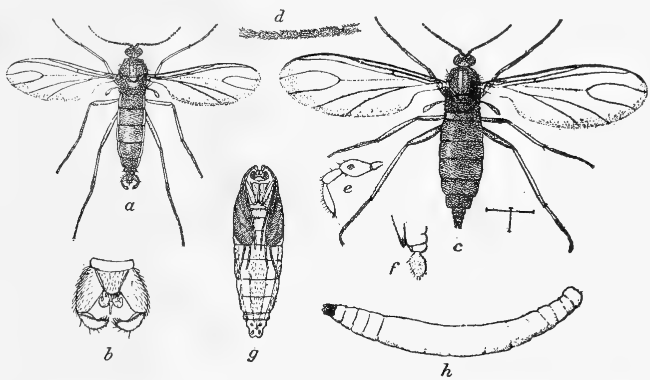

FIG. 29.—*Sciara inconstans: a*, male fly from above; *b*, external genital organs of the same; *c*, female; *d*, enlarged antennal joints of same; *e*, maxillary palpus of same; *f*, tip of abdomen of female from side; *g*, pupa ventral view; *h*, larva dorsal view—*a, c, g, h*, much enlarged; *b, d, e, f*, more enlarged (original).

DISTRIBUTION.

Owing to the difficulty of determination of these minute Mycetophilidæ, little is known concerning their distribution. Since the description of *Sciara inconstans* at Albany, N. Y., we have learned of a few more localities, a number of which have just been mentioned. The list comprises the following: Ottawa, Canada; Orono, Me.; Jamaica, L. I., N. Y.; Kennett Square, Pa.; Clementon and Riverton, N. J. (Smith); Washington, D. C.; Richmond, Va.; Streator, Ill.; Wooster, Ohio, and Nebraska City, Nebr.

RECENT REPORTED OCCURRENCES.

During the past three years *Sciara inconstans* Fitch has been reported to be more or less troublesome in different portions of the country. Where specific identifications have been made, they are mostly on the authority of Mr. Coquillett, who has also kindly criticized the illustration of the insect here presented.

January 28, 1897, Mr. N. H. Reed, Nebraska City, Nebr., sent specimens, with report that the flies were swarming around his house during the winter, but that he could not ascertain where they came from. He stated that he had never been bothered with these insects before, although he had kept plants in his house for years. No specific injury was reported.

March 1 of the same year, Dr. James Fletcher wrote concerning what was probably this species, stating that the larvæ fed in numbers in the earth of house plants and were suspected of injury to them. The flies were very numerous upon the windows of houses at Ottawa, Canada. A remedy was requested.

January 24, 1898, Mr. F. A. Sirrine, Jamaica, N. Y., sent specimens, with the statement that the larvæ were reported to feed upon roots of roses. He called the adults "black manure gnats."

March 18 of the same year, the late F. L. Harvey, Orono, Me., sent specimens of larvæ and flies of what was identified as probably this species, doing damage to the bulbs of Gloxinia.

December 18, 1899, Mrs. Taylor, Kennett Square, Pa., sent specimens of this insect taken from the soil in potted plants, but with no report as to what plants were injured. The flies had been noticed about a month prior to the date of writing.

February 8, 1900, we received the larva of a species of Sciara from Mr. Harry McC. Dowdy, Richmond, Va., with report that this insect was injurious to peas growing in flower pots. These larvæ when received were boring into the cotyledons of the peas. February 14 we received another communication with specimens of the adult, which were identified as *Sciara inconstans* Fitch.

February 27 we received another sending of this insect, with report that the flies were swarming in a greenhouse belonging to Mr. R. D. Kline, a market gardener of Streator, Ill. Injury was feared and remedies requested. Our correspondent stated that no especial damage had been done to any particular plant other than to lettuce, which was affected merely by the presence of the adult insects. The dead bodies of the flies were stated to be abundant in the windows of one of his greenhouses, and for that reason were considered quite undesirable.

Writing March 5, 1900, Mr. Kline stated that he made a practice of "smudging" his six greenhouses, treating two houses one week, and then passing to the next two for the following week. He believes by this method he is enabled to kill off many insects, including the fickle midge, although numbers are left to breed.

Nitrate of soda and pyrethrum, as well as tobacco, were used by Dr. Fletcher upon this or a similar species of Sciara in Canada, but without entirely satisfactory results.

THE SAME OR A RELATED SPECIES REPORTED INJURING CUCUMBERS IN HOTHOUSES.

Numerous complaints have reached this office of injuries to greenhouse plants of various kinds by this or related species of Sciara, but as it has been found impossible to obtain specimens of the adult the exact identity of the species remains in doubt. Injury to cucumbers grown under glass was a frequent subject of complaint. One instance of this nature may be cited as an example. November 28 and December 3, 1898, Mr. W. F. Preston, Dixon, Ill., wrote at considerable length, in regard to injuries by an insect which we identified as a species of Sciara, and which, he stated, was injuring cucumber vines in forcing houses in that city. There were, he said, at that time four plants for the growing of hothouse cucumbers for the Chicago market. Stable manure (horse) was considered the best fertilizer, and it was thought both by our correspondent and the writer that the presence of the insect was in part due to this manure. The small gnat-like fly with bluish wings was recognized as the parent of the maggot. As a remedy our correspondent had tried limewater, tobacco water, carbolic acid and water, bisulphide of carbon, sulphur, kerosene emulsion, fir-tree oil, and other substances, with no effect. Brine killed the insects, but also destroyed the vines. The insect was described as having cost the cucumber growers many hundreds of dollars during the year 1898. Messrs. Long & Co. made similar complaints of injuries in the same locality, our correspondence covering the subject extending from 1897 to 1900.

March 26, 1900, Miss Josie K. Carter, Bristol, Tenn., wrote in regard to the larvæ, which, judging from the description, was a species of Sciara, that was very troublesome to cucumber vines in that vicinity. The little thread-like worms were described as attacking the vines just under the surface of the earth and peeling the roots, making them look as if hot water had been poured over them.

LITERATURE OF THE FICKLE MIDGE.

The fickle midge was given its English as well as Latin name by Fitch in his second report on the insects of New York (p. 255), the description appearing as *Molobrus inconstans*, and drawn from individuals which had attracted his notice in December from the singular manner in which they ran about upon the paper on which he was writing. Flies were found at this time upon the windows, and it was believed that they had hatched from the earth in some flowerpots which were in the room. The fly was described as advancing two or three inches and then abruptly pausing or moving backward a step or two and instantly running in another direction for the same distance; then it would back up again and start off on another course.

As far as the writer is able to learn from a search through records available at this time, nothing further was gained in regard to the larval habits of the present species until a complaint of injury, by the larva, to the roots and bulbs of Gloxinia plants at South Deer Isle. This report was made by the late F. L. Harvey, in the Report of the Maine Agricultural Experiment Station for 1897 (p. 175). In the report for the following year (p. 127) reference was made to the same species, but the injury was attributed to an unknown species of Thrips. The person complaining of the injury placed slices of potato about the infested plants and the Thrips collected on them in great numbers.

In the September, 1899, number of Entomological News (Vol. X, pp. 201, 202), Mr. Jas. S. Hine published a note on this midge, with illustrations of larva, pupa, and of both sexes of the imago. Concerning injury, Mr. Hine says that the carnations in the greenhouse inspected were dying and that no cause was found except numbers of the minute white larvæ of this species which were boring inside of all the stems that showed serious injury. From all acquired knowledge of the habits of the Mycetophilidæ, Mr. Hine had supposed at first that the plants were killed in some other way and the insects were secondary in the nature of their attack, but by further observation he became convinced that they were feeding upon and injuring the growing plants.

NATURAL ENEMIES.

January 24, 1898, Mr. F. A. Sirrine wrote that the Anthomyiid *Cœnosia solita* Walk., was preying upon the adult gnats, appearing to feed exclusively upon this insect.

March 2, 1900, Mr. A. B. Eaton called attention to the occurrence of *Cœnosia solita* in the greenhouses of the Department of Agriculture, and to the fact that they captured other flies in the same locations. One was observed by Mr. Pratt and the writer having an adult of *Dolichopus spectabilis* Loew., a biting fly, in its mouth. They were also stated to be fond of the "white fly" (*Aleyrodes* sp.), and were frequently seen carrying the latter about while still alive. Many adult *Sciara inconstans* were found dead in the greenhouse, and it was thought that they had not only fallen victims to the Cœnosia, but that the presence of the latter in such numbers in the greenhouse had had considerable to do with keeping the gnats in check, as the gnats were comparatively rare, it being difficult to find living specimens at this time.

REMEDIES.

This insect is new as a pest, and we know so little concerning it and its food plants that it is a matter of some difficulty to advise as to the best methods for its treatment. We can, therefore, only suggest remedies that have been used with success against related species. Whatever is used should be tested first in a small way before trying it on a larger scale. This is particularly true of remedies which might possibly harm the plants affected.

The hydrocyanic acid gas method would, of course, kill all of the adult insects, but would hardly have any effect whatever on the larvæ living and feeding beneath the surface of the ground.

Tobacco in various forms is the standard remedy against similar insects, and, if used in liberal quantities in proper manner, should always produce good results. Some of our correspondents report satisfaction with this remedy against other insects, while others report that it is not entirely efficacious. Refuse tobacco stems kept moist about the plants are sufficiently deadly in their effects on the adults as to keep them in subjection. Some of the juice which soaks into the ground would have the same effect on the larvæ, and tobacco is, moreover, a fertilizer of considerable value.

When practicable, it is always well to sterilize the soil or manure used in the greenhouse by placing it in large closed metal receptacles and subjecting it to about 150 to 200° F. of heat. The same object can be obtained by passing hot steam or hot air through the material used.

Bisulphide of carbon and kerosene emulsion applied to the soil about the roots of affected plants will kill the larvæ, but the former method is rather expensive.

A method of killing the parent flies said to be employed in mushroom cellars in Europe for similar species consists in placing small, lighted lamps in shallow pans filled with water with a little kerosene floating on the surface. This attracts vast numbers of flies, as well as other injurious insects that may happen to be in the greenhouse, all of which are immediately killed when they come into contact with the kerosene. This, though not a perfect remedy, may be of assistance in reducing the numbers of the pest.

Other remedies recently recommended against the related gnats which are the cause of potato scab, namely, solutions of formalin and of corrosive sublimate, should be tested where their use is indicated, as in the case of peas about to be planted. Full directions for this method of treatment and for the preparation of these two insecticides, which, it should be remarked, are fungicides as well, are given in Farmers' Bulletin No. 127 of this Department.

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APPENDIX.

Since the present bulletin has been in the printer's hands, the writer has received a copy of Dr. James Fletcher's report as entomologist and botanist of the Experimental Farms of the Dominion of Canada for 1900, in which several of the species here treated are considered.

One of these is the variegated cutworm (*Peridroma saucia* Hbn.), which was the cause of a most remarkable outbreak in Canada, including British Columbia. This matter will be referred to somewhat more at length in a future publication on that species.

A somewhat similar but less formidable outbreak of the spotted cutworm (*Noctua c-nigrum*) was also reported in Canada, and as this latter species has been given more extended attention in the present bulletin it may be well to mention some of the more important features of the outbreak. Injury by this species in Canada was reported from Niagara and in several places north of Lake Ontario. It was also abundant at Ottawa. Almost all kinds of vegetation, with the exception of various grasses, were attacked, the larval habits assumed in this case resembling very closely those of the variegated cutworm. At Whitby the fruit of tomatoes were devoured, the cutworms eating through the skin and consuming the inside. Oats, peas, and cauliflower were also attacked. At Georgiana these cutworms stripped a field of carrots and mangels, devoured the leaves of Canada thistle, gooseberry, chokecherry, and peas, but a field of oats was left untouched.

A parasite of this cutworm (*Euplectrus frontalis* How.), was reared.

The greenhouse leaf-tyer (*Phlyctænia rubigalis* Guen.).—A detailed description of the larva of this species and its manner of working is given with reference to injury to roses, violets, and chrysanthemums at Toronto the previous year.

The greenhouse leaf-roller (*Cacœcia parallela* Rob.).—During the year 1900 this species came under notice for the first time in Canada, from its attack upon the foliage of rose bushes in greenhouses at Hamilton, Ontario. Injury was first noticed in June, 1899. A good account, including a full description of the larva, is given.

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BULLETIN No. 27.—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

SOME INSECTS

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THE VIOLET, ROSE, AND OTHER ORNAMENTAL PLANTS.

A COLLECTION OF ARTICLES DEALING WITH INSECTS OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY F. H. CHITTENDEN,

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DIVISION OF ENTOMOLOGY.

Entomologist: L. O. Howard.
First Assistant Entomologist: C. L. Marlatt.
Assistant Entomologists: Th. Pergande, F. H. Chittenden, Frank Benton.
Investigators: E. A. Schwarz, D. W. Coquillett.
Assistants: R. S. Clifton, Nathan Banks, F. C. Pratt, Aug. Busck, Otto Heidemann, A. N. Caudell, J. Kotinsky.
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