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L. O. HOWARD, Entomologist and Chief of Bureau.

PAPERS ON APHIDIDÆ.

STUDIES ON A NEW SPECIES OF TOXOPTERA,

WITH AN ANALYTICAL KEY TO THE GENUS AND NOTES ON REARING METHODS.

BY

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Entomological Assistants, Cereal and Forage Insect Investigations.

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PAPERS ON APHIDIDÆ.

STUDIES ON A NEW SPECIES OF TOXOPTERA, WITH AN ANALYTICAL KEY TO THE GENUS AND NOTES ON REARING METHODS.

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INTRODUCTION.

Toxoptera muhlenbergiæ has been under observation since the summer of 1908. On July 24 of that year Mr. V. L. Wildermuth, of this bureau, found this aphis at New Paris, Ohio, on a species of *Muhlenbergia*. It was thought at the time that it was *Toxoptera graminum*, to which species it bears a very close resemblance. The senior author found the same aphis at Richmond, Ind., later in the month, placed it in rearing on *Muhlenbergia*, and obtained the sexes in October. From the sexes it was very evident that the species was not *T. graminum*, as the male is wingless. Since *T. muhlenbergiæ* bore so close a resemblance to the destructive "green bug," a species that the senior author was then studying, he has also kept the former species under observation since that time. The junior author has named and described the species and has also drawn up a key for the identification of the members of this genus. The authors wish to thank Mr. Philip Luginbill, of the Bureau of Entomology, for his assistance in rearing through consecutive generations of this species.

DESCRIPTION OF THE SPECIES.

Toxoptera muhlenbergiæ n. sp.

WINGED VIVIPAROUS FEMALE.

(Fig. 1.)

Head brownish, thoracic plate dark brown, and abdomen pale green. Usually a small pale-yellowish area on the abdomen around each cornicle. Eyes black and ocelli dusky. Antennæ blackish excepting segments I, II, and the extreme base of III, which are pale brownish; slightly imbricate, 3 to 7 circular sensoria in a row on segment III, the usual one near the distal end of V, and several

small ones surrounding a larger one at distal end of base of VI; total length about equal to that of the body; segments III and filament of VI longest, the latter being slightly the longer of the two; IV and V subequal, their total length being subequal to III; base of VI about three-tenths the length of the filament or one-third of III. (See fig. 1, *b*.) Beak reaching slightly beyond the coxæ of the first pair of legs. Legs dark brown excepting the basal one-third or one-half of the femora and tibiæ. Wings with the discoidal vein once-branched, the branching being about two-thirds the distance from the base to the tip of the wing, the basal end not contiguous with the costal vein (occasionally one wing with the discoidal unbranched, and in one case the branching was at the extreme tip of the wing);

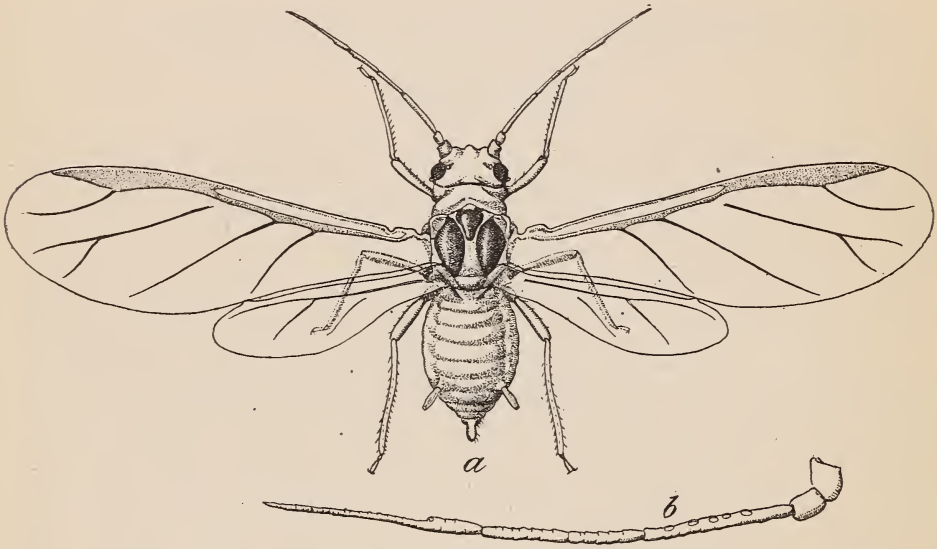

FIG. 1.—*Toxoptera muhlenbergiæ: a*, Winged viviparous female, greatly enlarged; *b*, antenna of same, more enlarged. (Original.)

veins dark brown. Lateral abdominal tubercles inconspicuous. Cornicles pale green, very slightly swollen in the middle, subequal in length to the style. Style pale green, and slightly longer than the hind tarsi.

Measurements (from specimens mounted in balsam): Length of body, 0.7999–0.9090 mm., average, 0.8471 mm.; width, 0.2909–0.4181 mm., average, 0.3526 mm.; length of wing, average, 1.88 mm.; width, average, 0.636 mm.; antenna, I, 0.05 mm.; II, 0.041 mm.; III, 0.2119–0.2608 mm., average, 0.23 mm.; IV, 0.0978–0.1385 mm., average, 0.1124 mm.; V, 0.1222–0.1467 mm., average, 0.1325 mm.; VI, base, 0.0652–0.0896 mm., average, 0.0787 mm.; VI, filament, 0.22–0.2689 mm., average, 0.2509 mm.; average total, 0.8955 mm.; cornicles, 0.09–0.12 mm., average, 0.0986 mm.; style, 0.0978–0.1141 mm., average, 0.1048 mm.; hind tarsus, 0.0978 mm.

Described from eight living specimens received from W. J. Phillips collected on *Muhlenbergia* at La Fayette, Ind., September 9, 1909. Types mounted on four balsam slides, in the collection of the Bureau of Entomology, U. S. Department of Agriculture.

WINGLESS VIVIPAROUS FEMALE.

(Fig. 2.)

Head and body entirely pale green, the head being slightly paler than the thorax and abdomen. Eyes black. Antennal segments I, II, and III very pale brownish, IV pale at base and gradually changing to dark brown or blackish; total length slightly more than half that of the body; filament of VI largest, it being about four times the basal portion of VI; III three times the length of IV and three-fourths filament VI; IV and V subequal, V being slightly the longer. Beak reaching the coxæ of the second pair of legs. Legs pale excepting the tarsi and distal ends of the tibiæ, which portions are blackish. Abdominal tubercles as in the winged form. Cornicles and style pale, with a slight greenish tint, and not unlike those of the winged female in form.

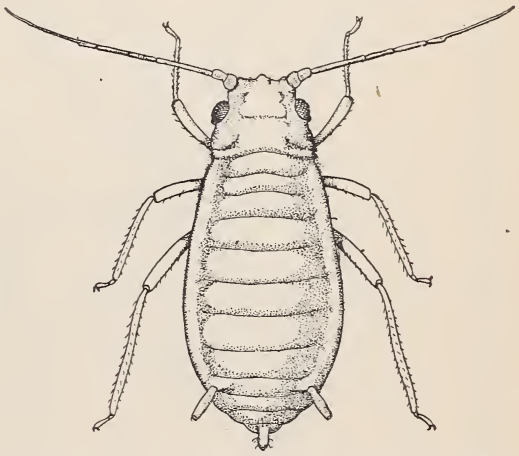

FIG. 2.—*Toxoptera muhlenbergiæ:* Wingless viviparous female. Greatly enlarged. (Original.)

Measurements (from specimens mounted in balsam): Length of body, 1.1308 mm.; width, 0.5198 mm.; antenna, I, 0.0489 mm.; II, 0.04 mm.; III, 0.1548–0.2037 mm., average, 0.1825 mm.; IV, 0.0815–0.1141 mm., average, 0.0994 mm.; V, 0.1059–0.1141 mm., average, 0.1108 mm.; VI, base, 0.0652–0.0815 mm., average, 0.0684 mm.; VI, filament, 0.2119–0.2771 mm., average, 0.2477 mm.; average total, 0.7977 mm.; cornicle, average, 0.1385 mm.; style, 0.1141 mm.; hind tarsus, 0.09 mm.

Described from six living specimens collected at La Fayette, Ind., September 9, 1909. Types mounted on four balsam slides, in the collection of the Bureau of Entomology, U. S. Department of Agriculture.

WINGLESS MALE.

(Fig. 3.)

Head dusky green to blackish, prothorax pale green, thoracic plate dark to blackish green, and the abdomen pale greenish yellow. Eyes black. Ocelli present as in the other forms. Antennæ blackish, excepting the two basal segments, which are pale dusky; irregularly placed circular sensoria as follows: 22–23 on III, 17–24 on IV, 11–17

on V, and the usual ones at the distal end of base of VI; subequal in length to that of the body; III the longest, it being nearly twice as long as IV and four times base of VI; IV and V subequal, and base of VI slightly less than one-third of filament of VI. (See fig. 3, *b*.) Beak reaching just beyond the coxæ of the second pair of legs. Legs pale, excepting the tarsi and distal ends of the tibiæ, which are blackish (in some specimens the basal ends of the femora are pale and the remainder gradually becoming dusky toward the apices, tibiæ dusky excepting the blackish tips, and the tarsi black). Cornicles and style whitish green.

FIG. 3.— *Toxoptera muhlenbergiæ: a*, Wingless male, greatly enlarged; *b*, antenna of same, more enlarged. (Original.)

Measurements (from specimens recently mounted in balsam): Length of body, average, 1.127 mm.; width, 0.4143 mm.; antenna, I, 0.057 mm.; II, 0.0489 mm.; III, 0.2934–0.3504 mm., average, 0.3209 mm.; IV, 0.1467–0.22 mm., average, 0.1793 mm.; V, 0.1548–0.1874 mm., average, 0.1712 mm.; VI, base, 0.0733–0.0896 mm., average, 0.0815 mm.; VI, filament, 0.2445–0.3097 mm., average, 0.269 mm.; average total, 1.1278 mm.; cornicles, average, 0.1074 mm.; style, average, 0.1026 mm.; hind tarsus, 0.1074 mm.

Described from seven living specimens. Types mounted in balsam on five slides, October 13, 16, and 18, 1909. In the collection of the Bureau of Entomology, U. S. Department of Agriculture.

WINGLESS OVIPAROUS FEMALE.

(Fig. 4.)

Head pale yellowish and the thorax yellowish green. Abdomen pale greenish, the sides being decidedly pale green and the median dorsum more of a yellowish, this latter being due to the yellow eggs within. Eyes black. Antenna with segments I and II concolorous

with the head; III pale but slightly dusky; IV and V pale dusky; VI blackish, slightly more than one-half the length of the body; filament of VI longest, it being one-fourth longer than III; III and IV subequal, and base of VI a little more than one-third of III. (See fig. 4, *b*.) Beak not reaching to the coxæ of the second pair of legs. Legs pale, excepting the distal ends of the tibiæ, which are dusky, and the tarsi, which are black. Hind tibia (fig. 4, *c*) swollen and bearing 15 to 21 rather large but inconspicuous sensoria. Cornicles cylindrical, pale yellow or greenish yellow, and about one-third longer than the hind tarsus. Style concolorous with the cornicles and slightly longer than the tarsus. The position assumed by the oviparous females is similar to that of other species, namely, with the hind tibiæ held back along the abdomen, and the abdomen tilted upward.

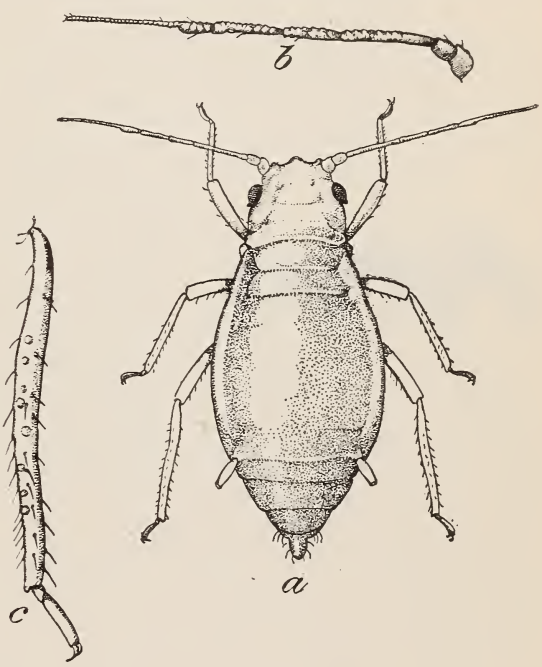

FIG. 4.—*Toxoptera muhlenbergiæ*: *a*, Wingless oviparous female, greatly enlarged; *b*, antenna of same, more enlarged; *c*, hind tibia of same, more enlarged. (Original.)

Measurements (from specimens recently mounted in balsam): Length of body, average, 1.796 mm.; width, average, 0.7855 mm.; antenna, I, 0.057 mm.; II, 0.048 mm.; III, 0.163–0.2363 mm., average, 0.2052 mm.; IV, 0.0978–0.1467 mm., average 0.1254 mm.; V, 0.1141–0.1548 mm., average, 0.1368 mm.; VI, base, 0.0652–0.0815 mm., average, 0.0748 mm.; VI, filament, 0.2282–0.29 mm., average, 0.2589 mm.; average total, 0.9061 mm.; cornicles, average, 0.1596 mm.; style, average, 0.1237 mm.; hind tarsus, average, 0.1042 mm.

Described from 12 living specimens. Types mounted on six slides. October 8, 13, 16, and 18, 1909. In the collection of the Bureau of Entomology, U. S. Department of Agriculture.

EGG.

(Fig. 5.)

Pale yellowish when first laid, gradually changing to pale green, then dark green, and finally to jet black. They are deposited singly on the leaves of *Muhlenbergia*. Form elliptical-oval. Measurements: Length, 0.56 mm.; width, 0.26 mm.

STEM-MOTHER.[1]

First instar (before first molt).—General color dark nile-green; head, beak, antennæ, and legs very dark gray, almost black; cornicles very dark, small, and inconspicuous; eyes black; antennæ 4-segmented.

Measurements (from two specimens in balsam): Length of body, 0.49 mm.; width, 0.20 mm.; antenna, I, 0.0326 mm.; II, 0.0326 mm.; III, 0.0896 mm.; IV, base, 0.0407 mm.; IV, filament, 0.0896 mm.; total length, 0.2851 mm.

Described from two specimens. Types on two balsam slides in collection of the Bureau of Entomology, U. S. Department of Agriculture. La Fayette, Ind., 1910.

Second instar (before second molt).—General color blue-green, the head having somewhat of a grayish cast. Antennæ 5-segmented; the three distal segments very dark, almost black; the basal segments pale gray. Beak black at tip, reaching to coxæ of the third pair of legs. Legs pale, excepting tarsi and distal portions of tibiæ, which are black. Tips of cornicles black, small, and inconspicuous as in the first instar.

FIG. 5.—*Toxoptera muhlenbergiæ:* Eggs. Greatly enlarged. (Original.)

Measurements (from two specimens recently mounted in balsam): Length of body, 0.54 mm.; width, 0.245 mm.; antenna, I, 0.0326 mm.; II, 0.0326 mm.; III, 0.065 mm.; IV, 0.0489 mm.; V, base, 0.0489 mm.; V, filament, 0.114 mm.; total length, 0.342 mm.; cornicles, 0.0326 mm.; hind tarsus, 0.0733 mm.

Described from two specimens. Types on two balsam slides in the collection of the Bureau of Entomology, U. S. Department of Agriculture. La Fayette, Ind., 1910.

Third instar (before third molt).—General color of body pale green, eyes black. Antennæ 5 segmented, entirely dusky, but darker near the tips, a single sensorium at the end of IV and several at end of base of V. Beak not reaching coxæ of third pair of legs, the tip black. Legs pale greenish gray, excepting the joints and distal portions of tibiæ, which are dusky, and the tarsi, which are black. Cornicles concolorous with body, excepting tips, which are dusky.

Measurements (from two specimens recently mounted in balsam): Length of body, 0.88 mm.; width, 0.40 mm.; antenna, I, 0.0407 mm.; II, 0.0326 mm.; III, 0.125 mm.; IV, 0.0733 mm.; V, base, 0.0652 mm.; V, filament, 0.14 mm.; total length, 0.4768 mm.; cornicles, 0.049 mm.

Described from two specimens. Types on two balsam slides, in the collection of the Bureau of Entomology, U. S. Department of Agriculture. La Fayette, Ind., 1910.

[1] Color notes of the five instars of the stem-mother were made by Mr. Phillips

Fourth instar (before fourth molt).—General color pale green, the head being slightly paler than other parts of the body, and the abdomen having somewhat of a mottled appearance, due to the presence of young within. Beak not reaching coxæ of third pair of legs, black at tip. Eyes black. Antennæ 5-segmented (one specimen showed six segments plainly), segment III with a constriction a little beyond the middle, indicating the point where it divides at the next molt; the two distal segments almost or quite black, the others dusky, shading into greenish gray at the base; sensoria as in the preceding instar. Legs greenish gray, shading into dusky near extremities; tarsi shining black, distal portion of tibiæ and joints quite dusky. Cornicles concolorous with abdomen, excepting tips, which are dusky. Style slightly paler than body.

Measurements (from two specimens recently mounted in balsam): Length of body, 0.90 mm.; width, 0.3912 mm.; antenna, I, 0.049 mm.; II, 0.04 mm.; III, 0.122 mm.; IV, 0.065 mm.; V, base, 0.057 mm.; V, filament, 0.114 mm.; total length, 0.447 mm.; cornicles, 0.049 mm.; hind tarsus, 0.0896 mm.

Described from two specimens. Types on two balsam slides, in the collection of the Bureau of Entomology, U. S. Department of Agriculture. La Fayette, Ind., 1910.

Fifth instar (adult stem mother).—Before the birth of any young the adult is pale green, but gradually the color deepens to apple-green. As in the preceding instar, the young show through the body wall, giving the abdomen somewhat of a mottled appearance. Usually there is a small yellowish area around each cornicle. Head much paler than body, and with a grayish tinge at anterior end. Beak barely reaching coxæ of second pair of legs, black at tip. Eyes jet-black. Antennæ less than one-half the length of body, segments III and filament of VI longest, they being subequal, but filament VI usually slightly the longer of the two; IV about two-thirds or less the length of III; IV and V subequal; base of VI about one-half the length of filament; the two basal segments concolorous with head; III dusky, shading to blackish at apex; the remaining segments black. Legs greenish gray, excepting the joints, which are dusky. Apices of tibiæ very dusky, and tarsi shining black. Cornicles pale translucent, and dusky at tips. Style pale translucent, sometimes dusky, and with a frosted appearance. All stages, including adult, are more or less pruinose.

Measurements (from five specimens recently mounted in balsam): Length of body, average, 1.34 mm.; width, average, 0.69 mm.; antenna, I, 0.057 mm.; II, 0.040 mm.; III, 0.14–0.175 mm., average, 0.155; IV, 0.08–0.1059 mm., average, 0.0945 mm.; V, 0.0978–0.1222 mm., average, 0.10 mm; VI, base, 0.073–0.089 mm., average, 0.08 mm.; VI, filament, 0.14–0.195 mm., average 0.171 mm.; average, total, 0.6975 mm.; cornicles, 0.11 mm.; style, 0.135 mm.; hind tarsus, 0.10 mm.

Described from five specimens. Types mounted on five balsam slides, in the collection of the Bureau of Entomology, U. S. Department of Agriculture. La Fayette, Ind., 1910.

Genus TOXOPTERA Koch.

Seven species of the genus *Toxoptera* have been described, the one described in this paper being the eighth. All, with the exception of this last and *T. caricis* Fullaway, occur in Europe, while only three (*T. graminum*, *T. aurantii*, and *T. muhlenbergiæ*) are known to America. *T. caricis* was described from specimens collected in Hawaii. The following table may be of service to other workers:

KEY TO THE GENUS.

I. General color of apterous viviparous females black or dark rusty.

a. Apterous females dark rusty; margin of abdomen bearing tuberculate hairs; wing veins pale fuscous, stigma white.....*scirpi* Passerini.
On *Scirpus specierum* and *S. lacustris*.

aa. Apterous females black; margin of abdomen not bearing tuberculate hairs.

b. Sixth antennal segment of winged female equal to one-sixth the terminal filament; wing veins and stigma fuscous; fork of cubital vein arising before the point where the stigmal vein originates.
aurantii Boyer de Fonscolombe.
On orange, citron, and *Camellia*.
Syn. *T. aurantiæ* Koch.
T. camelliæ Kaltenbach.
Ceylonia theaccola Buckton.

bb. Sixth antennal segment of winged female equal to one-fifth the terminal filament; wing veins and stigma not fuscous, pale yellowish; fork of cubital vein arising opposite or beyond the origin of the stigmal vein.
clematidis Del Guercio.
On ornamental *Clematis*.

II. General color green, yellow, or brownish yellow.

a. Body of wingless viviparous female dark green, variegated with shining black. Stigma green.....*variegata* Del Guercio.
On *Rhamnus alaternus*.

aa. Body uniformly green, yellow, or brownish yellow.

b. Style black, at least in the winged viviparous female.

c. Body of wingless viviparous female uniformly dark green; style black.
alaterna Del Guercio.
On *Rhamnus alaternus*.

cc. Body of wingless viviparous female brownish yellow, paler at the margins; style darker than body color; cornicles very large, extending beyond tip of style, much constricted at base and apex.....*caricis* Fullaway.
On *Carex* sp.

bb. Style green, yellow, or but slightly dusky.

d. Cornicles uniformly pale greenish or yellowish green; usually a small yellowish area on the abdomen at base of each cornicle; the media (third discoidal) branching at about three-fifths the distance from the base of the vein to the tip of the wing; antennal segments III and "VI filament" subequal. Males wingless...*muhlenbergiæ* n. sp.
On *Muhlenbergia* sp.

dd. Cornicles blackish at tip; the media (third discoidal) branching at about one-half, or less, the distance from the base of the vein to the tip of the wing; antennal segment "VI filament" noticeably longer than III. Males winged.....*graminum* Rondani.
On wheat, oats, rye, barley, and various grasses.

DISTRIBUTION OF TOXOPTERA MUHLENBERGIÆ.

This aphis has been found through northwestern and west-central Ohio and through east-central and northern Indiana. It probably may be found in any location in which *Muhlenbergia* flourishes.

FEEDING HABITS.

Individuals of this species concentrate on the tender shoots and are rarely found on the tough leaves unless the plants are badly infested. They congregate in the curled central growing shoot. As this leaf expands and unfolds, they go to the younger curled leaf just below this. When in great numbers, they cause these tender shoots to wilt and turn yellow.

HOST PLANTS.

Up to the present time *Muhlenbergia* sp. appears to be the normal host, though this aphis often goes to bluegrass (*Poa pratensis*) when first hatched, since the young sometimes appear before *Muhlenbergia* has started growth. Colonies have been established on wheat, though they do not appear to thrive very well on it.

LIFE HISTORY.

As stated previously, the sexes were reared in October, 1908, at Richmond, Ind. A number of eggs was obtained from these females and they were taken to La Fayette, Ind., in March, 1909, but failed to hatch. Later on in the year these aphides were found in abundance and rearings were begun, with the result that a large number of the sexes and an abundance of eggs were obtained in the fall.

CONTINUOUS-GENERATION EXPERIMENTS.

About 1,000 eggs were collected in the fall of 1909 with the hope of getting stem-mothers to start a series of continuous generations. None of these eggs hatched, however. Large numbers of eggs were found in the field and from these the continuous-generation series were started; that is, starting with the stem-mother and isolating her first born and the first born of each successive generation until the sexes appeared; and a second series, consisting of the last born from the stem-mother and the last born of each successive generation until the sexes appeared. By adding the number of first and last born generations and dividing the result by 2 we are able to arrive at the approximate number of generations that would be produced during the year. Much other data would also be accumulated in this way on the daily production of young, the maximum and minimum number of young produced, and the average length of life.

The table following gives in detail the consecutive generations of the first and last born series, starting with a stem-mother that hatched March 28, 1910.

Table of consecutive generations of Toxoptera muhlenbergiæ.

[b=born; d=died or disappeared.]

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.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.
	° F.	° F.																				
Mar. 28	84	53	b																			
Mar. 29	84	57	0																			
Mar. 30	76	60	0																			
Mar. 31	73	42	0																			
Apr. 1	63	37	0																			
Apr. 2	69	39	0																			
Apr. 3	73	42	0																			
Apr. 4	73	56	0																			
Apr. 5	76	62	0																			
Apr. 6	71	39	0																			
Apr. 7	46	29	0																			
Apr. 8	60	32	0																			
Apr. 9	73	42	0																			
Apr. 10	73	43	0																			
Apr. 11	80	50	0																			
Apr. 12	80	43	2	b																		
Apr. 13	62	32	0	0																		
Apr. 14	69	37	1	0																		
Apr. 15	80	52	3	0																		
Apr. 16	77	59	3	0																		
Apr. 17	71	35	0	0																		
Apr. 18	48	33	0	0																		
Apr. 19	40	32	0	0																		
Apr. 20	47	37	2	0																		
Apr. 21	58	32		0																		
Apr. 22	62	40	0	0																		
Apr. 23	65	30	0	0																		
Apr. 24	31	26	0	0																		
Apr. 25	44	30	0	0																		
Apr. 26	44	34	0	0																		
Apr. 27	43	35	0	0																		
Apr. 28	57	41	1	0																		
Apr. 29	71	46	0	0																		
Apr. 30	82	58	3	0													b					
May 1	66	50	0	7	b												0					
May 2	71	59	d		0												0					
May 3	69	43		1	0												0					
May 4	61	34		0	0												0					
May 5	57	36		3	0												0					
May 6	59	41		1	0												0					
May 7	62	45		2	0												0					
May 8	53	46		3	0												0					
May 9	52	49			0												0					
May 10	72	46		2	0												0					
May 11	73	54		2	0												0					
May 12	55	35		0	0												0					
May 13	57	36		2	0												0					
May 14	55	33		1	0												0					
May 15	59	40		2	0												0					
May 16	64	49			0												0					
May 17	69	54		4	0												0					
May 18	64	48		0	0												0					
May 19	75	50		1	0												0					
May 20	74	59		1	0												0					
May 21	76	59		1	0												0					
May 22	77	62		1	0												0					
May 23	80	65			4	b											0					
May 24	68	54		0	0	0											0					
May 25	69	44		0	1	0											0					
May 26	63	40		0	0	0											5					
May 27	66	38		0	1	0											1					
May 28	68	45		0	0	0											1					
May 29	78	59		1	0	0											0					
May 30	75	45			0	0											0					
May 31	60	41			d	0											0					
June 1	58	39		d		0											0					
June 2	69	41				0											0					

Table of consecutive generations of Toxoptera muhlenbergiæ—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.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.
	°F.	°F.																				
June 3	59	39				0											1	b				
June 4	61	44				0											0	0				
June 5	65	54				0											0	0				
June 6	70	46				0											0	0				
June 7	71	40				0											d	0				
June 8	72	51				0												0				
June 9	77	56				0												0				
June 10	70	53				0												0				
June 11	70	50				1	b											0				
June 12	75	45				1	0											2				
June 13	79	52					0															
June 14	83	61				2	0											0				
June 15	81	53				5	0											1				
June 16	87	57				2	0											3				
June 17	90	61				3	0											2				
June 18	91	63				1	0											2				
June 19	92	63				0	0											3				
June 20	94	60				0	0															
June 21	90	65				d	0											0				
June 22	93	65					1	b										0				
June 23	94	68					2	0										2				
June 24	96	69					2	0										2				
June 25	92	63					0	0										1				
June 26	91	62					0	0										3				
June 27	96	68					0	0														
June 28	75	62					0	0										3				
June 29	84	61					0	0										2				
June 30	86	64					0	0										0				
July 1	93	68					4	0										0				
July 2	94	72					3	0										1				
July 3	82	71						0														
July 4	86	64					2	0										3				
July 5	75	59						2	b													
July 6	85	64					3	1	0									0				
July 7	86	66					d	5	0									d				
July 8	88	65						0	0													
July 9	92	71						4	0													
July 10	91	69						1	0													
July 11	82	58							1	b												
July 12	86	65						1	1	0												
July 13	86	60						1	0	0												
July 14	83	61						d	1	0												
July 15	88	68							1	0												
July 16	89	68							2	0												
July 17	85	65							2	0												
July 18	77	56								0												
July 19	77	54							0	0												
July 20	80	54							0	0												
July 21	83	59							2	0												
July 22	83	63							d	0												
July 23	86	70								0								3				
July 24	88	73								2	b								1			
July 25	89	70									0											
July 26	91	64								0	0							2				
July 27	90	70								0	0							0				
July 28	94	65								1	0							1				
July 29	86	66								1	0							2	[1]b			
July 30	84	64								1	0							0	0			
July 31	83	54								1	0							0	0			
Aug. 1	80	53									0							0	0			
Aug. 2	86	61								2	0							0	3			
Aug. 3	90	64								3	0							0	2			
Aug. 4	81	60								d	0							d	1			
Aug. 5	83	54									2	b							1			
Aug. 6	82	51									0	0							2			
Aug. 7	86	60									3	0							2			
Aug. 8	74	54										0										

[1] Date of birth uncertain.

Table of consecutive generations of Toxoptera muhlenbergiæ—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.	Second generation.	Third generation.	Fourth generation.	Fifth generation.	Sixth generation.	Seventh generation.
	°F.	°F.																				
Aug. 9	86	59	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	....	1	....	....
Aug. 10	77	55	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	....	2	....	....
Aug. 11	85	56	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	....	1	....	....
Aug. 12	85	55	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	....	....	1	....	....
Aug. 13	87	56	....	....	....	....	....	....	....	....	d	0	....	....	....	....	....	....	....	0	....	....
Aug. 14	87	56	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	} 2	{	....
Aug. 15	92	67	....	....	....	....	....	....	....	....	....	6	b	....	....	....	....	....	....		{	....
Aug. 16	92	70	....	....	....	....	....	....	....	....	....	3	0	....	....	....	....	....	....	0	....	....
Aug. 17	91	67	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	....	3	....	....
Aug. 18	92	71	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	....	1	....	....
Aug. 19	78	62	....	....	....	....	....	....	....	....	....	5	0	....	....	....	....	....	....	2	....	....
Aug. 20	82	58	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0	....	....
Aug. 21	84	65	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	} 6	{	....
Aug. 22	90	64	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....		{	....
Aug. 23	86	63	....	....	....	....	....	....	....	....	....	3	0	....	....	....	....	....	....	2	....	....
Aug. 24	82	64	....	....	....	....	....	....	....	....	....	0	5	b	....	....	....	....	....	2	} b	{ ..
Aug. 25	84	74	....	....	....	....	....	....	....	....	....	2	5	0	....	....	....	....	....	1		{ ..
Aug. 26	80	47	....	....	....	....	....	....	....	....	....	5	2	0	....	....	....	....	....	0	0	....
Aug. 27	70	47	....	....	....	....	....	....	....	....	....	0	0	0	....	....	....	....	....	0	0	....
Aug. 28	75	50	....	....	....	....	....	....	....	....	....	0	0	0	....	....	....	....	....	0	0	....
Aug. 29	80	55	....	....	....	....	....	....	....	....	....	d	0	0	....	....	....	....	....	0	0	....
Aug. 30	85	59	....	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	d	4	....
Aug. 31	90	61	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0	....
Sept. 1	80	60	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	1	....
Sept. 2	70	53	....	....	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	0	....
Sept. 3	77	56	....	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	....	1	....
Sept. 4	86	56	....	....	....	....	....	....	....	....	....	....		{ 0	....	....	....	....	....	....	}	{ ..
Sept. 5	84	67	....	....	....	....	....	....	....	....	....	....	3	{ 0	....	....	....	....	....	....	1	....
Sept. 6	84	67	....	....	....	....	....	....	....	....	....	....		{ 7	b	....	....	....	....	....		{ ..
Sept. 7	82	63	....	....	....	....	....	....	....	....	....	....	d	0	0	....	....	....	....	....	0	....
Sept. 8	82	65	....	....	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	1	b
Sept. 9	85	60	....	....	....	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	0	0
Sept. 10	68	46	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	0	0
Sept. 11	69	48	....	....	....	....	....	....	....	....	....	....	....	} 1	{ 0	....	....	....	....	....	0	0
Sept. 12	80	56	....	....	....	....	....	....	....	....	....	....	....		{ 0	....	....	....	....	....	0	0
Sept. 13	79	59	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	d	0
Sept. 14	64	53	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0
Sept. 15	68	46	....	....	....	....	....	....	....	....	....	....	....	0	2	b	....	....	....	....	....	0
Sept. 16	73	46	....	....	....	....	....	....	....	....	....	....	....	0	0	0	....	....	....	....	....	0
Sept. 17	77	48	....	....	....	....	....	....	....	....	....	....	....	2	0	0	....	....	....	....	....	0
Sept. 18	80	54	....	....	....	....	....	....	....	....	....	....	....	0	} 1	{ 0	....	....	....	....	....	0
Sept. 19	85	65	....	....	....	....	....	....	....	....	....	....	....	0		{ 0	....	....	....	....	....	2
Sept. 20	75	58	....	....	....	....	....	....	....	....	....	....	....	0	1	0	....	....	....	....	....	1
Sept. 21	79	51	....	....	....	....	....	....	....	....	....	....	....	0	2	0	....	....	....	....	....	1
Sept. 22	78	54	....	....	....	....	....	....	....	....	....	....	....	d	1	0	....	....	....	....	....	0
Sept. 23	78	56	....	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	0
Sept. 24	70	63	....	....	....	....	....	....	....	....	....	....	....	....	2	0	....	....	....	....	....	1
Sept. 25	74	56	....	....	....	....	....	....	....	....	....	....	....	} 2	{ 0	....	....	....	....	....	....	} 2
Sept. 26	68	50	....	....	....	....	....	....	....	....	....	....	....		{ 0	....	....	....	....	....	....	
Sept. 27	72	51	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0
Sept. 28	65	42	....	....	....	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	0
Sept. 29	70	45	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	1
Sept. 30	75	49	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	1
Oct. 1	80	54	....	....	....	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	1
Oct. 2	78	48	....	....	....	....	....	....	....	....	....	....	....	} 2	{ 0	....	....	....	....	....	....	0
Oct. 3	77	57	....	....	....	....	....	....	....	....	....	....	....		{ 0	....	....	....	....	....	....	0
Oct. 4	84	65	....	....	....	....	....	....	....	....	....	....	....	1	0	....	....	....	....	....	....	1
Oct. 5	72	65	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0
Oct. 6	73	54	....	....	....	....	....	....	....	....	....	....	....	0	0	....	....	....	....	....	....	0
Oct. 7	57	35	....	....	....	....	....	....	....	....	....	....	....	0	[1] 0	....	....	....	....	....	....	0
Oct. 8	62	38	....	....	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	0
Oct. 9	70	43	....	....	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	0
Oct. 10	64	40	....	....	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	0
Oct. 11	64	42	....	....	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	0
Oct. 12	74	45	....	....	....	....	....	....	....	....	....	....	....	0	....	....	....	....	....	....	....	0
Oct. 13	77	46	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	0
Oct. 14	80	47	....	....	....	....	....	....	....	....	....	....	....	d	....	....	....	....	....	....	....	[2] 0

[1] Is adult ♂ now.

[2] Died Oct. 31; her young developed into the sexes.

OUTDOOR REARING SHELTERS.

From this table it will be seen that there were 14 generations of the first-born series and 7 of the last born. This would give approximately 10½ generations for the year.

MOLTING.

In 1909 some molting experiments were conducted. Five individuals that had just been born were placed in a specially prepared cage, as shown in figure 7, and observed throughout the molting period. After becoming adult it was found that there were 1 male and 1 oviparous and 3 viviparous females among these 5 individuals. In 1910 observations were also made on a stem-mother to note the number of molts. Of the 6 individuals, all molted 4 times without exception.

FECUNDITY OF THE SUMMER FORMS.

The 19 individuals concerned in the generation series produced 311 young, or an average of 16.3 young each. The maximum number of young produced by a single individual was 35. The maximum number of young produced by any individual in a single day was 5.

AGE WHEN INDIVIDUALS BEGIN REPRODUCING.

The period between birth and reproduction varies greatly, being longest in the spring, when it varies from 15 to 22 days. In summer the shortest period was 6 days, varying from 6 to 13 days. In the fall it varies from 9 to 13 days. The average period throughout the season for the 13 individuals of the series of first born is 13.1 days.

FIG. 6.—*Toxoptera muhlenbergiæ:* Eggs deposited in curled leaf sheath. Greatly enlarged. (Original.)

LENGTH OF LIFE OF THE VIVIPAROUS FORMS.

The length of life, like the period between birth and reproduction, varies greatly. During the spring, when lower temperatures prevail, the viviparous forms will live from 30 to 63 days, while in the summer they live from 16 to 29 days, and in the fall over 30 days. The average length of life throughout the season for the 13 viviparous individuals of the series of first born is 28.9 days.

THE SEXES.

The sexes make their appearance about the first week in October. There does not appear to be any particular generation that consists

entirely of the sexes. A viviparous female may produce oviparous and viviparous females and males or she may produce only the sexes.

Males and females reach maturity in from 15 to 23 days. The female will not oviposit without having first been fertilized and will live, under these conditions, for about a month, her abdomen becoming greatly distended with eggs. A female with her abdomen thus distended was dissected after death and found to contain 7 eggs. If a male be placed in a cage with an oviparous female when she reaches maturity she will begin oviposition in about 4 days. The oviparous females, whether in the presence of males or not, apparently always maintain their normal position on the plant, never elevating the tips of their abdomens, as is the case with *T. graminum*.

FIG. 7.—Lamp-chimney molting cage used in rearing aphides. (Original.)

PLACE OF OVIPOSITION.

When ready to oviposit, the females crawl down into the leaf sheath, which is usually separated from the plant stem for a part of its length and is somewhat curled, and deposit their eggs in this curled portion. The senior author has counted as many as 200 eggs in such a position. Figure 6 represents such a leaf sheath that has been uncurled and photographed with the eggs in position. In the fall of 1909 eggs were found by the thousands in just such situations.

FECUNDITY OF THE OVIPAROUS FEMALES.

The females of this species do not appear to be quite so prolific as those of its near relative, the destructive "green bug." They produce only from 1 to 5 eggs, though as many as 7 eggs have been taken from the body of a female that had not been fertilized.

MORTALITY OF EGGS.

For some cause or other the eggs appear never to hatch well. During the fall of 1908 from 50 to 100 eggs were collected; and in 1909 fully 1,000 were obtained, but not a single egg hatched, though they were treated in the same manner as eggs of *T. graminum* and other species that stood the winter in good shape. During the spring of 1910 eggs were found by the thousand in the open fields with every evidence that not more than one-half to 1 per cent had hatched, though no unusual circumstances seemed in any way connected with them.

REARING METHODS.

As the Section of Cereal and Forage Insects has been rearing grass and grain infesting aphides for over four years out of doors a brief summary is given of the methods employed, in the hope that future workers on these insects may find some useful suggestions.

FIG. 8.—Lamp-chimney generation cage used in rearing aphides. (Original.)

FIG. 9.—Lamp-chimney stock cage used in rearing aphieds. Original.)

The rearing stand (Pl. I) consists of a shelf 2 feet wide of tongue-and-groove $\frac{3}{4}$-inch boards, supported by a frame or base made of 2-inch by 4-inch material. These bases extend up above the shelf 20 inches and support a gable roof of lapped siding. The shelf is 2 feet from the ground. One side is closed by a hinged door that may be raised in case of a storm to prevent the cages from being blown over. This stand should be placed in the shade, preferably of trees, with the hinged side toward the direction from which the prevailing storms come. When it is not storming the hinged door should be let down to permit of free passage of air. It is also well to place a thermograph on the shelf with the cages in order that continuous temperature records may be secured.

The rearing cages used were of three kinds, a cage to observe molting (fig. 7), one for continuous-generation series (fig. 8). and a stock cage (fig. 9).

The cage for the molting observations (fig. 7) consists of a 5-inch flowerpot and the ordinary lantern globe, with a muslin cover over the top. A plant is potted, and a thin piece of black paper is fitted closely about the plant, the paper being the full size of the pot. Absorbent cotton is then pushed down about the plant to fill in completely the space between plant and paper; the cotton is then blackened with carbon ink. In this manner the grayish-white cast skins of the aphides can readily be seen against the black background.

The cage for the consecutive-generation series (fig. 8) is the same as the molting cage minus the paper.

The stock cage (fig. 9) consists of a 10-inch flowerpot and a 6-inch globe. This globe is the same as the one commonly used in villages for street lamps.

All pots should be placed in saucers and irrigated—never watered from the top, as this causes the soil to become very hard and the plants will not grow so well.

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TECHNICAL SERIES NO. 25, PART II.

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BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

PAPERS ON APHIDIDÆ.

THE YELLOW CLOVER APHIS.

BY

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Entomological Assistant, Cereal and Forage Insect Investigations.

ISSUED NOVEMBER 12, 1914.

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W. B. Hall, J. T. Monell, *collaborators.*

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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 Kaltenbach[3] 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 Wilson[1] 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 table[3] 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 Sirrine); 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 Lahore, 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 underside 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 (*Onobrychis sativa*), alfalfa, bur clover (*Medicago maculata*), alsike clover, English clover, and mammoth clover (*Trifolium medium perenne*). The aphis 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.

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

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*.

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.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
0.061	0.052	0.435	0.261	0.234	0.148	0.139	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

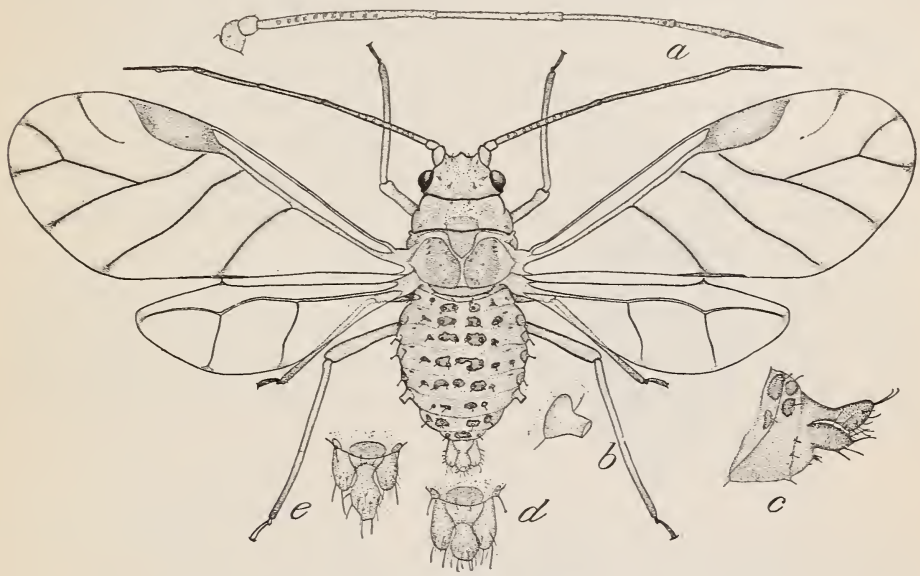

FIG. 11.—The yellow clover aphis (*Callipterus trifolii*): Winged viviparous female, much enlarged *a*, Antenna of same; *b*, cornicle of same; *c*, end of abdomen and cauda of same, lateral view; *d*, cauda and anal plate of same in natural position; *e*, cauda of same, depressed, showing its full length.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

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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 (stigmal 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 filament.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
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.

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

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.

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.

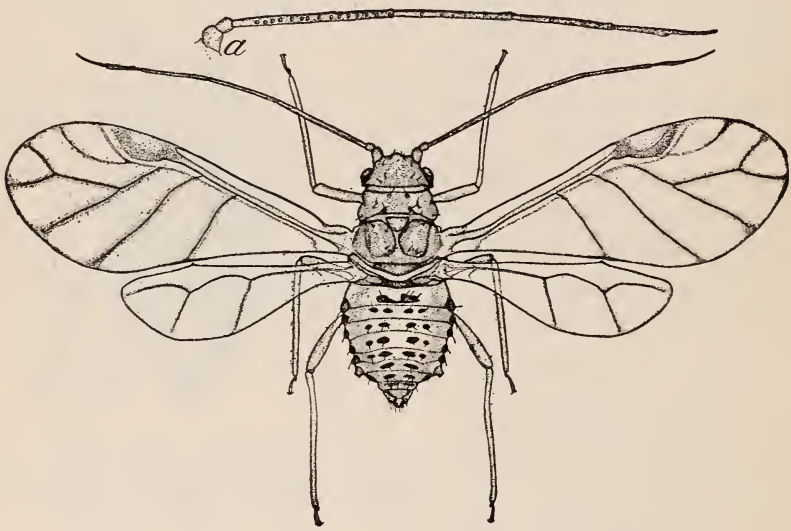
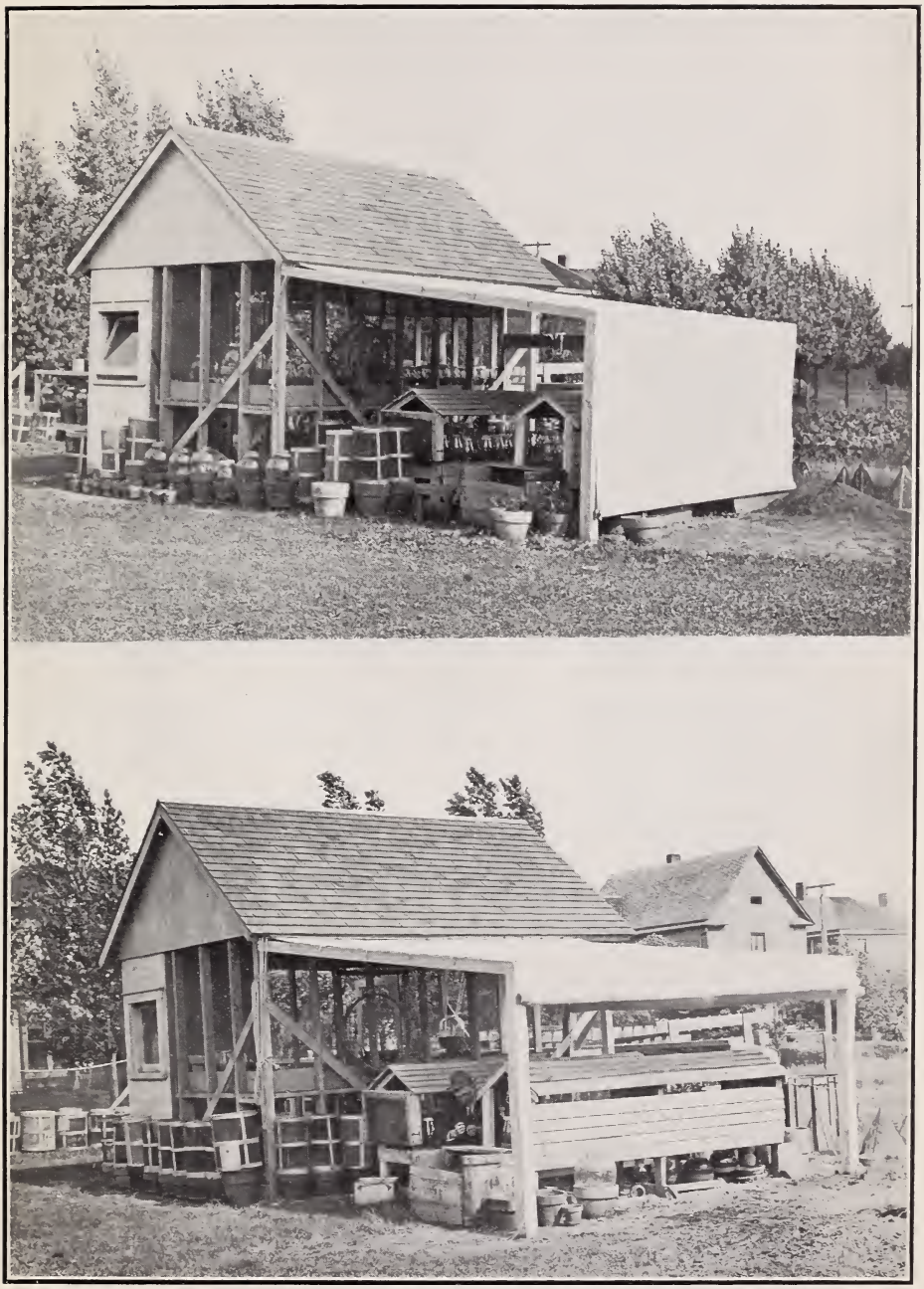


FIG. 13.—The yellow clover aphis: Winged male, much enlarged. *a*, Antenna of same ,greatly enlarged. (Original.)

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.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
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*).

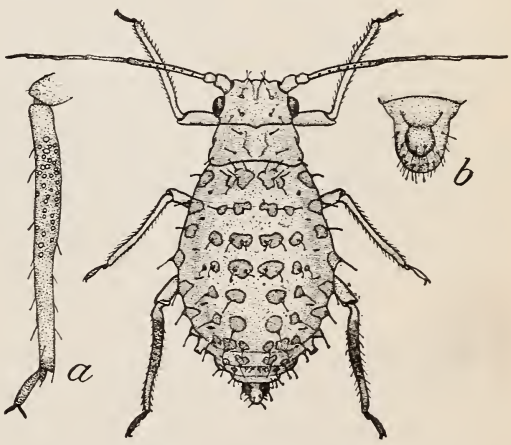


FIG. 14.—The yellow clover aphis: Wingless oviparous female, much enlarged. *a*, Hind tibia of same; *b*, cauda and anal plate of same. *a*, *b*, Greatly enlarged. (Original.)

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.
Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
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 aphis 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 12½ (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.	Temperature.[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.	Eighth 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 aphis 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.
1913.	°F	°F.																								
May 18	79	48	o	0																						
19	72	50	3	o																						
20	76	56	1	2	b																					
21	82	62	7	3	0																					
22	65	52	1	2	0																					
23	57	48	1	3	0																					
24	70	40	1	2	o																					
25	72	52	1	2	0																					
26	70	54	4	3	o																					
27	60	52	2	2	o																					
28	81	49	2	3	o																					
29	86	57	5	5	o																					
30	87	64	2	4	o																b					
31	78	62	.....	7	o																o					
June 1	82	64	.....	3	o																o					
2	79	59	.....	3	4	b															o					
3	79	61	.....	3	6	o															o					
4	82	54	.....	5	2	o															o					
5	76	56	.....	4	6	o															o					
6	90	62	.....	6	6	o															o					
7	91	55	.....	5	2	o															o					
8	59	44	.....	1	3	o															4					
9	63	47	.....	1	2	o															} 6	{				
10	75	45	.....	1	o	o																				
11	75	45	.....	2	o	o															2					
12	82	45	.....	1	5	o															2					
13	85	52	.....	2	3	0															4					
14	91	51	.....	2	5	o															6					
15	95	65	.....	5	4	6	b														5					
16	97	65	.....	7	5	6	o														8					

17	100	66		5	6	8	o														8						
18	97	64		3	4	5	o														4						
19	97	66		1	4	6	o														6						
20	101	66		1	2	5	o														3						
21	95	70		o	2	5	7	b													6						
22	84	62		o	2	4	1	o													2						
23	75	63		o	2	2	5	o													3						
24	81	75		o	o	2	8	o													3						
25	86	72		o	o	6	6	o													3						
26	88	69		o	o	4	7	o													4						
27	92	71		o	o	2		o													5						
28	94	74		o	o	1		o													2						
29	95	74		o	o	2		o													1	b					
30	94	76		o	o			7	b													o					
July 1	94	75		o	o			6	o													o					
2	90	71		o	o			2	o													o					
3	90	73			o			6	o													o					
4	92	74						3	o													o					
5	93	74							o													1					
6	95	66							o													6					
7	84	60							o													2					
8	91	64							2													2					
9	94	66							4	b												3					
10	90	60								o												2					
11	85	57							3	o												5	b				
12	89	70							2	o												2					
13	88	62							2	o												2	o				
14	95	67							3	o													o				
15	94	69							4	o													o				
16	94	76							4	o													o				
17	95	75							2	o													4				
18	88	66							3	1													3				
19	84	64							o	2	b												6				
20	85	60							o	4													6				
21	79	56							2	2	o												2				
22	80	55							o	2	o												4				
23	88	60							o	3	o												7				
24	81	67							4	3	o												2				
25	80	52							2	o	o												3				
26	89	61							3	2	o												8				
27	93	72							2	4	3	b											5				
28	95	73							3	o	8	o											7				
29	94	71								3	2	o											6				
30	98	74									4	o											5				
31	98	74									7	o											6				
Aug. 1	95	66										o											5				
2	87	60										o											o				
3	90	61										4	b										1				
4	87	59										5	o										2				
5	84	59										5	o										2	b			
6	89	62										4	o											o			
7	88	70										7	o											o			

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.
1913.	°F.	°F.																								
Aug. 8	93	73										3	o											o			
9	97	75										5	o											o			
10	92	73										1	4	b										o			
11	86	68										1	7											9			
12	74	64										2	3	o										6			
13	84	70										4	6	o										4			
14	83	72										1	5	o										3			
15	83	70											8	o										9			
16	91	74											6	o										4			
17	95	73											4	6	b									6			
18	91	73											3	6	o									3	b		
19	86	72											2	5	o									1	o		
20	88	67											4	8	o									2	o		
21	90	72											2	5	o										o		
22	90	68											1	o	o										o		
23	75	58											o	3	o										o		
24	78	55											o	2	3	b									2		
25	86	55											6		3	o									1		
26	82	60											o		2	o									1		
27	92	69													2	o									3		
28	94	66														o									6		
29	94	53														o									1		
30	80	53														o									1		
31	82	61														o									6		
Sept. 1	82	64														o									2		
2	98	64														4	b								6		
3	98	68														2	o								7		
4	98	69														4	o								5		
5	94	64														3	o								2		
6	92	68														6	o								3		

	7	91	68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	o	.....	.....	.....	.....	.....	.....	.....	7	.....	.....
	8	92	64	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	o	.....	.....	.....	.....	.....	.....	.....	3	.....	.....
	9	96	53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	o	.....	.....	.....	.....	.....	.....	.....	2	b	.....
	10	79	50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1	b	.....	.....	.....	.....	.....	.....	.....	o	.....
	11	85	57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	12	90	61	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	13	71	52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	14	70	48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	15	73	59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	16	69	56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	17	76	67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	18	73	58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	19	73	52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	20	71	55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	21	55	45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	o	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	22	50	42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	o	o	.....	.....	.....	.....	.....	.....	.....	o	.....
	23	50	37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	1	.....
	24	76	53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	o	.....	.....	.....	.....	.....	.....	.....	6	.....
	25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	2	b	.....	.....	.....	.....	.....	.....	2	.....
	26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	o	.....	.....	.....	.....	.....	.....	2	.....
	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	1	o	.....	.....	.....	.....	.....	.....	1	.....
	28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	o	.....	.....	.....	.....	.....	.....	o	.....
	29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	5	o	.....	.....	.....	.....	.....	.....	2	.....
	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	o	o	.....	.....	.....	.....	.....	.....	5	.....
Oct.	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	5	o	.....	.....	.....	.....	.....	.....	3	.....
	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2	o	.....	.....	.....	.....	.....	.....	3	.....
	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	1	o	.....	.....	.....	.....	.....	.....	1	.....
	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	4	o	.....	.....	.....	.....	.....	.....	1	.....
	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	3	o	.....	.....	.....	.....	.....	.....	1	.....
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	o	.....	.....	.....	.....	.....	.....	5	.....
	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	o	.....	.....	.....	.....	.....	.....	2	.....
	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	o	.....	.....	.....	.....	.....	.....	5	.....
	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	o	.....	.....	.....	.....	.....	.....	1	b
	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	o	.....	.....	.....	.....	.....	.....	.....	o
	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	o	.....	.....	.....	.....	.....	.....	.....	o
	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	o	.....	.....	.....	.....	.....	.....	.....	o
	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	o	.....	.....	.....	.....	.....	.....	.....	o
	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	o	.....	.....	.....	.....	.....	.....	.....	o
	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	(1)	.....	.....	.....	.....	.....	.....	.....	(1)
		.....	.....	65	99	75	64	34	24	45	26	24	42	61	40	10	34	66	49	.....	.....	85	25	84	47	58	41	.....

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-

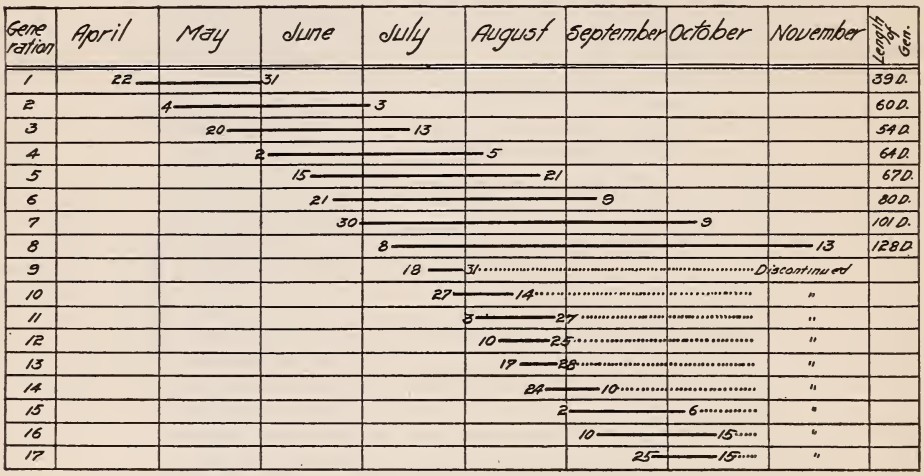


FIG. 15.—Diagram showing periods and succession of generations in the yellow clover aphis, La Fayette, Ind., 1913. (Original.)

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 aphis 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 aphis are the weather conditions, more especially heavy rains. The aphis 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 aphis 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 aphis in chimney cages, although it has never been found attacking it in the field.

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ERRATA.

Page 15, legend to figure 9, second line, for *aphieds* read *aphides.*
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Page 19, line 18, for *Unobrychis* read *Onobrychis.*

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