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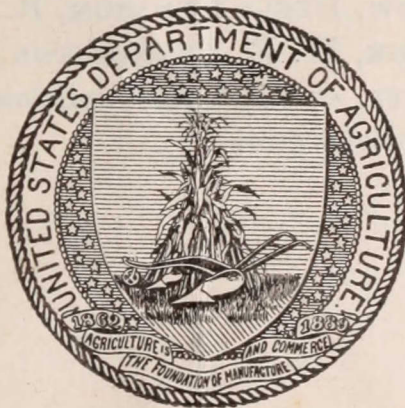
THE YELLOW CLOVER APHIS.

BY

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PAPERS ON APHIDIDÆ.

THE YELLOW CLOVER APHIS.

(*Callipterus trifolii* Monell.)¹

By J. J. DAVIS,

Entomological Assistant, Cereal and Forage Insect Investigations.

INTRODUCTION.

The yellow clover aphis, or plant louse (*Callipterus trifolii* Monell), is common and oftentimes abundant throughout the eastern half of the United States, although it has never been considered a pest in this country and consequently little of its life history and habits has been studied. The author takes this opportunity of gratefully acknowledging the assistance of Mr. Alfred F. Satterthwait and Dr. Henry Fox, both of the Bureau of Entomology, who continued the experiments during the writer's absence.

SYNONYMY.

Callipterus trifolii was first described by Mr. J. T. Monell (1882)² from specimens collected at Washington, D. C., and forwarded to him by Mr. Theodore Pergande. Buckton (1899) described this species under the name *Chaitophorus maculatus* from specimens collected in India on lucern, or what is known in America as alfalfa (*Medicago sativa*). Dr. Bashambar Das, of the Government college, Lahore, India, has very kindly sent us specimens of *maculatus* Buckton, collected on the type host plant (*Medicago sativa*), and a careful examination has shown no characters distinguishing it from Monell's *trifolii*. Dr. Das writes that to his knowledge the species has not been collected on *Trifolium* in India.

What will probably prove to be identical with the species under discussion was described by Kaltenbach³ in 1846 as *Aphis ononidis*. We have not as yet had an opportunity to examine the European material relating to this species, however, and thus prefer to leave this question undecided until a comparison can be made. Should it prove identical, it will naturally have priority over both *trifolii* and *maculatus*.

¹ Synonym: *Chaitophorus maculatus* Buckton.

² Dates in parenthesis refer to Bibliography, p. 40.

³ Kaltenbach, J. H. Entomologische Zeitung, Stettin, Jahrgang 7, pp. 173-174, June, 1846.

GENERIC POSITION.

Whether or not Kaltenbach's *ononidis* is specifically synonymous with *trifolii*, it can still be definitely placed in the same genus. *Aphis ononidis* was described first by Kaltenbach, and the species has since been placed in the genus *Chaitophorus* by Koch, *Myzocallis* by Passerini, and *Therioaphis* by Walker. As Wilson¹ has pointed out, *Therioaphis* seems hardly sufficiently distinct to be placed as a separate genus. Buckton described the species *maculatus*, which is now considered a synonym of *trifolii*, in the genus *Chaitophorus*, but it is universally considered as not a member of this genus. The species *trifolii* was placed in the genus *Callipterus* by Monell, who described the species, and it has since been placed in the genus *Myzocallis* by some authors. This species can not be placed in Mordwilko's generic table,² but can be run down in Wilson's table³ to the genus *Callipterus*, although in the list of species Wilson places *trifolii* Monell under the genus *Myzocallis*. Likewise in studying Wilson's synopsis of characters of the genera this species can best be placed in the genus *Callipterus*. All of the characters given for the genus *Callipterus* agree reasonably well for *trifolii*, while this is not the case with the characters given for the genus *Myzocallis*.

We must therefore conclude that *trifolii* should be placed in *Callipterus*, although it is recognized as an intermediate species and not a typical member of the genus.

DISTRIBUTION.

IN AMERICA.

In America *Callipterus trifolii* is generally distributed throughout the eastern half of the United States, except possibly in the extreme southern portions. The species was originally described from Washington, D. C., and has since been reported in literature from Iowa (Osborn and Serrine); Delaware (Sanderson); Illinois, Minnesota, Kansas, North Dakota, Virginia, Missouri, and New York (Davis); Michigan and New York (Gillette); New Jersey (Smith); Indiana (Morrison); and Nebraska (Williams). In addition to these States Mr. R. A. Vickery has taken it in North Carolina, Mr. George G. Ainslie in South Carolina, Tennessee, and Kentucky, and Messrs. E. O. G. Kelly and Paul Hayhurst in Maryland. Prof. F. M. Webster found it in Indiana as early as 1887, our first record of its capture after the original collections were made in 1880. The accompanying

¹ Wilson, H. F. Can. Ent., vol. 42, no. 8, pp. 253-259, Aug., 1910.

² Mordwilko, A. Ann. Rept. Zool. Mus. Imperial Acad. Sci., vol. 13, pp. 353-384, Sept. 17, 1908.

³ Loc. cit.

map (fig. 10) shows the present known distribution of the species in the United States, compiled largely from records in this office made by various members of the staff.

IN ASIA.

In Asia the species under consideration was first reported from Jodhpur, India, by Buckton (1899), and the writer has received specimens from Dr. Das, presumably collected at Lahorè, India.

FOOD PLANTS.

In America the universal food plant of this species is red clover (*Trifolium pratense*), on which it is usually to be found on the under-side of the leaves, living more or less solitary. We have reared it also on white clover (*Trifolium repens*).

In 1909 Mr. T. H. Parks, at that time connected with the Bureau of Entomology, conducted a series of experiments in testing the ability of *Callipterus trifolii* to live on various plants. The plants used in these experiments were white clover, sweet clover (*Melilotus* spp.), timothy, spring vetch, Japan clover (*Lespedeza* spp.), sanfoin (*Unobrychis sativa*), alfalfa, bur clover (*Medicago maculata*), alsike clover, English clover, and mammoth clover (*Trifolium medium perenne*). The aphid would not breed on the first seven plants in these tests. On bur clover it lived for a number of days and then disappeared, the results in this case being inconclusive. On alsike, English, and mammoth clovers (all species of *Trifolium*) they bred without difficulty.

In India the species lives on lucern (*Medicago sativa*)—indeed Buckton received reports that it was destructive to this plant—and, as already stated, Dr. Das reports that it has never been found in that country on *Trifolium*. We are as yet unable to explain why this species lives on *Trifolium* and not alfalfa in America, while in India it is found on alfalfa but apparently not on *Trifolium*.

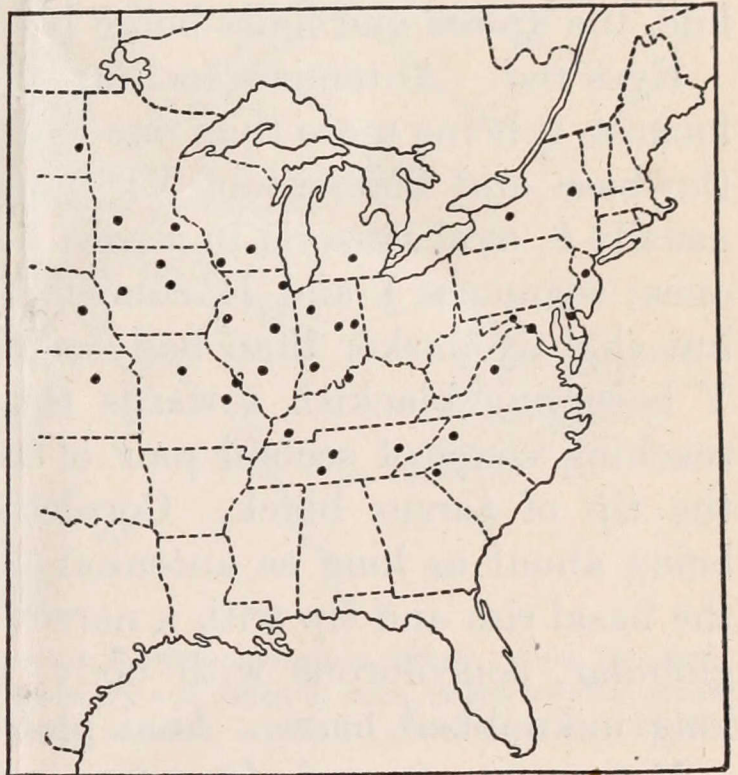


FIG. 10.—Map showing distribution of the yellow clover aphid (*Callipterus trifolii*) in the United States. (Original.)

DESCRIPTIONS.

WINGLESS STEM-MOTHER.

General color gamboge. Head and body bearing numerous tuberculate capitate hairs or spinelike hairs in a more or less regular order, as follows: Head with three in a row on each side of the dorsal median line; two pairs, one not always conspicuous, projecting from the front, and a single one on each side near the posterior border; prothorax with two near anterior border and six along the posterior border; remainder of body bearing two rows of capitate hairs on each side of the dorsal median line, the tubercles bearing these two rows being confluent, so as to present the appearance of a single row on each side, with two hairs to each tubercle; laterad of these are two distinct rows of tuberculate hairs on each side. The tubercles on the head and prothorax are dusky at their apices and the capitate hairs are black; other tubercles are rimmed at base with a blackish line, the apices and hairs being black.

Eyes red. Antennæ reaching about to the cornicles; segment III longest, it being more than one-third longer than VI (base + filament), the base and filament of VI subequal; segment III with 7 to 10, usually 8, oval sensoria in a row, V and base VI with the usual distal ones; segments I and II concolorous with body; III and IV pale, but slightly darker than body color and with a faint brownish tint; V becoming blackish towards tip, and VI black. Beak not quite reaching coxæ of second pair of legs. Legs paler than body color, the tip of tarsus black. Cornicles as long as width at the base, being about as long as antennal segment I, concolorous with body, the basal rim and tip with a narrow blackish line, on border. Cauda globular, concolorous with body, bearing a number of moderately long unknobbed hairs. Anal plate conspicuously bilobed.

Measurements made from two individuals, May 5, 1913, at La Fayette, Ind., immediately upon placing in balsam and before any change of form occurred, are as follows: Length of body, 1.55 mm.; width, 0.77 and 0.81 mm., respectively; length of spines, 0.078 mm.; of tubercles, 0.05 mm.; length of cornicles, 0.061 mm.; width at tip, 0.035 mm.; antennal measurements as follows:

I.	II.	III.	IV.	V.	VI base.	VI filament.	Total.
<i>Mm.</i> 0.061	<i>Mm.</i> 0.052	<i>Mm.</i> 0.435	<i>Mm.</i> 0.261	<i>Mm.</i> 0.234	<i>Mm.</i> 0.148	<i>Mm.</i> 0.139	<i>Mm.</i> 1.330
.....	.....	.417	.243	.252	.148	.148	.....
.061	.052	.495	.287	.261	.156	.139	1.451
.069	.052	.487	.278	.243	.148	.139	1.416

WINGED VIVIPAROUS FEMALE.

(Fig. 11.)

General color of body pale yellowish green, with dusky tuberculate areas more or less uniformly placed on the dorsum. Capitate hairs and tubercles not so prominent as in the apterous forms. Head bearing three capitate hairs, more or less in a row on each side of the median dorsum, an additional one on each side, near the posterior margin, and a pair projecting from the front, one on each side of the median ocellus. Prothorax with two similar hairs near the posterior margin and an additional one on each side. The thoracic plate

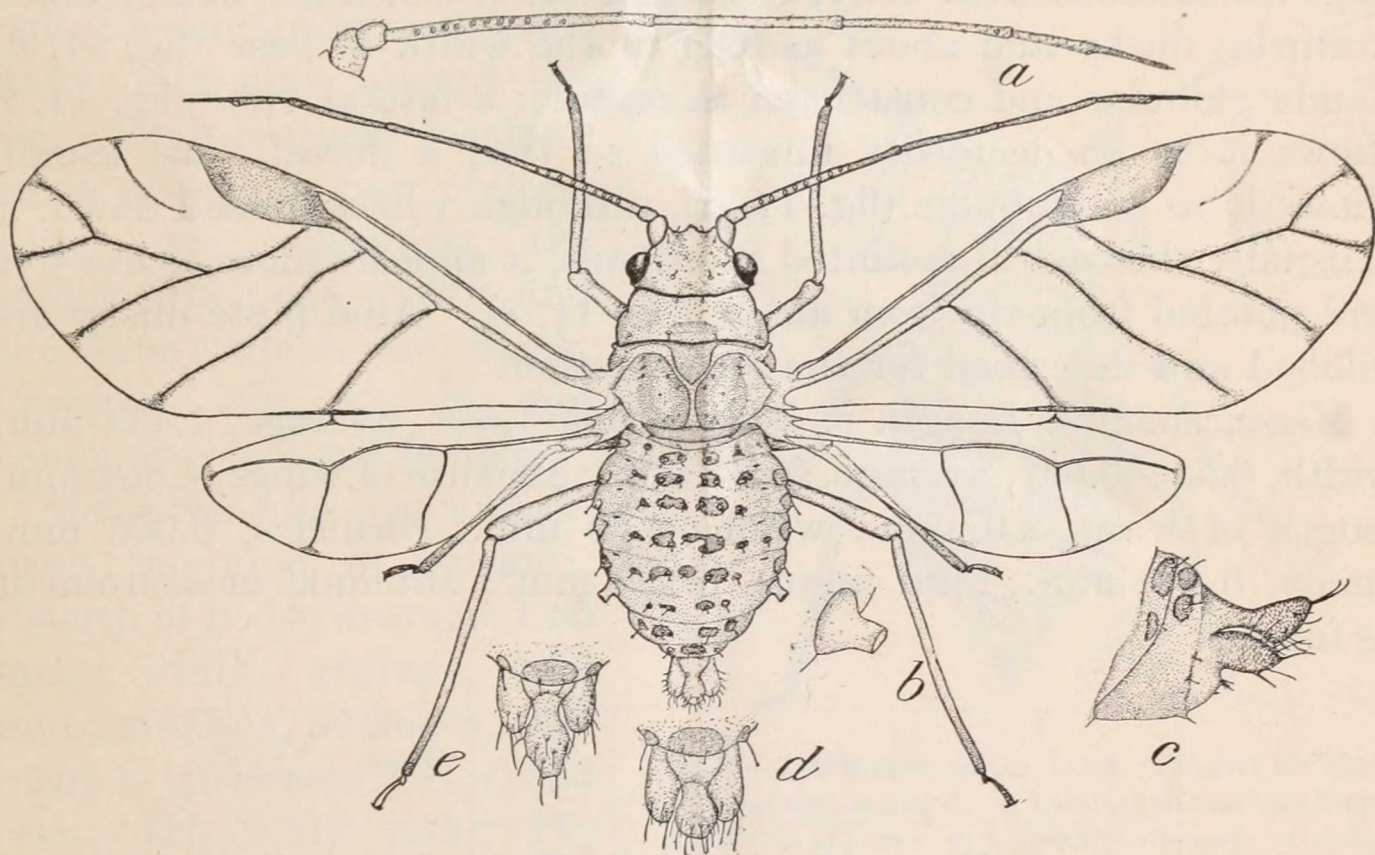


FIG. 11.—The yellow clover aphid (*Callipterus trifolii*): Winged viviparous female, much enlarged *a*, Antenna of same; *b*, cornicle of same; *c*, end of abdomen and cauda of same, lateral view; *d*, cauda and anal plate of same in natural position; *e*, cauda of same, depressed, showing its full length. *a-e*, Greatly enlarged. (Original.)

bears numerous minute pits or clear circular areas, some of which bear hairs. Abdomen with a row of coalesced tuberculate dusky areas, each area usually bearing two capitate hairs, as described for the stem-mother, and a longitudinal row of dusky tuberculate areas, each area smaller than those just mentioned and each bearing but a single hair. On the margins, and often projecting from its body, thus giving the border the appearance of being coarsely dentate, are rows of setæ bearing tuberculate areas, one row on each side. Although there is some slight variation in the position of the hairs and maculations, and the maculations on the abdomen also vary more or less in shape and size, the foregoing is the usual arrangement.

Eyes dark red to brown. Antennæ about as long as the body; relative lengths of segments as for stem-mother; segment III bearing 9 to 12 oval sensoria in a row, and the usual ones at apex of V and of base VI; concolorous with body at base, gradually darkening towards apex (fig. 11, *a*). Beak not reaching coxæ of second pair of legs. Wings hyaline, veins dark brown to blackish, with a very narrow brownish border, and small brownish areas at their apices; basal half of radial sector (stigmatal veins) obsolescent toward basal half; terminal forks of the median (discoidal vein) branching at a point slightly less than one-half the distance from the tip of wing to where the media first branches; width almost one-half its length. Legs concolorous with body, excepting tarsi, which are nearly black. Cornicles dusky and about as long as the width at base (fig. 11, *b*). Cauda globular and constricted at middle; a lateral view (fig. 11, *c*) shows it to be decidedly upturned so that a dorsal view usually shows it to be globular (fig. 11, *d*), although when pressed down, as is usually the case in mounted specimens, it appears more or less oval and pointed from tip from above (fig. 11, *e*). Anal plate dusky and bilobed and described for the stem-mother.

Measurements: Length of body, 1.345–1.564, average, 1.454 mm.; width, 0.582–0.691, average, 0.642 mm.; expanse of wings, 4.654 mm.; length of wing, 2.0 mm., width, 0.80 mm.; cornicles, 0.066 mm.; cauda, 0.139 mm.; hind tarsus, 0.129 mm.; antennal measurements as follows: ¹

I.	II.	III.	IV.	V.	VI base.	VI fila- ment.
<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>
0.0815	0.057	0.522	0.391			
.0733	.057	.505	.383	0.359	0.179	0.179
.0733	.049	.513	.375	.326	.163	.163
.0733	.057	.538	.359	.350	.179	.179
.0733	.057	.513	.379	.310	.179	.179
.0815	.057	.538	.375	.326	.147	.147
	.049	.522	.375	.310	.163	.163
	.057	.522	.342	.318	.179	.163
.0815	.057	.513	.375	.310		
	.057	.522	.359	.310	.163	.155
.0815	.057	.497	.359	.310	.163	.146
.0815	.057	.489	.359	.301	.155	.155
² .07	.043	.514	.271	.243	.143	.143
(²)	.057	.471	.313	.285	.143	.157
(³)		.428	.285	.285	.157	.143
(³)		.414	.328	.271	.157	.143
(³)	.042	.428	.285	.285	.143	.143
(³)	.042	.414	.271			
(³)		.499	.342	.299	.185	.128
(³)		.485	.357			
³ .043	.043	.428	.314	.271	.157	.128
³ .071	.057	.485	.314	.314	.128	.128

¹ From specimens collected at Urbana, Ill., except as noted.
² Measurements by J. T. Monell from specimens collected by Paul Hayhurst, at Washington, D. C.
³ Measurements by J. T. Monell from type specimens, which were collected at Washington, D. C.

WINGLESS VIVIPAROUS FEMALE.

(Fig. 12.)

General color pale yellowish green, with dusky tuberculate areas bearing capitate setæ on the dorsum, arranged as described for the stem-mother and as shown in figure 12. Both the tubercles and capitate hairs (fig. 12, *a*) are more prominent in this form than in the winged female.

Eyes dark red. Antennæ almost as long as the body; relative lengths of segments as in other forms; segment III with 7 to 12, usually 9 or 10, oval sensoria in a row and the usual distal ones on V and base of VI; basal segments pale, the remaining ones gradually darkening toward the tip. Beak scarcely reaching coxæ of second pair of legs. Legs pale, excepting the joints, which are dusky, and the tarsi, which are black. Cornicles (fig. 12, *b*) and cauda as in winged female.

Measurements (from specimens mounted in balsam): Length of body, average, 1.60 mm.; width, average, 0.76 mm.; antenna, averages, segment I, 0.076 mm.; II, 0.053 mm.; III, 0.517 mm.; IV, 0.347 mm.; V, 0.316 mm.; VI base, 0.156 mm.; VI filament, 0.162 mm.; total, average, 1.627 mm.; cornicles, 0.062 mm.; cauda, 0.171 mm.; hind tarsus, 0.130 mm.

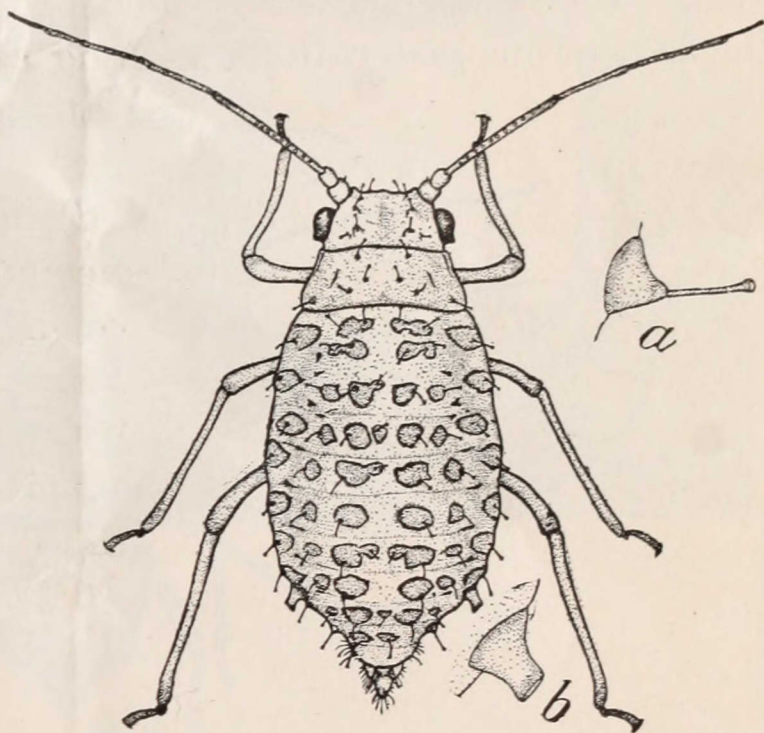


FIG. 12.—The yellow clover aphid: Wingless viviparous female, much enlarged. *a*, Lateral capitate hair of same; *b*, cornicle of same. *a*, *b*, Greatly enlarged. (Original.)

WINGED MALE.

(Fig. 13.)

Wingless males unknown. Head and thorax light olive-green; abdomen pale yellowish green, with rather conspicuous black markings. Similar to the winged female but smaller, with more slender body (the illustration, fig. 13, shows the abdomen too robust), and the dusky tubercular areas on the dorsum of abdomen smaller. Head and thorax bearing a number of hairs in a more or less regular order as shown in the illustration. As stated, the abdominal markings are reduced in comparison to those on other forms. The areas of the two median rows are larger than those of the lateral rows, but they vary

more or less in the number of hairs borne on each, some having two and others but one. The cephalic and thoracic hairs are unknobbed or but inconspicuously capitate, and those on the abdomen may also be capitate or not, usually inconspicuously knobbed.

Eyes dark red to blackish. Antennæ dusky to black, reaching a little beyond tip of abdomen; relative lengths of segments as in the other forms; segment III with 13 to 16 oval sensoria more or less in a row; IV with 3 to 5; V with 3 to 5, not including the usual distal one; and VI base with 1 sensorium surrounded by several smaller ones at the tip (fig. 13, *a*). Beak not reaching coxæ of second pair of legs. Venation as described for the female. Cornicles and cauda dusky, the latter edged with black; in form they agree with those of the viviparous generations.

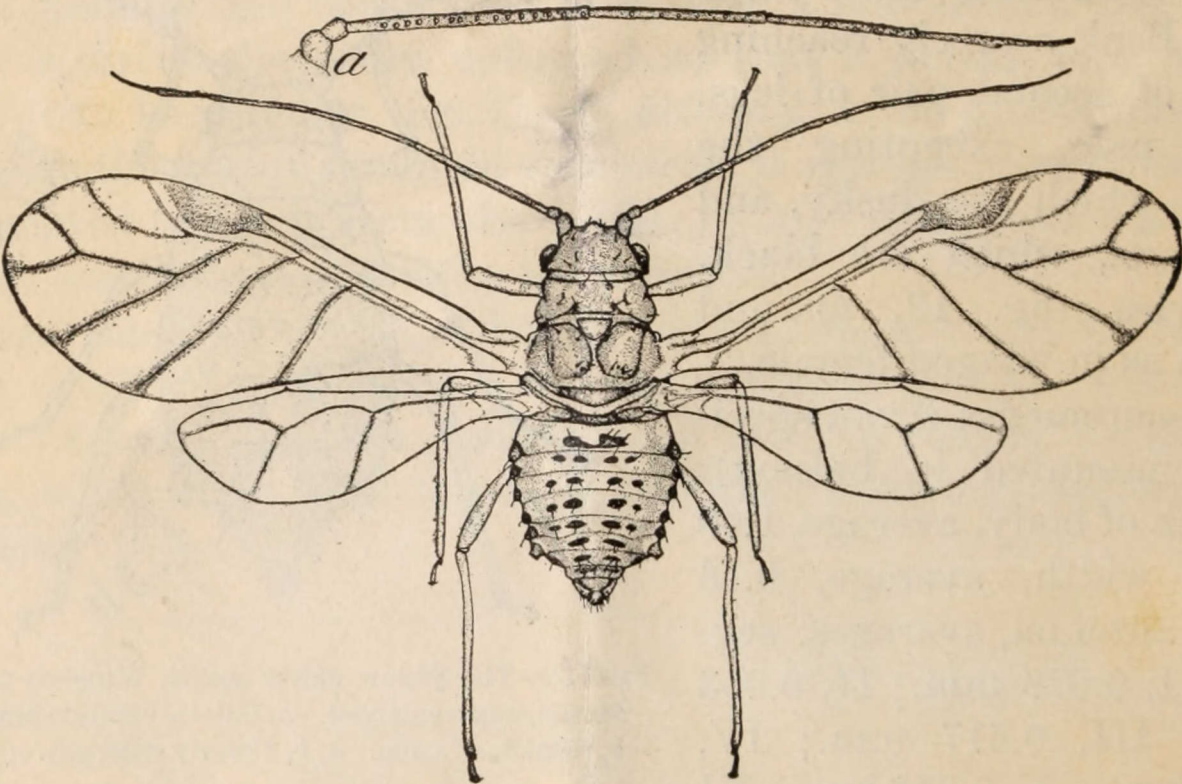


FIG. 13.—The yellow clover aphid: Winged male, much enlarged. *a*, Antenna of same, greatly enlarged. (Original.)

Measurements (averages): Length of body, 1.3 mm.; width, 0.53 mm.; expanse of wings, 4.1 mm.; length of wing, 1.8 mm.; cornicles, 0.049 mm.; hind tarsus, 0.130 mm. Antennal measurements as follows:

I.	II.	III.	IV.	V.	VI base.	VI filament.	Total.
<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>
0.065	0.053	0.473	0.277	0.261	0.147	0.163	1.439
.065	.057	.473	.277	.277	.147	.163	1.459
.065	.057	.522	.277	.293			
.081	.065	.546	.293	.309	.171	.155	1.620
¹ .065	.049	.505	.326	.309	.163	.163	1.580
¹ .073	.049	.522	.326	.318	.155	.155	1.598
¹ .065	.049	.530	.342	.293	.147	.147	1.573
¹ .065	.049	.554	.359	.277	.139	.139	1.582

¹ Measurements made immediately upon mounting in balsam; other antennal measurements are from balsam mounts after standing and clearing.



OUTDOOR REARING SHELTERS USED IN LIFE-HISTORY STUDIES ON THE YELLOW CLOVER APHIS.

WINGLESS OVIPAROUS FEMALE.

(Fig. 14.)

General color yellowish orange to orange when fully mature. The body is usually yellowish when the female first reaches maturity, but as the eggs, which are of an orange color, begin to develop within the body they show through the semitransparent skin, giving the conspicuous orange color to the body. Head and prothorax pale yellow, mesothorax and metathorax varying from yellow to orange according to age since maturity. Dusky tuberculate areas conspicuous. These and the black capitate hairs arranged as on the stem-mother.

Eyes blackish or brownish black. Antennæ not reaching to base of cornicles; relative lengths of segments as in other forms; segment III bearing 7 to 10 oval sensoria in a row, and segments V and base of VI with the usual distal areas; basal segments concolorous with head, others gradually darkening toward apex. Legs pale yellowish except tarsi; proximal halves of hind tibiæ swollen and bearing 25 to 40 inconspicuous, irregularly placed, circular sensoria (fig. 14, *a*). Cornicles and cauda concolorous with abdomen, often dusky at margins. Cauda knobbed as in other forms, but the anal plate is rounded at the tip and does not have the slightest emargination (fig. 14, *b*).

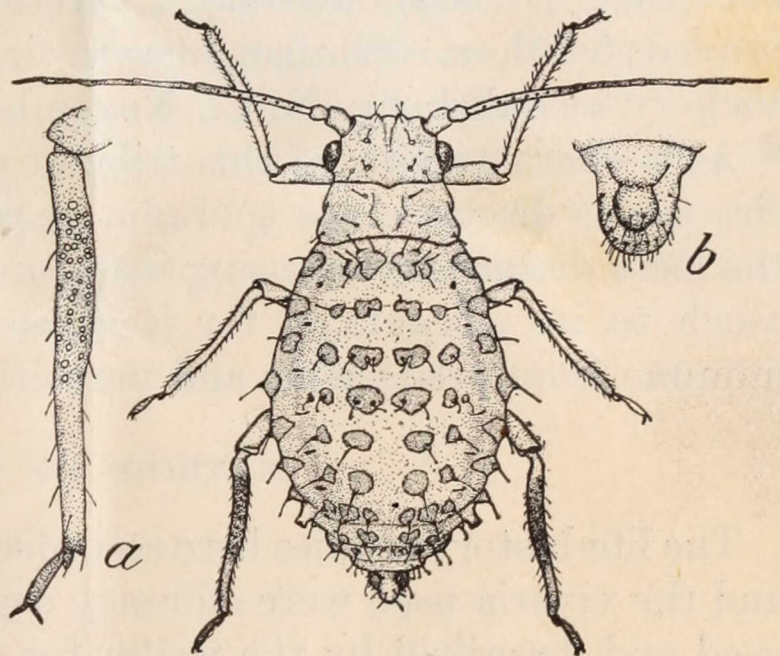


FIG. 14.—The yellow clover aphid: Wingless oviparous female, much enlarged. *a*, Hind tibia of same; *b*, cauda and anal plate of same. *a*, *b*, Greatly enlarged. (Original.)

Measurements: Length of body (average), 1.8 mm.; width, 0.86 mm.; cornicles, 0.061 mm.; hind tarsus, 0.134 mm.; antennal measurements as follows:

I.	II.	III.	IV.	V.	VI base.	VI filament.	Total.
<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>
0.082	0.057	0.473	0.236	0.228	0.139	0.139	1.354
.065	.057	.434	.204	.204	.122	.139	1.225
.065	.057	.407	.204	.204	.147	.139	1.223
.065	.057	.391	.196	.212	.130	.147	1.198
.065	.065	.399	.196	.212	.130	.147	1.214
.082	.065	.434	.196	.212	.139	.147	1.275
.073	.057	.407	.196	.212	.130	.147	1.222
.065	.065	.399	.196	.212	.130	.147	1.214
.065	.057	.383	.196	.212	.139	.139	1.191
.073	.065	.391	.179	.179	.130	.139	1.156
.073	.057	.359	.179	.196	.122	.139	1.125

EGG.

The egg is elliptical, bright orange when first laid, gradually changing to shining jet black, and measures 0.575 mm. in length by 0.248 mm. in width.

LIFE HISTORY AND HABITS.

With *Callipterus trifolii*, as with most other plant-lice, a number of generations of winged and wingless viviparous females are produced during the summer, and the true sexes, consisting of winged males and wingless oviparous females, appear in the fall; these females in turn laying eggs on the stems and leaves of clover to carry the species over the winter months. This species does not have an alternate host, nor does it ever pass the winter, in the latitude of La Fayette, Ind., as viviparous females. However, in the Southern States it probably does winter as viviparous females, for Mr. Geo. G. Ainslie found the viviparous forms not uncommon at Clemson College, S. C., in December (Dec. 3, 1908), whereas a careful search for sexual individuals proved fruitless. Similar observations were made by Mr. R. A. Vickery at Salisbury, N. C., November 11, 1909.

As is characteristic of this tribe of plant-lice (Callipterini) the species under discussion is sporadic in habit and is very easily roused, the least disturbance causing it to jump from its host. This habit is much to its advantage, for it seems to render the species almost immune from predaceous and parasitic enemies.

METHODS OF STUDY.

The life-history studies here recorded were made in outdoor shelters, and the vivaria used were chimney cages such as had previously been used and described by the writer for other species of aphides.¹ The outdoor shelter consisted of frame benches, placed under a canvas canopy (Pl. II) to protect the cages and shelters from the intense midsummer sun. This was necessary, for while the aphides might live out of doors without special protection from the sun, there they have the advantage of a constant circulation of air which is not possible within the glass chimney cages.

The generation series were begun with the stem-mother hatching from the winter egg, and the first and last born generation series continued to the true sexual forms in the fall. In this way the maximum and minimum number of generations annually was obtained under what might be considered optimum conditions, at least from the standpoint of natural enemies and harmful climatic conditions.

¹ U. S. Dept. Agr., Bur. Ent., Tech. Ser. No. 12, Pt. VIII, p. 159. (See also Bul. 25, Pt. I, of the same series.)

GENERATION EXPERIMENTS.

Eggs which were laid on the stems and leaves of red clover plants in the fall of 1912 were kept out of doors under natural conditions throughout the winter, and these began to hatch during the latter half of April, 1913. The young which were used to begin the continuous-generation experiments hatched April 22, and it is worthy of note that this was almost a month after the eggs of *Macrosiphum pisi*, kept under identical conditions, hatched this same year. This is all the more unusual since *trifolii* invariably produces the sexual forms and deposits its eggs noticeably earlier in the fall than does *pisi*.

The young stem-mother—the aphid hatching from the egg being so called—which hatched April 22 and was placed on a red clover plant gave birth to her first young on May 4 and her last young on May 30. In the first-born generation series, that is, taking the *first young of the first young* in each new generation, 17 generations were obtained, counting the oviparous generation as the last. On the other hand, in the last-born generation series, beginning with the last to be borne by the individual which hatched from the egg April 22 and following the series of the last born of each “last-born” generation, there were in all only 8 generations. In other words, there was a maximum of 17 generations and a minimum of 8, from which we may reckon that the approximate average number of yearly generations is $12\frac{1}{2}$ (Tables I and II).

TABLE I.—Line of generations of *Callipterus trifolii* from egg to oviparous generation in fall, La Fayette, Ind., 1913.

Generation from egg.		Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Productive period.	Life after last young.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Date of death or disappearance.	Total length of life.
				Days.		Days.	Days.					Days.
First-born generation series	1.....	Apr. 22.....	May 4	12	May 30	27	1	65	2.4+	7	May 31	39
	2.....	May 4.....	May 20	16	June 20	32	13	99	3.1—	7	July 3	60
	3.....	May 20.....	June 2	13	June 23	22	11	75	3.4+	6	July 4	45
	4.....	June 2.....	June 15	13	June 29	15	1	64	4.3—	8	June 30	28
	5.....	June 15.....	June 21	6	June 26	6	1	34	5.6+	8	June 27	12
	6.....	June 21.....	June 30	9	July 4	5	0	24	4.8	7	July 4	13
	7.....	June 30.....	July 8	8	July 28	21	0	45	2.1+	4	July 28	28
	8.....	July 8 or 9..	July 18	9 to 10	July 29	12	0	26	2.2—	4	July 29	20 to 21
	9.....	July 19 or 20.	July 27	7 to 8	July 31	5	0	24	4.8	8	July 31	12 to 13
	10.....	July 27.....	Aug. 3	7	Aug. 14	12	0	42	3.5	7	Aug. 14	18
	11.....	Aug. 3.....	Aug. 10	7	Aug. 25	16	2	61	3.8+	8	Aug. 27	24
	12.....	Aug. 10 (?)..	Aug. 17	(?) 7	do.....	9	1	40	4.4+	6	Aug. 26	16
	13.....	Aug. 17.....	Aug. 24	7	Aug. 27	4	1	10	2.5	3	Aug. 28	11
	14.....	Aug. 24.....	Sept. 2	9	Sept. 10	9	0	34	3.7+	6	Sept. 10	17
	15.....	Sept. 2 or 3..	Sept. 9	6 to 7	Oct. 6	28	0	¹ 66	2.4—	8	Oct. 6	34 to 35
	16.....	Sept. 9.....	Sept. 25	16	Oct. 15	21	0	² 49	2.3+	7	Oct. 15	36
	17.....	Sept. 25 ³ ..										
Last-born generation series	2.....	May 30.....	June 8	9	June 29	22	0	85	3.9—	8	June 29	30
	3.....	June 29.....	July 5	6	July 13	9	0	25	2.8—	6	July 13	14
	4.....	July 11.....	July 17	6	Aug. 5	20	0	84	4.2	8	Aug. 5	25
	5.....	Aug. 5.....	Aug. 11	6	Aug. 20	10	1	47	4.7	9	Aug. 21	16
	6.....	Aug. 18.....	Aug. 24	6	Sept. 9	17	0	58	3.4+	7	Sept. 9	22
	7.....	Sept. 9.....	Sept. 23	14	Oct. 9	17	0	⁴ 41	2.4+	6	Oct. 9	30
	8.....	Oct. 9 ³ ..										

¹ The 3 young born Oct. 5 and 6 were reared to maturity and proved to be 1 viviparous and 2 oviparous females; and of the 7 born Oct. 4, five were reared to maturity and all were oviparous females.

² 7 young (2 born Oct. 9, 2 born Oct. 10, and 3 born Oct. 11) kept in a separate cage, and of the 6 maturing 1 was viviparous and the remaining 5 oviparous females.

³ Oviparous females.

⁴ Of the first 7 young, born Sept. 23–24, 5 were reared to maturity, 4 being viviparous and 1 an oviparous female.

TABLE II.—*Table of consecutive generations of Callipterus trifolii, La Fayette, Ind., 1913.*

Date.			Tempera- ture. ¹	First-born generation series.																	Last-born generation series.							
			Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.
1913.			° F.	° F.																								
Apr.	22		82	47	² b																							
	23	.....	81	58	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	24	.....	77	59	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	25	.....	61	44	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	26	.....	64	42	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	27	.....	53	37	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	28	.....	61	41	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	29	.....	77	38	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	30	.....	83	43	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	May	1		91	48	o																						
2		.....	89	52	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
3		.....	87	58	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
4		.....	83	62	1	b	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
5		.....	81	81	5	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
6		.....	84	53	4	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
7		.....	66	42	1	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
8		.....	71	45	o	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
9		.....	74	53	4	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
10		.....	56	36	o	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
11		.....	58	30	1	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
12		.....	64	42	3	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
13		.....	83	53	1	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
14		.....	83	60	3	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
15		.....	81	62	1	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
16		.....	85	49	3	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
17		.....	71	50	8	o	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

¹ Temperatures are those recorded from the hour of examination one day to the hour of examination the next.

² The position of the letter "b" at the head of each column shows that the aphid was born on the date indicated. The total number of young for each female is given at the foot of each column, respectively.

TABLE II.—Table of consecutive generations of *Callipterus trifolii*, La Fayette, Ind., 1913—Continued.

Date.	Temperature.		First-born generation series.																	Last-born generation series.							
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.
May 18.....	79	48	0	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19.....	72	50	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20.....	76	56	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21.....	82	62	7	3	b	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22.....	65	52	1	2	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23.....	57	48	1	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24.....	70	40	1	2	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25.....	72	52	1	2	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26.....	70	54	4	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27.....	60	52	2	2	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
28.....	81	49	2	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29.....	86	57	5	5	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30.....	87	64	2	4	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31.....	78	62	.....	7	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 1.....	82	64	.....	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.....	79	59	.....	3	4	.....	b	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3.....	79	61	.....	3	6	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.....	82	54	.....	5	2	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.....	76	56	.....	4	6	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6.....	90	62	.....	6	6	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7.....	91	55	.....	5	2	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.....	59	44	.....	1	2	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9.....	63	47	.....	1	2	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10.....	75	45	.....	1	0	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11.....	75	45	.....	2	0	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12.....	82	45	.....	1	5	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13.....	85	52	.....	2	3	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14.....	91	54	.....	2	5	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15.....	95	65	.....	5	4	.....	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16.....	97	65	.....	7	5	.....	6	b	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE II.—Table of consecutive generations of *Callipterus trifolii*, La Fayette, Ind., 1913—Continued.

Date.	Temperature.		First-born generation series.																	Last-born generation series.							
	Maximum.	Minimum.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.	Ninth generation.	Tenth generation.	Eleventh generation.	Twelfth generation.	Thirteenth generation.	Fourteenth generation.	Fifteenth generation.	Sixteenth generation.	Seventeenth generation.	First generation.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.	Eighth generation.
Aug. 8.....	93	73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9.....	97	75	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....
10.....	92	73	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	0	.....	.....	.....
11.....	86	68	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	6	.....	.....	.....
12.....	74	64	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	4	.....	.....	.....
13.....	84	70	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	9	.....	.....	.....
14.....	83	72	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	6	.....	.....	.....
15.....	83	70	.....	.....	.....	.....	.....	.....	.....	.....	.....		8	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	4	.....	.....	.....
16.....	91	74	.....	.....	.....	.....	.....	.....	.....	.....	.....		6	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	3	.....	.....	.....
17.....	95	73	.....	.....	.....	.....	.....	.....	.....	.....	.....		4	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....
18.....	91	73	.....	.....	.....	.....	.....	.....	.....	.....	.....		3	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	3	.....	.....	.....
19.....	86	72	.....	.....	.....	.....	.....	.....	.....	.....	.....		2	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....
20.....	88	67	.....	.....	.....	.....	.....	.....	.....	.....	.....		4	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
21.....	90	72	.....	.....	.....	.....	.....	.....	.....	.....	.....		2	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
22.....	90	68	.....	.....	.....	.....	.....	.....	.....	.....	.....		1	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
23.....	75	58	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
24.....	78	55	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
25.....	86	55	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
26.....	82	60	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
27.....	92	69	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
28.....	94	66	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
29.....	94	53	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
30.....	80	53	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
31.....	82	61	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
Sept. 1.....	82	64	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
2.....	98	64	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
3.....	98	68	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
4.....	98	69	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
5.....	94	64	.....	.....	.....	.....	.....	.....	.....	.....	.....		0	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....
6.....	92	68	.....	.....	.....	.....	.....	.....	.....	.....	.....		6	.....	.....	.....	.....	.....	.....	.....	.....	.....			.....	.....	.....

三三

All oviparous.

As will be noticed by referring to figure 15 the first generation extended over a period of 39 days, from April 22 to May 31; the second, 60 days; the third, 54 days, etc.; and the eighth generation, which includes the last generation of the last-born series, being the longest, a period of 128 days. It is interesting to note that on May 4 individuals of the first 2 generations coexisted in the insectary; on June 4, 3 generations; on July 4, 5 generations; on August 4, 8 generations, or from the fourth to the eleventh; on September 4, 10 generations, or from the sixth to the fifteenth; and on October 4, 11 generations, or from the seventh to the seventeenth. Also, it will be observed that sexual generations occurred in the last 10 generations, from the eighth to the seventeenth inclusive, thus, with the additional data previously reported by Webster and Phillips, and by the writer, thoroughly dis-

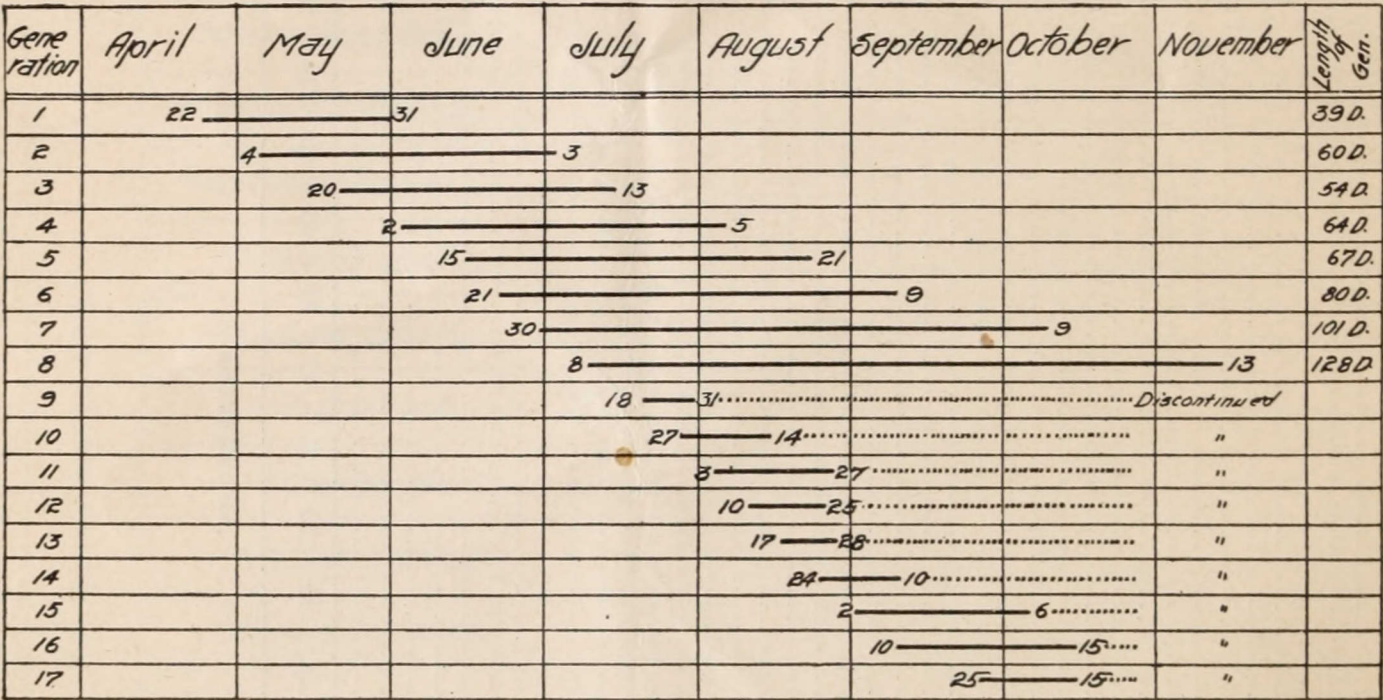


FIG. 15.—Diagram showing periods and succession of generations in the yellow clover aphid, La Fayette, Ind., 1913. (Original.)

proving the theory held by some that the sexual forms appear necessarily in a certain definite generation.

Our records show that the first oviparous females were observed in the experimental cages early in October, they having been born September 25, and our field records prove that the sexual forms may be produced even earlier than this. As has been inferred, the sexual forms seem to appear after the earliest weather conditions indicative of winter, although occasionally viviparous females have been observed until killed by cold weather. It was a usual occurrence for the same female to produce young part of which were viviparous and part oviparous.

Again referring to Tables I and II it will be seen that the immature stage varied from 6 to 16 days, depending on the temperature; the average for the year, in the 1913 series, being 9.1 days. The productive period, from birth of first young to birth of last young, like-

wise varied considerably, covering from 4 to 32 days, with an average of $15.4 +$ days. The largest number of young produced by an individual female was 99 and the average of the 22 regular generations in the series was 50, averaging $3.2 +$ young per day per female throughout the entire season, the largest number of young produced in a single day by one female being 9.

With only an occasional exception the aphides in these experiments were wingless. Crowded conditions, predicative of a shortage of food, always resulted in a large percentage of winged forms.

Messrs. W. J. Phillips and T. H. Parks followed this species through two series of generations in 1909 at La Fayette, Ind., beginning with young found in the field May 13, and a synopsis of their experiments is here given in Tables III and IV. In general the results they obtained agree with our own studies in 1913.

TABLE III.—Line of generations of *Callipterus trifolii* from May 13, 1909, to oviparous generation, La Fayette, Ind. (Phillips and Parks).

Generation from May 13.		Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Productive period.	Life after last young.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Date of death or disappearance.	Total length of life.
				Days.		Days.	Days.					Days.
First-born generation series.	1.....	May 13 ¹ ...	May 20....	7	June 11....	23	1	78	3.3+	7	June 12....	30
	2.....	May 20....	May 31....	11	June 24....	25	1	82	3.2+	7	June 25....	36
	3.....	May 31....	June 9....	9	June 18....	10	1	22	2.2	5	June 19....	19
	4.....	June 9....	June 20....	11	July 13....	24	1	68	2.8+	5	July 14....	35
	5.....	June 20....	June 28....	8	July 17....	20	1	38	1.9	5	July 18....	28
	6.....	June 28....	July 10....	12	July 22....	13	2	44	3.3+	6	July 24....	26
	7.....	July 10....	July 17....	7	Aug. 10....	25	4	68	2.7+	7	Aug. 14....	35
	8.....	July 17....	July 26....	9	Aug. 6....	12	0	38	3.1+	6	Aug. 6....	20
	9.....	July 26....	Aug. 2....	7	Aug. 16....	15	0	43	2.8+	5	Aug. 16....	21
	10.....	Aug. 2....	Aug. 13....	11	Aug. 17....	5	0	19	3.8	7	Aug. 17....	15
	11.....	Aug. 13....	Aug. 23....	10	Sept. 14....	23	2	46	2.0	4	Sept. 16....	34
	12.....	Aug. 23....	Sept. 22....	10	Sept. 15....	14	6?	16	1.1+	3	Sept. 21 ?..	29?
	13.....	Sept. 2....	Sept. 11....	9	Oct. 18....	38	3	² 86	2.2+	7	Oct. 21....	49
	14.....	Sept. 11....	Sept. 20....	9	Sept. 24....	5	1	14	2.8	8	Sept. 25....	14
	15.....	Sept. 20....	Oct. 7....	17	Oct. 21....	15	11	³ 13	.08	4	Nov. 1....	42
	16.....	Oct. 7 ⁴										
Last-born generation series.	2.....	June 12....	June 18....	6	July 11....	24	1	67	2.7	7	July 12....	30
	3.....	July 11....	July 17....	6	July 21....	5	1	23	4.6	7	July 22....	11
	4.....	July 21....	July 29....	8	Aug. 16....	19	0	43	2.2+	6	Aug. 16....	26
	5.....	Aug. 16....	Aug. 26....	10	Sept. 5-7..	11-13		29		8	Sept. 5-7..	20-22
	6.....	Sept. 5-7..	Sept. 15....	8-10	Oct. 5....	21	1	⁵ 32	1.5+	6	Sept. 6....	29-31
	7.....	Oct. 1-5....										

¹ Notes do not say definitely that the aphides were born May 13.

² The last 8 young (born Oct. 9-18) were reared to maturity and all proved to be oviparous females.

³ First young was oviparous. Of the 7 others reared to maturity 6 were oviparous females and 1 a viviparous female.

⁴ Oviparous females.

⁵ Of the last 10 young 3 lived to maturity, 1 being an oviparous female and 2 viviparous females.

TABLE IV.—Line of generations of *Callipterus trifolii* from May 13, 1909, to oviparous generation, La Fayette, Ind. (Phillips and Parks).

Generation from May 13.		Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Productive period.	Life after last young.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Date of death or disappearance.	Total length of life.
				Days.		Days.	Days.					Days.
First-born generation series...	1.....	May 13 ¹ ...	May 20....	7	May 25....	6	2	27	4.5	6	May 27....	14
	2.....	May 20....	May 31....	11	June 24....	25	1	83	3.3+	7	June 25....	36
	3.....	May 31....	June 8....	8	June 28....	21	0	60	2.8+	7	June 29....	29
	4.....	June 8....	June 18....	10	July 14....	27	3	90	3.3+	7	July 17....	36
	5.....	June 18....	June 28....	10	Aug. 3....	37	1	60	1.06	5	Aug. 4....	47
	6.....	June 28....	July 9....	11	July 19....	11	0	42	3.8+	7	July 19....	21
	7.....	July 9....	July 16....	7	Aug. 6....	22	1	85	3.8+	7	Aug. 7....	29
	8.....	July 16....	July 23....	7	Aug. 3....	12	0	31	2.5+	5	Aug. 3....	18
	9.....	July 23....	July 31....	8	Aug. 23....	24	0	76	3.3+	5	Aug. 23....	31
	10.....	July 31....	Aug. 9....	9	Aug. 14....	6	0	16	2.6+	10	Aug. 14....	14
	11.....	Aug. 9....	Aug. 14....	5	Aug. 23....	10	1	40	4.0	5	Aug. 24....	15
	12.....	Aug. 14....	Aug. 23....	9	Sept. 17....	26	3	71	2.7+	6	Sept. 20....	37
	13.....	Aug. 23....	Aug. 30....	7	Oct. 2....	34	2	78	2.2+	6	Oct. 4....	42
	14.....	Aug. 30....	Sept. 11....	12	Sept. 23....	13	1	41	3.1+	6	Sept. 24....	25
	15.....	Sept. 11....	Sept. 20....	9	Oct. 21....	42	11	² 52	1.2+	8	Nov. 1....	51
	16.....	Sept. 20....	Oct. 6....	16	Oct. 28....	23	11	³ 24	1.0	8	Nov. 8....	49
	17.....	Oct. 6. ⁴										
Last-born generation series...	3.....	June 24....	July 1....	7	July 19....	20	3	48	2.4	6	July 21....	27
	4.....	July 19....	July 27....	5	Aug. 16....	21	1	74	3.5+	8	Aug. 17....	29
	5.....	Aug. 16....	Aug. 26....	10	Oct. 4....	40	7	⁵ 75	1.8+	5	Oct. 11....	56

¹ Exact date of birth not given.

² Some of the last-born young were reared to maturity and they proved to be males and oviparous females.

³ Of the 24 young, 23 were reared to maturity and all proved to be oviparous females.

⁴ Oviparous female.

⁵ Last young died before maturing.

Mr. R. L. Webster has followed the successive generations of this species in the insectary of the Illinois State Entomologist from the eggs which hatched March 27 through nineteen generations to October 18. The nineteenth generation disappeared before maturing and the oviparous generation was not obtained. In his experiments, reported by Dr. J. W. Folsom (1909), he found that the length of time from birth to maturity varied from 5 to 24 days, with an average for the season of 10 days, and the length of life of an individual varied from 9 to 43 days, with an average of 22. The largest number of young produced in one day by a single female was 13, with a yearly average of 3.7 young per day; the maximum number of young born of a female was 75, the average for the series being 34.8 young per female.

MOLTING.

So far as our observations extend, the yellow clover aphid invariably molts but four times. Table V records the molting records of six individuals from data obtained by Mr. Parks in 1909 at La Fayette, Ind.

TABLE V.—Periods of molts of *Callipterus trifolii*, viviparous generation.

Date of birth.	Age at first molt, second instar.	Age at second molt, third instar.	Age at third molt, fourth instar.	Age at fourth molt, fifth instar.	Age at birth of first young.
1909.	Days.	Days.	Days.	Days.	Days.
May 15.....	2	3	6	9	10
May 20.....	2	6	8	11	11
Do.....	2	5	8	10	11
May 31.....	2	4	6	8	9
Do.....	2	5	7	8	8
June 8.....	2	4	6	9	10

FECUNDITY IN RELATION TO OTHER SPECIES.

In comparison with its associate on clover, *Macrosiphum pisi* Kalt., *Callipterus trifolii* is quite noticeably less prolific. While *pisi*, according to our 1913 experiments, produces an average of about 65 young and a maximum number per female of 124 young, *trifolii*, on the other hand, averages 50 young and produced a maximum of 99 young per female. Likewise a single *pisi* has produced as high as 13 young in one day while the maximum number of young per day borne by a female *trifolii* was 9, and this was an unusual number.

From dissections made in Illinois several years ago the writer found that the oviparous females contained an average of 10 eggs per individual. The past fall (1913) 8 oviparous females were examined and found to contain the following numbers of apparently fully developed eggs each, respectively: 13, 13, 14, 10, 12, 13, 14, 16—an average of 13.1 + eggs per female. In the latter counts only females

which had not previously laid eggs were used, while in the earlier counts no choice was made, which probably accounts for the differences in the average. Similar egg counts for *Macrosiphum pisi* show it to be much more prolific in egg production; in fact the counts for *pisi* were nearly twice those for *trifolii*.

Although we find both species attacking red clover, the one (*pisi*) is often quite abundant and destructive to clover, while the other (*trifolii*) is seldom if ever injurious. One of the principal causes of this difference will be readily understood from what has just been noted, namely, the great difference in fecundity of both viviparous and oviparous females. Other habits which doubtless have an influence in making *trifolii* less abundant are its sporadic mode of living, the comparatively late date of hatching from the egg, and the additional fact that it always winters in the egg stage while in *pisi* the eggs hatch earlier in spring and many individuals winter as viviparous females, thus giving it the advantage of an early start. Further, *pisi* has a variety of hosts, which is not true of *trifolii* in America; and, finally, the latter species requires a much smaller quantity of sap for becoming mature than does *pisi*, and as a result it is individually less harmful to the plant.

NATURAL ENEMIES.

Doubtless the most important checks on the yellow clover aphid are the weather conditions, more especially heavy rains. The aphid fungus, *Empusa aphidis*, is likewise quite an important factor in holding this plant-louse in check.

On account of its habits of living singly and jumping from the leaf at the least disturbance, this species is seldom attacked by internal parasites. Mr. Paul Hayhurst noticed a few parasitized specimens of this species at Chevy Chase Lake, Md., July 9, 1907, but apparently no parasites issued. The writer has likewise found occasional specimens parasitized, but has never reared the parasites.

Of the coccinellids, three species, *Megilla maculata* DeG., *Hippodamia convergens* Guer., and *Coccinella 9-notata* Herbst, were reared to the adult stage in the insectary at Washington, from larvæ which were feeding on *Callipterus trifolii* on material received from Cadet, Mo., June 19, 1889.

The writer observed the 9-spotted ladybird (*Coccinella 9-notata* Herbst) attacking the yellow clover aphid at Urbana, Ill., September 18, 1913, and larvæ of what were considered the same species were not uncommon on the badly infested clover plants, devouring the aphides.

At La Fayette, Ind., we have reared a species of *Aphidoletes* from larvæ feeding on this aphid in chimney cages, although it has never been found attacking it in the field.

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