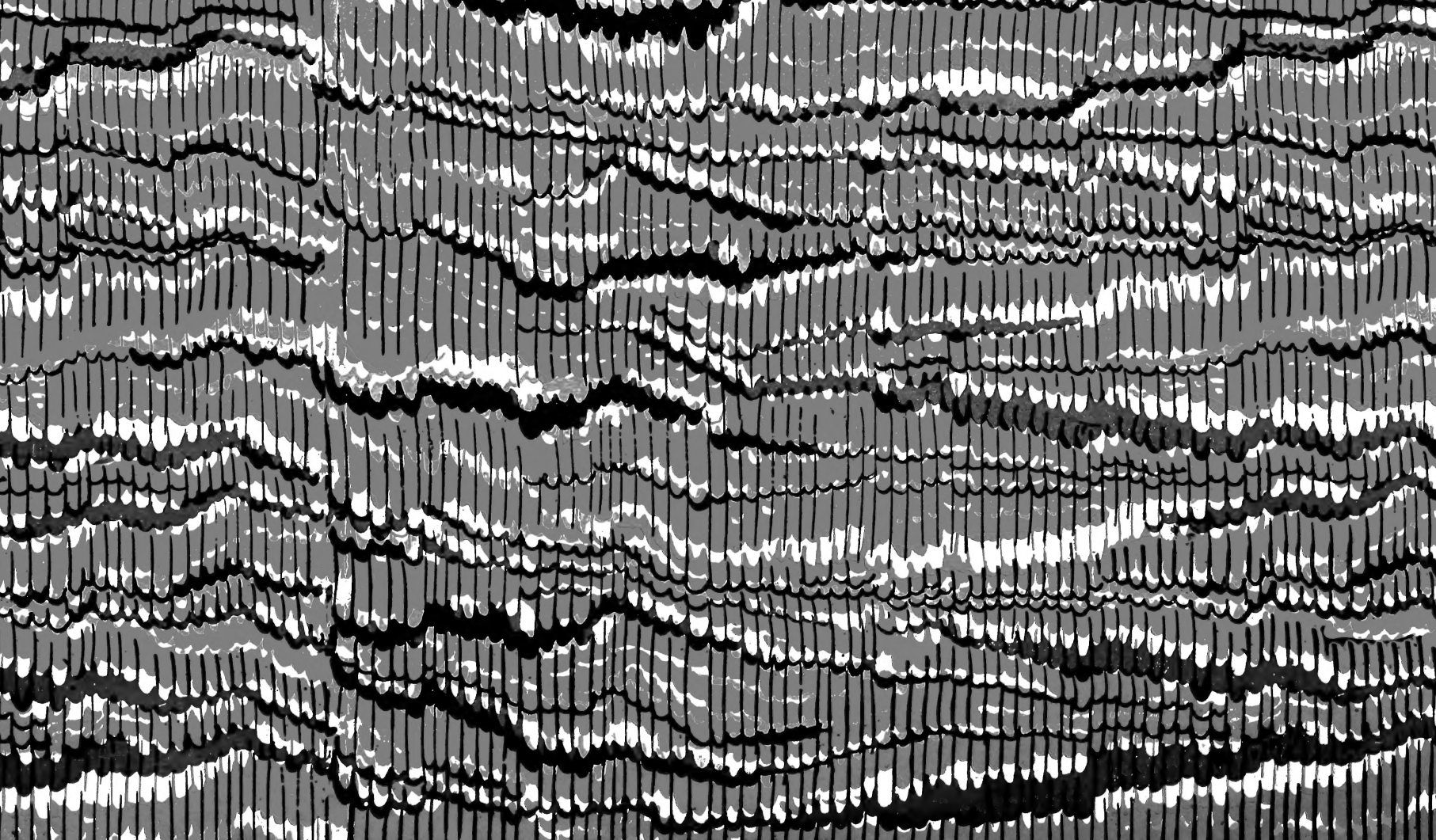

TECHNICAL SERIES, No. 12.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

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1912.

BUREAU OF ENTOMOLOGY.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., October 5, 1912.

SIR: I have the honor to transmit herewith for publication as Technical Series No. 12, of this bureau, nine papers dealing with the classification, description, or habits and life history of various insects belonging to groups of economic importance.

These papers, prepared by different employees of the bureau and published separately during the years 1906–1908, are as follows: Catalogue of Recently Described Coccidæ, by J. G. Sanders; Habits and Life Histories of some Flies of the Family Tabanidæ, by James S. Hine; A Contribution to our Knowledge of the Thysanoptera of California, by Dudley Moulton; New Genera and Species of Aphelininæ, with a Revised Table of Genera, by L. O. Howard; The More Important Aleyrodidæ Infesting Economic Plants, with Description of a New Species Infesting the Orange, by A. L. Quaintance; A Record of Results from Rearings and Dissections of Tachinidæ, by Charles H. T. Townsend; The Orange Thrips, by Dudley Moulton; Biological Studies on Three Species of Aphididæ, by John June Davis; A New Genus of Aleyrodidæ, with Remarks on Aleyrodes nubifera Berger and Aleyrodes citri Riley and Howard, by A. L. Quaintance.

Respectfully,

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

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.[1]

[1] The nine papers constituting this bulletin were issued in separate form on June 5, 1906; Aug. 29, 1906; Apr. 5, 1907; July 12, 1907; Oct. 21, 1907; Sept. 18, 1908; Feb. 11, 1909; Feb. 20, 1909, and Sept. 1, 1909.

ILLUSTRATIONS.

PLATES.

TEXT FIGURES.

ERRATA.

Page 18, line 9 from bottom, for *Parlatoria* read *Parlatorea*.
Page 70, line 24, for *bergi* read *bergii*.
Plate VII, facing page 92, for *Aleyrodes anonæ* read *Aleurodicus anonæ*.
Page 93, line 19, for *Spireæ* read *Spirææ*.
Page 105, line 7, after *chitinized* insert comma and omit *anal*.
Page 116, line 3, for *is* read *are*.
Page 122, line 5, for *stop* read *spot*.
Page 153, line 8, for *maidaphides* read *maidaphidis*.

MISCELLANEOUS PAPERS.

CATALOGUE OF RECENTLY DESCRIBED COCCIDÆ.

By J. G. Sanders, M. A., *Assistant.*

Since the publication, in March, 1903, of Mrs. Fernald's Catalogue[a] many new genera, species, and varieties of Coccidæ from various regions have been described by enthusiastic entomologists. Nine genera, 6 subgenera, 137 species, and 22 varieties comprise the following catalogue, which is fairly complete to date. The majority of the references are to publications which have appeared since March, 1903; however, a few previous to this date are cited, which were overlooked by Mrs. Fernald in the stupendous task of preparing her most useful contribution to coccidology.

The Bureau of Entomology maintains a complete bibliography, by the card-index system, of all publications pertaining to Coccidæ, both economic and systematic. At the suggestion of Prof. T. D. A. Cockerell, and with his valuable assistance, the writer has prepared a supplementary catalogue of new species only, which he hopes to publish *annually* hereafter. In this work the writer respectfully begs the assistance of all authors by the sending of separates or notices of publication, and specimens, if possible, to this Bureau, where they will be properly cared for and recorded.

The large national collection of Coccidæ, containing 1,038 identified species, of which number 660 are types and cotypes—besides much unidentified material from Australia, India, China, and Japan—has been carefully arranged alphabetically in cases built especially for the purpose. Each specimen is carefully wrapped in lens paper and put into a small telescopic pasteboard box, 50 by 75 mm. and varying from 10 to 50 mm. in depth, properly labeled on the edge. Five rows of these boxes, card-index style, fill the regulation insect drawer; and, with the drawers labeled, but a moment is necessary to find any specimen desired. Locality cards, giving all known data for each specimen, are also filed in alphabetical order.

The writer once more begs the assistance of all workers on Coccidæ in publishing annually a complete bibliography of all new species and in the maintenance of a complete bibliographical card index of all publications relating to scale insects.

[a] Bul. 88, Hatch Exp. Sta., Mass. Agric. Coll. A Catalogue of the Coccidæ of the World. By Mrs. Maria E. Fernald.

Subfamily **MONOPHLEBINÆ.**

Monophlebus stebbingii mangiferæ Green.

Monophlebus stebbingii mangiferæ "Green," Stebbing, Jn. Linn. Soc. Lond., XXIX, p. 142 (1904).
Habitat—Lahore, India.
On Mango.

Monophlebulus townsendi Ckll.

Monophlebulus townsendi Ckll., Proc. Dav. Ac. Sci., x, p. 127 (1905).
Habitat—Philippine Islands.

Mimosicerya, new section of *Icerya*; Ckll., The Entom., XXXV, p. 233 (1902). Type, *hempeli.*

Icerya candida Ckll.

Icerya candida Ckll., Proc. Dav. Ac. Sci., x, p. 128 (1905).
Habitat—Philippine Islands.
"On cultivated tree with large oblong-ovate rough leaves."

Icerya colimensis Ckll.

Icerya colimensis Ckll., Mem. Soc. Cient. Ant. Alz., XIX, p. 81 (1902).
Habitat—Mexico.
On undetermined shrub.

Icerya littoralis tonilensis Ckll.

Icerya littoralis var. *tonilensis* Ckll., Mem. Soc. Cient. Ant. Alz., XIX, p. 80 (1902).
The Entom., XXXV, p. 318 (1902).
Habitat—Mexico.

Icerya rileyi larreæ Ckll.

Icerya rileyi var. *larreæ* Ckll., Mem. Soc. Cient. Ant. Alz., XIX, p. 82 (1902).
Habitat—Mexico.
On Larrea.

Subfamily **MARGARODINÆ.**

Ultracœlostoma, n. subg. of *Cœlostomidia;* Ckll., The Entom., XXXV, pp. 114, 258 (1902). Type, *assimilis.*

Xylococcus matumuræ Kuwana.

Xylococcus matumuræ Kuwana, Insect World, IX, 3, March (1905). Fig.

Subfamily **ORTHEZIINÆ.**

Polyocellaria[a] n. gen., Imhof, Biol. Centralblatt, XX, p. 527 (1900).
Kirkaldy, Can. Ent., XXXVIII, p. 10 (1906).

Arctorthezia, n. sect. of *Orthezia;* Ckll., The Entom., XXXV, pp. 114, 259 (1902). Type, *occidentalis.*

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[a] Described from Switzerland as a two-winged insect with hooked halteres, 10-jointed antennæ, 8 and 12 eyes and single-jointed tarsi. It is without much doubt a male Orthezia, but can not be an aphide, as considered by Kirkaldy.

Orthezia galapagoensis Kuwana.

Orthezia galapagoensis Kuwana. Jn. N. Y. Ent. Soc., x, p. 28 (1902). Fig.
Habitat—Galapagos Islands.
On *Cordea lutea; Scalesia microcephala.*

Orthezia olivacea Ckll.

Orthezia olivacea Ckll., Can. Ent., xxxvii, p. 136 (1905).
Habitat—Colorado.
In nests of *Lasius* sp. under rocks.

Orthezia solidaginis Sanders.

Orthezia solidaginis Sanders, Ohio Naturalist, iv, p. 94 (1904). Fig.
Pr. Ohio Ac. Sci., iv, sp. papers No. 8, Coccidæ of Ohio, p. 32 (1904). Fig.
Habitat—Ohio.
On *Solidago canadensis; Solidago* sp.

Subfamily **CONCHASPINÆ.**

Conchaspis fluminensis Hempel.

Conchaspis fluminensis Hemp., Bol. Agr. Sao Paulo, v, p. 312 (1904).
Habitat—Rio de Janeiro.
On an unknown shrub.

Subfamily **DACTYLOPIINÆ.**

Bambusaspis, n. sect. of *Asterolecanium;* Ckll., The Entom., xxxv, p. 114 (1902).
Type, *miliaris.*

Asterolecanium greeni Marchal.

Asterolecanium greeni Marchal, Bul. Mus. d'Hist. Nat., vii, p. 455 (1904). Fig.
Habitat—France (in greenhouse); Ceylon.
On *Rheedia lateriflora.*

Asterolecanium pustulans sambuci Ckll.

Asterolecanium pustulans var. *sambuci* Ckll., The Entom., xxxvi, p. 112 (1903).
Habitat—Egypt.
On *Sambucus.*

Asterolecanium rehi Rübsaamen.

Asterolecanium rehi Rübs., Marcellia, i, p. 62 (1902).
Habitat—Madeira Islands.
On *Globularia salicina.*

Phenacobryum Ckll., The Entom., xxxv, p. 114 (1902).
Synonym of *Antecerococcus* Green (1900).

Eriococcus sordidus Green.

Eriococcus sordidus Green, Victorian Naturalist, xxi, p. 68 (1904). Fig.
Habitat—Australia.
On *Helichrysum ferrugineum.*

Eriococcus tricarinatus Fuller.

Eriococcus tricarinatus Fuller, Notes on Coccidæ W. Austr., p. 8 (1897).
Trans. Ent. Soc. Lond., p. 442 (1899). Fig.
Eriococcus simplex dealbata Fernald, Catalogue of Coccidæ, p. 78 (1903).
Habitat—Western Australia.
"On *Eucalyptus gomphocephala*, on galls of *Maskellia globosa* Fuller."

Genus **AMELOCOCCUS** Marchal. Type, *alluaudi*.

Amelococcus Marchal, Ann. Soc. Ent. France, LXXIII, p. 557 (1904).

Amelococcus alluaudi Marchal.

Amelococcus alluaudi Marchal, Ann. Soc. Ent. Fr., LXXIII, p. 557 (1904).
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).

Habitat—Madagascar.
On branches of *Euphorbia intisy*.

Sphærococcus pustulans Green.

Sphærococcus pustulans Green, Victorian Naturalist, XXII, p. 7 (1905). Fig.
Habitat—Australia.
On *Eucalyptus goniocalyx*.

Phenacoccus cockerelli King.

Phenacoccus cockerelli King, Can. Ent., XXXV, p. 195 (1903).
Habitat—Colorado.
On *Amelanchier*.

Phenacoccus kuwanæ Coleman.

Phenacoccus kuwanæ Coleman, Jn. N. Y. Ent. Soc., II, p. 62 (1903). Fig.
Habitat—California.
On lichen on *Picea breweriana*.

Phenacoccus ripersioides W. & T. Ckll.

Phenacoccus ripersioides W. & T. Ckll., Tr. Am. Ent. Soc., XXIX, p. 112 (1903).
Habitat—New Mexico.
With *Lasius niger* (8,000 feet altitude).

Genus **TRABUTINA** Marchal. Type, *elastica*.

Trabutina Marchal, Bul. Mus. d'Hist. Nat., VII, p. 448 (1904).

Trabutina elastica Marchal.

Trabutina elastica Marchal, Bul. Mus. d'Hist. Nat., VII, p. 448 (1904). Fig.
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).
Habitat—Algeria.
On *Tamarix articulata*.

Trionymus hordei Lindeman.

Westwoodia hordei Lindeman, ——— ———.
Korbuly, Csanad: Banhegyes (Kaszaper) (1886).
Horvath, Magyar, K. A. Rov. A. Koz., Jelentes, (1) 8, p. 96 (1892).
Sajo, Zeitschr. f. Pflanzenkr., IV, p. 151 (1894).
Trionymus hordei Ckll., Ent. News, XV, p. 40 (1904).

Trionymus nanus Ckll.

Trionymus nanus Ckll., Can. Ent., XXXVII, p. 136 (1905).
Habitat—Colorado.
On roots of grass under stones.

Pseudococcus andersoni (Coleman).

Dactylopius andersoni Coleman, Jn. N. Y. Ent. Soc., XI, p. 62 (1903). Fig.
Habitat—California.
On *Cupressus goveniana; Libocedrus decurrens.*

Pseudococcus crotonis (Green).

Dactylopius crotonis Green (sine descr.), Tropic. Agric., XXIV, p. 44 (1905).
Habitat—Ceylon.
On *Castilloa* sp.

Pseudococcus dudleyi (Coleman).

Dactylopius dudleyi Coleman, Jn. N. Y. Ent. Soc., XI, p. 63 (1903). Fig.
Habitat—California.
On *Cupressus macnabiana.*

Pseudococcus elongatus (Reuter).

Dactylopius elongatus Reut., Medd. Soc. Faun. Fennicæ, 66, 251 (1903).

Pseudococcus ephedræ var., Ckll.

Pseudococcus ephedræ var., Ckll., Mem. Soc. Cient. Ant. Alz., XVII, p. 145 (1902).
Habitat—Mexico.
On agave.

Pseudococcus lilacinus Ckll.

Pseudococcus lilacinus Ckll., Pr. Dav. Ac. Sci., X, p. 128 (1905).
Habitat—Philippine Islands.
On cultivated orange.

Pseudococcus tayabanus Ckll.

Pseudococcus tayabanus Ckll., Pr. Dav. Ac. Sci., X, p. 129 (1905).
Habitat—Philippine Islands.
On cultivated cacao.

Pseudococcus vagabundus (Von Schilling).

Dactylopius vagabundus Von Schill., Allg. Zeits. f. Ent., VIII, p. 305 (1903).
Giard, Bul. Soc. Ent. France, pp. 232, 233 (1903).
Reh, Allg. Zeits. f. Ent., IX, p. 36 (1904).
"=a mixture of *Pulvinaria camellicola Phenacoccus aceris, P. æsculi,* and *P. mespili=pruni.*"—Giard.

Pseudococcus virgatus var., Ckll.

Pseudococcus virgatus (Ckll.) var., Pr. Dav. Ac. Sci., X, p. 128 (1905).
Habitat—Philippine Islands.
On cultivated Croton.

Antonina australis Green.

Antonina australis Green, Proc. Linn. Soc. N. S. W., pt. 3, p. 463 (1904). Fig.
Habitat—Australia.
On *Cyperus rotundatus.*

Subfamily **TACHARDIINÆ**

Tachardia albizziæ Green.

Tachardia albizziæ Green (sine descr.), Ind. Mus. Notes, v, p. 98 (1903).
Habitat—Ceylon.

Tachardia aurantiaca Ckll.

Tachardia aurantiaca Ckll., Can. Ent., xxxv, p. 65 (1903).
Habitat—Java.
On grape fruit (*Citrus*).

Tachardia cærulea Hempel.

Tachardia cærulea Hemp., Bol. Agr. Sao Paulo, v, p. 314 (1904).
Habitat—Rio de Janeiro.

Tachardia fici Green.

Tachardia fici Green, Ind. Mus. Notes, v, p. 97 (1903). Fig.
Habitat—India.
On *Ficus religiosa; F. bengalensis.*

Tachardia glomerella Ckll.

Tachardia glomerella Ckll., Ent. News, xvi, p. 52 (1905).
Habitat—New Mexico.
On *Gutierrezia glomerella.*

Subfamily **COCCINÆ.**

Pulvinaria coulteri Ckll.

Pulvinaria coulteri Ckll., Zool. Anzeiger, xxix, p. 514 (1905).
Habitat—Colorado.
On *Rosa* sp. (wild).

Pulvinaria goethei King.

Pulvinaria goethei King (sine descr.), Allg. Zeits. f. Ent., viii, p. 460 (1903).
Habitat—Germany.
On *Alnus glutinosa.*

Pulvinaria grabhami Ckll.

Pulvinaria grabhami Ckll., The Entom., xxxvi, p. 261 (1903).
Habitat—Madeira.
On leaves of *Jossinia tinifolia*, attended by *Iridomyrmex humilis.*

Pulvinaria innumerabilis betheli King.

Pulvinaria innumerabilis var. *betheli* King, Can. Ent., xxxv, p. 195 (1903).
Habitat—Colorado.
On *Alnus.*

Pulvinaria maxima Green.

Pulvinaria maxima Green, Ent. Mo. Mag., xl, p. 206 (1904). Fig.
Habitat—Java.
On stems of *Erythrina lithosperma.*

Pulvinaria polygonata Ckll.

Pulvinaria polygonata Ckll., Pr. Dav. Ac. Sci., x, p. 131 (1905).
Habitat—Philippine Islands.
"On a cultivated shade tree."

Pulvinaria psidii philippina Ckll.

Pulvinaria psidii philippina Ckll., Pr. Dav. Ac. Sci., x, p. 132 (1905).
Habitat—Philippine Islands.
On a cultivated *Ficus*.

Pulvinaria rehi King.

Pulvinaria rehi King (sine descr.), Allg. Zeits. f. Ent., VIII, p. 460 (1903).
Habitat—Germany.

Pulvinaria tyleri Ckll.

Pulvinaria tyleri Ckll., Pr. Dav. Ac. Sci., x, p. 132 (1905).
Habitat—Philippine Islands.
On "cadena de amor."

Pulvinaria vitis opacus King.

Pulvinaria vitis var. *opacus* King (sine descr.), Allg. Zeits. f. Ent., VIII, p. 461 (1903).
Habitat—Germany.

Pulvinaria vitis sorbusæ King.

Pulvinaria vitis var. *sorbusæ* King (sine descr.), Allg. Zeits. f. Ent., VIII, p. 461 (1903).
Habitat—Germany.

Pulvinaria vitis verrucosæ King.

Pulvinaria vitis var. *verrucosæ* King (sine descr.), Allg. Zeits. f. Ent., VIII, p. 461 (1903).
Habitat—Germany.

Eriopeltis coloradensis Ckll.

Eriopeltis coloradensis Ckll., Can. Ent., XXXVII, p. 136 (1905).
Habitat—Colorado.
On stems of grass.

Ceroplastes sanguineus Ckll.

Ceroplastes sanguineus Ckll., Ent. News., XVI, p. 162 (1905).
Habitat—Paraguay.
On *Maytenus* sp.

Ceroplastes schrottkyi Ckll.

Ceroplastes schrottkyi Ckll., Ent. News, XVI, p. 162 (1905).
Habitat—Paraguay.
On *Salix chilensis*.

Ctenochiton serratus Green.

Ctenochiton serratus Green, Victorian Nat., XXI, p. 67 (1904). Fig.
Habitat—Australia.
On *Styphelia* sp.

Eucalymnatus subtessellatus (Green).

Lecanium subtessellatum Green, Cocc. Ceylon, pt. III, p. 206 (1904). Fig.
Habitat—Ceylon.
On leaves of undetermined tree.

Genus **STICTOCOCCUS** Ckll. Type, *sjostedti*.

Stictococcus T. D. A. Ckll., Can. Ent., XXXV, p. 64 (1903).

Stictococcus sjostedti T. & W. Ckll.

Stictococcus sjostedti T. & W. Ckll., Can. Ent., xxxv, p. 64 (1903).
Habitat—Cameroons, Western Africa.

Coccus arundinariæ (Green).

Lecanium arundinariæ Green, Cocc. Ceylon, pt. III, p. 220 (1904). Fig.
Habitat—Ceylon.
On *Arundinaria* sp.

Coccus bicruciatus (Green).

Lecanium bicruciatum Green, Cocc. Ceylon, pt. III, p. 214 (1904). Fig.
Habitat—Ceylon.
On *Memecyclon umbellatum; Nothopegia colebrookiana; Eleagnus latifolia; Calophyllum* sp.; *Eugenia* sp.

Coccus capparidis (Green).

Lecanium capparidis Green, Cocc. Ceylon, pt. III, p. 187 (1904). Fig.
Habitat—Ceylon.
On *Capparis moonii.*

Coccus diversipes Ckll.

Coccus diversipes Ckll., Pr. Dav. Ac. Sci. x, p. 130 (1905).
Habitat—Philippine Islands.
"On cultivated fern 'parasite.'"

Coccus frontalis (Green).

Lecanium frontale Green, Cocc. Ceylon, pt. III, p. 192 (1904). Fig.
Habitat—Ceylon.
On leaves of "kina" (*Calophyllum* sp.).

Coccus incisus King.

Calymnatus incisus King, Rev. Chil. Hist. Nat., VI, p. 255 (1902).
Habitat—South America.
On nutmeg.

Coccus marsupialis (Green).

Lecanium marsupiale Green, Cocc. of Ceylon, pt. III, p. 212 (1904). Fig.
Habitat—Ceylon.
On *Piper nigrum; Pothos scandens; Anona* sp.

Coccus signiferus (Green).

Lecanium signiferum Green, Cocc. of Ceylon, pt. III, p. 197 (1904). Fig.
Habitat—Ceylon.
On *Caryota urens; Alpinia nutans; Begonia* sp. (cult.).

Mesolecanium inflatum Hempel.

Mesolecanium inflatum Hemp., Bol. Agr. Sao Paulo, V, p. 316 (1904).
Habitat—Rio de Janeiro.
On Myrtaceæ.

Eulecanium curtisi Kirkaldy. (Not valid.)

Eulecanium curtisi Kirkaldy, The Entom., XXXVII, p. 257 (1904).

Eulecanium folsomi Ckll.

Eulecanium folsomi Ckll., Can. Ent., xxxv, p. 193 (1903).
Proc. Ent. Soc. Wash., vii, p. 129 (1905).

Habitat—Illinois.
On Paw-paw (*Asimina triloba*).

Eulecanium lüstneri (King).

Lecanium lüstneri King, Allg. Zeits. f. Ent., viii, p. 409 (1903) (sine descr.).

Eulecanium pulchrum (King).

Lecanium pulchrum King, Allg. Zeits. f. Ent., viii, p. 410 (1903) (sine descr.).

Paralecanium calophylli (Green).

Lecanium (*Paralecanium*) *calophylli* Green, Cocc. Ceylon, pt. iii, p. 240 (1904). Fig
Habitat—Ceylon.
On *Calophyllum* sp.

Paralecanium expansum javanicum (Green).

Lecanium expansum var. *javanicum* Green, Ent. Mo. Mag., xl, p. 205 (1904).
Habitat—Java.
On *Anomianthus heterocarpus*.

Paralecanium expansum metallicum (Green).

Lecanium expansum var. *metallicum* Green, Ent. Mo. Mag., xl, p. 205 (1904).
Ann. Mag. Nat. Hist., (7), xiv, p. 377 (1904).

Habitat—Java; Malay Peninsula.
On *Myristica fragrans*.

Paralecanium expansum quadratum (Green).

Lecanium expansum var. *quadratum* Green, Cocc. of Ceylon, pt. iii, p. 236 (1904). Fig.
Habitat—Ceylon.
On cultivated nutmeg; undetermined tree.

Paralecanium expansum rotundum (Green).

Lecanium expansum var. *rotundum* Green, Ent. Mo. Mag., xl, p. 206 (1904).
Habitat—Java.
On *Rhizophora mucronata*.

Paralecanium peradeniyense (Green).

Lecanium (*Paralecanium*) *peradeniyense* Green, Cocc. Ceylon, pt. iii, p. 241 (1904). Fig.
Habitat—Ceylon.
On *Piper nigrum* (cult.).

Paralecanium zonatum (Green).

Lecanium (*Paralecanium*) *zonatum* Green, Cocc. Ceylon, pt. iii, p. 245 (1904). Fig.
Habitat—Ceylon.
On *Garcinia spicata*.

Saissetia discrepans (Green).

Lecanium discrepans Green, Cocc. Ceylon, pt. iii, p. 204 (1904). Fig.
Habitat—Ceylon.
On tea plant, in nest of *Cremastogaster dohrni* or exposed.

Saissetia psidii (Green).

Lecanium psidii Green, Cocc. Ceylon, pt. III, p. 225 (1904). Fig.
Habitat—Ceylon.
On *Psidium guava; Mangifera indica; Artocarpus integrifolia; Eugenia* sp.; *Fagreæ; Myristica moschata.* Often inclosed in nests of *Œcophylla smaragdina.*

Saissetia punctulifera (Green).

Lecanium punctuliferum Green, Cocc. Ceylon, pt. III, p. 205 (1904). Fig.
Habitat—Ceylon.
On *Michelia champaca; Ærna lanata.*

Physokermes concolor Coleman.

Physokermes concolor Coleman, Jn. N. Y. Ent. Soc., XI, pp. 72, 77 (1903).
Habitat—California.
On *Abies concolor.*

Physokermes taxifoliæ Coleman.

Physokermes taxifoliæ Coleman, Jn. N. Y. Ent. Soc., XI, pp. 73, 77 (1903).
Habitat—California.
On *Pseudotsuga taxifolia.*

"Lecanium" insolens King.

Lecanium insolens King, Rev. Chil. Hist. Nat., VI, p. 255 (1902).
Habitat—Brazil.
On *Philodendron.*

"Lecanium" limnanthemi Goury.[a]

Lecanium limnanthemi Goury, Feuille des Jeunes Nat., Feb., p. 62 (1905).
Habitat—France.
On submerged petiole of *Limnanthemum nymphoides.*

"Lecanium" tenebricophilum Green.

Lecanium tenebricophilum Green, Ent. Mo. Mag., XL, p. 204 (1904). Fig.
Habitat—Java.
Within tunnels in branches of *Erythrina lithosperma.*

Subfamily **DIASPINÆ.**

Chionaspis angustata Green.

Chionaspis angustata Green, Victorian Nat., XXI, p. 67 (1904). Fig.
Habitat—Australia.
On *Leptospermum lævigatum.*

Chionaspis candida Green.

Chionaspis candida Green, Victorian Nat., XXII, p. 6 (1905). Fig.
Habitat—Australia.
On *Callistemon salignus.*

Chionaspis cinnamomi Green.

Chionaspis cinnamomi Green, Jn. Bomb. N. H. Soc., XVI, p. 354 (1905). Fig.
Habitat—Ceylon.
On leaves of *Cinnamomum.*

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[a] No description was given. It is very improbable that it is a Coccid.

Chionaspis coronifera Green.

Chionaspis coronifera Green, Jn. Bomb. N. H. Soc., XVI, p. 353 (1905). Fig.
Habitat—Ceylon.
On undetermined tree.

Chionaspis decurvata Green.

Chionaspis decurvata Green, Ind. Mus. Notes, V, p. 63 (1903). Fig.
Habitat—India.
On rice (*Oryza sativa*).

Chionaspis formosa Green.

Chionaspis formosa Green, Pr. Linn. Soc. N. S. W., pt. III, p. 462 (1904). Fig.
Habitat—Australia.
On leaves of *Eucalyptus tereticornis*.

Chionaspis gleditsiæ Sanders.

Chionaspis gleditsiæ Sanders, Ohio Naturalist, III, p. 413 (1902). Fig.
Pr. Ohio Ac. Sci., IV, sp. papers No. 8, p. 46 (1904). Fig.
Habitat—Ohio, Pennsylvania, West Virginia, Maryland, Virginia, District of Columbia.
On *Gleditsia triacanthos*.

Chionaspis ortholobis bruneri Ckll.

Chionaspis ortholobis bruneri Ckll., Can. Ent., XXX, p. 133 (1898).
A synonym of *Chionaspis salicis-nigræ* (Walsh).

Chionaspis subcorticalis Green.

Chionaspis subcorticalis Green, Jn. Bomb. N. H. Soc., XVI, p. 351 (1905). Fig.
Habitat—Ceylon.
Under loose bark of *Artocarpus integrifolia*.

Chionaspis sylvatica Sanders.

Chionaspis sylvatica Sanders, Ohio Naturalist, IV, p. 95 (1904). Fig.
Pr. Ohio Ac. Sci., IV, sp. papers No. 8, p. 46 (1904). Fig.
Habitat—Ohio, Pennsylvania, West Virginia, Maryland, Virginia, District of Columbia.
On *Nyssa sylvatica*.

Howardia lobulata Del Guercio.

Howardia lobulata Del Guercio, Bul. Ent. Soc. Ital., XXXIV, pp. 179, 185 (1902).
Leonardi, Ann. R. Scuola Sup. Agr. Portici, V, pp. 1–5 (1903).
Synonym of *Rhopaloaspis riccæ* (Targ.).

Diaspis cordiæ Rübsaamen.

Diaspis cordiæ Rübs., Marcellia, IV, 5, p. 122 (1905).
Habitat—Rio de Janeiro.
On *Cordia curassavica*.

Diaspis squamosus Newst. & Theobald.

Diaspis squamosus Newst. & Theob., 2d Rep. Ec. Ent. Br. Mus., p. 185 (1904). Fig.
Habitat—Egypt.
On peach and pear.

Phenacaspis bupleuri (Marchal).

Chionaspis (*Phenacaspis*) *bupleuri* Marchal, Bul. Mus. d'Hist. Nat., VII, p. 454 (1904).
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).

Habitat—Algeria.
On *Bupleurum gibraltaricum.*

Phenacaspis ceratoniæ (Marchal).

Chionaspis (*Phenacaspis*) *ceratoniæ* Marchal, Bul. Mus. d'Hist. Nat. VII, p. 452 (1904). Fig.
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).

Habitat—Algeria.
On *Ceratonia siliqua.*

Phenacaspis strobilanthi (Green).

Chionaspis strobilanthi Green, Jn. Bomb. N. H. Soc., XVI, p. 352 (1905). Fig.
Habitat—Ceylon.
On *Strobilanthus* sp.

Hemichionaspis theæ ceylonica (Green).

Chionaspis theæ var. *ceylonica* Green, Jn. Bomb. N. H. Soc., XVI, p. 354 (1905). Fig.
Habitat—Ceylon.

Hemichionaspis townsendi Ckll.

Hemichionaspis townsendi Ckll., Pr. Dav. Ac. Sci., X, p. 135 (1905).
Habitat—Philippine Islands.
On bark of *Gossypium* sp.

Leucaspis corsa Lindinger.

Leucaspis (*Euleucaspis*) *corsa* Lind., Zool. Anzeiger, XXIX, 8, p. 252 (1904).
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).

Habitat—Corsica.
On *Pinus laricio.*

Leucaspis cupressi Coleman.

Leucaspis cupressi Coleman, Jn. N. Y. Ent. Soc., XI, p. 71 (1903). Fig.
Habitat—California.
On *Cupressus goveniana.*

Leucaspis kelloggi Coleman.

Leucaspis kelloggi Coleman, Jn. N. Y. Ent. Soc., XI, p. 68 (1903). Fig.
Habitat—California.
On *Pseudotsuga taxifolia; Abies magnifica; A. grandis; A. concolor; A. shastensis.*

Leucaspis kermanensis Lindinger.

Leucaspis (*Salicicola*) *kermanensis* Lind., Zool. Anz., XXIX, 8, p. 253 (1904).
Speiser, Zeits. f. wiss. Insekt., I, 12, p. 520 (1905).

Habitat—Corsica.
On *Salix persica; S. zygostemon; Populus euphratica.*

Leucaspis leonardi Ckll.

Leucaspis pini Berl. & Leon., Cherm. Ital., Fasc. I, No. 19 (1895).
Leucaspis leonardi Ckll., Jn. N. Y. Ent. Soc., XI, p. 84 (1903).
Habitat—Italy.
On *Pinus picea.*

Fiorinia bidens Green.

Fiorinia bidens Green, Jn. Bomb. N. H. Soc., XVI, p. 351 (1905). Fig.
Habitat—Ceylon.
"On leaves of undetermined tree."

Genus **RHOPALOASPIS** Del Guercio. Type, *riccæ*.

Rhopaloaspis Del Guercio, Bul. Soc. Ent. Ital., XXXIV, pp. 185–188 (1902).

Rhopaloaspis riccæ (Targ.) = *Leucaspis riccæ* Targ.

Aspidiotus californicus Coleman.

Aspidiotus californicus Coleman, Jn. N. Y. Ent. Soc., XI, p. 64 (1903). Fig.
Habitat—California.
On *Pinus sabiniana; P. ponderosa; P. lambertiana; P. attenuata.*

Aspidiotus capensis Walker.

Aspidiotus capensis Green, Ann. Mag. Nat. Hist. (7), XIV, p. 375 (1904). Fig.
Habitat—Cape Colony.
On undetermined plant.
This species, which is in the British Museum, has been redescribed and restored to science by Mr. E. E. Green.

Aspidiotus capsulatus Green.

Aspidiotus capsulatus Green (sine descr.), Jn. Bomb. N. H. Soc., XVI, p. 343 (1905).
Habitat—Java.
On *Piper nigrum.*

Aspidiotus coniferarum shastæ Coleman.

Aspidiotus coniferarum var. *shastæ* Coleman, Jn. N. Y. Ent. Soc., XI, p. 67 (1903). Fig.
Habitat—California.
On *Cupressus macnabiana.*

Aspidiotus cuculus Green.

Aspidiotus cuculus Green, Jn. Bomb. N. H. Soc., XVI, p. 341 (1905). Fig.
Habitat—Ceylon.
In abandoned galls of *Amorphococcus mesuæ* Green.

Aspidiotus ehrhorni Coleman.

Aspidiotus (*Diaspidiotus*) *ehrhorni* Coleman, Jn. N. Y. Ent. Soc., XI, p. 68 (1903). Fig.
Habitat—California.
Under lichens on *Abies concolor; Libocedrus decurrens.*

Aspidiotus florenciæ Coleman.

Aspidiotus florenciæ Coleman, Jn. N. Y. Ent. Soc., XI, p. 66 (1903). Fig.
Habitat—California.
On *Pinus ponderosa.*

Aspidiotus immaculatus Green.

Aspidiotus (*Hemiberlesia*) *immaculatus* Green, Victorian Nat., XXI, p. 65 (1904). Fig.
Habitat—Australia.
On *Styphelia virgata.*

Aspidiotus moreirai Hempel.

Aspidiotus moreirai Hemp., Bol. Agr. São Paulo, v, p. 320 (1904).
Habitat—Rio de Janeiro.
On leaves of *Drymus* sp.

Aspidiotus ohioensis York.

Aspidiotus (*Diaspidiotus*) *ohioensis* York, Ohio Naturalist, v, p. 325 (1905). Fig.
Habitat—Ohio.
On *Æsculus glabra.*

Aspidiotus oxycoccus Woglum.

Aspidiotus oxycoccus Woglum, Can Ent., xxxviii, p. 73 (1906). Fig.
Habitat—New Jersey.
On Cranberry (*Oxycoccus*).

Aspidiotus piceus Sanders.

Aspidiotus piceus Sanders, Ohio Naturalist, iv, p. 96 (1904). Fig.
Pr. Ohio Ac. Sci., iv, sp. papers No. 8, p. 66 (1904). Fig.
Habitat—Ohio.
On *Liriodendron tulipifera.*

Aspidiotus pisai Hempel.

Aspidiotus pisai Hemp., Bol. Agr. São Paulo, v, p. 320 (1904).
Habitat—Rio de Janeiro.
On leaves of *Drymus* sp.

Aspidiotus pseudospinosus Woglum.

Aspidiotus pseudospinosus Woglum, Can. Ent., xxxviii, p. 75 (1906). Fig.
Habitat—Florida.
On saw-palmetto.

Aspidiotus pustulans Green.

Aspidiotus pustulans Green, Ent. Mo. Mag., xli, p. 31 (1905). Fig.
Habitat—Java.
On *Erythrina lithosperma.*

Aspidiotus riveræ Ckll.

Aspidiotus riveræ Ckll., Ent. News, xvi, p. 161 (1904).
Habitat—Chile.
On stems of *Chusquea.*

Aspidiotus subfervens Green.

Aspidiotus (*Targionia*) *subfervens* Green, Victorian Nat., xxi, p. 66 (1904). Fig.
Habitat—Australia.
On *Acacia* sp.; *Pomaderris* sp.

Aspidiotus subrubescens corticoides Green.

Aspidiotus (*Evaspidiotus*) *subrubescens* var. *corticoides* Green, Victorian Nat., xxii, p. 3, (1905). Fig.
Habitat—Australia.
On *Eucalyptus globosus.*

Aspidiotus tayabanus Ckll.

Aspidiotus tayabanus Ckll., Pr. Dav. Ac. Sci., x, p. 133 (1905).
Habitat—Philippine Islands.
"On cultivated plant called 'rosal' or 'campopot.'"

Cryptophyllaspis bornmülleri Rübsaamen.

Cryptophyllaspis bornmülleri Rübs., Marcellia, I, fasc. i-ii, p, 62 (1902).
Habitat—Canary Islands; Madeira.
On *Globularia salicina.*

Cryptophyllaspis occultus elongatus (Green).

Aspidiotus (*Cryptophyllaspis*) *occultus* var. *elongatus* Green, Jn. Bomb. N. H. Soc., XVI, p. 345 (1905). Fig.
Habitat—Ceylon.
On leaves of *Grewia* sp.

Pseudaonidia curculiginis (Green).

Aspidiotus (*Pseudaonidia*) *curculiginis* Green, Ent. Mo. Mag., XL, p. 208 (1904). Fig.
Habitat—Java.
On leaves of *Curculigo recurvata.*

Chrysomphalus cistuloides (Green).

Aspidiotus (*Chrysomphalus*) *cistuloides* Green, Jn. Bomb. N. H. Soc., XVI, p. 342 (1905). Fig.
Habitat—Ceylon.
On leaves of *Cinnamomum.*

Chrysomphalus malleolus (Green).

Aspidiotus (*Chrysomphalus*) *malleolus* Green, Jn. Bomb. N. H. Soc., XVI, p. 342 (1905). Fig.
Habitat—Ceylon.
On leaves of *Mimusops hexandra.*

Chrysomphalus pedronis (Green).

Aspidiotus (*Chrysomphalus*) *pedronis* Green, Jn. Bomb. N. H. Soc., XVI, p. 341 (1905). Fig.
Habitat—Ceylon.
"On leaves of undetermined tree."

Chrysomphalus quadriclavatus (Green).

Aspidiotus (*Chrysomphalus*) *quadriclavatus* Green, Jn. Bomb. N. H. Soc., XVI, p. 343 (1905). Fig.
Habitat—Ceylon.
On leaves of *Murraya exotica.*

Chrysomphalus taprobanus (Green).

Aspidiotus (*Aonidiella*) *taprobanus* Green, Jn. Bomb. N. H. Soc., XVI, p. 344 (1905). Fig.
Habitat—Ceylon.
On leaves of *Phyllanthus myrtifolius.*

Targionia phyllanthi (Green).

Aspidiotus (*Targionia*) *phyllanthi* Green, Jn. Bomb. N. H. Soc., XVI, p. 344 (1905). Fig.
Habitat—Ceylon.
On stems and twigs of *Phyllanthus myrtifolius*.

Odonaspis penicillata Green.

Odonaspis penicillata Green, Jn. Bomb. N. H. Soc., XVI, p. 346 (1905). Fig.
Habitat—Ceylon.
On a large bamboo (*Gigantochloa aspera*).

Aonidia ebeni "Green" Leonardi=*Aonidia crenulata* Green. Green in litt., July 6, 1905.

Aonidia echinata Green.

Aonidia echinata Green, Jn. Bomb. N. H. Soc., XVI, p. 347 (1905). Fig.
Habitat—Ceylon.
On *Hemicyclia sepiaria*.

Aonidia javanensis Green.

Aonidia javanensis Green, Ent. Mo. Mag., XLI, p. 31 (1905). Fig.
Habitat—Java.
On leaves of *Myristica fragrans*.

Aonidia pulchra Green.

Aonidia (*Greeniella*) *pulchra* Green, Victorian Nat., XXII, p. 4 (1905). Fig.
Habitat—Australia.
On leaves of *Callistemon salignus*.

Aonidia pusilla Green.

Aonidia pusilla Green, Jn. Bomb. N. H. Soc., XVI, p. 347 (1905). Fig.
Habitat—Ceylon.
On leaves of *Carissa spinarum*.

Gymnaspis spinomarginata Green.

Gymnaspis spinomarginata Green, Jn. Bomb. N. H. Soc., XVI, p. 348 (1905). Fig.
Habitat—Ceylon.
On leaves of *Mesua ferrea*.

Genus **MYTILELLA** Leonardi. Type, *carinata*.

Mytilella Leonardi, Annali di Agr., V, p. 120 (1903).

Genus **AONIDOMYTILUS** Leonardi. Type, *concolor*.

Aonidomytilus Leonardi, Annali di Agr., V, p. 102 (1903).

Genus **FERNALDIELLA** Leonardi. Type, *indentata*.

Fernaldiella Leonardi, Annali di Agr., V, p. 105 (1903).

Lepidosaphes cockerelliana Kirkaldy. (Not valid.)

Lepidosaphes cockerelliana Kldy., The Entom., XXXVII, p. 257 (1904).
Synonym of *L. alba* Ckll.

Lepidosaphes bicornis (Green & Lidg.).

Mytilaspis bicornis Green & Lidg., Victorian Nat., xvii, p. 9 (1900). Fig.
Leonardi, Annali di Agr., v, p. 85 (1903). Fig.
Habitat—Victoria, Australia.
On *Eucalyptus globulus.*

Lepidosaphes cassiniæ Green.

Mytilaspis cassiniæ Green, Victorian Nat., xxii, p. 4 (1905). Fig.
Habitat—Victoria, Australia.
On *Cassinia aculeata.*

Lepidosaphes corrugata Green.

Lepidosaphes corrugata Green, Ent. Mo. Mag., xl, p. 209 (1904).
Habitat—Java.
On stems of *Coffea arabica.*

Lepidosaphes ficifolii (Berlese).

Mytilaspis ficifolii Berlese, Atti del R. Inst. d'Incorrag. (5), v (1903). Fig.
Habitat—Italy.
On leaves of *Ficus carica.*

Lepidosaphes hymenantheræ (Green).

Mytilaspis (*Coccomytilus*) *hymenantheræ* Green, Victorian Nat., xxii, p. 5 (1905). Fig.
Habitat—Victoria, Australia.
On *Hymenanthera banksii.*

Lepidosaphes intermedia victoriæ (Green).

Mytilaspis intermedia var. *victoriæ* Green, Victorian Nat., xxii, p. 5 (1905).
Habitat—Victoria, Australia.
On *Acacia montana.*

Lepidosaphes multipora (Leonardi).

Mytilaspis multipora Leon., Annali di Agr., v, p. 87 (1903). Fig.
Green, Victorian Nat., xxii, p. 6 (1903).
Habitat—New Zealand.
On *Pittosporum undulatum.*

Lepidosaphes rubrovittatus Ckll.

Lepidosaphes rubrovittatus Ckll., Pr. Dav. Ac. Sci., x, p. 135 (1905).
Habitat—Philippine Islands.
On cultivated *Eugenia malaccensis.*

Lepidosaphes ungulata Green.

Lepidosaphes ungulata Green, Ent. Mo. Mag., xli, p. 30 (1905). Fig.
Habitat—Java.
On *Syzygium pseudo-jambolanum.*

Lepidosaphes wilga (Green).

Mytilaspis wilga "Green" Leonardi, Annali di Agr., v, p. 43 (1903). Fig.
Habitat—Australia.
On "*Wilga.*"

Opuntiaspis javanensis Green.

Opuntiaspis javanensis Green, Ent. Mo. Mag., XLI, p. 28 (1905). Fig.
Habitat—Java.
On *Agave mexicana.*

Euparlatoria Leonardi, Ann. R. Sc. Sup. di Agr. Portici, v, p. 15 (1903).
To include *banksiæ, calianthina, cingala, myrtus, parlatoriæ, pergandii, proteus,* and *theæ.*

Parlatoria atalantiæ Green.

Parlatoria (*Websteriella*) *atalantiæ* Green, Jn. Bomb. N. H. Soc., XVI, p. 350 (1905). Fig.
Habitat—Ceylon.
On leaves of *Atalantia zeylanica.*

Parlatoria pergandii phyllanthi Green.

Parlatoria pergandii var. *phyllanthi* Green, Jn. Bomb. N. H. Soc., XVI, p. 350 (1905). Fig.
Habitat—Ceylon.
On leaves of *Phyllanthus myrtifolius.*

Parlatoria pseudaspidiotus Lindinger.

Parlatoria pseudaspidiotus Lindgr., Insekten Börse, XXII, 33, p. 131 (1905).
Habitat—India.
On orchids (*Vanda hookeriana* and *V. teres*).

Genus **CRYPTOPARLATOREA** Lindinger. Type, *leucaspis.*

Cryptoparlatorea Lindgr., Insekten Börse, XXII, 33, p. 132 (1905).

Cryptoparlatorea leucaspis Lindinger.

Cryptoparlatorea leucaspis Lindgr., Insekten Börse, XXII, 33, p. 132 (1905).
Habitat—Japan.
On needles of *Juniperus* sp.

O

MISCELLANEOUS PAPERS.

HABITS AND LIFE HISTORIES OF SOME FLIES OF THE FAMILY TABANIDÆ.

By James S. Hine, *Columbus, Ohio.*

THE BLACK-STRIPED HORSEFLY.

(*Tabanus lasiophthalmus* Macquart.)

This species was reared from the egg to the adult. The fly is one of the earliest of its genus to appear in the spring, adults having been taken at Columbus, Ohio, as early as May 20, and it is common during the first half of June. The eggs are placed in masses on various plants that grow in low, wet ground, but I have not observed them over water. The masses are pure shining black when fully colored, rather small for members of the genus, only slightly convex, and accompanied with an unusual amount of cementing material, which nearly obscures the form and arrangement of the individual eggs. The mass in place suggests somewhat a drop of tar or other black substance fastened to the surface of a leaf of the common cattail reed (*Typha latifolia*), a sedge, or some other plant.

The eggs are usually deposited after the 10th of June, and the specimens from which larvæ for rearing hatched were taken in Medina County, Ohio, on a common sedge found growing near the outlet of a small spring. They were collected June 28 and hatched the next day and the day after. As I had not been successful up to this time in keeping very young larvæ for any length of time, it was decided to try different methods of treatment in order to find out, if possible, which is best suited to their requirements. Some were placed in a jar containing water only; others in a jar containing water with a couple of inches of sand in the bottom. A third jar in which larvæ were placed contained wet muck, while the fourth lot were placed in a jar containing moist sand to the depth of about 3 inches, covered over the top with a quantity of fine leaves of water plants. In all the breeding jars were placed plenty of small crustaceans and other minute invertebrates procured from water by means of a fine-meshed sieve.

It was soon observed that the larvæ in breeding jar No. 4 fed on the crustaceans and at the end of a few days showed a distinct increase in size. Those in the jars containing water soon died, and jar No. 3 did not appear to be a success, so all but No. 4 were abandoned. The larvæ in this last, however, were separated and placed in similar jars, one specimen in each, and reared to full size, the adult fly being procured the following spring.

Since, as stated, three of the four jars started with were soon abandoned, what is said hereafter regarding the method used in rearing pertains to the single one retained. A glass jar was selected so that the actions of the larvæ could be observed through it; a small jar seemed desirable because the larvæ are predaceous and eat their own kind as readily as anything else, for which reason it is necessary after a short time to place only a single specimen in a jar; also, even a small receptacle furnishes plenty of room, and the long series, which it is desirable to have, takes as much space in the insectary as one cares to give to a single species. Only the quantity of sand and other material necessary to success should be placed in the breeding jar, as it is desirable once in a while to look this material over carefully in order to locate the very small specimens and find out what they are doing.

All things considered, half-pint jelly glasses were found to be well suited for the purpose and easily obtainable. Covers proved to be desirable in order to prevent too rapid evaporation of moisture, but a small perforation or two in them was necessary to furnish ventilation. As the muck which was tested as soil for the jars grew much mold, clean lake sand was chosen as decidedly preferable for the purpose. The covering of plant material mentioned furnished a resting place for the small crustaceans offered for food, and the larvæ themselves seemed to choose to remain in it in preference to burrowing into the sand, although they were apt to be found in any part of the jar. Algæ made good material for covering, but only a small amount could be used, and too much water was detrimental, as either in excess tended to develop decay, and consequently a bad odor, which was observed to be unfavorable to the insects. The principal point in favor of the algæ, as compared with some other things, was that they contained no hollow stems or large pieces into which the larvæ could crawl, but still, because composed of small soft particles, furnished a mat in which they could hide. When it was desired to locate these larvæ it was easily done by picking the mass to pieces. As odors, which are often fatal to the larvæ, were likely to develop from the material put in for food and also from other sources, it was found necessary to watch the jars continually, giving them a thorough cleansing once in a while, and perhaps putting in fresh sand and plant material occasionally.

Larvæ when first hatched were about 2 mm. in length; they grew rather slowly, but in fifteen days after hatching had doubled their length. They fed readily on the small crustaceans which were given them. It was impossible to give these small crustaceans their proper surroundings, so many of them died, and it was observed that the young larvæ fed on these as well as on the specimens which they killed themselves. The larvæ could be seen crawling about in the jars; they appeared to remain very near the upper surface of the sand most of the time, and when food was scarce did much crawling, but when food was plentiful satisfied their appetites and hid among the plant material, where they remained quiet.

A difference in size in the various larvæ soon became apparent, and the older they became the greater this difference. On July 23, twenty-five days after hatching, some specimens measured as much as 7 mm., while others measured only 3 mm. At this date angleworms were given for food and were accepted readily, and appeared to be as satisfactory as the crustaceans, but it would seem that the latter are preferable for the stage just after hatching.

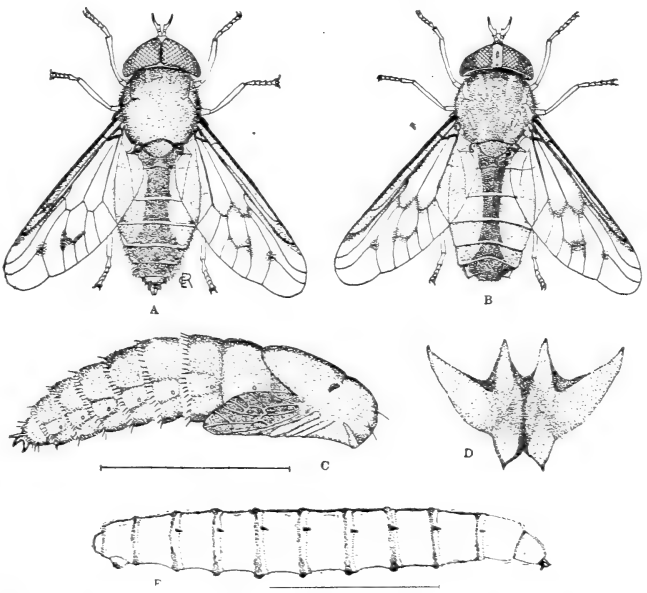

FIG. 1.—*Tabanus lasiophthalmus:* A, male; B, female; C, pupa; D, terminal abdominal teeth of pupa; E, undersized larva. All enlarged (original).

July 27 some of the larvæ were 10 mm. in length, and August 2 the same specimens measured 12 mm.; thus at this stage they grew more rapidly than when they were younger. They fed actively till about the middle of September, when they had become apparently full grown, or 25 mm. long. Length in the larvæ of tabanids is not a satisfactory means of indicating the size, for the segments telescope on one another in such a way that it is difficult to take two measurements exactly alike, but an endeavor was made in this case to make the different measurements similar, so I am satisfied that those given are sufficient to indicate the comparative sizes of the different ages. After the 15th of September the few specimens remaining alive buried themselves in the sand of the breeding jars and were quiet most of the time until the 10th of March, when one pupated, the adult emerging

on the 25th of the same month; the others died before the pupal stage was reached. I have noted that larvæ of various species of tabanids taken from their natural habitats during the winter did not produce adults in spring much before the same species appeared naturally, but in this case, where the specimen was kept under artificial conditions during its entire life, the adult appeared almost two months earlier than is normal in nature.

The mature larva (fig. 1, E) is not notably different from those of other species of Tabanus so far as form and appearance are concerned. The color is a dirty white with a pinkish shade over most of the body; the prolegs are not so prominent as in many species, and on this account specimens appear somewhat maggot-like. On either side of the body is a longitudinal row of very small black spots or specks, one to each segment and located just above the ventral prolegs; these spots are lacking on some of the anterior and some of the posterior segments; their presence appears to be characteristic of the species, at least so far as my acquaintance with different larvæ goes. Mature specimens are about 25 mm. in length.

I have not taken the larva of this species in its natural habitat, therefore can not say anything as to where it is to be found, but suspect it lives in débris, or in the ground around low places near where the eggs are laid.

The pupa (fig. 1, C) is somewhat dusky in coloration, the thorax being almost black. The terminal teeth of the abdomen (fig. 1, D) are quite different from those of any species studied so far, and these differences alone make its determination easy. The dorsal and lateral teeth are much larger than the ventral, the lateral being much larger than any of the others; the ventral teeth point almost directly backward, while the direction of the others is largely upward. The thoracic spiracle is rather small and nearly longitudinal, its rima is curved, but no distinct hook is formed at the posterior end. Length, 18 mm.

The adult (fig. 1, A, B) measures from 13 to 15 mm. Eyes pilose, ocelligerous tubercle present, wings hyaline, cross-veins and furcation of the third vein margined with brown, abdomen broadly red on the sides; female subcallus denuded and shining black, frontal callosity also shining black, as wide as the front and separated from a denuded spot above by a pollinose interval, front slightly widened above; male subcallus not denuded, eyes very plainly pilose, head about equal in size to that of the female.

THE AUTUMN HORSEFLY.

(*Tabanus sulcifrons* Macquart.)

This is one of the common species of its family over a wide range. It is not so generally distributed as some of the other species, but where it occurs is apt to be abundant and very injurious to all kinds of stock. I have studied the species in several localities, but most of my knowledge of its habits was gained in Summit and Medina counties, Ohio, where it is a pest of the first magnitude. This country, where the ground is highest, has an elevation of 1,000 to 1,200 feet, and is more or less broken by gullies crossing here and there, and through each flows a stream of clear water of larger or smaller

dimensions. These streams are fed by small springs and therefore contain water the year round, forming in their beds pools and riffles over which the sexes of *sulcifrons* may be seen flying much of the time.

I am not fully prepared to say why this particular species is so abundant in these counties and entirely absent in other counties of the same latitude in the western part of the same State; but it appears that there is present some condition which is necessary to its successful existence. The statement may be made in this connection that the autumn horsefly appears to prefer high ground, such as described,

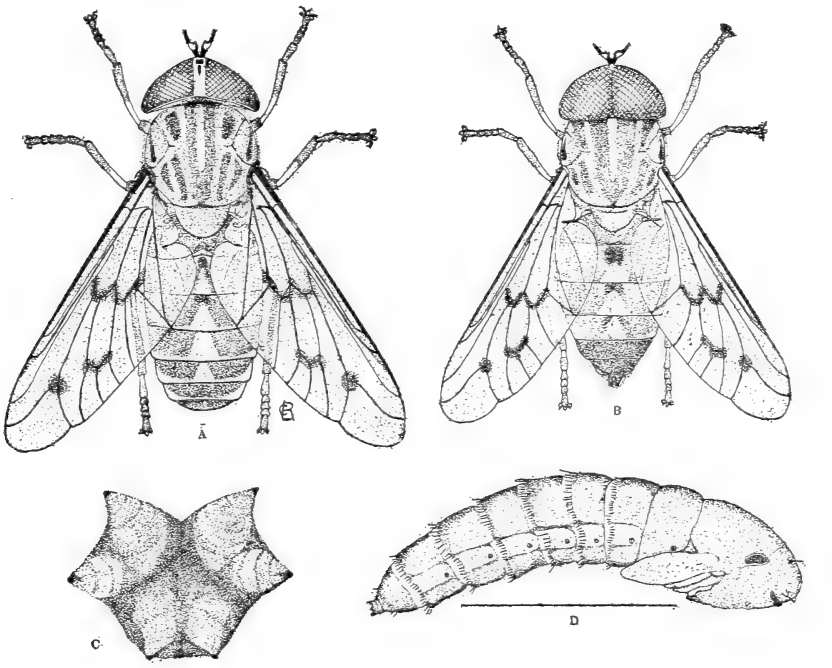

FIG. 2.—*Tabanus sulcifrons:* A, female; B, male; C, terminal abdominal teeth of pupa; D, pupa. All enlarged (original).

to low bottom land where many other horseflies find conditions exactly to their liking.

The adult (fig. 2, A, B) is a large brown fly 18 to 21 mm. in length. Palpi brownish, antennæ nearly black, with each third segment brownish at the base; legs dark, bases of the tibiæ lighter, the front pair black with the exception of the bases of the tibiæ and therefore much darker in general coloration than the others; wings with a distinct brownish tinge, cross-veins at the end of the discal cell, and the furcation of the third vein plainly margined with dark brown, first posterior cell open.

Female: Front of moderate width, sides parallel, frontal callosity shining brown, not quite as wide as the front, nearly square and with a linear prolongation above. Segments of the abdomen above with prominent, gray hind margins which expand into large gray triangles at the middle; usually a black marking on the anterior part of each of the second and third segments at the apex of the gray triangle.

Male: Division between the large and small facets of the eye prominent; head somewhat more convex than in the female, but of nearly the same size. Coloration in its entirety as in the other sex.

In Ohio the first specimens of the species usually appear about July 20 and specimens have been taken as late as the middle of September, but the period of greatest abundance is the first three weeks of August.

The adults are most in evidence when the sun is shining most brightly. As evening approaches they become less active and seek a resting place among foliage, on some tree trunk, on a fence or post, or in some similar place, where they remain quiet until the sun appears the following morning. These flies have a tendency to collect in certain favorable places in large numbers at evening, and if the collector or observer finds such a place, a visit to it by 7 o'clock in the morning will give an opportunity to procure plenty of specimens of both sexes, or abundance of notes on habits. When the sun has warmed the atmosphere somewhat, the flies begin to run over the objects on which they passed the night, or to fly from one perch to another. Both sexes are plentiful, the males often more plentiful than the females, and there is no difference in habits that makes it possible to readily distinguish the sexes. Specimens are easily taken, for by using care they may be picked up with the thumb and fingers, or if it is desired to use a net, it is not difficult to procure large numbers in a few minutes.

The only times I have observed copulation in the Tabanidæ were in places similar to the one just described and always about 8 o'clock in the morning. In a paper by the writer on the "Tabanidæ of Ohio"[a] it is recorded (p. 8) that on the 18th of August, between 8 o'clock and half past 8, several pairs of *T. sulcifrons* were observed in couple on the fence, and several pairs taken. The male in instances observed clung to the edge of a rail, and the female, with legs and wings motionless and touching nothing, hung suspended. My observations at this time led me to think that the opportunity for studying the mating habits of the species in question, and also of some others of its family, is confined to a particular time of day, and subsequent observations have not made it necessary to alter this opinion. On August 17 of the following year, about the same hour and near the place where the observations mentioned above were made, I captured nine pairs of the species, most of which were on the fence. At this time an effort was made to add to the data obtained before. It was then observed that when pairs were disturbed sufficiently to cause them to leave, the male did all the flying and proceeded only a short distance before alighting, either on the ground or on low-growing foliage, or it flew in a curve and soon returned to the fence. Coition in no case observed lasted over ten minutes, and all the pairs were taken within a quarter of an hour, after which time no more could be found.

As the hour became later fewer and fewer specimens were to be seen, and long before noon nearly all of the flies had left the places

[a] Ohio State Academy of Science, Special Papers, No. 5, May 1, 1903.

where they were so abundant earlier in the day. Either they had gone in search of food—the females to different animals for the purpose of sucking blood and the males to various places where they could find nectar and other liquid substances to their liking—or else they had gone to the water, over which could be seen both sexes flying in abundance, now and then striking the surface with their abdomens, but flying so rapidly that the observer had difficulty in determining the nature of their actions or what was accomplished by them. However, if the day was dark and cloudy there was not much activity among them, and on some of the cooler days or when it was raining they were hardly ever seen at all. An acquaintance with their habits at such times revealed the fact that they were passing the time among the foliage, usually on the underside of a leaf, where they remained quiet until pleasant weather appeared again.

The habits of the sexes while flying over water have been investigated a great deal, but after all there are some points not fully understood. There appears to be no choice as to the kind of water, for running brooks are chosen as well as stagnant ponds. At first there was some question in my mind as to whether both sexes have the habit of striking the surface in their gyrations over water, but observation soon proved that one sex as well as the other visits ponds and streams regularly, and so far as I could see there is no difference in their habits so far as the dipping is concerned, and specimens taken in the act bear out this statement. Over a small pond in which there was an abundance of aquatic vegetation in parts and open water in other parts, I observed many of the insects flying. Specimens, after flying about for a time, often came to rest on the foliage and sometimes on the surface of the open water. Under such circumstances the sex could be determined readily. Along swiftly flowing streams specimens found favorite resting places on the stones that protruded above the water, or else on the bank near the water's edge.

The food habits of the adults are of especial interest, and every opportunity for studying these was utilized. I am thoroughly convinced that the females take much other food than blood and do not believe it would be overstating the facts to say that specimens of this sex may pass the period of adult life without taking blood at all. Both sexes of *sulcifrons* run over foliage a great deal and often have been observed sipping up water that forms on the leaves as dew. This dew in many cases carries nourishment in solution, and on trees infested by aphides, scale insects, and various other species, especially of the order Hemiptera, much food material is included. Many leaves become coated with honeydew dried to a semisolid state. The water that collects on these leaves during clear nights dissolves some of this material and makes it available as food for horseflies. I have watched many specimens on wet stones and damp sand along brooks.

They move from one place to another, stopping now and then to sip up any small amount of liquid that they find, and if one watches closely he may see this liquid disappear from small depressions where they have introduced their sucking mouth parts. I have examined many specimens of both males and females and found their alimentary tracts filled with a liquid slightly yellowish in coloration, indicating that it contained something besides clear water. In Summit County, Ohio, some cucumber trees (*Magnolia acuminata*) were found to be thoroughly infested with a species of scale of the genus Eulecanium. Male and female flies visited these trees in numbers and fed on the honeydew excreted by the scale insects.

A number of species of the family Tabanidæ, aside from the one under consideration, have been observed feeding on the excretions of insects. At Sandusky, Ohio, within a few minutes I took the sexes of no less than six species of the genera Chrysops and Tabanus feeding on honeydew from an aphis, which was abundant on Phragmites, a large species of aquatic grass.

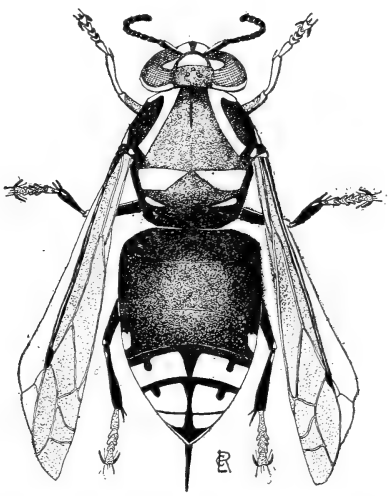

FIG. 3.—*Vespa maculata*, enlarged (original).

The various species of Tabanidæ have a great many natural enemies and *sulcifrons* is no exception in this regard. Aside from certain species of birds which are known to devour the flies occasionally, I have observed that the common bald-faced hornet (*Vespa maculata* L., fig. 3) is very active in capturing both sexes, either for food for itself or for its young. Around the cucumber trees mentioned above the flies were abundant, and while located under one of these one afternoon I saw something come tumbling down through the branches to the ground. When in position to see what it was, I found it to be a horsefly which was being held by a hornet. The matter was interesting, and I watched to see what transpired. The fly was too heavy for the hornet to carry, but the latter, equal to the occasion, immediately began to dismember the former, cutting off such parts as were not wanted. With its scissor-like mandibles, and otherwise well prepared for what was to follow, the hornet soon got into position and first clipped the slender neck of its victim, thus separating the head from the rest of the body. Legs and wings came next in order, and finally the abdomen; so that nothing was retained but the thorax. After lacerating this somewhat and disposing of some of the outer chitinous covering, it rolled the remainder into a sort of a ball and flew away with it—I suppose to its nest.

After one example of this kind had been observed, watch was made for others, and it was found that the occurrence was common. The hornets could be heard buzzing in all parts of the tree, and when one had the opportunity it pounced upon a fly and, holding on with its feet, came down with its prey to the ground, both insects making an abundance of noise with their wings.

August 6 under a single tree I saw the hornets kill three males and a female of the tabanid within the space of half an hour. At other times during succeeding days the occurrence was watched until it was proven that the habit is a natural one for this particular species of hornet.

Some variations in the actions of the hymenopteron were noted. In some cases, after cutting off the head and some of the appendages of the fly, it flew to one of the lower branches of the tree with the remains and finished the trimming while clinging to a twig by one hind leg and using the other legs to hold and manipulate its victim.

The possibility that the hornet stung its prey, when it first pounced upon it, was considered, and although there was no definite way of proving that such is not the fact, results of observation do not seem to indicate such a procedure. In one or two instances observed the pair came down into the water of a brook that flowed beneath the tree. Under these conditions the hornet became confused and released its hold on the fly, the latter flying away apparently unharmed.

Various species of spiders occasionally catch flies of this species, either by netting them in their webs or by jumping upon them from concealment.

The use of insecticides against adult horseflies has been more or less unsatisfactory, and whatever good has been accomplished has come almost entirely as a result of using some substance that acted as a repellent to the flies; for they are so retiring in their habits that as soon as anyone approaches with a sprayer an animal they are troubling, they are apt to leave and consequently do not usually receive a direct application. Effort on the part of different investigators to bring out an effective repellent has resulted in the testing of many substances which have penetrating odors. I have used a mixture prepared in the proportion of 1 pint of carbolic acid and 1 quart of pine tar to 3 gallons of kerosene. Application was made with a hand sprayer or atomizer, with the view of testing its effects on the adults of *Tabanus sulcifrons*. It was satisfactorily demonstrated that the mixture has properties as a repellent, but of such short duration that it could hardly receive practical consideration. When specimens were given a direct application they were readily affected and as a first result flew away a short distance and then dropped to the ground.

I have spent much time in an endeavor to work out the life history of this species, but my efforts have not been fully rewarded.

Although the eggs have been procured in many stages of development by dissecting the females, the habits of oviposition have not been observed. The form of the eggs and the number produced by a single female are as in other species of its size. Specimens containing eggs almost fully developed were taken in various places, but I could not get any clue as to where oviposition occurred by dissecting the females where they were collected, as I had hoped to do; therefore all that can be said at this time is, we hope to be able to obtain full information on the life history of the autumn horsefly in the future.

The pupa case (fig. 2, D) of the species was procured by locating a female which had just emerged. The place where this pupa case was taken is on a side hill, about 75 feet above the bed of a small stream. The description follows:

Length 26 mm., diameter 6 mm. Color yellowish brown, the thorax being nearly the same color as the abdomen. Tubercles of the head region well marked and distinctly darker than the surrounding parts. Prothoracic spiracular tubercle brown in color, elevated, narrow, ventral half oblique, dorsal half turned directly forward, thus forming a distinct bend near the middle of the length; rima nearly straight from outer end to the middle and evenly curved for the remainder of its length, inner tip curved backward, thus forming a well-defined hook. First abdominal spiracle nearly round; its rima following the posterior curvature, very narrow, but a little widened above; remaining abdominal spiracles a little smaller than the first one, each with a short, slightly curved or straight rima. Terminal abdominal segment with several small spines near the middle of its length and six larger spines at its apex (fig. 2, C). These spines are all brown in color, with the apex of each approaching black. Six apical spines of nearly the same size; the dorsal pair point upward, outward, and slightly backward, the lateral one on each side outward and backward, while the ventral pair extend almost directly backward. These six spines mark the corners of a hexagon with nearly equal sides, but the ventral pair are a little nearer together than the dorsal pair.

THE BLACK AND WHITE HORSEFLY.

(*Tabanus stygius* Say.)

This horsefly is very common in the vicinity of the Lake Laboratory, at Sandusky, Ohio, where most of my observations on the species were made. The adults appear about the 1st of July each season, and are on the wing for several weeks thereafter. The females were often observed biting cattle and horses, and are known to be important stock pests. The males were often seen in the marshes, on grasses infested by aphides, and it is known that this sex, and occasionally the females also, feed on honeydew which these insects excrete. The species oviposits principally on the leaves of Sagittaria standing in shallow water, habitually placing the eggs just above the point where the petiole meets the expanded part of the leaf (fig. 4). The precision with which this habit is followed becomes a matter of much interest. Out of hundreds of masses of eggs

observed, only a very few were placed on other species of plants or in a different position on the leaf (fig. 5). The female (fig. 6) is occupied for a half hour or more in placing the several hundred eggs composing a single mass, and during this time the observer can take a position close by and watch the proceedings without frightening her away, but species of Tabanus are more particular about the approach of intruders than are various Chrysops.

The egg mass (figs. 4, 5) is white when first placed but turns brown shortly; it is very convex, and is composed of about five layers, one above the other. Individual eggs are of nearly the same size as those

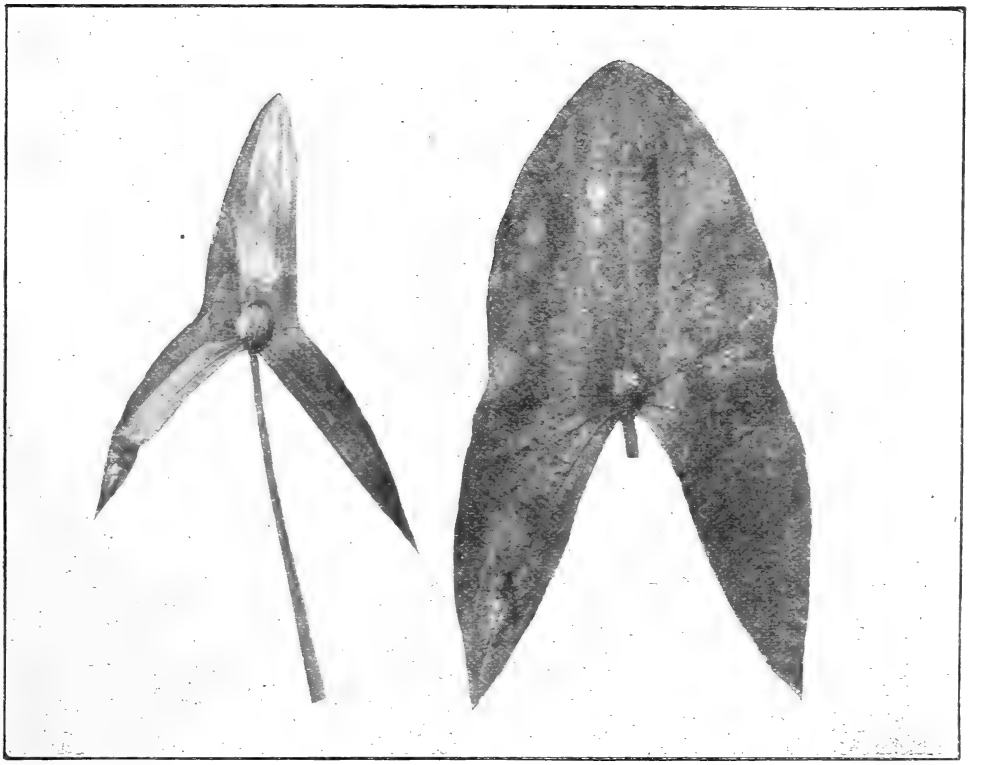

FIG. 4.—Eggs of *Tabanus stygius*, showing the location, with reference to the leaf, in which they are usually found. From a photograph; reduced (original).

of the black horsefly (*Tabanus atratus* Fab.), and are similar to them in form. Hatching, as observed, occurred in seven days after oviposition. From a careful study of microscopic sections of eggs killed as soon as laid it was concluded that development does not begin until after oviposition, consequently the time given is the entire incubation period.

When first hatched the larvæ contain a considerable amount of unused yolk, which furnishes them food for a time; it is therefore unnecessary for them to eat anything for a few days. This is advantageous no doubt, for food is not always just at hand, and in case it is

not, the fact that nourishment is furnished naturally gives them an opportunity to investigate their surroundings.

At hatching time nearly all the larvæ that come from a single mass of eggs appear at the same time and when they have freed themselves from the shells go tumbling down into the water, scattering more or less and sinking to the bottom, where it is difficult to observe their further actions.

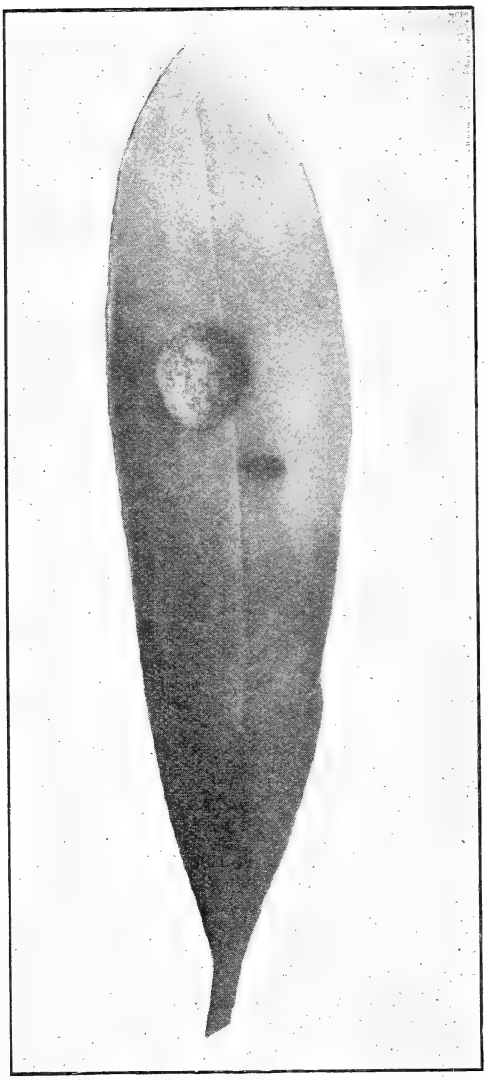

FIG. 5.—Eggs of *Tabanus stygius*, showing a position in which they are not often found. From a photograph (original).

I proved to my satisfaction that horsefly larvæ are palatable to the small catfish (*Amiurus melas*), although I am not fully informed of how much value the fish is in destroying them under natural conditions. From a large number of these larvæ, hatched July 21, 200 were counted out on the morning of the 23d, and placed in a quart jar of water containing two young fishes slightly more than an inch in length. Before noon of the same day all the larvæ had been devoured. At another time 300 larvæ were put into an aquarium with 12 of the catfish, with the result that the former disappeared within the space of an hour or two.

July 21 a number of larvæ just hatched were placed in a breeding jar containing damp sand covered over the top with fine plant material, and small crustaceans were put in for food. The larvæ took kindly to the surroundings, accepted the food offered, and began to grow from the start. After a couple of weeks, as angleworms were much easier to obtain, these were substituted for the crustaceans, with no bad effects on the larvæ, which continued to grow, though rather slowly. The largest attained a length of about 10 mm. by the beginning of winter, when they ceased eating. They appeared to be in good condition in the spring, but for some reason died without further increase in size.

August 2, of the same year, I took a large larva of this species in Summit County, Ohio, from under a flat stone along a brook that ran from a spring. When taken this specimen measured over 40 mm. in length and had every appearance of being mature, but it continued to eat the angleworms given it until late in the fall. It then ceased feeding until the following spring, when it took a small amount of food and entered the pupal stage about the middle of May, the adult, a male, issuing June 14.

From what I have learned of the life cycle of the species it seems hardly possible that it passes all its transformations in a single year, for the larvæ reared from eggs were not over 8 mm. long when the specimen over 40 mm. long was collected; and as the latter did not produce the adult until about the normal time for adults to appear under natural conditions, it does not seem possible that the first-mentioned larvæ could have reached maturity and produced adults before the second year.

FIG. 6.—Adult female of *Tabanus stygius*. From a photograph: enlarged (original).

Larva, when first hatched, 4 mm. long; entirely light colored; form as in older specimens. As growth continues size is the only noticeable change.

The mature larva has been figured and described in detail by Hart in his paper, "On The Entomology of the Illinois River and Adjacent Waters."[a]

Pupa (fig. 7, A) 29 mm. long; color dark, approaching fuscous; prothoracic spiracle strongly bent at the middle; rima oblique and straight for the outer half of its length, remainder gradually curved, with a broad hook at the inner end. Teeth at the end of the abdomen (fig. 7, B) six in number, nearly equidistant from one another, of nearly the same size, with the extreme tips slightly turned inward.

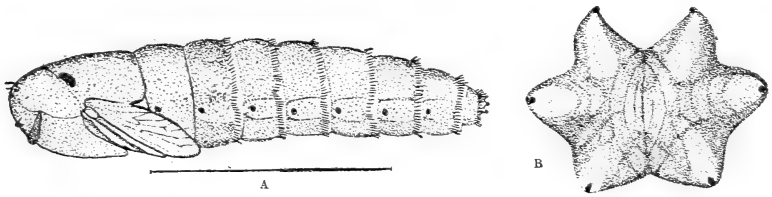

FIG. 7.—*Tabanus stygius*; A, pupa; B, terminal abdominal teeth of same. Enlarged (original).

The pupa of *stygius* is much like that of *sulcifrons*, but there is some difference in the prothoracic spiracles and in the abdominal teeth.

[a] Bul. Ill. State Lab. Nat. Hist., Vol. IV, Art. VI, pp. 239–240, Pl. XI, figs. 47, 48, 1895.

Adult 20 to 22 mm. in length. Third segment of the antenna reddish at the base, blackish at the apex; legs black, the front tibiæ reddish at base; wings yellowish brown, cross veins and furcation of the third vein margined with darker; abdomen uniformly black. Female, thorax plainly white pollinose; male, thorax uniformly grayish brown.

The species is nearly related to *T. nigrescens*, which has the thorax of the female almost uniformly black.

THE RIVER HORSEFLY.

(*Tabanus virax* Osten Sacken.)

I have never observed this species to be especially common, but it is widely distributed, having been taken in a number of the Eastern

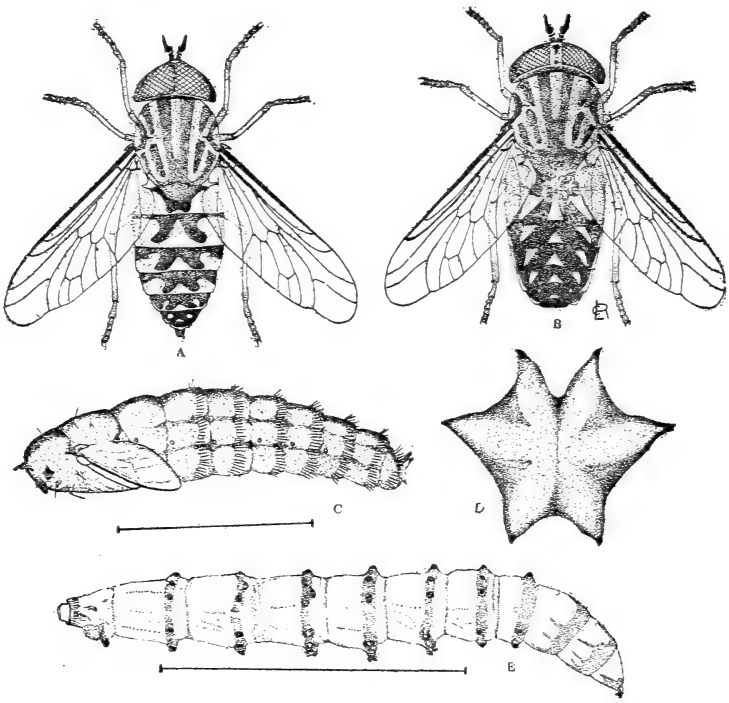

FIG. 8.—*Tabanus virax:* A, male; B, female; C, pupa; D, terminal abdominal teeth of pupa; E, larva. All enlarged (original).

States. Since specimens are not plentiful they are not often observed around stock, but it is known that they have the same habits in this regard as the other members of the family. The male has been taken fully as often as the female, on protruding stones in swift-flowing streams, and in sunny spots in woods near such streams. The species is on the wing during the last half of June.

Adult (fig. 8, A, B) from 14 to 16 mm. in length, slightly elongate; antennæ black, first segment partially reddish in the female; thorax with five gray stripes separated by black; wings hyaline; legs black in general color, with the basal part of each tibia yellowish; abdomen with a prominent middorsal row of gray triangles and gray spots on each side.

Female: Palpi light yellow; front wider above than below, frontal callosity shining black, almost as wide as the front and with a narrow extension above. Abdomen with three rows of gray spots extending for its whole length; in this sex the gray spots are small but well defined.

Male: Palpi nearly black, much darker than in the female. The general arrangement of colors on the abdomen is the same as in the other sex, but the lateral gray spots are larger.

Eggs are placed on stones that project above the water in riffles of streams. They do not differ in particular from the eggs of other species of the genus, but the masses observed were not so convex as those of the black horsefly, and being placed on stones of a color similar to themselves are rather difficult to see. Females have been observed ovipositing as early as June 8, but most often eggs are deposited after this date.

Larvæ occur in the streams in the fall. In September and October each year we collect the larvæ of the dobson fly (*Corydalis cornuta* L.) for study in the laboratory. Whether we obtain these larvæ by turning stones at the edge of swift riffles, or by means of a net stretched across the riffles to catch such specimens as are dislodged by turning stones behind the net in the stream, we find plenty of the larvæ of this horsefly. I have collected much in streams, but the larva of the river horsefly is the only tabanid larva taken in riffles so far. I have not found it difficult to rear these larvæ, when taken at the season mentioned, by placing them in damp sand and feeding them on angleworms. As winter approaches they refuse to eat and take up a position in the sand and remain quiet until the following spring; then they feed actively for a few days and change to the pupa. Like other tabanid larvæ they are not particular as to their food; all that appears to be necessary is that they obtain small, soft-bodied animals. Crustaceans serve them as well as insects and their own species as well as some other species—whatever, in fact, is in the sand of the breeding cage.

Larva (fig. 8, E), when full grown, about 25 mm. long. General color yellowish white, anterior margin of each thoracic segment and a narrow band, including the prolegs, on the anterior half of the first seven abdominal segments opaque, and appearing darker than the other parts, which are more or less shining and usually finely striate longitudinally. Prothoracic segment divided by longitudinal grooves into four nearly equal parts, which may be called the dorsal, ventral, and lateral areas. The lateral areas are shining and finely striated on the posterior third and opaque on the anterior two-thirds; the dorsal and ventral areas are opaque on about the anterior fourth and distinctly shining on the remaining parts. The ventral space is plainly divided into two equal parts by a longitudinal groove. In order to see the character of this segment, it must be fully extended. The mesothoracic and metathoracic segments have a number of longitudinal grooves, some of which are very narrowly bordered by opaque darker coloring, which proceeds backward from the narrow anterior border of these segments. Each of the first seven abdominal segments has on its anterior part a transverse row of eight tubercles which encircle the segment. These all bear short spines or claws at the apex, excepting a dorsal pair on each of

the first three or four segments. They may be called prolegs, since they have the parts necessary to such organs and, what is more, are used as prolegs. On the posterior dorsal border of most of the abdominal segments there may be a narrow, irregular, opaque marking of the same color of the narrow band in the region of the prolegs; eighth segment on each side with two narrow, curved markings which have the appearance of being composed of contiguous punctures. These markings are of the same shade of color as the other darker areas, and the lower one is more than twice as long as the upper.

Pupa (fig. 8, c) 18 mm. long and 4 mm. in diameter. Light brown in color, thorax somewhat paler than the abdomen. Antennal and other tubercles of the head and thorax prominent and darker than the surrounding parts. Prothoracic spiracular tubercle slightly elevated, reniform, oblique; rima uniformly curved for nearly its whole length; but just before the anterior end the curvature is stronger, although no hook is formed. First abdominal spiracle nearly round; rima almost uniformly curved, posteriorly very slightly widened just at the end, anteriorly slightly narrowed and curved so as to form a short hook. The other abdominal spiracles agree with the first one in general, but there is slight variation in the enlargement and curvature of the extreme ends. Terminal teeth (fig. 8, D) prominent, shining brown in color, darkest at the extreme tips. Dorsal pair of teeth smallest and closer together than the ventral, lateral teeth longer and larger than the ventral and located much beneath the dorsal, in fact they are nearly midway between the dorsal and ventral.

THE BLACK HORSEFLY.

(*Tabanus atratus* Fabricius.)

The eggs of this horsefly—male and female adults of which are shown in figure 9—are placed in masses of various sizes on the leaves and stems of grasses and sedges and other plants growing in marshy or wet ground, but not necessarily in the water. A single mass may contain as many as 500 eggs, but often they are smaller and they may be larger; they are white when first placed, but soon turn brownish. The mass is very convex and composed of several layers, one above the other, the bottom layer being attached to the surface of the leaf or stem and the other layers each to the one that was placed before it. Each egg is elongate spindle shaped, between 2 and 3 mm. in length and narrowed at each end. A female was observed ovipositing June 23 at 11 o'clock. The eggs were taken and kept in a room out of the sun, where they hatched on the morning of July 2 before 6 o'clock, thus requiring an incubation period of nearly nine full days. It has been proven that the eggs of tabanids hatch more quickly when exposed to the sun during the day, as where they are usually deposited; therefore, the time given is probably too long for eggs under natural conditions.

There is no definite way, so far as observed, of telling the eggs of the black horsefly from those of other species of its genus, but being a large species the masses are much larger than in some others, and are more convex than usual. The particular place of oviposition is in a measure characteristic.

Larvæ, when first hatched, are about 3 mm. in length, white, and with a narrow darker shade at the union of each two segments. As soon as they drop to the ground they begin to burrow and are soon beneath

the surface, where they can not be seen. At first these larvæ are very hard to see on account of their small size; consequently not much has been learned of their habits under natural conditions; but when nearly grown they are to be found in a variety of places. Walsh was the first to make reference in writing to this species in the larval stage. He found specimens in floating débris and rotten logs and on one occasion under a log on dry land. I have taken them while digging in the ground in the vicinity of ponds, from under stones on ditch banks, from the water with dip nets, and occasionally in most unexpected places. However, if one is looking for them he is likely to meet with more or less disappointment, as the finding of one specimen does not indicate necessarily that others may be taken under the same conditions.

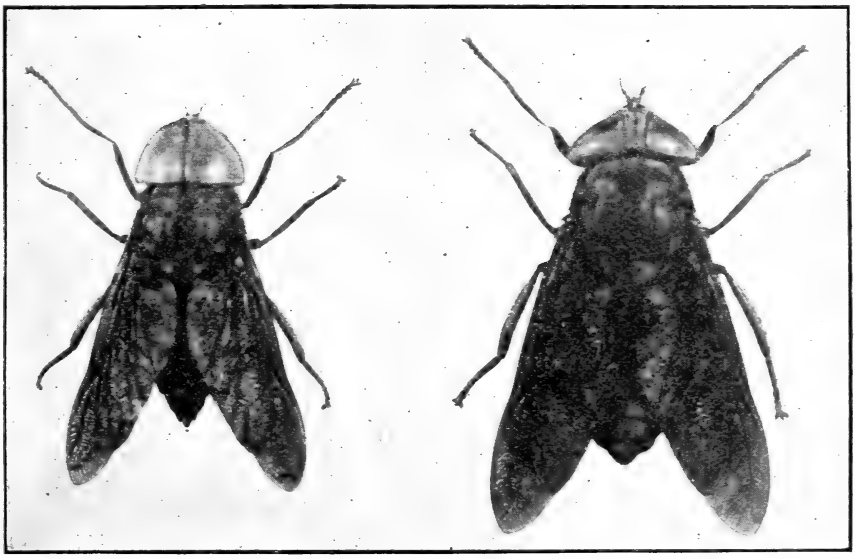

FIG. 9.—*Tabanus atratus:* Adult male at left, female at right. From a photograph; enlarged (original).

The fact that specimens have been taken from floating logs and débris suggests that they may be transported for longer or shorter distances in this way, and during high water stranded upon ground which, when the flood subsides, is high and dry and far removed from the bed of the stream. Since the species in all its habits is closely associated with water and wet ground, this seems to be the only way of explaining the appearance of larvæ in dry soil and in places remote from where the eggs are laid.

Full-grown larva nearly 2 inches in length. General color yellowish white, with wide dark brown bands at the union of each two segments. Prothoracic segment on each side with two lateral grooves, which do not quite reach the posterior border of the segment, and a dorsal groove continued for the entire length. These grooves and a number of irregular dots on the posterior part are dark colored, while the remainder of the segment is light. Mesothoracic segment, on each side, with four longitudinal grooves, which reach nearly the entire length. The dark markings on this segment include a narrow anterior border, the lateral grooves, and a number of

irregular dots near the posterior margin. The metathoracic segment is like the last, except that the dark color on the anterior margin is wider and the posterior, instead of being dotted, is uniformly brown. The abdominal segments are each similar to the metathoracic, but the dark markings in the region of the lateral grooves are more or less abbreviated. Last abdominal segment with two pairs of dark markings; the ventral pair extend the whole length of the segment and are connected just behind the anal prominence by a cross-band; the dorsal pair are oblong, somewhat irregular in outline, and extend from the anterior margin to beyond the middle of the length. At the anterior ventral border of each of the first seven abdominal segments is a transverse series of prolegs, three on either side of the midventral line. These prolegs are located within the dark transverse bands, but are lighter in color than these and prominent enough to be seen easily. Above the prolegs on either side of the middorsal line is a small swelling which appears as a rudimentary proleg; before the two is a distinct transverse light spot still within the dark area.

The head of the larva is very small for so large an insect and the mouth parts are minute. The mandibles consist of two strongly chitinized pieces, and work by being pushed endwise backward and forward. When drawn in, the anterior ends point directly forward, but when protruded, these same ends point downward and backward, thus forming a pair of hooks by means of which the prey is held. The larva is able to protrude its mandibles very quickly and to use them very effectively on soft-bodied invertebrates on which it is known to feed.

Pupa (fig. 10, B) about 1¼ inches in length. Color brownish yellow. Antennal and other tubercles of the head darker than the surrounding parts. Prothoracic spiracle

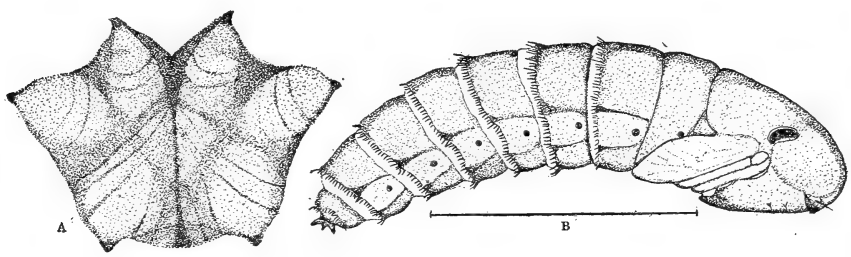

FIG. 10.—*Tabanus atratus:* B, pupa; A, terminal abdominal teeth of same. Enlarged (original).

slightly elevated, clear brown in color, reniform and oblique, rima gradually curved to near the dorsal end, where a distinct hook is formed by a sharp bend. Abdominal spiracles nearly round; rima of the first short and gradually curved and with a slight hook at the dorsal end. Terminal teeth (fig. 10, A) arranged in pairs, a ventral pair and a pair on each side formed by a dorsal and a lateral tooth. The distances between these teeth is variable; the two dorsal are nearest together, then follows the distance between a dorsal and a lateral, the distance between the two ventral, while the distance between a ventral and a lateral on each side is greatest of any.

THE MARSH EARFLY.

(*Chrysops mœrens* Walker.)

The marsh earfly is a common species in the marshes near the Lake Laboratory, at Sandusky, Ohio. The adults appear each year during the latter part of June and are abundant by the 10th of July. They continue to be common all through the latter month and August, and a few are to be found in September. Eggs were first observed during the first days of July and were present in varying numbers during the following two months.

During the time the female is ovipositing she is not easily disturbed;

consequently one has an excellent opportunity to watch the procedure. The accompanying illustration (fig. 11) was made from a photograph of a living specimen which was found in the act of egg-laying and carried, with the leaf, to the laboratory where the picture was taken. During the whole time she continued ovipositing without showing any signs that she was aware of what was going on or that she had any concern for the welfare of her eggs.

The method of placing the eggs is similar to that recorded for *C. callidus* in my paper on "The Tabanidæ of Ohio,"[a] pages 4 and 5. The female alights on the leaf with her head downward and begins the process by pushing the tip of her abdomen forward toward the under part of the thorax and placing the protruding end of an egg against the leaf. The end sticks fast in consequence of the glue-like substance which accompanies it, and she then moves the tip of her abdomen back to its normal position, thus freeing the egg. By similar movements one or two eggs are placed to one side of the first, and two or three to the other side of it. The unfinished end soon becomes V-shaped; she moves slowly forward and lifts the tip of her abdomen to one arm of the V and places eggs along down until the apex is reached; then changes to the other arm of the V and places eggs along down to the apex on this side. It was noted in specimens of this species observed that sometimes a female would place as many as three rows of eggs on one side, one after the other, before changing to the opposite side. It is only necessary to study a mass of these eggs in order to see the precision, in reference to one another, with which the different specimens are arranged.

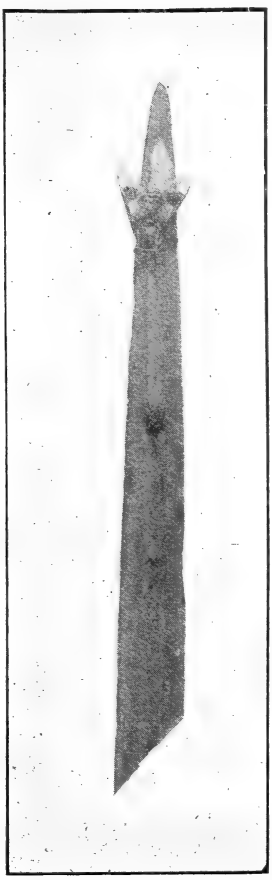

FIG. 11.—*Chrysops mœrens* ovipositing. From a living specimen (original).

The eggs (fig. 12) are placed on various aquatic plants, oftentimes standing in rather deep water and at times as much as 20 rods from shore. I have always found them on scattering plants around the edges of grassy areas and not back among the dense growth; consequently they are easily seen, not only on account of conspicuous location, but also because of their shining black color, which contrasts strongly with the green leaves to which they are attached.

It has occurred to me that, on account of the uniform methods of placing the eggs followed by various species and the strong contrast of these eggs with their surroundings, there are times when hand

[a] Ohio State Academy of Science, Special Papers, No. 5, May 1, 1903.

picking might be of consequence, although I realize that in most cases such procedure would not be practicable. In order to demonstrate what could be done in the way of gathering eggs of this species, on the morning of July 17 I went out in a small rowboat and collected for an hour. At the end of this time a count showed 433 masses, and an average of 250 specimens to each mass—a result obtained by counting several and striking the average—gives a total of 108,250 single eggs taken as a result of the hour's work.

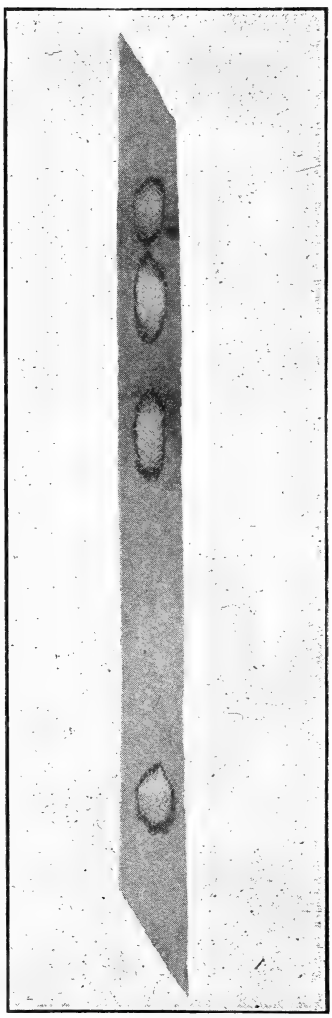

FIG. 12.—Eggs of *Chrysops mœrens:* Four masses on short section of leaf of Spharganium. From a photograph (original).

Eggs laid from 8.45 to 9.30 o'clock on the morning of July 13 hatched before noon of July 19, thus making the incubation period six days in length. This is the shortest incubation period I have observed for any of the species of the family.

In a previous paper I suggested that kerosene might be of consequence if used on the surface of stagnant water over which eggs are in place, in order that the larvæ when they hatch and drop to the water must pass through a film of the oil. Data on this point are very difficult to obtain in the natural breeding grounds of the flies, for it is almost impossible to find the very small larvæ after they have dropped from the eggs and have become more or less scattered among the débris which is usually plentiful in these places. I undertook to test the matter by the use of a tank of water on the surface of which kerosene was placed at the rate of half a pint to each square yard of surface. Spharganium leaves to which eggs were attached were brought in from the marsh and put into a bottle, as one would arrange a bouquet, and this placed on the bottom of the tank so that the parts of the leaves to which the eggs were attached were a foot or more above the surface of the water which contained the layer of kerosene. Even under these conditions an exact count could not be obtained, because the kerosene appeared to affect different specimens differently. Some were killed very quickly, some died after an hour or more, while others did not appear to suffer particular inconvenience from the treatment. Further observation is necessary in order to be able to give conclusive statements regarding the matter.

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U. S. D. A., B. E. Tech. Ser. 12, Pt. III. D. F. I. I., April 5, 1907.

MISCELLANEOUS PAPERS.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE THYSANOPTERA OF CALIFORNIA.

By Dudley Moulton, *Special Agent.*

INTRODUCTION.

Upon undertaking a study of the life history of the pear thrips (*Euthrips pyri*), and incidentally of other thrips as they came to notice, the writer was impressed by the great deficiency in our knowledge of these insects. In California it seemed, indeed, that new species could be collected on almost every side, and when trying to classify these specimens it was found that the individuals possessed most of the characteristics which would place them readily in any certain genus, but that there would often be found striking though minor differences. In several cases it has been necessary to extend the original generic descriptions to include California forms.

In a short published account of California thrips,[a] Miss Daniel states that previous to that time (1904) four species of thrips were known to exist in California. To this number her paper would add five. The writer finds, however, that one of her species, *Caliothrips woodworthi*, is the already described *Heliothrips fasciatus* of Pergande. Thus only eight were known previous to 1906. The writer has been able to gather abundant specimens of all of these thrips and now adds sixteen more new species and two varieties, making a total of twenty-six. It has been necessary to erect a new genus to include the species *Orothrips kelloggii*. The genus *Megalothrips*, represented by *Megalothrips hesperus*, has not before been recorded as found in America.

Economically considered, the thrips constitute an important group in California, because of the ravages of several species. Growers of deciduous and citrus fruits and of garden truck and nurserymen and florists have suffered at times very considerably, but not until

[a] New California Thysanoptera. By S. M. Daniel. Ent. News, Vol. XV, No. 9, pp. 293–297, November, 1904.

the conditions in the Santa Clara Valley became so grave that something had to be done was any very serious study given to these insects.

Orange growers in southern California were made very apprehensive a few years ago by the appearance of small brown spots on their oranges, caused by the feeding of the grass thrips (*Euthrips tritici* Fitch). The injury was, however, superficial, as a spot only was produced on the orange peel, the quality of the fruit being in no way injured nor its qualities of keeping affected. Yet because of the spots many of the best oranges had to be passed out as culls. This same thrips has been reported injuring alfalfa by its feeding within the blossoms. The damage was hardly noticed when the alfalfa was cut for hay, but for seed purposes the crop was an almost absolute failure. The grass thrips is everywhere present in wild and cultivated flowers and in blossoms of most of the indigenous trees. The writer has often been able to collect hundreds of specimens of this thrips with a single sweep of the net from the blossoms of the California sage (*Artemisia californica*), and from the manzanitas, especially *Arctostaphylos tomentosa*. This thrips is perhaps seen most commonly in our garden flowers—roses, lilacs, etc.—and does little or no apparent injury. Often, however, one finds ill-shaped and partly dead outer petals of rose buds or even full-blown roses. This injury, when not caused by mildew, can be quite easily traced to the grass thrips, which feeds in the tip of the bud on the outer end of the petals, just before or while the petals are spreading. This injury is common, but as roses unfold rapidly, the larger, inner petals are not injured, and the outer, smaller, imperfect ones may be picked off and the rose left apparently perfect. This species is perhaps the most widespread of all the thrips. Only at intervals does its injury render it a pest. Its appearance is very like that of the pear thrips (*Euthrips pyri*), and to the casual observer either species could easily be mistaken for the other.

The feeding injuries of *Heliothrips hæmorrhoidalis* are limited largely to azaleas, cherry laurel, and laurestina, and to greenhouse and other ornamental shrubs. The writer has found in greenhouses azalea plants which have been completely killed by these insects. Affected laurestina plants produce contorted, ragged, and pale leaves.

The injury of *Trichothrips ilex* on the Christmas berry (*Heteromeles arbutifolia* is noticeable wherever that plant grows. This insect has been found only on the one plant, and it is interesting to note that the plant is indigenous only to limited areas in the Coast Range region near San Francisco Bay. The Christmas berry is one of the showiest of California shrubs when, from November to January, it displays its fine clusters of crimson berries. When the plants are badly infested with thrips the leaves are deformed and ragged and the weakened blossoms produce small and imperfect berries. The

berries have no special value commercially, but in their perfect state are used extensively for Christmas decorations.

The onion thrips (*Thrips tabaci* Lind.) finds an almost ideal habitat in the extensive onion-seed farms in California, and its injury to this plant in some sections and during some years is almost prohibitive of onion growing.

Especially to be mentioned, however, is the injury caused by the pear thrips (*Euthrips pyri* Daniel). This is strictly a fruit-tree pest, attacking as it does nearly all varieties of deciduous fruits. No other thrips is recorded as having done so much damage as has this one, and the problem for its control is a difficult one to solve. The writer's experience has been that, outside of purely cultural methods, we have no effective artificial means for checking it. Its natural insect enemies are few, and from the very nature of the pest's life habits it can not be controlled effectively by those beneficial forms which are already present. A parasitic fungus has for the time being proved a quite effective check, but the weather conditions, moist and warm for two years past (during 1905 and 1906), have been almost ideal for the growth of such fungi, and it is extremely doubtful if this check would prove at all effective under other conditions. The pear thrips is limited in its distribution to the deciduous-fruit areas around San Francisco Bay.

It is interesting to note the relations of some of the California thrips to their food plants. *Orothrips kelloggii* is found only in blossoms of manzanita and madroña—both trees peculiarly Californian—whose cup-shaped blossoms afford an ideal home for this striking thrips. *Æolothrips kuwanaii* is common only in the wild California lilac. *Trichothrips ilex* is peculiar to the Christmas berry, and has thus far been collected from no other plant. *Euthrips pyri* is limited in its feeding to cultivated fruits. *Cryptothrips californicus* is most often found under the old shells of the brown apricot scale (*Lecanium armeniacum*) and the black scale (*Saissetia oleæ*). It has been taken from these places mostly during the winter, and it may be that it is under the old shells only for protection, but the writer suspects that it may be a scavenger.

In preparing this paper the writer has introduced descriptions of genera only when it has been necessary to extend the characters to include California species. For other generic descriptions the reader is referred to Hinds's monograph of the North American forms.[a]

The already recognized characters of ovipositor, wings, antennæ, and mouth appendages are the principal ones here used in the keys for classifying the species. In describing new thrips the writer has made

[a] Contribution to a Monograph of the Insects of the Order Thysanoptera Inhabiting North America. By Warren Elmer Hinds. Proc. U. S. Nat. Mus., Vol. XXVI, No. 1310, pp. 79–242, Pls. I–XI, December 20, 1902.

the customary measurements, and, in addition, has reduced the lengths of antennal segments to microns. In most other respects the plan adopted by Hinds has been followed. The writer has redescribed the three species of Miss Daniel (*Cryptothrips californicus*, *Euthrips pyri*, and *Sericothrips apteris*) to make their descriptions conform with the others.

CLASSIFICATION OF CALIFORNIA THYSANOPTERA.

KEY TO THE SUBORDERS AND FAMILIES.

I. Female with a saw-like ovipositor. Terminal abdominal segment of female conical, of male usually broadly rounded. Wings usually present; fore pair strongest, with more or less well-developed veins; double fringed behind. Membrane of wings with microscopic hairs.....Suborder TEREBRANTIA.

A. Antennæ with nine segments. Fore wings broad and rounded, with prominent ring vein and cross veins. Ovipositor upcurved.....(A) Family ÆOLOTHRIPIDÆ.

B. Antennæ with six to eight (nine?) segments. Wings present or absent; when present usually narrow and pointed at tips. Ovipositor downcurved.....(B) Family THRIPIDÆ.

II. Female without ovipositor. Terminal abdominal segment tubular in both sexes. Wings usually present, both pairs similar; front pair with only a rudimentary, median, longitudinal vein; wings with simple fringe on both margins except fore wing, which is double fringed on posterior edge near tip by a few hairs; membrane of wings without microscopic hairs. Antennæ eight-segmented.....Suborder TUBULIFERA.

(C) Family PHLŒOTHRIPIDÆ.

KEY TO THE GENERA.

(A) Family ÆOLOTHRIPIDÆ.

1. All segments of antennæ freely movable and diminishing in size gradually at tip. Maxillary palpi seven-segmented, labial palpi four-segmented.....(1) *Orothrips*, new genus.
2. Last four segments of antennæ closely united and together shorter than the fifth. Maxillary palpi three-segmented, labial palpi four-segmented.

(2) *Æolothrips* Haliday.

3. *Caliothrips* Daniel.[a]

(B) Family THRIPIDÆ.

1. Antennæ with eight segments (nine?).

a. Wings wanting; prothorax almost as large as pterthorax; body with or without reticulated structure.....(3) Genus *Sericothrips* Haliday.

a'. Wings fully developed.

b. Body with markedly reticulate surface; last segment of antenna drawn out and very much longer than the seventh.

(4) Genus *Heliothrips* Haliday.

b'. Body without reticulate structure; eighth antennal segment only a little longer than the seventh.

(5) Genus *Euthrips* Targione-Tozzetti.

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[a] *Caliothrips woodworthi*, new genus and species, was described in Entomological News for November, 1904 (Vol. XV, No. 9, pp. 296–297). The writer of the present paper has been unable to see the type specimen, but from the description believes that it will prove to be none other than the male of *Heliothrips fasciatus* Pergande, or a closely related species.

(B) Family THRIPIDÆ—Continued.

2. Antennæ with seven segments.

a. Fore wings broad, reticulated and without front fringe.

(6) Genus *Parthenothrips* Uzel.

a'. Fore wings narrowed near tip; fringe present on anterior margin.

(7) Genus *Thrips* Linnæus.

(C) Family PHLŒOTHRIPIDÆ.

1. Head about as long as broad .....(8) Genus *Trichothrips* Uzel.

2. Head markedly longer than broad.

a. Fore femora armed with tooth at tip....(9) Genus *Acanthothrips* Uzel.

a'. Fore femora without such tooth.

b. Head more than twice as long as wide; males with prominent clasping organs projecting from the side of sixth segment; very large thrips.....(10) Genus *Megalothrips* Uzel.

b'. Head about one and one-half times as long as wide; males without such clasping organs.....(11) Genus *Cryptothrips* Uzel.

KEY TO THE SPECIES.

1. Genus *Orothrips*, new genus.
   Represented by one species .....(1) *O. kelloggii*, new species.
2. Genus *Æolothrips* Haliday.
   Represented by one species and a variety.....(2) *Æ. kuwanaii*, new species.
   (3) *Æ. kuwanaii robustus*, new variety.
3. Genus *Sericothrips* Haliday.
   a. Body very dark brown, nearly black; pterthorax yellow; legs brown.
   (4) *S. apteris* Daniel.
   b. Body uniform brown; surface of body strongly reticulated; legs yellow.
   (5) *S. reticulatus*, new species.
   c. Body and legs uniform brown; four stout spines on the dorsal side of segment 9 .....(6) *S. stanfordii*, new species.
4. Genus *Heliothrips* Haliday.
   a. All legs yellow; antennæ twice as long as head; wings slender, with one distinct longitudinal vein in center; small darkened area near base. Food plants are azaleas, laurestinas, dahlias, etc.
   (7) *H. hæmorrhoidalis* Bouché.
   b. Legs brown, with tips of femora, both ends of tibiæ, and tarsi light-brown to yellow; antennæ one and one-half times as long as head; wings gray-brown with two transparent-white cross-bands, one at base and one at three-fourths the wings' length; two longitudinal veins, the second branching from the first near the broadened base of the wing, the first uniting with the costa to form the fore part of a strong ring vein.
   (8) *H. fasciatus* Pergande.
5. Genus *Euthrips* Targioni-Tozzetti.
   a. Without prominent spines on fore angles of prothorax; longitudinal veins not regularly set with spines.
   b. Head noticeably wider than long; sense cones on segments of antennæ very long and slender; general color of body light lemon-yellow.
   (9) *E. orchidii*, new species.
   b'. Head about as wide as long; general color of body brown.
   c Basal segment of antenna concolorous with head and with segment 2; postocular spines wanting; two spines on posterior part of thorax dividing the hind margin into equal portions; about sixteen spines on hind vein of fore wing; general color brown to dark brown .....(10) *E. pyri* Daniel.

5. Genus *Euthrips* Targioni-Tozzetti—Continued.

c'. First segment of antenna of a lighter color than head and lighter than segment 2; postocular spines present and of medium length; three small spines bordering hind margin of prothorax on either side; posterior vein of wing with about twelve spines.
(11) *E. ehrhornii*, new species.

a'. With spines on fore angles of prothorax; longitudinal veins set regularly with spines.

b. Fore tibia armed at end with tooth..(12) *E. ulicis californicus*, new species.

b'. Fore tibia without such tooth.

c. General color of body brown to dark brown; individuals small, total length less than 1 mm.; with several quite long spines but with no short ones along posterior margin of prothorax.
(13) *E. minutus*, new species.

c'. General color of body yellow to brown; with a circlet of several large and several small spines bordering posterior margin of prothorax.

d. Fifth antennal segment about five-sixths as long as 4.
[a](14) *E. occidentalis* Pergande.

d'. Fifth antennal segment about two-thirds as long as 4.
[a](15) *E. tritici* Fitch.

6. Genus *Parthenothrips* Uzel.

Represented by one species.....(16) *P. dracænæ* Heeger.

7. Genus *Thrips* Linnæus.

a. Head noticeably wider than long.

b. Body color dark brown, thorax and other parts often orange tinted, inner crescents bordering ocelli orange-red; wings light brown with lighter colored area near base; body length about 1.25 mm.
(17) *T. madronii*, new species.

b'. Body color light yellow to light brown, inner crescents of ocelli light brown; wings uniform light colored; body length about 1 mm.
(18) *T. tabaci* Lindeman.

a'. Head as long or longer than wide; body long and slender; color almost transparent, sometimes shaded light brown.
(19) *T. bremnerii*, new species.

8. Genus *Trichothrips* Uzel.

a. Postocular spines wanting; all prominent spines on thorax and abdomen with blunt tips; antennæ about two and one-half times as long as head; each fore tarsus armed with a large tooth.
(20) *T. dens*, new species.

a'. Postocular spines prominent; body spines normal; antennæ not over twice as long as head; each fore tarsus armed with a small tooth.

b. Sides of head almost straight; fore femora of males greatly enlarged; fore tibiæ and tarsi and segments 3 to 6 of antennæ yellow.
(21) *T. femoralis*, new species.

b'. Sides of head slightly arched; fore femora of males not more than twice as broad as tibiæ; all tarsi and segment 3 of antennæ yellow.
(22) *T. ilex*, new species.

b''. All tarsi gray-brown and only base of segment 3 of antennæ yellow.
(23) *T. ilex dumosa*, new variety.

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[a] Many specimens of these two species have been examined and the variations in size, color, and relative lengths of antennal segments are so great that no sharp dividing line between the two species can be drawn.

9. Genus *Acanthothrips* Reuter.
   Represented by a single species .....(24) *A. doaneii*, new species.
10. Genus *Megalothrips* Uzel.
   Represented by a single species.....(25) *M. hesperus*, new species.
11. Genus *Cryptothrips* Uzel.
   Represented by a single species .....(26) *C. californicus* Daniel.

Family ÆOLOTHRIPIDÆ.[a]

The antennæ are nine-segmented. Ocelli are present in both sexes. The maxillary palpi are three to seven segmented; labial palpi are four or five segmented (sometimes two segmented in European forms). The wings are large, broad, and rounded at the outer ends. Each fore wing has a heavy ring vein and two longitudinal veins extending from base to near tip; each fore wing has from three to five cross-veins; the fore wings are without a fringe on the front margin. Both sexes bear a peculiar thumb and fore-finger-like hook on the outer side of the second segment of each fore tarsus. The ovipositor of the female is upturned. Males have the first abdominal segment much longer than the second. The members of this family have very long legs.

1. Genus OROTHRIPS, new genus.

Head wider than long. Ocelli present in both sexes. Antennæ nine-segmented, all sutures freely movable; third and fourth about equal in length. Maxillary palpi geniculate, seven-segmented; labial palpi five-segmented. Prothorax about one-third wider than long, its hind margin bordered with several quite strong spines on either side. Legs long and slender; fore femora thickened in both sexes; all tibiæ armed. Second fore tarsal segment in both sexes with hook-like appendage. Wings present in both sexes, broader in distal third, narrower near base. Anterior part of ring vein and two longitudinal veins thickly set with stout spines. Fore wing with two broad, darkened cross-bands near center and tip respectively, also darkened area near base.

(1) **Orothrips kelloggii**, new species. (Pl. I, figs. 1–4.)

Measurements: Head, length 0.16 mm., width 0.22 mm.; prothorax, length 0.16 mm., width 0.28 mm.; mesothorax, width 0.43 mm.; abdomen, width 0.41 to 0.50 mm.; total body, length 1.80 mm. Antennæ: 1, 36μ; 2, 54μ; 3, 114μ; 4, 108μ; 5, 60μ; 6, 45μ; 7, 42μ; 8, 24μ; 9, 33μ; total, 0.51 mm. General *color* dark brown, sometimes light brown, prothorax and abdomen shaded with orange.

Head about one-fifth wider than long and about as long as and retracted into prothorax; cheeks strongly arched; back of head transversely striated and clothed with small spines, a single pair posterior to ocelli, largest. *Eyes* large, black, with light posterior margin,

[a] It has been necessary to extend the characters of the family Æolothripidæ as given by both Uzel and Hinds in order to include California forms.

pilose, with large prominent facets. *Ocelli* orange colored, granulated, separated, and margined inwardly with dark orange-brown crescents; posterior ocelli approximate to but not bordering inner margin of eyes. *Mouth-cone* short, reaching about halfway across the prothorax, maxillary palpi geniculate, seven-segmented, first segment very large and almost as long as the other six; labial palpi five-segmented. *Antennæ* nine-segmented, uniform dark brown except tip of segment 2, which is light brown, and base of 3, which is yellow; all segments quite uniformly clothed with short dark hairs; segments 3 and 4 each with two elongated, light-colored, membranous sense areas on outer side, one dorsal and one ventral; segments 5 and 6 each with a simple sense cone on under side near tip.

Prothorax about one-third wider than long, constricted in the center of sides, very faintly cross-striated, uniformly covered with numerous spines; circle of twelve quite stout spines on posterior margin. *Mesonotum* striate-reticulate; with several stout spines, two on each side, two near center, and two on posterior margin. Mesothorax largest, quite smoothly and evenly rounded at union with metathorax; sides converge gradually toward the posterior. *Legs* unicolorous with body, except trochanters, tips of fore tibiæ, and fore tarsi, which shade to yellow; fore coxæ and femora thickened, other legs long and slender, legs thickly covered with short spines; fore tarsi each with thumb and forefinger-like hook; all tibiæ armed with spines near tip, hind tibiæ with several and a double row on inner side. Fore *wings* broadest near tip, narrower near base; anterior margin broadly rounded at tip, posterior margin nearly straight outward from scale; fore wings with a ring vein, two longitudinal and five cross veins; longitudinal veins and anterior part of ring vein thickly and regularly set with short spines. These spines are dark except on inner light area, where they are white. Fore *wings* without anterior fringe and with hairs on the posterior margin which do not average as long as the width of the wing; wings clear white with three darkened areas, one at base, one at tip, and a large irregular area near center. All cross veins are included in or margin on this central darkened area. Scales at base long and slender, each bears seven spines. Hind wings clear white and without veins; margined in front with short and behind with long simple fringe.

Abdomen ovate, or strongly spindle-shaped when distended; fourth and fifth segments largest, tapering gradually from fifth to the tip; segments 1 to 7 with a few short inconspicuous hairs on prominent angles; segment 8 with a single pair of stout spines; segment 9 with three long and several short pairs.

Males are similar, but with long, slender bodies.

Described from nine females and six males.

Food plants: Manzanita and madroña blossoms.

Habitat: Santa Clara Valley, California.

2. Genus ÆOLOTHRIPS Haliday.[a]

Head about as broad as long. Ocelli present in both sexes. Antennæ nine-segmented, the last four segments closely joined and together shorter than the one preceding; the third segment longest. Maxillary palpi three-segmented and geniculate. Prothorax about as long or a little longer than the head, without large bristles. Legs very long and slender; fore femora somewhat thickened in both sexes; fore tibiæ usually unarmed, although sometimes armed; second fore tarsal segment in both sexes with hooklike appendage. Wings usually present in both sexes; fore wing somewhat narrowed before the middle; fore part of ring vein furnished with very short hairs, which hardly overreach the edge of the wing and which increase in length toward the tip. Fore wings white, with dark cross or longitudinal bands. First abdominal segment in the males is much longer than the second, and the ninth is drawn out at the hind angles into short clasping organs or hooks.

(2) **Æolothrips kuwanaii**, new species. (Pl. I, figs. 5–8.)

Measurements: Head, length 0.13 mm. (varying to 0.16 mm.), width 0.17 mm. (to 0.18 mm.); prothorax, length 0.16 mm., width 0.20 mm.; mesothorax, width 0.30 mm.; total body, length 1.66 mm. Antennæ: 1, 36μ; 2, 51μ; 3, 84μ; 4, 81μ; 5, 69μ; 6, 7, 8, and 9, 51μ; total, 0.37 mm. *Color* of insect brown—sometimes dark brown—with conspicuous red pigment blotches, this red showing especially vivid through the membranous parts between the segments.

Head about as wide or only a little wider than long, rounded in front and only slightly elevated between basal segments of antennæ; cheeks arched; back of head faintly cross-striate with one especially prominent line near posterior margin; with several not prominent spines. *Eyes* prominent, black; with large facets, pilose. *Ocelli* present, placed well forward on anterior part of head, posterior ocelli contiguous with inner margin of eyes, orange-yellow and margined inwardly with deep orange crescents. *Mouth-cone* long, reaching to posterior margin of prothorax, pointed bluntly; maxillary palpi three-segmented, basal segment large, terminal one very small. *Antennæ* nine-segmented, two and one-half times as long as head; brown, unicolorous with body except segment 3, which is lemon-yellow shaded light-brown at tip; all segments except basal one thickly and uniformly clothed with short spines, those on tip of 2 are stoutest, spines on segments 1, 2, 4, and 5 are brown, those on 3 and style are white; sense area on 3 long and slender, on 4 a similar larger area; a simple sense cone on lower side of segment 6 near tip.

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[a] Genus modified to include California forms. *Æolothrips kuwanaii* differs only in minor details from the *Æolothrips* of other writers, so that it seems best to extend this genus rather than to create a new one.

Prothorax a little wider than long, and only slightly larger than head, with an emargination and thickening of the wall near center of each side; clothed with numerous small spines. *Mesothorax* largest; *metathorax* with sides almost straight and parallel except near posterior edge, where they turn abruptly inward. *Legs* dark brown, fore femora thickened, fore and second tibiæ armed at tip with two strong spines, last tibiæ with several spines at tip, and with two rows of smaller ones on inner side; each fore tarsus armed with a stout hook and tooth; all legs thickly set with small spines. Fore *wings* broadly rounded at tips, with two longitudinal veins which unite with ring vein near tip; with three cross veins and the vestige of a fourth; second longitudinal vein set with about twenty-six short, dark spines; spines also present on first longitudinal vein, but white and not conspicuous. Anterior margin of wing without fringe; hind margin with long, double fringe. Wings clear white, with dark brown longitudinal band covering posterior half from near base to near tip. Microscopic hairs on light-colored area white, those on darkened area brown. Hind pair of wings clear white, excepting a small, light brown longitudinal area near base; without veins; margined in front with short and on hind edge with long simple fringe.

Abdomen elongate-ovate, about one-third as wide as long. All segments uniform brown, with light brown intersegmental membrane, splashed conspicuously with red pigment; segments 2 to 7, inclusive, each with a dark cross line near anterior margin. Segments 1 to 8 without conspicuous hairs or spines; segment 9 bears eight long and several smaller spines along posterior margin. The three last segments form the sheath for the large upturned ovipositor.

Males are much smaller, with antennæ almost uniform brown and abdomen furnished with large clasping organs at tip.

Described from nine females and three males.

Food plant: California lilac (*Ceanothus thyrsiflorus*).

Habitat: Saratoga, Santa Clara County, Cal.

(3) **Æolothrips kuwanaii**, variety **robustus**.

Measurements: Head, length 0.16 mm, width 0.20 mm; prothorax, length 0.20 mm, width 0.23 mm; width of mesothorax 0.38 mm; total body length 2.4 mm. Antennæ: 1, 36μ; 2, 60μ; 3, 114μ; 4, 69μ; 5, 69μ; 6, 7, 8, and 9, 51μ; total 0.38 mm. *Color* quite uniform dark brown, with conspicuous red pigment blotches; the third antennal segment is light brown, with a touch of purple pigment at its base.

A single specimen of this insect, which is about one-third larger than *A. kuwanaii*, has been taken from an apricot tree near Cupertino, Cal.

Family THRIPIDÆ.

(3) Genus SERICOTHRIPS Haliday.

Body broad and having a silky luster, due to the presence of numerous minute spines on the abdominal segments. Head fully one and one-half times as wide as long. Eyes large and protruding; ocelli present in both sexes. Antennæ eight-segmented. Maxillary palpi three-segmented. Prothorax much longer than the head, without long spines at hind angles. Legs, especially hind pair, quite slender. Wings either reduced or fully developed; when present the fore wing is broad at basal fourth, the remainder being very narrow; only one longitudinal vein developed; fore fringe long; spines on veins numerous and moderately developed; abdomen in some species strongly arched and its segments broad and short; tip of abdomen conical in both sexes; abdomen of male much more slender throughout. (After Hinds.)

To include California forms this genus must be extended as follows: Head may be almost as long as wide; ocelli wanting; maxillary palpi two or three segmented; head may be as long as prothorax; legs medium stout. The three California forms now recognized are wingless.

(4) **Sericothrips apteris** Daniel.

Measurements: Head, length 0.13 mm., width 0.16 mm.; prothorax, length 0.13 mm., width 0.2 mm.; length of pterthorax 0.08 mm., width 0.26 mm.; width of abdomen 0.40 mm.; total body length 0.65 to 1.0 mm. Antennæ: 1, 18μ; 2, 39μ; 3, 45μ; 4, 39μ; 5, 36μ; 6, 54μ; 7, 15μ; 8, 18μ; total, 0.25 mm. General *color* very dark brown, pterthorax lighter, abdomen almost black.

Head rounded in front, elevated between bases of antennæ; back of head cross-striate, with a spine on each side just inward from each eye and several posterior to eyes; cheeks arched, sides roughened. *Eyes* prominent, not pilose; together they occupy about one-half the width of the head. *Ocelli* wanting. *Mouth cone* long, extending to mesothorax, tipped with black; maxillary palpi three-segmented. *Antennæ* eight-segmented, basal joints widely separated; first two segments broadest; suture near tip of segment 6, which often makes the antennæ appear nine-segmented; spines prominent; color quite uniform brown.

Prothorax of even length with head, sides evenly arched, with a few not prominent spines; pronotum faintly reticulate-striate; color dark brown. *Pterthorax* not nearly so long as head, narrow in front, diverging posteriorly; color orange-yellow to light brown; surface marked with transverse reticulating wrinkles; wings wanting. *Legs* moderately stout; hind femora with spines at tip; color brown, tibia and tarsi shading yellow.

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Abdomen broadly oval; segments 2 to 7, with an irregular row of about twelve spines along posterior margin; spines on last two segments short but quite strong; color very dark brown to almost black.

Redescribed from numerous specimens including several cotypes kindly furnished by Miss Daniel.

Food plant: Grass.

Habitat: Counties about San Francisco Bay, California.

This species is described in Entomological News for November, 1904, page 295. I have taken specimens from grass on the campus of the University of California, at Berkeley, Cal., where it was first found, and from the same food plant in the Niles Canyon, Alameda County, and on the campus of the Leland Stanford, Jr., University, Palo Alto, Cal. It is easily distinguished from the other species of the genus in that the pterthorax is decidedly lighter colored than the rest of the body, which is very dark brown to brown-black.

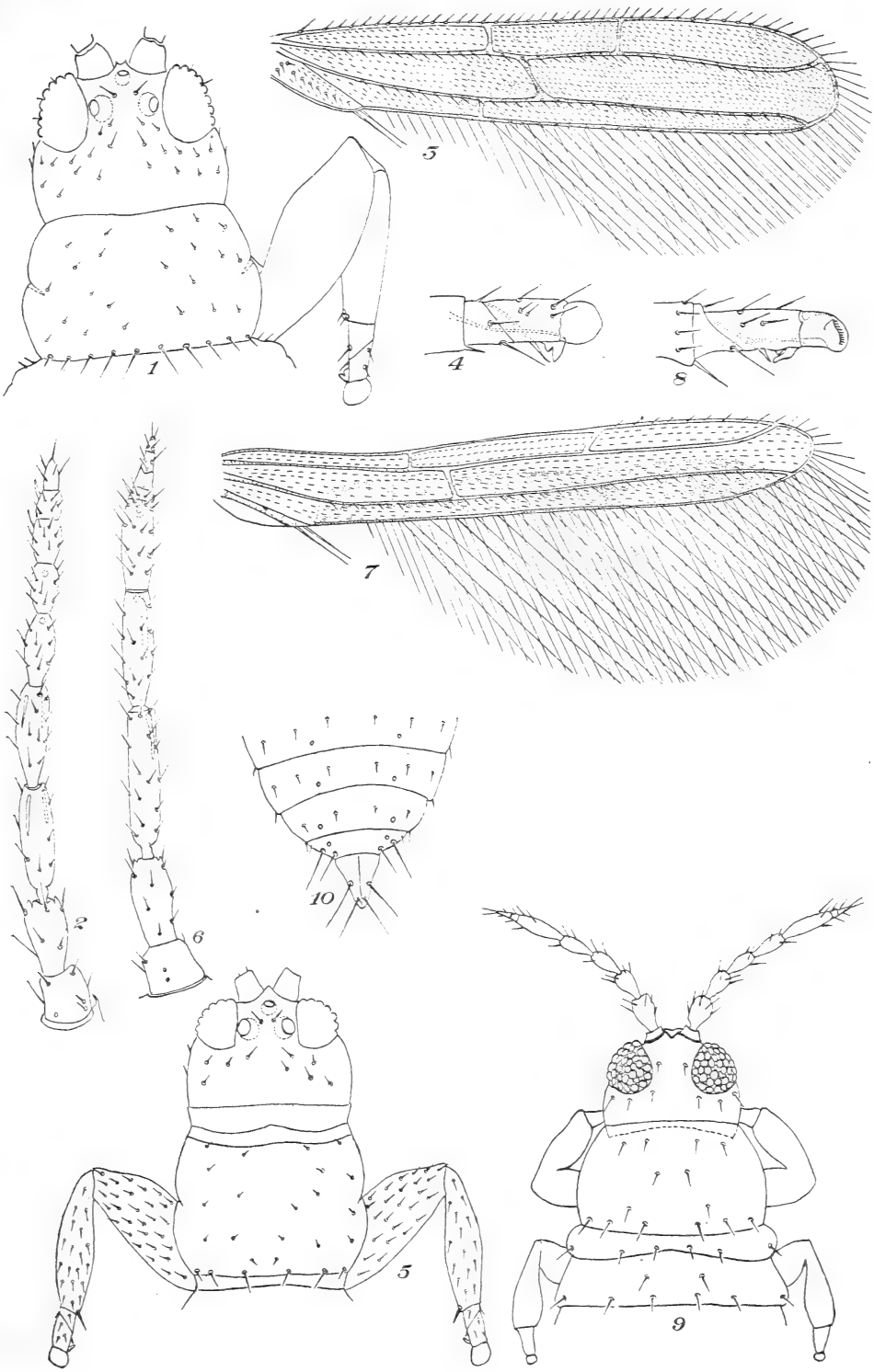
(5) **Sericothrips reticulatus**, new species. (Pl. I, figs. 9, 10.)

Measurements: Head, length 0.16 mm., width 0.20 mm.; prothorax, length 0.18 mm., width 0.26 mm.; abdomen, width 0.48 mm.; total body length 1.41 mm. Antennæ: 1, 21μ; 2, 48μ; 3, 54μ; 4, 54μ; 5, 51μ, 6, 69μ; 7, 12μ; 8, 21μ; total, 0.336 mm. *Color* brown, head and thorax lighter, and abdomen shading to dark brown at tip; legs yellow. Body increasing in size gradually from head to sixth abdominal segment, from where it tapers abruptly to the small ninth and conical tenth.

Head small as compared with other segments of body; cheeks arched, edges roughened; frons with two prominent darkened angles directly above basal segments of antennæ and with an intermediate angular depression. Head surface strongly reticulate, with no conspicuous spines and with but few very small hairs. *Eyes* large, prominent, with coarse facets, not pilose, with light-colored outer borders, pigment very dark purple. *Ocelli* absent. *Mouth cone* broad, pointed bluntly at tip; maxillary palpi two-segmented. *Antennæ* eight-segmented, slightly more than twice as long as head, segments almost uniform brown, sense hairs light colored and inconspicuous.

Prothorax but slightly longer than head. It bears a few very small hairs, but no spines. *Mesothorax* smallest segment of body excepting the last two of the abdomen, with *metathorax* only a little larger, and together they are wider, although not so large, as the prothorax. They bear no conspicuous hairs or spines. *No wings* or wing-pads are present. All *legs* are medium stout, unarmed, and with only a few inconspicuous hairs; color yellow, tarsi tipped with brown.

Abdomen brown, shading darker toward the tip; broadly oval; segments 1 to 4 increasing in size gradually; segments 4, 5, and 6 about equal, segment 7 tapering, 8 abruptly tapering to meet the very small ninth and conical tenth. Entire upper surface of abdomen reticulate.



THYSANOPTERA OF CALIFORNIA.

Fig. 1.—*Orothrips kelloggii*, head and prothorax of female. Fig. 2.—*Orothrips kelloggii*, left antenna of female. Fig. 3.—*Orothrips kelloggii*, right fore wing of female. Fig. 4.—*Orothrips kelloggii*, fore tarsus of female. Fig. 5.—*Æolothrips kuwanaii*, head and prothorax of female. Fig. 6.—*Æolothrips kuwanaii*, right antenna of female. Fig. 7.—*Æolothrips kuwanaii*, right fore wing of female. Fig. 8.—*Æolothrips kuwanaii*, fore tarsus of female. Fig. 9.—*Sericothrips reticulatus*, head, prothorax, and mesothorax of female. Fig. 10.—*Sericothrips reticulatus*, end of abdomen of female.

Segments 1 to 8 have each several very small hairs, segments 9 and 10 each with six or eight quite long, conspicuous spines.

Described from one female.

Food plant: Grass.

Habitat: Campus of the Leland Stanford Junior University, California.

This species has many characters in common with the *Prosopothrips vejdovskyi* described by Uzel.[a]

(6) **Sericothrips stanfordii**, new species. (Pl. II, fig. 11.)

Measurements: Head, length 0.12 mm., width 0.16 mm.; prothorax, length 0.13 mm., width 0.21 mm.; width of abdomen 0.36 mm; total body, length 1.25 mm. Antennæ: 1, 21μ; 2, 36μ; 3, 36μ; 4, 39μ; 5, 33μ; 6, 48μ; 7, 9μ; 8, 15μ; total, 0.24 mm. *Color* brown, tips of tibiæ yellow, tarsi yellow, with brown tips.

Head rounded in front, cheeks almost straight, roughened; surface of head cross-striate almost to a reticulation; a spine just inward from and two or three posterior to each eye; none, however, are prominent. *Eyes* medium, with light-colored inner and outer borders; slightly pilose, not protruding. *Ocelli* absent. *Mouth-cone* broad at base, blunt and dark-brown at tip; maxillary palpi three-segmented. *Antennæ* eight-segmented; twice as long as head; brown, segment 3 light brown.

Prothorax bears no prominent spines and but few short inconspicuous hairs; sides slightly arched; surface faintly cross-striate. *Mesothorax* and *metathorax* resemble abdominal segments; the mesothorax is the smaller; they bear no conspicuous spines or hairs; cross-striate on upper surface. Color uniform brown with rest of body. *No wings* are present. *Legs* medium stout, third pair armed with spines; tips of tibiæ yellow, tarsi yellow, each with a conspicuous brown spot at tip.

Abdomen dark brown, with light-colored bands on posterior edges of all segments excepting last two; these bands have small longitudinal, wavy thickenings; intersegmental membrane light brown or yellow. Body elongate-ovate; third, fourth, and fifth segments largest, tapering gradually to tip (segments cross-striate, especially on their anterior parts). Segments 1 to 7 each with several regularly placed small hairs; on last three segments, and especially on the last two, these hairs become quite strong, prominent spines.

Described from four females.

Food plant: Grass.

Habitat: Campus of the Leland Stanford Junior University, California.

4. Genus HELIOTHRIPS Haliday.

(7) **Heliothrips hæmorrhoidalis** Bouché and (8) **H. fasciatus** Pergande.

For descriptions of these two species see Hinds's Monograph of the Thysanoptera of North America, pages 168 and 174, respectively.

[a] Monographie der Ordnung Thysanoptera, page 166.

Heliothrips hæmorrhoidalis is one of the commonest thrips in greenhouses, where it feeds on azaleas, ferns, and dahlias; out of doors it feeds and becomes very destructive on laurestinas.

Heliothrips fasciatus (Pl. II, figs. 12–14) has been taken from oranges in Colusa County by Mr. E. K. Carnes, from pea vines in Santa Rosa by Mr. O. E. Bremner, and the writer has taken it from wild vetch sweepings in the Santa Cruz Mountains, Santa Clara County, Cal.

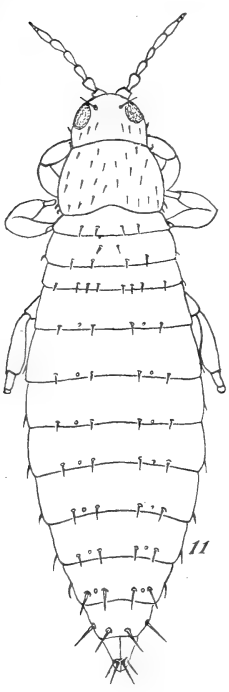
5. Genus EUTHRIPS Targione-Tozzetti.

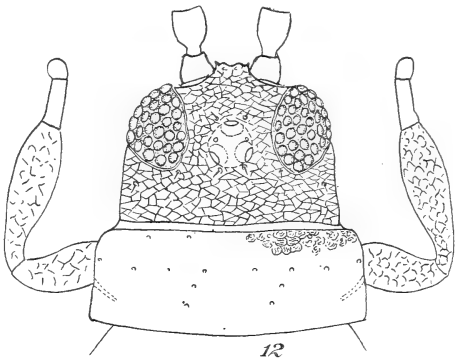
Ocelli usually present, but sometimes more or less rudimentary. Antennæ eight-segmented. Maxillary palpi three-segmented. Prothorax as long or somewhat longer than head, with two long spines on each hind angle and one similar spine on each anterior angle in many species, but this is wanting in others. Legs usually unarmed, but in a few species with a stout tooth on the under side of fore tibia at end. Wings usually fully developed, but sometimes reduced; when present they are moderately broad, and in those species which have a spine at the fore angle of the pronotum both longitudinal veins are closely and regularly set with spines for their entire length. Spines on the abdomen are moderately stout, anal spines are long and slender. These species are usually active and most of them have the power of springing.

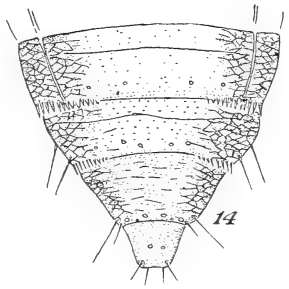
(9) **Euthrips orchidii**, new species. (Pl. II, figs. 15–18.)

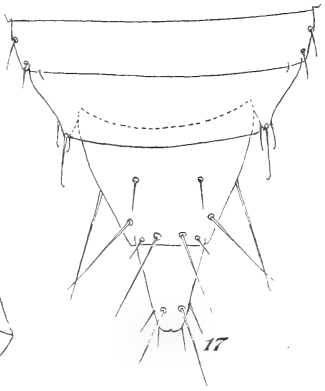
Measurements: Head, length 0.10 mm., width 0.15 mm.; prothorax, length 0.10 mm., width 0.18 mm.; mesothorax, width 0.22 mm.; abdomen, width 0.25 mm.; total body, length 0.88 mm. Antennæ: 1, 18μ; 2, 30μ; 3, 48μ; 4, 48μ; 5, 48μ; 6, 54μ; 7, 12μ; 8, 21μ; total, 0.28 mm. *Color* yellow, head and all legs light lemon-yellow, wings light brown.

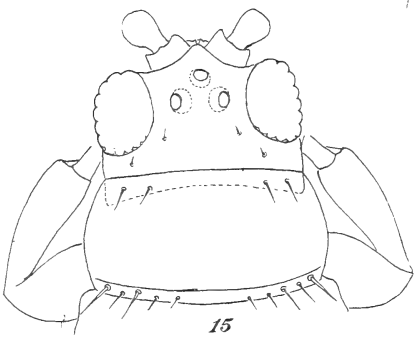
Head one-third wider than long, retracted into prothorax, angular in front, with concave depressions receiving basal joints of antennæ; spines inconspicuous; cheeks almost straight; head broadest across eyes. *Eyes* relatively large, occupying about one-half the length of the head, prominent; pigment granular and from deep red to purple; facets of eye as large as ocelli, eyes pilose. *Ocelli* subapproximate, margined inwardly with orange-red crescents. *Mouth-cone* short, reaching hardly beyond posterior margin of head, pointed and with a brown spot at tip; maxillary palpi three-segmented. *Antennæ* eight-segmented, light lemon-yellow, with tips of segments 4, 5, and 6 shading to light brown; segments 3, 4, and 5 of about the same length, segment 6 longest; forked sense cones on segments 3 and 4 long and slender, a short and a long simple sense cone near tip of segment 5, a similar pair on 6; on this latter segment the inner long cone is very long and reaches almost to tip of antennæ. All spines and sense cones are pale and inconspicuous.

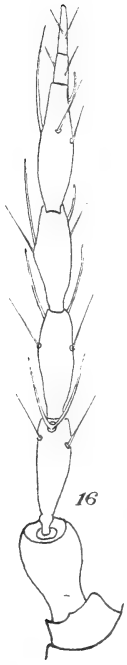


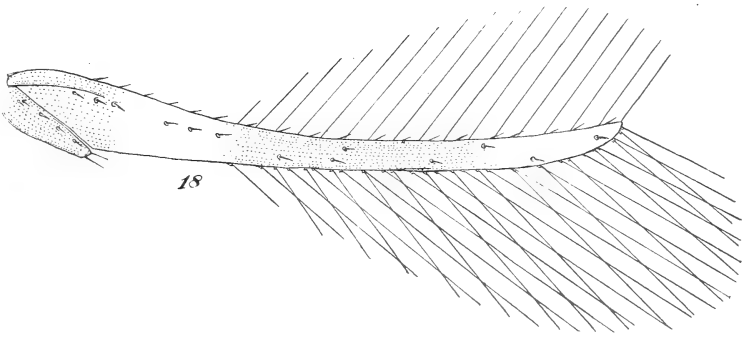












THYSANOPTERA OF CALIFORNIA.

Fig. 11.—*Scricothrips stanfordii*, female. Fig. 12.—*Heliothrips fasciatus*, head and prothorax of female. Fig. 13.—*Heliothrips fasciatus*, right antenna of female. Fig. 14.—*Heliothrips fasciatus*, end of abdomen of female. Fig. 15.—*Euthrips orchidii*, head and prothorax of female. Fig. 16.—*Euthrips orchidii*, right antenna of female. Fig. 17.—*Euthrips orchidii*, end of abdomen of female. Fig. 18.—*Euthrips orchidii*, right fore wing of female.

Prothorax almost twice as wide as long, all angles broadly and evenly rounded; a prominent line across the posterior part which might easily be mistaken for the hind margin; with two short and quite stout spines on each posterior angle; all spines light colored and not readily seen. *Mesothorax* largest, sides of *metathorax* almost parallel and very slightly arched. *Legs* uniform light yellow; all tibiæ with a spine at tip, hind tibiæ with a row of regularly placed spines on upper inner side; all tarsi with a brown spot at tip. *Wings* present and fully developed; fore wings light brown, with two white areas, one near base and one at tip. A single rudimentary vein at base of each fore wing; spines of wing few and scattered, except two groups of three each near base and five on scale; wing broadest at base, anterior margin bowed, posterior margin straight from base to near tip, where it curves forward to form a scythe-like tip; both anterior and posterior fringes long and sparse.

Abdomen ovoid, tip conical, segments 9 and 10 drawn out, and spines on these last two are long and prominent.

Described from four females.

Specimens collected from orchids in greenhouse, Fruitvale, Alameda County, Cal., by Mr. O. E. Bremner.

(10) **Euthrips pyri** Daniel. (Pl. III, figs. 19–24.)

Measurements: Head, length 0.13 mm., width 0.15 mm.; prothorax, length 0.13 mm., width 0.2 mm.; mesothorax, width 0.28 mm.; abdomen, width 0.31 mm.; total length 1.26 mm. Antennæ: 1, 33μ; 2, 45μ; 3, 63μ; 4, 54μ; 5, 33μ; 6, 66μ; 7, 9μ; 8, 12μ; total, 0.31 mm. *Color* dark brown, tarsi light brown to yellow.

Head slightly wider than long, cheeks arched, anterior margin angular, back of head transversely striate and bearing a few minute spines and a pair of very long prominent spines between posterior ocelli. *Eyes* prominent, oval in outline, black with light borders, coarsely faceted and pilose. *Ocelli* are approximate, yellow, margined inwardly with orange-brown crescents, posterior ones approximate to but not contiguous with light inner borders of eyes. *Mouth-cone* pointed, tipped with black; maxillary palpi three-segmented; labial palpi two-segmented, basal segment very short. *Antennæ* eight-segmented, about two and one-half times as long as head, uniform brown except segment 3, which is light brown; spines pale; a forked sense cone on dorsal side of segment 3, with a similar one on ventral side of segment 4.

Prothorax about as long but wider than head; a weak spine at each anterior and two large, strong ones on each posterior angle; other spines are not conspicuous. *Mesothorax* with sides evenly convex, angles rounded; metanotal plate with four spines near front edge, inner pair largest. The mesonotal and metanotal plates are faintly striate.

Legs moderately long, uniform brown except tibiæ and tarsi, which are yellow. Spines on tip of fore and middle tibiæ weak; several strong spines on hind tibiæ. *Wings* present, extending beyond tip of abdomen, about twelve times as long as wide, pointed at tips; costa of fore wings thickly set with from twenty-nine to thirty-three quite long spines; fore vein with twelve or fifteen arranged in two groups of three and six respectively on basal half of wing and a few scattering ones on distal part; hind vein with fifteen or sixteen regularly placed spines; costal fringe on fore wing about twice as long as costal spines.

Abdomen subovate, tapering abruptly toward the tip from the eighth segment; longest spines on segments 9 and 10; abdomen uniform brown, connective tissue yellow.

Redescribed from many specimens, including several cotypes from Miss Daniel.

Male unknown.

Food plants: Apricots, apples, almonds, cherries, figs, grapes, pears, prunes, plums, walnuts. The insect is found mostly on deciduous fruits.

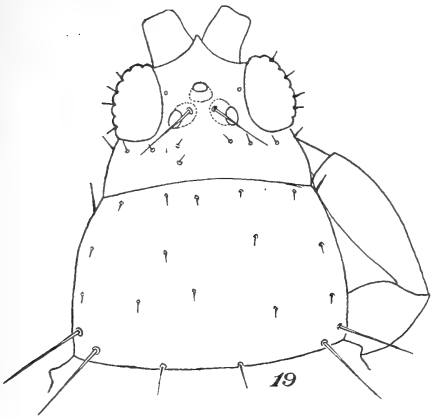
Habitat: San Francisco Bay region, California.

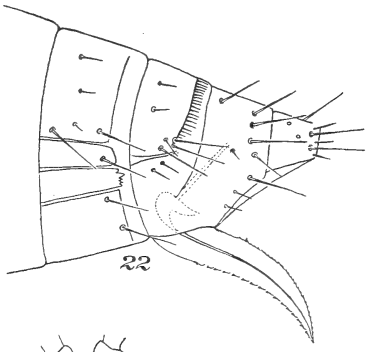
(11) **Euthrips ehrhornii**, new species. (Pl. III, figs. 25, 26.)

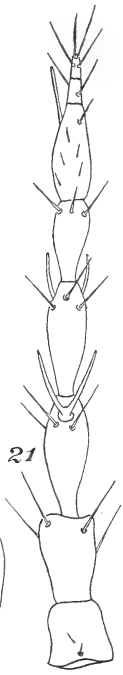
Measurements: Head, length 0.11 mm., width 0.13 mm.; prothorax, length 0.14 mm., width 0.18 mm.; mesothorax, width 0.23 mm.; abdomen, width 0.29 mm.; total body length 1.2 mm. Antennæ: 1, 24μ; 2, 39μ; 3, 48μ; 4, 45μ; 5, 36μ; 6, 54μ; 7, 6μ; 8, 9μ; total, 0.26 mm. General *color* brown, head light brown, thorax a little darker, abdomen brown to dark brown.

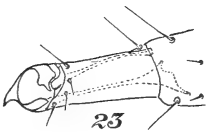
Head slightly longer than wide; front of head angular, and with concave depressions to receive basal segments of antennæ; cheeks roughened; posterior part of head faintly cross striate. Spines between ocelli prominent; postocular spines present but small. *Eyes* large, oval, slightly protruding, with an emargination on the side of the head between cheek and eye; pigment purple. *Ocelli* separated, margined inwardly with orange-red crescents. *Mouth cone* long and pointed; maxillary palpi three-segmented. *Antennæ* subapproximate; uniform brown except segment 1, basal half of 3, and tip of 4, which are gray-brown.

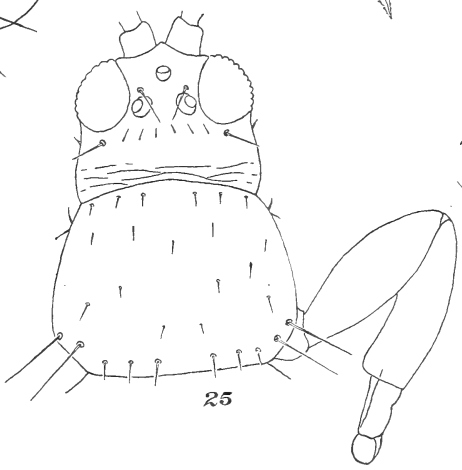
Prothorax widest across posterior part; all angles rounded. Two large spines on each posterior angle with several smaller ones along posterior margin; of these latter the inner ones are the larger; large spines on posterior angles are dark brown; no conspicuous spines on anterior angles. Sides of both *mesothorax* and *metathorax* slightly arched; pterthorax may be of a darker shade of brown than prothorax. *Legs* uniform brown, except all trochanters, which are white, and tibiæ,

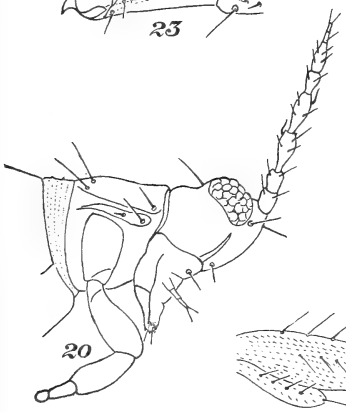


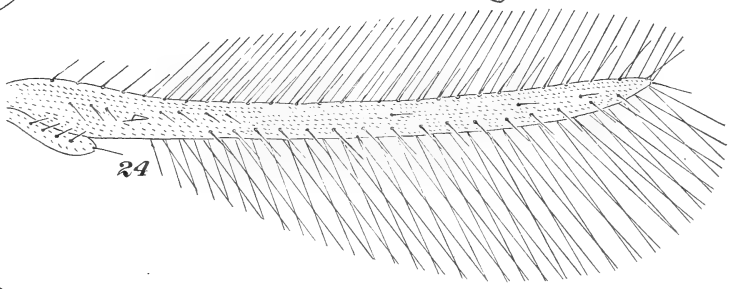


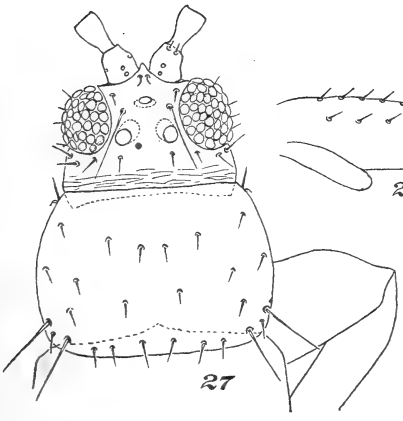


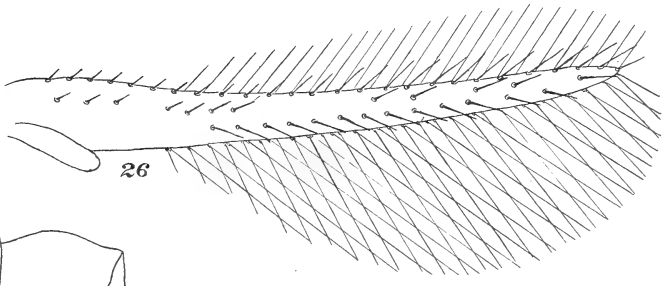












THYSANOPTERA OF CALIFORNIA.

Fig. 19.—*Euthrips pyri*, head and prothorax of female. Fig. 20.—*Euthrips pyri*, head and prothorax of female from side. Fig. 21.—*Euthrips pyri*, right antenna of female. Fig. 22.—*Euthrips pyri*, end of abdomen of female from side. Fig. 23.—*Euthrips pyri*, fore tarsus of female. Fig. 24.—*Euthrips pyri*, right fore wing of female. Fig. 25.—*Euthrips ehrhornii*, head and prothorax of female. Fig. 26.—*Euthrips ehrhornii*, right fore wing of female. Fig. 27.—*Euthrips ulicis californicus*, head and prothorax of female.

which are light brown; each hind tibia armed at tip with a spine; all tarsi with a brown spot at tip. *Wings* fully developed, uniform light gray-brown, all veins weak. Fore margin and hind vein set regularly with conspicuous dark brown spines, about twenty-six on fore margin and thirteen on hind vein; fore vein with twelve spines arranged in two groups of three and four on basal half of wing and five scattered spines on distal half.

Abdomen elongate-ovate, pointed at tip. Spines at sides increasing in prominence toward tip, those on 9 and 10 largest and most conspicuous of any on body. Hairs in comb-like structure on posterior margin of segment 8 closely placed.

Described from two females.

Food plant: Grass.

Habitat: Alum Rock Canyon, Santa Clara County, Cal.

This species is very close to *Euthrips pyri*.

(12) **Euthrips ulicis californicus**, new variety. (Pl. III, fig. 27; Pl. IV, figs. 28–31.)

Measurements: Head, length 0.13 mm., width 0.17 mm.; prothorax, length 0.21 mm., width 0.25 mm.; mesothorax, width 0.36 mm.; abdomen, width 0.40 mm.; total body, length 1.33 mm. Antennæ: 1, 30μ; 2, 45μ; 3, 75μ; 4, 66μ; 5, 48μ; 6, 66μ; 7, 15μ; 8, 18μ; total, 0.36 mm. *Color* dark-brown, except tarsi and fore tibiæ, which are light brown or yellow.

Head slightly wider than long, deeply set in prothorax; cheeks straight, parallel; front of head broad and quite straight, having only a small elevation between bases of antennæ; head noticeably square in front; back of head transversely striate; large spine on back of head just inward from each eye and anterior to each posterior ocellus; a pair of small backwardly curved spines on apex of head; four or five spines posterior to each eye, the outer one of each group being prominent on the side of the cheek. *Eyes* medium, prominent, but not protruding; pilose; with light inner borders, pigment deep red to black. *Ocelli* large, separated, orange colored, with orange brown crescents, posterior ones almost contiguous with light borders around eyes. *Mouth cone* pointed, maxillary palpi three-segmented. *Antennæ* eight-segmented, about two and one-half times as long as head; brown, unicolorous with body except segment 3, which is yellow, and 4, which is light brown; forked sense cones are found on segments 3 and 4 and a pointed sense scale set in a transparent area near tip of segment 6. Segments 3 and 4 constricted near their tips.

Prothorax noticeably larger than head, sides convex; a short spine on each anterior angle and two long prominent spines on each posterior angle. *Mesothorax* largest, anterior angles broadly rounded, posterior ones slightly constricted to meet the smaller metathorax. Sides of *metathorax* almost straight and parallel posterior angles

rounded. *Legs* brown, concolorous with body except fore tibiæ, which are yellow, shading to brown on sides, fore tarsi, which are yellow, and other tarsi which are yellow to light brown. Fore femora thickened. Fore tarsi armed each with a stout tooth, and near this is a protuberance on which is set a sharp spine. *Wings* present; fore wings brown, except basal fourth, which is white; costa and both longitudinal veins set with long, conspicuous brown spines, twenty-six on costa, twenty on fore vein, sixteen on hind vein, five on scale.

Abdomen ovate; third to sixth segments largest and about equal; the seventh to tenth tapering gradually to form the conical tip. A few quite prominent spines along sides of abdomen, but long and slender ones only on segments 9 and 10, a circlet of eight on segment 9 and six on segment 10.

Males smaller than females; antennæ, legs, and wings with similarly placed spines; fore femora thickened, fore tibiæ armed with teeth. Tip of abdomen with prominent spines, penis upturned; antennæ with segments 1 and 5 to 8 brown, and 2, 3, and 4 yellow.

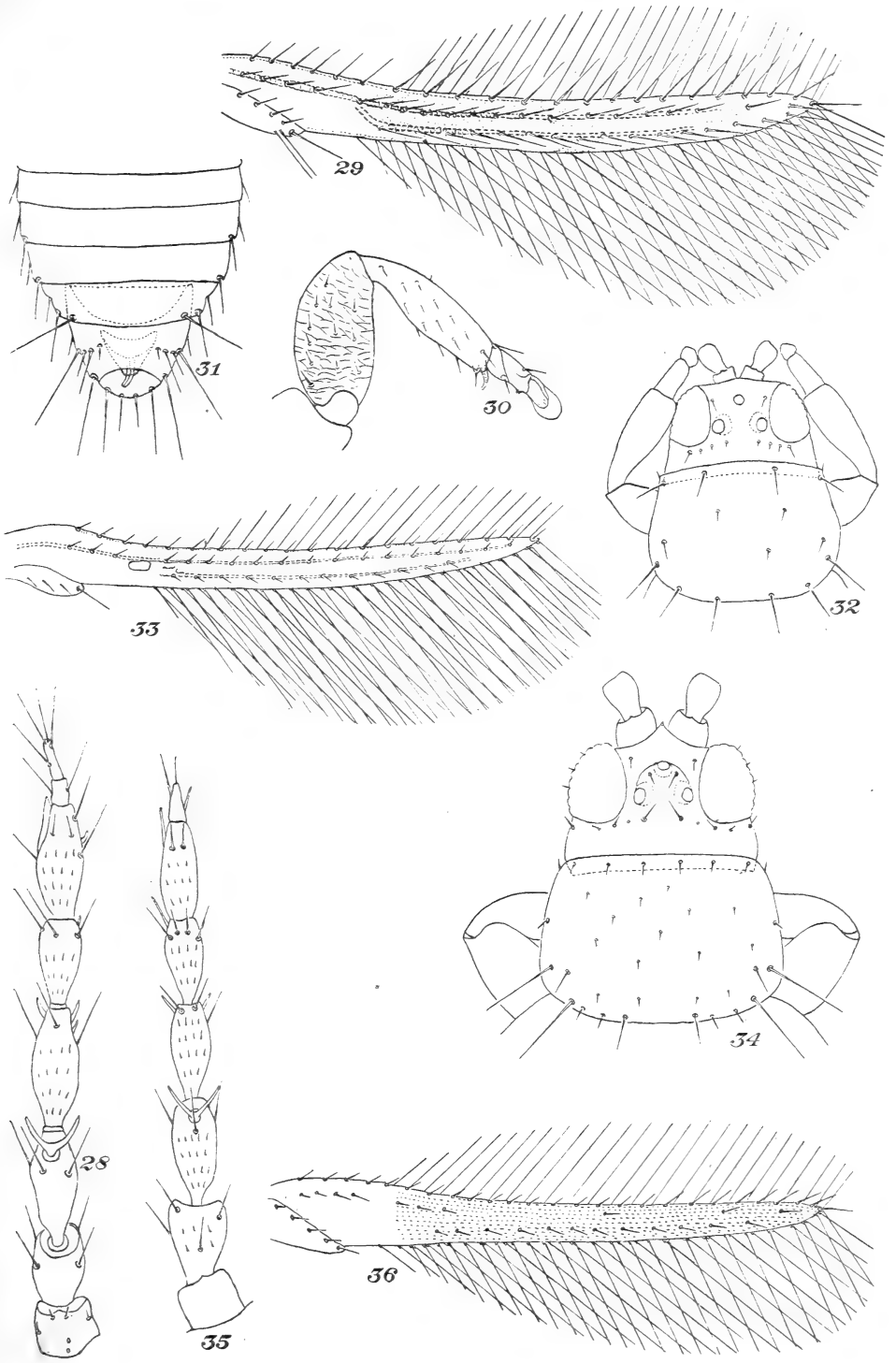
Described from three females and four males, specimens taken from vetch sweepings near Wrights Station, Santa Clara County, Cal.

The species here described corresponds in almost every respect to the *Physopus ulicis* Haliday, as described by Uzel in his Monographie der Ordnung Thysanoptera, page 115. The genus name *Physopus* has since been changed to *Euthrips* by Hinds in his Monograph of the Thysanoptera of North America. I therefore have called this species *Euthrips ulicis californicus*. The *Physopus ulicis* of Uzel is recorded as found in England (Haliday), in Finland (Reuter), and in Bohemia (Uzel).

(13) **Euthrips minutus**, new species. (Pl. IV, figs. 32, 33.)

Measurements: Head, length 0.096 mm., width 0.14 mm.; prothorax, length 0.105 mm., width 0.17 mm.; mesothorax, width 0.21 mm.; abdomen, width 0.24 mm.; total body, length 0.83 mm. Antennæ: 1, 21μ; 2, 30μ; 3, 39μ; 4, 36μ; 5, 30μ; 6, 42μ; 7, 9μ; 8, 12μ; total, 0.21 mm. *Color* uniform dark brown, wings gray-brown.

Head about one and one-half times as wide as long, retracted into thorax; anterior margin of head almost straight, being but slightly and smoothly elevated in front; cheeks straight, diverging posteriorly; no conspicuous markings on head. A weak spine close in front of each posterior ocellus and one behind each eye; other spines very inconspicuous. *Eyes* moderately large, not protruding, pigment of a deep red. *Ocelli* widely separated, posterior ones contiguous with light inner margins of eyes; considerably larger than facets of eyes; orange-yellow; margined inwardly with large orange crescents. *Mouth-cone* short; maxillary palpi three-segmented. *Antennæ* inserted a little below the margin, slightly more than twice as long as head, quite uniform brown.



THYSANOPTERA OF CALIFORNIA.

Fig. 28.—*Euthrips ulicis californicus*, left antenna of female. Fig. 29.—*Euthrips ulicis californicus*, right fore wing of female. Fig. 30.—*Euthrips ulicis californicus*, fore leg of female. Fig. 31.—*Euthrips ulicis californicus*, end of abdomen of male. Fig. 32.—*Euthrips minutus*, head and prothorax of female. Fig. 33.—*Euthrips minutus*, right fore wing of female. Fig. 34.—*Thrips madronii*, head and prothorax of female. Fig. 35.—*Thrips madronii*, right antenna of female. Fig. 36.—*Thrips madronii*, right fore wing of female.

Prothorax noticeably larger than head, without conspicuous markings; anterior angles straight, posterior broadly rounded. A large spine on each anterior angle and a second on anterior margin on either side about half way between the first spine and the median line; three large spines on posterior margin on either side about equidistant apart, the outer one being the conspicuous spine on the posterior angle; other spines extremely small. *Mesothorax* widest, sides arched, evenly united with metathorax; sides of *metathorax* almost straight, but widening toward the abdomen. Thorax slightly orange colored. *Legs* medium, brown, except fore tibiæ and all tarsi, which are light brown. Hind tibiæ and tarsi armed each with a sharp spine. *Wings* present, reaching to tip of abdomen; gray-brown, each with a small, white, transparent area about one-fifth the wing's length from its base. Two longitudinal veins, fore vein extending from base to near tip, hind vein appears close after the white area and fades before the end. Fore margin of wing and longitudinal veins set regularly with short, sharp-pointed brown spines, twenty-three on fore margin, eighteen on fore vein, twelve on hind vein.

Abdomen with prominent spines only on last few segments; a weak comb-like arrangement of spines on the posterior margin of segment 8.

Described from one female.

Food plant: Grass.

Habitat: Berkeley, Cal.

(14) **Euthrips occidentalis** Pergande, and (15) **Euthrips tritici** Fitch.

For descriptions of these species see Hinds's Monograph of the Thysanoptera of North America, pages 152 and 148, respectively.[a]

6. Genus **PARTHENOTHRIPS** Uzel.

(16) **Parthenothrips dracænæ** Heeger.

For description see Hinds's Monograph, page 176. Specimens taken from dracæna in greenhouse in San Francisco, by Mr. E. M. Ehrhorn.

7. Genus **THRIPS** Linnæus.

(17) **Thrips madronii**, new species. (Pl. IV, figs. 34–36.)

Measurements: Head, length 0.11 mm., width 0.15 mm.; prothorax, length 0.13 mm., width 0.20 mm.; mesothorax, width 0.33 mm.; abdomen, width 0.33 mm.; total body, length 1.25 mm. Antennæ: 1, 27μ; 2, 39μ; 3, 60μ; 4, 54μ; 5, 45μ; 6, 54μ; 7, 21μ; total, 0.3 mm. *Color*

[a] The writer has taken specimens of these two species of *Euthrips* (*occidentalis* and *tritici*) from the most of our wild and cultivated flowers. They are commonly found together. The variations in size, color, and in the relative lengths of segments of the antennæ (in each of the two species) are so great that the writer has been unable to draw a sharp line of distinction between them.

uniform brown, usually dark brown; wings gray-brown, lighter at base; tibiæ and tarsi sometimes light brown.

Head almost as long as wide, front of head angular, basal segments of antennæ set in concave depressions in front of head; cheeks arched, sides roughened; posterior part of head cross-striate. No prominent spines on head, although there is a row of small spines on each side immediately back of the eyes, the inner ones of which are the larger. *Eyes* prominent, slightly protruding, pilose, margined inwardly with light borders; pigment black. *Ocelli* subapproximate, separated from inner margin of eyes; light orange colored and margined inwardly with deep orange-red crescents; usually with circular thickening connecting anterior ocellus with outside of posterior ones, and included within this, on either side of the anterior ocellus, is a small spine. *Mouth cone* long, pointed; maxillary palpi three-segmented; labial palpi two-segmented, first very short, second very long and slender. *Antennæ* with all segments of uniform width and color, except 2, which is somewhat wider and a little darker brown; sometimes segment 3 is also a little lighter brown.

Prothorax about as long as head but somewhat wider; all angles rounded; a pair of prominent spines on each posterior angle, with a smaller pair on posterior margin near center; sometimes a third quite prominent spine is present near larger ones on posterior angles. *Mesothorax* largest; *metathorax* smaller with sides almost straight, hind angles rounded. All segments uniform brown. *Legs* medium, concolorous with body; hind tibiæ armed with several stout spines. *Wings* fully developed, noticeably broader at base and gradually narrowing toward the tip, light brown, except basal one-fourth, which is light gray-brown. Costal and longitudinal veins prominent only on basal half of wing; costa with about twenty-six regularly placed spines; fore longitudinal vein with two groups on basal half, first group of four and second of three; three other spines on distal half; hind vein with twelve regularly placed spines.

Abdomen uniform dark-brown, with a darker brown line across anterior margins of segments 2 to 7; connective tissue brown; stout spines on sides of all segments, these becoming longer near the tip with the longest on segments 9 and 10. Comb-like arrangement of spines on posterior margin of segment 8.

Males much smaller than females and with large light-colored oval areas on ventral sides of segments 3 to 6.

Described from twenty-one females and three males.

Food plants: Blossoms of madroña, California laurel, and California lilac.

Habitat: Santa Clara Valley, California.

This species in a general way resembles *Euthrips pyri*, and either one at a casual glance could be easily mistaken for the other.

(18) **Thrips tabaci** Lindeman.

For description see Hinds's Monograph, page 179.

Thrips tabaci is common everywhere in wild and cultivated flowers, but its principal food plant is the onion. It has been very destructive on several large seed farms where onions are grown for seed purposes. It is commonly known as the onion thrips.

(19) **Thrips bremnerii**, new species. (Pl. V, figs. 37–39.)

Measurements: Head, length 0.1 mm., width 0.10 mm.; prothorax, length 0.12 mm., width 0.14 mm.; mesothorax, width 0.18 mm.; abdomen, width 0.21 mm.; total body, length 1.08 mm. Antennæ: 1, 21μ; 2, 33μ; 3, 42μ; 4, 36μ; 5, 33μ; 6, 39μ; 7, 15μ; total, 0.21 mm. *Color* uniform light lemon-yellow, shading to light brown; abdominal segments often shaded brown on dorsal side. Body long and slender.

Head about as long as wide, angular in front, basal segments of antennæ received in concave depressions on upper front side, back of head faintly cross-striate; cheeks arched but little. A spine on either side of anterior ocellus and one immediately behind each posterior ocellus, the spines light, concolorous with head and not conspicuous. *Eyes* prominent, protruding, pilose, black or deep purple by transmitted light, red by reflected light. *Ocelli* subapproximate, very light and margined inwardly with light-brown crescents. *Mouth cone* shading dark brown toward the end and tipped with black; maxillary palpi three-segmented, labial palpi two-segmented, terminal one very long. *Antennæ* quite uniform light brown, basal segment often lighter or second segment darker.

Prothorax but little larger than the head; all angles rounded, and if the body is distended, together with the light colored intersegmental membrane, the prothorax is quite round; two large brown spines on each posterior angle, with a row of three on each side along the hind margin, the inner one being the larger. *Pterthorax* somewhat darker than prothorax; sides of mesothorax rounded, sides of metathorax narrowed in front, forming a quite noticeable concave depression on either side. *Legs* medium, concolorous with or somewhat lighter than body, hind tibiæ alone armed with spines, a dark-brown spot on the tip of each tarsus. *Wings* fully developed, though not reaching to tip of abdomen, broad at base; uniform white with brown spines. Veins are either very rudimentary or, as in some specimens, highly developed. In these latter the two longitudinal veins may be seen extending to and joining the margin on either side of the tip; also there are two cross veins, one at about one-third, and a second at about two-thirds the wing's length from the base; they connect costa and fore longitudinal vein. Costa with twenty-five spines; fore vein with twelve, arranged as follows: Two groups of four and three, respectively, on basal half of wing, and five others regularly placed on distal half; twelve on hind vein.

Abdomen long and slender; segments 3 to 8 with a brown line near anterior margin; spines on last segments not noticeably long.

Described from twenty-five females.

Food plant: Figs. Specimens taken from the inside of ripe figs.

Habitat: Santa Clara Valley, California.

Family PHLŒOTHRIPIDÆ.

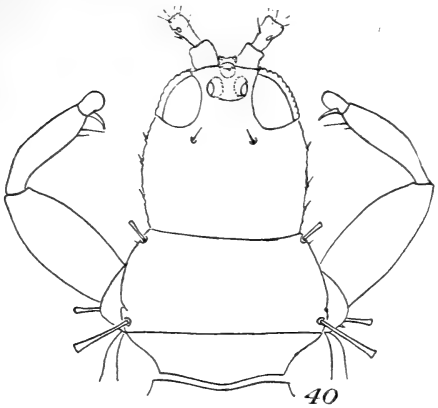
8. Genus TRICHOTHRIPS Uzel.

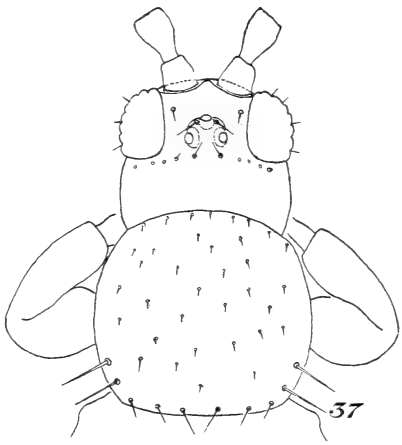
(20) **Trichothrips dens**, new species. (Pl. V, figs. 40–43.)

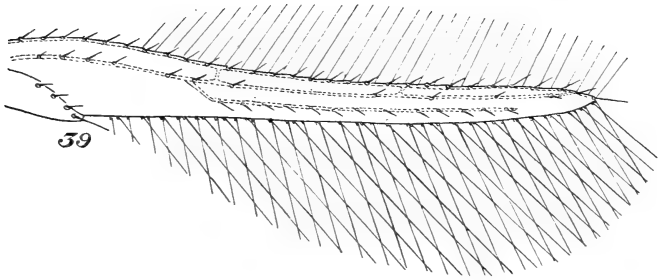
Measurements: Head, length 0.26 mm., width 0.25 mm.; prothorax, length 0.15 mm., width 0.31 mm.; mesothorax, width 0.35 mm., abdomen, width 0.40 mm.; tube, length 0.17 mm.; total body, length 1.5 mm. Antennæ: 1, 30μ; 2, 60μ; 3, 90μ; 4, 78μ 5, 54μ; 6, 54μ; 7, 48μ; 8, 24μ; total, 0.44 mm. *Color* brown, with conspicuous red pigment blotches on body and legs.

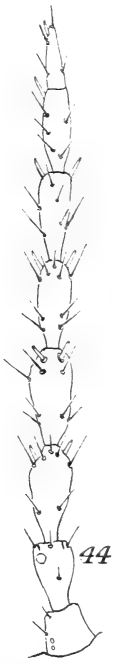
Head about as long as wide, broadly rounded in front; frons elevated only slightly between basal segments of antennæ. Cheeks arched, converging posteriorly; with edges roughened; bearing a few short, stout spines which are raised on small tubercles. Red pigment on head is conspicuous. A pair of short, inconspicuous, postocular spines are present. *Eyes* large, with small facets, black by transmitted light, with light inner borders and light lemon-yellow, transparent outer borders; not pilose. *Ocelli* present, subapproximate, margined inwardly with dark crescents, anterior one on apex of head. *Mouth cone* pointed, reaching beyond posterior margin of prothorax. *Antennæ* eight-segmented, one and two-thirds times as long as head; brown, unicolorous with body, except that the base and tip of segment 3 and bases of segments 4 and 5 shade to light brown or lemon-yellow. Segment 1 truncate; 2 constricted at base into a broad stalk and fitting ball-and-socket-like into a depression in segment 1; 3 to 6 inclusive each with a slender stalk at base, each also somewhat constricted at the distal end; 7 cylindrical-ovate and very closely and evenly united with 8, which is conical. A dark spot on segment 2 is probably a sense area; segments 3 to 6 inclusive each with three simple sense cones, with one cone on segments 5 and 6 rudimentary; 7 and 8 bear each a simple sense cone and a fringe of eight or nine sense hairs on their inner margin.

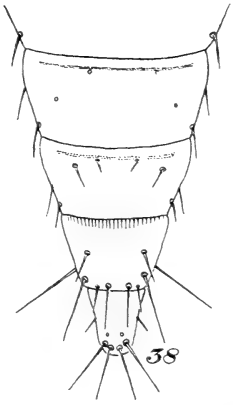
Prothorax about half as long as head but wider than head is long. It bears no hairs other than a single, stout, transparent, knobbed pair on the hind angles and a similar smaller pair on the anterior angles. *Mesothorax* and *metathorax* about equal in width and slightly wider than prothorax; with sides almost parallel; they bear no conspicuous spines or hairs. Each *fore coxa* projects considerably beyond margin at sides of prothorax and forms what appears to be the prominent angle; each bears a short, stout, transparent, knobbed hair on prominent angle.

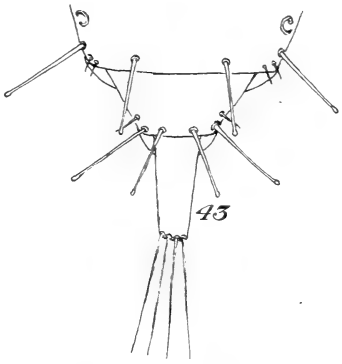


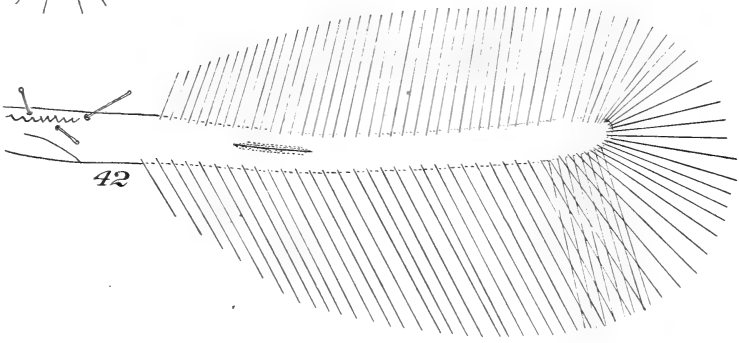












THYSANOPTERA OF CALIFORNIA.

Fig. 37.—*Thrips bremnerii*, head and prothorax of female. Fig. 38.—*Thrips bremnerii*, end of abdomen of female. Fig. 39.—*Thrips bremnerii*, right fore wing of female. Fig. 40.—*Trichothrips dens*, head and prothorax of female. Fig. 41.—*Trichothrips dens*, left antenna of female. Fig. 42.—*Trichothrips dens*, right fore wing of female. Fig. 43.—*Trichothrips dens*, end of abdomen of female. Fig. 44.—*Trichothrips femoralis*, right antenna of female.

Fore femora enlarged; fore tarsi stout and each armed with a stout tooth. Other than a single row of stout spines on the hind tibiæ, the legs bear no conspicuous spines and only a few small hairs. *Wings* reach to base of tube; both pairs equal; edges parallel; with simple fringe of long, straight hairs on both margins. Fore wings double fringed on posterior margin near tip by seven or eight hairs. Membrane of wings transparent, shaded gray-brown near base. Fore wings each with a single median rudimentary vein and center of wing along vein shaded light brown. Base of wing bears three knobbed hairs, one long and two short ones; costal margin near base with wavy thickenings.

Abdomen about as wide as thorax, last three segments tapering abruptly; tube slender and about two-thirds as long as head; terminal hairs as long as tube. The abdomen is brown and red, unicolorous with the thorax and head. Each posterior angle of all segments except the first bears a stout, transparent, knobbed hair, these increasing in length from the second to and including the ninth. Other smaller hairs are also found on the prominent angles.

Described from one female; male unknown.

Food plant: Apricot.

Habitat: Santa Clara Valley, California.

(21) **Trichothrips femoralis**, new species. (Pl. V, fig. 44; Pl. VI, figs. 45, 46.)

Measurements: Head, length 0.21 mm., width 19 mm., prothorax, length 0.20 mm., width 0.33 mm. (including coxa); mesothorax width 0.38 mm.; abdomen, width 0.40 mm.; tube, length 0.16 mm.; total body, length 1.7 mm. Antennæ: 1, 33μ; 2, 48μ; 3, 66μ; 4, 66μ; 5, 66μ; 6, 63μ; 7, 63μ; 8, 48μ; total, 0.52 mm. *Color* uniform dark-brown, except fore tibiæ and tarsi and segments of antennæ, 3 to 6 inclusive, which are yellow; middle and hind tarsi light brown. Orange-colored pigment may be seen in lighter colored specimens.

Head slightly longer than wide; rounded in front; frons elevated between basal segments of antennæ; cheeks almost straight and parallel; margins roughened; back of head with cross striations. Postocular spines prominent; other small spines not conspicuous. *Eyes* occupying about one-third the length of the head, with small facets, not pilose; with light, irregular, orange-tinted inner borders and light lemon-yellow narrower outer borders. *Ocelli* present, anterior one on apex of head, posterior ones orange-tinted and contiguous, with light inner borders of eyes. *Mouth cone* small, no longer than width at base, tip bluntly pointed; rudimentary chitinous thickening on either side about halfway between base of cone and eyes, equally well developed on both sides. *Antennæ* eight-segmented, slightly more than twice as long as head; basal segment brown; 2 brown, shading to

yellow; 3 to 6 inclusive are yellow, with 5 and 6 shading to gray-brown at tips; 7 and 8 brown. Dark-brown area on inner margin of segment 2 probably a sense area; simple sense cones on segments 3 to 8.

Prothorax almost as long as head and about one-third wider than long; it bears ten prominent spines, a pair on anterior margin, one on each anterior angle, one midway on each side, and two on each posterior angle. Sides of *mesothorax* almost parallel and united evenly with the sides of the metathorax, which latter converge posteriorly. The *fore coxæ* are protruding and form what appear to be the prominent sides of the prothorax; each is tipped with a long spine. Fore femora enlarged; fore tarsi each armed with a very small tooth. *Wings* reaching nearly to base of tube, both pairs similar, clear white, with a long simple fringe on both anterior and posterior margins.

Abdomen about equal or slightly wider than the mesothorax; segments 2 to 7 inclusive taper uniformly, with hind angles prominent. Abdomen uniform brown with the thorax and head; red pigment conspicuous. Segments 1 to 7 each with two long spines on each side near posterior margin, the outer ones in each case appearing as the spine on the outer prominent angle; the spines approach each other and the margin on segments 7, 8, and 9 to form a pair on the prominent angles. Segments 1 to 7 have each two pairs of strong, incurved spines at about one-fourth the width of the abdomen from the margin and in each case the hinder pair is the stouter; these spines function in holding the wings when at rest. Tip of tube bears six long spines about as long as the tube itself, and several shorter ones. Scales present on last segments of females.

Males are similar to females in most respects, but possess the very greatly enlarged fore femora and do not have scales on the last abdominal segments.

Described from one female and two males.

Food plant: Wild mullein.

Habitat: Newcastle, Cal.

(22) **Trichothrips ilex**, new species. (Pl. VI, figs. 47–49.)

Measurements: Head, length 0.21 mm., width 0.20 mm.; prothorax, length 0.13 mm., width, including coxa, 0.32 mm.; mesothorax, width 0.38 mm.; abdomen, width 0.50 mm., length of tube 0.16 mm.; total length of body 1.70 mm. Antennæ: 1, 30μ; 2, 51μ; 3, 60μ; 4, 60μ; 5, 60μ; 6, 54μ; 7, 54μ; 8, 30μ; total, 0.35 mm. *Color* very dark brown, almost black; all tarsi and tips of fore tibiæ and segments 3 and 4 of antennæ shading to yellow.

Head about as long as wide, broadly rounded in front, frons projecting between basal segments of antennæ; cheeks slightly convex, and with edges roughened, back of head with transverse striations. Postocular spines prominent. *Eyes* medium, with small facets, not

protruding, not pilose, with light-yellow outer margin and a light, irregular inner border. *Ocelli* present, granulated, anterior one on apex and posterior ones bordering inner margins of eyes. *Mouth cone* about as broad as long, reaching nearly to posterior margin of prosternum, pointed at tip; chitinous thickenings between base of mouth-cone and eyes very rudimentary and about equally well developed. Maxillary palpi two-segmented; basal segment very small, second segment long. Labial palpi two-segmented, basal segment shortest. *Antennæ* eight-segmented, about twice as long as head; color brown, except segment 3 and basal parts of segments 4, 5, and 6, which are yellow. Segment 2 with darkened sense area on dorsal surface; 3 to 7 have simple sense cones; 7 and 8 have a row of sense hairs.

Prothorax about twice as wide as long; it bears ten long spines, two on anterior margin, one on each anterior angle, one near middle of each side, and two at each posterior angle. Sides of *pterthorax* slightly convex, converging both anteriorly and posteriorly. Fore coxæ apparently immovably set and forming the outer angles of the prothorax; fore femora somewhat enlarged; all tarsi with a brown spot at tip and armed with a small tooth. *Wings* reaching nearly to tip of eighth segment, both pairs similar; first pair light brown, hind pair gray; each with a long, simple fringe on both margins; tip of fore wing double fringed behind by about twelve hairs; with three prominent spines at base and a wavy thickening near anterior margin at base; wings without veins.

Abdomen broadly ovate, segments 1 to 7 inclusive about equal; eighth tapering abruptly to meet the smaller ninth and very narrow tenth; segments with two long and several shorter spines on prominent angles, these spines increasing in length toward the tip. Segments 1 to 7 each with two pairs of inwardly curved spines about one-fourth the width of the abdomen from the margin; the posterior pair in each case is the larger. Tip of tube bears six long and several short hairs. Females with scales on last segments of abdomen.

Described from numerous specimens.

Male similar to female, but without scales on abdomen.

Food plant: Christmas berry (*Heteromeles arbutifolia*).

Habitat: Coast region of California.

(23) **Trichothrips ilex dumosa**, new variety.

The members of this variety are very similar to the species, differing only in minor details. The two insects are about equal in size; the head is somewhat longer in *T. ilex dumosa*, the antennæ are brown, with only the base of segment 3 yellow; all tarsi are gray-brown to brown. The food plant is the scrub oak, *Quercus dumosa*.

Habitat.—Saratoga, Santa Clara County, Cal.

9. Genus ACANTHOTHRIPS Uzel.

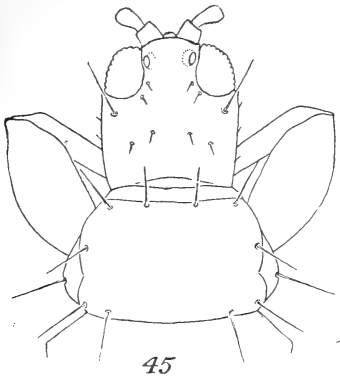
(24) **Acanthothrips doaneii**, new species (Pl. VI, figs. 50–52.)

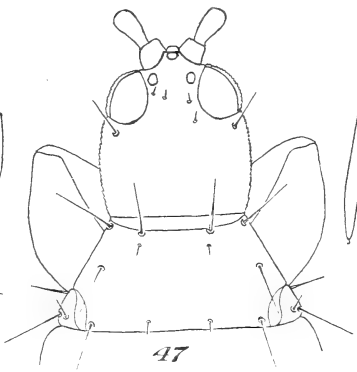
Measurements.—Head, length 0.37 mm., width 0.25 mm.; prothorax, length 0.20 mm., width, including protruding coxa, 0.45 mm.; mesothorax, width 0.50 mm.; abdomen, width 0.50 mm.; tube, length 0.28 mm.; total body, length 2.4 mm. Antennæ: 1, 48μ; 2, 69μ; 3, 126μ; 4, 120μ; 5, 114μ; 6, 81μ; 7, 78μ; 8, 45μ; total, 0.633 mm. *Color* very dark brown, except tips of tibiæ, tarsi, and basal and distal parts of segments 3 to 6, inclusive of antennæ, these parts shading to yellow.

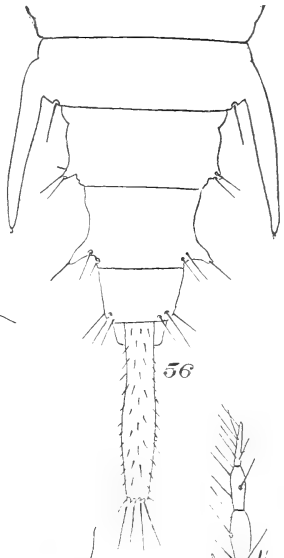
Head about one-third longer than wide; cheeks converging posteriorly; frons elevated between basal segments of antennæ; back of head with cross striations, roughened and set with small spines raised on conspicuous tubercles. *Eyes* large, slightly bean-shaped, not pilose, finely faceted, each with an orange-colored inner border and a light lemon-yellow, uniform outer border. *Ocelli* present, anterior one near apex of head, posterior ones contiguous with central concave portions of inner margins of eyes. *Mouth cone* pointed, reaching almost to posterior margin of prosternum. *Antennæ* eight-segmented, scarcely twice as long as head; segments 1, 2, 7, and 8 dark brown, 3 to 6 inclusive brown, shading light brown or yellow at either end; segment 1 cylindrical; 2 subclavate, 3 to 6 inclusive constricted to broad stalks at base, and constricted abruptly at their distal ends where they receive sense cones, two on segments 3 and 7, three (one rudimentary) on 5 and 6, four (two rudimentary) on segment 4.

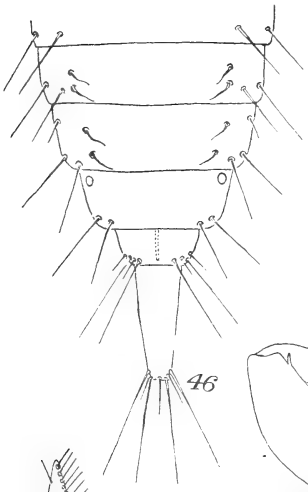
Prothorax about twice as wide as long, reticulate, bearing a single pair of short spines on anterior angles and a long pair of knobbed hairs on posterior angles; surface faintly covered with short inconspicuous hairs. *Mesothorax* with front margin almost straight, projecting beyond sides to form a short, rounded shelf where the segment is widest; sides almost parallel, constricted after the middle, posterior angles rounded. *Metathorax* with sides evenly convexed, roughened, and reticulate; mesonota and metanota also reticulate. *Fore coxæ* protruding beyond and not readily distinguished from sides of prothorax; fore femora greatly enlarged and armed on inner margin of distal part with a stout tooth, each fore tarsus also armed with a tooth; other legs long and slender. *Wings* fully developed, both pairs alike, with regular fringe of long, closely arranged hairs on either margin; a wavy thickening along anterior margin at base of fore wing, upon which stand one long and two short knobbed hairs; distal anal wing margin double fringed with about twenty-four hairs.

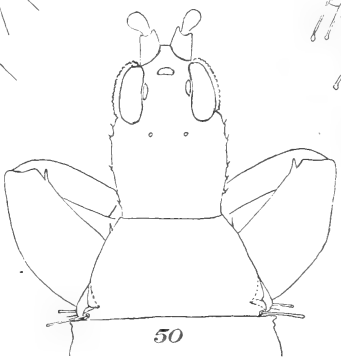
Abdomen about as wide as mesothorax and slightly wider than the metathorax. Sides of segments 1 to 5 almost equal and parallel, other segments tapering gradually to meet the tube; a pair of knobbed hairs on each prominent angle; tip of tube bears six long and several short hairs.

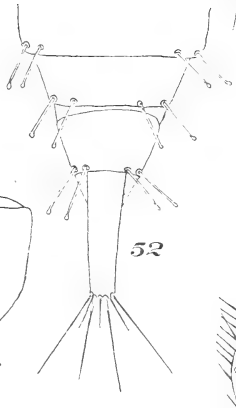


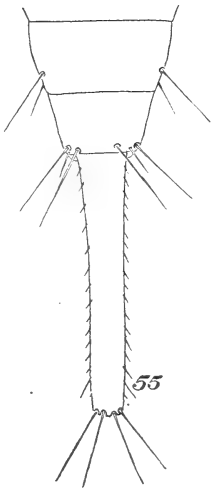


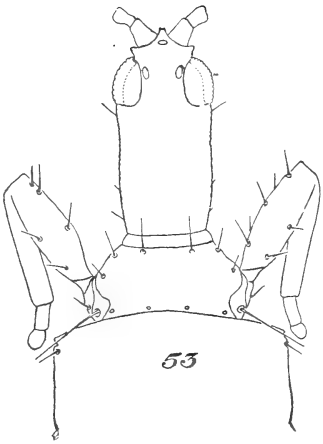












THYSANOPTERA OF CALIFORNIA

Fig. 45.—*Trichothrips femoralis*, head and prothorax of female. Fig. 46.—*Trichothrips femoralis*, end of abdomen of female. Fig. 47.—*Trichothrips ilex*, head and prothorax of female. Fig 48.—*Trichothrips ilex*, left antenna of female. Fig. 49.—*Trichothrips ilex*, base of right fore wing of female. Fig. 50.—*Acanthothrips doaneii*, head and prothorax of male. Fig. 51.—*Acanthothrips doaneii*, left antenna of male. Fig. 52.—*Acanthothrips doaneii*, end of abdomen of male. Fig. 53.—*Megalothrips hesperus*, head and prothorax of female. Fig. 54.—*Megalothrips hesperus*, right antenna of female. Fig. 55.—*Megalothrips hesperus*, end of abdomen of female. Fig. 56.—*Megalothrips hesperus*, end of abdomen of male.

Described from one male.
Food plant: Grass.
Habitat: Alum Rock Canyon, Cal.

10. Genus **MEGALOTHRIPS** Heeger.

(25) **Megalothrips hesperus**, new species. (Pl. VI, figs. 53–56.)

Measurements: Head, length 0.58 mm., width 0.26 mm.; prothorax, length 0.25 mm., width 0.46 mm.; metathorax, width 0.83 mm.; abdomen, width 1 mm.; tube, length 0.83 mm., width 0.11 mm.; total body, length 4.66 mm. Antennæ: 1, 75μ; 2, 84μ; 3, 315μ; 4, 234μ; 5, 195μ; 6, 102μ; 7, 75μ; 8, 90μ; total, 1.17 mm. *Color* dark brown, with orange or red pigment; all tibiæ and tarsi shaded to yellow; bases of antennal segments 3, 4, 5, and 6 are lemon-yellow.

Head more than twice as long as wide, greatest width across eyes; cheeks roughened, almost parallel, slightly concave close behind eyes, constricted at union with prothorax; frons elevated between bases of first segments of antennæ; back of head transversely striate and with a few short spines set on very small tubercles. *Eyes* large, with conspicuous light-yellow outer borders; with small facets and very faintly pilose. *Ocelli* present, anterior one on apex of head, posterior ones contiguous, with indistinct, light inner margins of eyes. *Mouth cone* broad and short, with blunt tip, and reaching hardly halfway across prosternum. Maxillary palpi two-segmented, basal segment very short; labial palpi very small. *Antennæ* eight-segmented, about twice as long as head; segments 1, 2, 7, and 8, and tips of 4, 5, and 6 brown; tip of 3 light-brown; segment 3 with a long, narrow stalk; segments 4 and 5 similar, but with shorter stalks. Darkened sense area on segment 2; one sense cone on segment 6, two on segments 3 and 5, four on 4, and a row of sense hairs on segment 8.

Prothorax about one-half wider than long, transversely striate; it bears six prominent spines, two on anterior margin, a pair on anterior angles, and a larger pair on the posterior angles. *Mesothorax* with prominent, square, anterior angles; sides almost straight and parallel, with edges roughened, united evenly with metathorax. *Metathorax* with posterior angles broadly rounded. *Legs* long and slender; all femora dark-brown; tibiæ yellow, shaded with brown near the middle; tarsi yellow tipped with brown; trochanters with red pigment. All legs armed with long, stout, yellow spines; these are especially prominent on femora; fore coxæ protruding, forming the prominent angles of the prothorax. *Wings* present, reaching to tip of fourth abdominal segment; membrane white; both pairs with long, simple anterior and posterior fringes of closely arranged hairs; anterior wings double fringed along their posterior distal margin for about half their length; each wing with a single rudimentary vein.

Abdomen with segments 2, 3, and 4 widest and about equal; other segments tapering evenly to base of tube. Tube long and slender and about seven times as long as wide. Segments 2 to 7, inclusive, each closely transversely striate, with a dark transverse line near anterior border. Intersegmental membrane brown, with net structure. When the abdomen is distended the connecting tissue is almost as wide as the segment itself. Segments each with two or three prominent spines on angles.

Male: Head, length 0.58 mm., width 0.23 mm.; prothorax, length 0.23 mm., width 0.42.; metathorax, width 0.73 mm.; abdomen, width 0.72 mm.; tube, length 0.63 mm., width 0.10 mm.; clasper, length 0.66 mm.; total body, length 4.66 mm. As long but somewhat smaller than female. Wings present. A long tube-like clasper projects from either side of segment 6; this is black at the base and shades to yellow-brown, and on the tip it bears a short bulb-like hair. Segments 7 and 8 each have a similar though smaller side projection near the posterior edge; the pair on segment 8 is the larger and is thumb-shaped. Scales present, tube tipped with eight long, clear lemon-yellow hairs and several smaller ones. Posterior half of abdomen and the tubes are very dark brown.

Described from two females and one male.

Food plant: Unknown.

Habitat: Stanford University, Cal.

11. Genus **CRYPTOTHRIPS** Uzel.

(26) **Cryptothrips californicus** Daniel.

Measurements: Head, length 0.26 mm., width 0.16 mm.; prothorax, length 0.15 mm., width, including prominent coxa, 0.25 mm.; mesothorax, width 0.33 mm.; abdomen, width 0.38 mm.; total body, length 1.7 mm. Antennæ: 1, 24μ; 2, 51μ; 3, 75μ; 4, 69μ; 5, 51μ; 6, 45μ; 7, 42μ; 8, 27μ; total, 0.35 mm. General *color* black, often dark brown under the microscope, with purple pigment.

Head cylindrical, one and one-half times as long as wide; front of head strongly prominent between basal segments of antennæ; sides almost straight and parallel, roughened, converging only slightly posteriorly; back of head transversely striate; head without conspicuous spines, except a single one posterior to each eye. *Eyes* large, prominent, but not protruding, with rather small facets; not pilose. *Ocelli* situated far forward, anterior one on tip of prominent apex. *Mouth cone* broad at base, short, reaching only a little past the middle of the pronotum; maxillary palpi three-segmented and quite long and slender. *Antennæ* with eight segments, separated at base by prominent prolonged vertex; segments 1 and 2 dark brown, unicolorous with head, 3 and base of 4 yellow, others shading brown toward the tip.

Prothorax small, about as long as width of head; sides straight, but extending outward posteriorly, with a prominent blunt spine on each hind angle; the protruding fore coxæ form what appear to be the prominent angles. *Pterthorax* hardly as wide as abdomen, sides almost straight, narrowed abruptly in front, gradually behind. *Legs* long and slender and unicolorous with body; fore coxæ greatly enlarged. *Wings* extending to seventh abdominal segment; both pairs alike, clear white and with long simple fringe on both anterior and posterior margins, excepting fore wings at tips, which are double fringed behind by about six hairs.

Abdomen long and slender; it tapers gradually from second to eighth segments; the ninth segment is small; the tenth, the tube, is very small and slender. Hairs on prominent angles of segments 7, 8, and 9 long and slender; several long and several shorter ones on end of tube. Protruding scales on last abdominal segments of males.

Males similar to but usually somewhat smaller than the females.

Redescribed from many specimens. For original description see Entomological News, 1904, page 293.

This thrips has been found almost exclusively under the old shells of the brown apricot scale (*Lecanium armeniacum* Craw) and the black scale (*Saissetia oleæ* Bern.) and probably feeds on the remains of the old scales.

Habitat: Central and southern California.

LIST OF CALIFORNIA THYSANOPTERA AND THEIR FOOD PLANTS.

Species.	Food plants.
(1) *Orothrips kelloggii*, new species	Manzanita and madroña blossoms.
(2) *Æolothrips kuwanaii*, new species	California lilac (*Ceanothus thyrsiflorus*).
(3) *Æolothrips kuwanaii*, variety *robustus*.	(Found on apricot tree.)
(4) *Sericothrips apteris* Daniel	Grass.
(5) *Sericothrips reticulatus*, new species	Grass.
(6) *Sericothrips stanfordii*, new species	Grass.
(7) *Heliothrips hæmorrhoidalis* Bouché	Azaleas, ferns, dahlias, cherry laurel, laurestina.
(8) *Heliothrips fasciatus* Pergande	Oranges, pea vines, wild vetch.
(9) *Euthrips orchidii*, new species	Orchids.
(10) *Euthrips pyri* Daniel	Apricots, apples, almonds, cherries, figs, grapes, pears, prunes, plums, walnuts.
(11) *Euthrips ehrhornii*, new species	Grass.
(12) *Euthrips ulicis californicus*, new variety	Vetch.
(13) *Euthrips minutus*, new species	Grass.
(14) *Euthrips occidentalis* Pergande	Most wild and cultivated flowers.
(15) *Euthrips tritici* Fitch	Grass, alfalfa, California sage (*Artemisia californica*), manzanitas (especially *Arctostaphylos tomentosa*), oranges, roses, lilacs, etc.
(16) *Parthenothrips dracænæ* Heeger	Dracæna.
(17) *Thrips madronii*, new species	Blossoms of madroña, California laurel, and California lilac.

Species.	Food plants.
(18) *Thrips tabaci* Lindeman	Wild and cultivated flowers, onion.
(19) *Thrips bremnerii*, new species	Figs.
(20) *Trichothrips dens*, new species	Apricot.
(21) *Trichothrips femoralis*, new species	Wild mullein.
(22) *Trichothrips ilex*, new species	Christmas berry (*Heteromeles arbutifolia*).
(23) *Trichothrips ilex dumosa*, new variety	Scrub oak (*Quercus dumosa*).
(24) *Acanthothrips doaneii*, new species	Grass.
(25) *Megalothrips hesperus*, new species	Unknown.
(26) *Cryptothrips californicus* Daniel	Unknown (This species has been found under the old shells of the brown apricot scale (*Lecanium armeniacum* Craw) and the black scale (*Saissetia oleæ* Bern.) and probably feeds on the remains of the old scales.)

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MISCELLANEOUS PAPERS.

NEW GENERA AND SPECIES OF APHELININÆ, WITH A REVISED TABLE OF GENERA.

By L. O. Howard, Ph. D.

INTRODUCTION.

Technical Series, No. 1, published in June, 1895, comprised a consideration of the Aphelininæ of North America, together with some mention of the insects of this group found in other parts of the world. In that publication the species of thirteen genera were considered, and twenty-six species were described. The economic importance of the group was pointed out and tables of host relations were printed. It was shown that economically these minute parasites are by far the most important of the parasites of the Diaspinæ, and in the twelve years that have elapsed since the publication of the bulletin their economic importance has become even more evident. It is claimed in California that the San Jose scale is held in subjection by these creatures, and in point of fact observations by Johnson and others in the East have shown that under certain conditions *Aphelinus fuscipennis* How. may multiply to such an extent as to produce a very high percentage of parasitism of this scale insect. Whether these parasites in the eastern United States will ever become as effective as in California, however, seems doubtful, on account of the longer breeding season on the Pacific coast, and as a matter of fact the opportunity to test the question does not exist, so universal and so effective has become the use of the lime-sulphur sprays in the eastern States.

In the twelve years since the publication of Technical Series, No. 1, many different species of Aphelininæ have been reared in one part of the world or another, and most of them have been referred to the writer for study. Very few, however, have been described; these are as follows:

Myiocnema (n. g.) pallida Ashmead. Canadian Entomologist, XXXII, No. 11, Nov., 1900, p. 349. Reared by A. Craw from *Saissetia oleæ* Bernard (*Lecanium oleæ*), collected by Geo. Compere, Brisbane, Queensland.

Aphelinus simplex Zehntner. Med. v. h. Proefst. Oost-Java, n. s., No. 36, 1897, pp. 19–20, Pl. I, figs. 18, 19. Reared by L. Zehntner, Java, from *Chionaspis sacchari-folii* Zehntner.

Encarsia planchoniæ Howard. Proc. U. S. Nat. Mus., XVIII, No. 1092, 1896, pp. 635–636. Reared by E. Ernest Green, Punduloya, Ceylon, from *Asterolecanium delicatum* Green (*Planchonia delicata*).

Encarsia aonidiæ Howard. Ibid., p. 636. Reared by E. Ernest Green, Punduloya, Ceylon, from *Aonidia corniger* Green.

Encarsia flaviclava Howard. Journ. Linn. Soc. Lond., XXV, 1894, No. 97. Collected on St. Vincent, B. W. I., by H. H. Smith.

Coccophagus orientalis Howard. Proc. U. S. Nat. Mus., XVIII, No. 1092, 1896, pp. 633–634. Reared by E. Ernest Green, Punduloya, Ceylon, from *Ceroplastes actiniformis* Green, *Coccus viridis* Green (*Lecanium viride*), *Saissetia hemisphærica* Targioni Tozzetti (*Lecanium coffeæ* Signoret), and *Pseudococcus longispinus* Targioni Tozzetti (*Dactylopius adonidum*).

Coccophagus flavescens Howard. Ibid., p. 634. Reared by E. E. Green, Punduloya, Ceylon, from *Saissetia hemisphærica* Targioni Tozzetti (*Lecanium coffeæ* Signoret).

Coccophagus fletcheri Howard. Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., 1897, p. 63. Reared by J. Fletcher from *Eulecanium fletcheri* Cockerell, Ottawa, Canada.

Prospalta tristis Zehntner. Med. v. h. Proefst. Oost-Java, n. s., No. 29, 1896, pp. 11–12, pl., figs. 17–21. Reared by L. Zehntner from *Aleyrodes bergi* on sugar cane.

Prospalta berlesei Howard. Ent. News, XVII, No. 8, Oct., 1906, pp. 291–293. Reared by A. Berlese, Florence, Italy, from *Diaspis pentagona* Targioni Tozzetti, received from Washington, D. C., U. S. A.

Ablerus aureonotus Howard. Journ. Linn. Soc. Lond., XXVI, 1896, p. 157. Captured by H. H. Smith, Balthazar, Grenada, B. W. I.

Ablerus (Azotus) pulchriceps Zehntner. De plantenluizen van het suikerriet op Java, VIII, IX. (Med. v. h. Proefst. West-Java, No. 38, 1899, pp. 10–11, Pl. II, figs. 15–17.) Reared by L. Zehntner on *Aleyrodes* on sugar cane, Java. Belongs to *Azotus* Howard.

Physcus flavidus Zehntner. De plantenluizen van het suikerriet op Java. (Med. v. h. Proefst. West-Java, No. 37, 1898, pp. 5–7, pl., figs. 11–16.) Reared by L. Zehntner, Java, from *Chionaspis madiunensis* Zehntner.

Aneristus (n. g.) ceroplastæ Howard. Can. Ent., XXVII, No. 12, 1895, p. 351. Reared by T. D. A. Cockerell, Jamaica, B. W. I., from *Ceroplastes* sp. on *Euphorbia hypericifolia*.

Azotus (n. g.) marchali Howard. Proc. Ent. Soc. Wash., IV, No. 2, 1898, pp. 138–139. Reared by Paul Marchal, at Paris, France, from *Epidiaspis piricola* Del Guercio (*Diaspis ostreæformis* Signoret); and by W. M. Maskell from *Aspidiotus hederæ* Vallot (*Aspidiotus nerii* Bouché), Sidney, N. S. W.

Archenomus (n. g.) bicolor Howard. Ibid., pp. 137–138. Reared by Paul Marchal, Paris, France, from *Epidiaspis piricola* Del Guercio (*Diaspis ostreæformis* Signoret).

The present paper comprises a description of twenty new species and five new genera. Nearly all of these were received from other parts of the world, but some of them have no doubt already been established in this country. In fact, in looking over the material that has accumulated since the publication of Technical Series No. 1, it becomes obvious that the Aphelinine fauna of the United States, par-

ticularly of the eastern United States, has been undergoing a change. Species that were abundant eight or twelve years ago have become scarce, and introduced species have taken their places. It is indeed difficult to decide whether any of our Aphelininæ are natives of the United States. The introduction of plants from abroad, including very many different kinds of hothouse plants bearing scale insects, has resulted in the introduction not only of new scale insects, but of a number of species of scale-insect parasites. These parasites have undoubtedly in some instances attacked native scale insects and have increased in number. It seems very possible that *Coccophagus lecanii* Fitch and *Aphelinus mytilaspidis* Le Baron are native species. The same, too, is probably the case with *Eretmocerus corni* of Haldeman, but it seems probable that of the remaining species the great majority are of foreign origin.

In order to facilitate the recognition of genera, the descriptions of the new forms contained in this paper are prefaced by a catch table of genera. This table applies only to females. The males of many genera are not known, and as a rule females are reared in infinitely greater abundance than males, affording a strong suspicion that alternation of generations accompanied by parthenogenesis may hold with a number of the species. With the present paper and with Technical Series No. 1, and particularly where the observer has access to von Dalla Torre's catalogue, there should be no very great difficulty in recognizing described species and in deciding whether species reared have been described.

Subfamily APHELININÆ Howard.

Table of Tribes.

Tarsi 5-jointed [a]——Tribe I. *Aphelinini* Ashmead.
Tarsi 4-jointed——Tribe II. *Pteroptricini* Ashmead.

Tribe I. APHELININI.

Table of Genera.

Females.

1. Fore wings with an obliquely transverse hairless line below stigma—— 2
   Fore wings without such an oblique hairless line—— 8
2. Antennæ 4-jointed—— 3
   Antennæ 6-jointed—— 4
   Antennæ 7-jointed—— 7
3. Scape long, slender; pedicel swollen; funicle joint very minute; club long and broad——*Marlattiella*, new genus.
4. Ovipositor exserted to from one-fifth to one-third length of abdomen—— 5
   Ovipositor not at all or but slightly exserted—— 6

[a] In the middle tarsi of *Encarsia luteola* and *E. quaintancei* the 2 terminal segments of the middle tarsi have coalesced, making them appear 4-jointed.

5. Notal sclerites normal, wings hyaline ..... *Centrodora* Foerster.
   Mesopostscutellum acutely triangular, fore wings with an irregular pattern of dark lines or spots ..... *Perissopterus* Howard.
6. Wings hyaline, or with a slight fuscous patch, eyes naked ..... *Aphelinus* Dalman
7. Antennal club 3-jointed, the 2 funicle joints longer than broad and subequal in length ..... *Mesidia* Foerster.
8. Antennæ 6-jointed 9
   Antennæ 7-jointed 10
   Antennæ 8-jointed 13
9. Antennæ with a scape, pedicel, 3 ring joints (funicle), and a moderately long club ..... *Thysanus* Haliday.
   (*Plastocharis* Foerster.)
10. Club 1-jointed; ovipositor extruded to one-half length of abdomen 11
    Club 2-jointed; ovipositor scarcely extruded 12
11. Stigmal vein squarely truncate at tip ..... *Ablerus* Howard.
    Stigmal vein with a swollen and rounded tip ..... *Azotus* Howard.
12. First funicle joint shorter than second and third ..... *Physcus* Howard.
13. Antennal club 2-jointed 14
    Antennal club 3-jointed 15
14. Hind tibiæ armed with very stiff black bristles ..... *Myiocnema* Ashmead.
    Hind tibiæ not so armed ..... *Encarsia* Foerster.
15. Stigmal vein lacking; wings with a very long fringe.
    Aspidiotiphagus Howard.
    Stigmal vein present; marginal cilia comparatively short 16
16. Marginal vein shorter than submarginal ..... *Prospalta* Howard.
    Marginal vein as long as or longer than submarginal 17
17. Antennal scape short, flagellum strongly flattened; hind tibiæ flattened and with a row of short bristles above ..... *Aneristus* Howard.
    Antennal scape not especially short, flagellum subcylindrical; hind tibiæ normal ..... *Coccophagus* Westwood.

Tribe II. PTEROPTRICINI.

TABLE OF GENERA.

Females.

1. Antennæ 5-jointed 2
   Antennæ with more than 5 joints 3
2. Funicle joints 1 and 2 ring joints ..... *Eretmocerus* Haldeman.
   Funicle joint 1 very short; joint 2 slender, four times as long as joint 1.
   Cales, new genus.
3. Antennæ 7-jointed 4
   Antennæ 6-jointed 5
   Antennæ 8-jointed 6
4. Tarsal joints of middle leg short and subequal in length; middle tibial spur as long as first two tarsal joints together ..... *Casca*, new genus.
   First tarsal joint of middle leg as long as joints 2 and 3 together; middle tibial spur not quite as long as first tarsal joint ..... *Bardylis*, new genus.
5. Club of antenna 3-jointed, joints subequal in length; only one funicle joint.
   Artas, new genus.
   Club of antenna 2-jointed; wings spotted ..... *Marietta* Motschulsky.
6. Club 3-jointed; funicle joints 1 and 2 very short, 3 longer than 1 and 2 together and much wider than either ..... *Pteroptrix* Westwood.
   Club apparently 2-jointed; funicle joints 1 and 2 very short, 3 and 4 each longer than 1 and 2 together ..... *Archenomus* Howard.

Genus **MARLATTIELLA**, new genus.

Female.—Tarsi 5-jointed. Wings with an oblique hairless streak extending from stigma backward to near base of wing; the disc otherwise uniformly and rather densely ciliate; marginal vein much longer than submarginal; stigmal evident and plainly furnished with a rounded knob at tip; fore wing obtusely rounded at tip. Antennæ 4-jointed; scape inserted near mouth border, long, slender, reaching to top of head; pedicel considerably swollen, longer than broad; the single funicle joint very small, almost like a ring joint and rather oblique; club long and broad, rather blunt at apex, longer than scape, pedicel, and funicle together, and with sparse longitudinal striations. Axillæ of mesoscutum very narrow. Middle tarsi with first joint nearly as long as second and third together; middle tibial spur about as long as corresponding first tarsal joint. Hind tarsi longer than middle tarsi. Ovipositor somewhat extruded. Eyes hairy.

Male.—Unknown.

Type.—The following species:

Marlattiella prima, new species. (Fig. 13.)

Female.—Length 0.84 mm.; expanse 1.54 mm.; greatest width of fore wing 0.24 mm. General color dull orange-yellow; eyes reddish brown; ocelli carmine; closed mandibles dusky; all legs uniformly light yellow. Wings hyaline, veins faintly dusky.

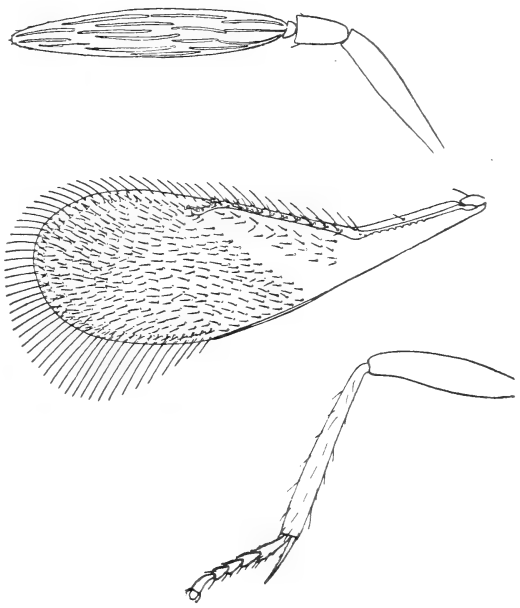

FIG. 13.—*Marlattiella prima:* Antenna, fore wing, and middle leg of female. Greatly enlarged (original).

Male.—Unknown.

Type.—No. 10297, U. S. National Museum. Described from 10 female specimens bred from *Leucaspis japonica* Cockerell, collected by C. L. Marlatt, October 11, 1901, at Tientsin, China, on a "bush with variegated foliage," possibly a *Croton*.

Genus **MESIDIA** Foerster.

Mesidia Foerster. Hymenopterologische Studien, Heft II, 1856, p. 30.

This genus, hitherto known only through Foerster's brief characterization, is intermediate between *Aphelinus* and *Coccophagus*, hav-

ing the oblique hairless line on the fore wing, extending from stigma to near base of wing, of *Aphelinus* and having the three joints before the club of the antennæ of equal length, as with *Coccophagus*. Other female generic characters may be derived from the new species described below. The ovipositor is strong and well extruded. The femora are slightly swollen. The antennal club is ovate and flattened; funicle joints 1, 2, and 3 subequal in width and each somewhat shorter than the basal joint of the club; pedicel triangular, rather broader and longer than first funicle joint; club with sparse longitudinal striæ, as in *Coccophagus*. Eyes densely hairy, but with very

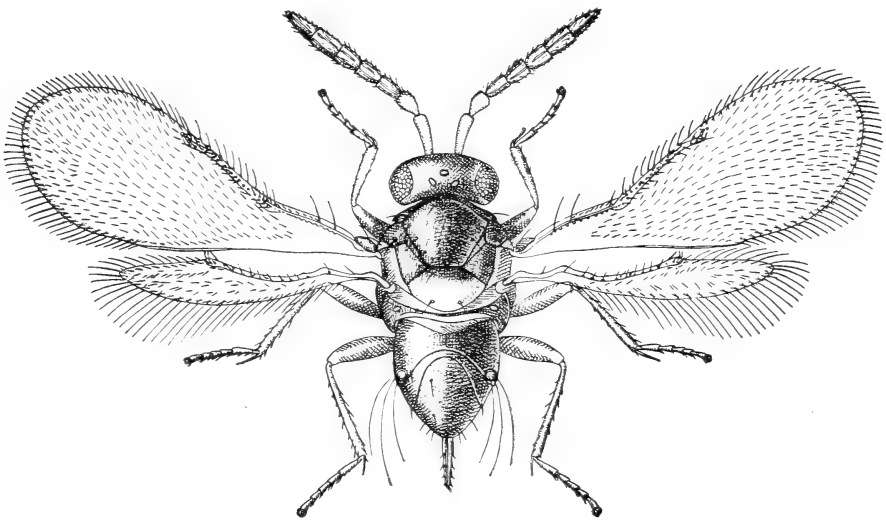

FIG. 14.—*Mesidia mexicana:* Female. Greatly enlarged (original).

short hairs. Marginal vein of fore wings as long as submarginal; stigmal obscure and almost lacking.

Type.—The following species:

Mesidia mexicana, new species. (Fig. 14.)

Female.—Length 0.68 mm.; expanse 1.4 mm.; greatest width of fore wing 0.24 mm. General color dark brown, nearly all of mesoscutellum except anterior border yellowish; all coxæ, femora, and antennæ brownish; tibiæ and tarsi whitish; wing veins dusky. All of mesonotum, except light portion of scutellum, finely and closely aciculate, as is also the mesoscutum.

Type.—No. 10298, U. S. National Museum. Described from 9 female specimens reared from an *Aleyrodes* collected on "Palo de Gusano" by C. H. T. Townsend at S. Francisco del Peal, Tabasco, Mexico, July 1, 1887.

Genus AZOTUS Howard.

Azotus Howard. Proc. Ent. Soc. Wash., Vol. IV, No. 2, 1898, pp. 138–139.

This interesting genus was described in the male sex only in the Proceedings of the Entomological Society of Washington, Vol. IV,

No. 2 (1898), pp. 138–139, the type species being *A. marchali* Howard reared by Dr. Paul Marchal at Paris from *Epidiaspis piricola* Del Guercio (*Diaspis ostreæformis* Signoret) and subsequently by W. M. Maskell from *Aspidiotus hederæ* Vallot (*Aspidiotus nerii* Bouché) received from Sydney, N. S. W.

Of the species described below a good series of females is before the writer and the following generic characterization of the female is therefore presented:

Female.—Ovipositor apparently normally extruded to from one-third to one-half the length of abdomen. Antennæ 7-jointed, there being no suture dividing the club into the two segments of which it is evidently homologically composed. (In the original description of the male antenna it was called 8-jointed, although no true suture

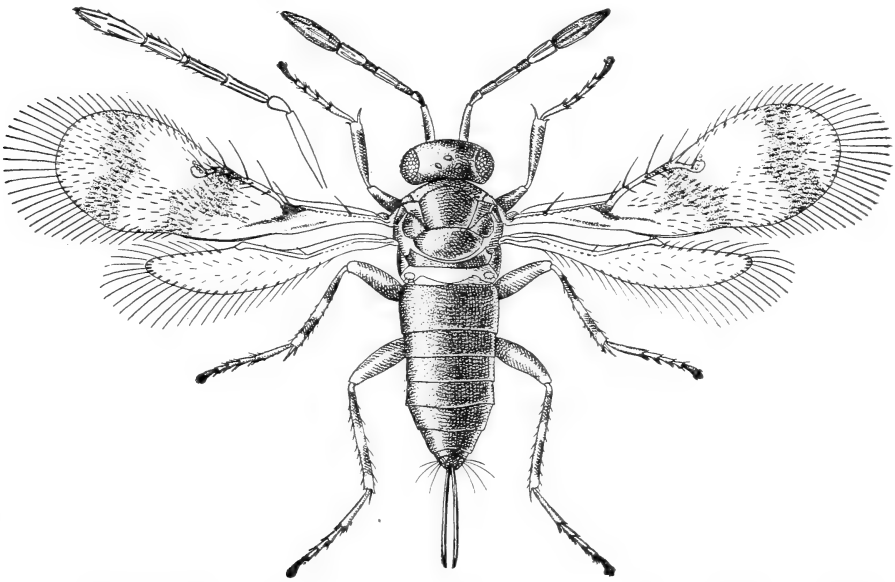

FIG. 15.—*Azotus capensis:* Female, and antenna of male. Greatly enlarged (original.)

occurs with the club in that sex.) Club nearly as long as last 3 funicle joints together; funicle joints 1, 2, and 4 nearly equal in length, 1 rather the shorter of the three; funicle joint 3 much shorter, although not so disproportionately short as in the male. All tarsi 5-jointed; joint 1 nearly as long as the others together; middle tibial spur about half as long as first tarsal joint. Marginal vein of fore wings not as long as submarginal; marginal cilia not especially long.

Azotus capensis, new species. (Fig. 15.)

Female.—Length 0.9 mm.; expanse 1.8 mm.; greatest width of fore wing 0.24 mm. General color black, with greenish metallic reflections on notum; antennæ brown, with base and tip of scape, tip of pedicel, and all of funicle joints 2 and 4 nearly white; all coxæ and femora brown, femora light at tips; trochanters white; front tibiæ

brown, light at tips: middle and hind tibiæ nearly white, with two brown bands: front tarsi light brown, terminal joint dark brown; middle and hind tarsi nearly white, the last joint brown. Eyes crimson. Marginal vein of fore wings brown; wings hyaline, with a transverse brown patch below marginal vein and another one nearer tip of wing; an oblique shade at point where submarginal vein turns upward to costa.

Male.—Length 0.6 mm.; expanse 1.8 mm.; greatest width of fore wing 0.24 mm. Antennæ uniformly light brown. Legs as in female, except that middle and hind tibiæ are uniformly brown, light at extremities, and that all tarsi are brownish. In the fore wings the brown shade below the marginal vein is present, but the outer brown shade is much fainter.

Type.—No. 10299, U. S. National Museum. Described from 12 male and 17 female specimens bred from an *Asterolecanium* on *Euryops tenuissimus*, Cape of Good Hope, South Africa, by C. P. Lounsbury, October, 1898.

NOTE.—*Ablerus pulchriceps* Zehntner (De Plantenluizen van het suikerriet op Java, VIII, IX, pp. 10, 11, Plaat ii, figs. 15, 16, 17), reared from *Aleyrodes longicornis* Zehntner in Java, belongs to this genus and greatly resembles this species, judging from Zehntner's well-drawn figures.

Genus **ENCARSIA** Foerster.

Encarsia Foerster. Kleine Monographien, 1878, pp. 65–66. (Type, *Encarsia tricolor* Foerster.)

TABLE OF SPECIES.

Females.

1. Tarsi of middle legs 4-jointed; joints 4 and 5 apparently coalesced 2
   Middle tarsi plainly 5-jointed 3
2. Pedicel and first funicle joint subequal in length ..... *luteola* Howard.
   First funicle joint shorter than pedicel and than second funicle joint. *quaintancei*, new species.
3. Club flattened ..... *flaviclava* Howard.
   Not flattened 4
4. First funicle joint swollen ..... *angelica* Howard.
   Not swollen 5
5. Pedicel and first funicle joint subequal in length 6
   Pedicel shorter than first funicle joint 8
   Pedicel longer than first funicle joint, which is distinctly shorter than second 10
6. Funicle joints 1 and 2 subequal in length; flagellar striations barely discernible 7
   Funicle joint 2 considerably longer than 1; striations close and distinct. *planchoniæ* Howard.
7. Fore wings with disc closely and completely ciliate *portoricensis*, new species.
   Fore wings with a round bare space below stigma *pergandiella*, new species.

8. All funicle joints subequal and concolorous 9
   Funicle joint 1 nearly as long as 2 and 3 together; the latter subequal and white; joint 1 and the club black ..... *diaspidis*, new species.
9. Terminal joint of club shorter than basal joint ..... *aonidiæ* Howard.
   Club joints equal in length ..... *coquillettii* Howard.
10. First funicle joint distinctly shorter than second ..... *townsendi*, new species.

Encarsia diaspidis, new species.

Female.—Length 1.6 mm.; expanse 3.6 mm.; greatest width of fore wing 0.5 mm. Eyes markedly hairy. Antennal scape robust; pedicel somewhat longer than broad; 1st funicle joint twice as long as pedicel; joints 2 and 3 much shorter and subequal in length and width; club rather slender and pointed, longer than funicle joints 2 and 3 together; all joints, including scape, plainly hairy. General color orange-yellow; antennæ black, joints 2 and 3 of funicle white; eyes reddish; dorsum of abdomen and metanotum infuscated, except for tip of abdomen, which is yellow; all legs uniform honey-yellow; wing veins yellowish.

Male.—The male *Encarsia* has not been described; but I have a slide from Lounsbury containing male specimens reared from the same host, in the same locality, and at the same time as the female described above, and these are probably the males of *E. diaspidis.* They are described as follows, generic characters included: Length 1.08 mm.; expanse 2.4 mm.; greatest width of fore wing 0.44 mm. Antennæ 8-jointed; scape not long, slightly swollen in middle; pedicel short, only as long as broad; 1st funicle joint long, 6 times as long as broad; funicle joints 2 and 3 subequal in length and width and each about one-half as long as joint 1; club 3-jointed, the segments as distinct as those of funicle; club joints 1 and 2 about equal in length to funicle joints 2 and 3; terminal joints shorter and rather obtusely pointed at tip; all flagellar joints strongly longitudinally striate. First joint of middle tarsus longest; middle tibial spur about as long as first tarsal joint. General color very dark brown, nearly black; antennæ uniformly dark brown; femora brown, hind femora darker than front and middle femora; trochanters light yellow; all tibiæ dusky, lighter at tips; tarsi yellowish, with their terminal joints brown.

Type.—No. 10300, U. S. National Museum. Described from 6 female and 6 male specimens, reared July, 1897, from a *Diaspis* on *Acacia horrida* at Bathurst, Cape Colony, South Africa, by C. P. Lounsbury.

This species is probably not a true *Encarsia.*

Encarsia portoricensis, new species.

Female.—Length 1 mm.; expanse 1.84 mm.; greatest width of fore wings 0.28 mm. Antennæ rather stout, with flagellum uniformly hairy, longitudinal striation only faintly discernible; scape uni-

formly slender; pedicel very slightly longer than broad; 1st funicle joint about as long as pedicel; joint 2 very slightly longer than 1 and about equal to joints 3 and 4 and each of the two club joints. Submarginal and marginal veins about equal in length, stigmal very short and entering the wing at a small angle. Middle tarsi and tibial spur as with the preceding species. General color lemon-yellow; ocelli dark crimson, eyes very dark crimson; antennæ and legs dusky; abdomen with a brownish dorsal central patch. The specimen from Porto Rico has the abdomen entirely brown above and the pronotum and anterior portion of mesoscutum brownish.

Male.—Unknown.

Type.—No. 10301, U. S. National Museum. Described from 3 female specimens reared January, 1899, by Mr. A. Busck from *Aleyrodes* sp. on a climbing vine, Bayamon, Porto Rico (Bur. Entom. No. 8423°) and 1 female specimen received March, 1907, from Mr. E. K. Carnes of the California Board of Horticultural Commissioners, labeled "on *Aleyrodes* sp. Mexico."

Encarsia pergandiella, new species.

Female.—Length 0.58 mm.; expanse 1.46 mm.; greatest width of fore wing 0.14 mm. Antennæ long, slender, and faintly hairy; pedicel and first funicle joint subequal in length; remaining funicle joints increasing gradually in length; basal joint of club slightly longer than terminal joint and the preceding funicle joint. Ovipositor slightly extruded. First tarsal joint of middle legs long and slender, nearly as long as the remaining 4 joints together; middle tibial spur about one-half length of 1st tarsal joint. Front wings rather narrow, with a considerably longer fringe than usual; discal cilia rather sparse, and a round perfectly hairless spur below stigma. General color uniform honey-yellow; eyes and ocelli red.

Male.—Unknown.

Type.—No. 10302, U. S. National Museum. Described from 7 female specimens reared by Mr. Theo. Pergande from an Aleyrodes on *Xanthium strumarium*, Washington, D. C., September 25, 1900 (Bur. Entom. No. 9321°). Also reared by Mr. Pergande at Washington, D. C., November 20, 1894, from an *Aleyrodes* on blackberry (Bur. Ent., No. 6452).

Encarsia townsendi, new species.

Female.—Length 0.66 mm.; expanse 1.56 mm.; greatest width of fore wing 0.22 mm. Antennæ with numerous hairs, but with very faint striation; scape not especially long; pedicel longer than wide; first funicle joint about as long as wide, shorter than pedicel and only one-half as long as second funicle joint; second and remaining funicle joints subequal in length and width, as is also basal joint of club (terminal joint of club missing on all specimens).

Middle tarsi with joint 1 as long as 2 and 3 together: middle tibial spur as long as joint 1. Ovipositor considerably extended. Face and vertex orange-yellow; ocelli carmine; eyes dark red; mesoscutellum dull lemon-yellow; remainder of notum and dorsum of abdomen light brown; tip of abdomen yellowish; antennæ dusky; legs and antennal veins dusky; fore wings with a faint dusky shade below marginal vein.

Male.—Unknown.

Type.—No. 10303, U. S. National Museum. Described from 5 female specimens reared June 19, 1897, from an *Aleyrodes* on a coarse grass taken at Sangrillo del Chico, Tabasco, Mex. (Bur. Ent., No. 741), by C. H. T. Townsend.

Encarsia quaintancei, new species.

Female.—Length 0.66 mm.; expanse 1.4 mm.; greatest width of fore wing 0.18 mm. Middle tarsi 4-jointed as with *luteola*, the fourth and fifth segments apparently coalesced. Pedicel of antennæ twice as long as broad; joint 1 of funicle somewhat longer than broad, shorter than pedicel and shorter than second funicle joint; second, third, and fourth funicle joints increasing gradually in length; club joints subequal in length. Fore wings with a small rounded hairless space below and beyond stigma, not extending to one-half the wing breadth. Eyes hairy. Mesoscutum delicately hexagonally reticulated; axillæ delicately reticulate. General color brown; mesoscutellum wholly lemon-yellow; tips of abdomen and flagellum of antennæ yellowish; all legs faintly yellowish; wings hyaline.

Male.—Unknown.

Type.—No. 10304, U. S. National Museum. Described from 1 female specimen reared August 29, 1900, by Theo. Pergande from *Aleyrodes* sp. on *Polygonum*, Bladensburg road, D. C.

The species is named for Prof. A. L. Quaintance in recognition of his excellent work on the Aleyrodidæ.

Genus PROSPALTA Howard.

Prospalta Howard. Insect Life, Vol. VII, 1894, p. 6. (Type, *Prospalta aurantii* Howard.)

Prospalta maculata, new species. (Fig. 16.)

Female.—Length 1 mm.; expanse 2.24 mm.; greatest width of fore wing 0.31 mm. Comes rather close to *P. murtfeldtii* How., but the antennæ are not so strongly clubbed. The color is as follows: Antennal club brown, whitest at tip; scape and funicle joints 2 and 3 whitish; general color of body and legs light yellow; middle and hind tibiæ each with two brown bands; first tarsal joint of middle and hind legs brown; first, fourth, fifth, and sixth abdominal seg-

ments with a complete brown cross-band; second and third with a brown cross-band interrupted in the middle. Mesoscutum with two longitudinal brown bands; axillæ brown; mesoscutellum with two large brown spots. Wings hyaline.

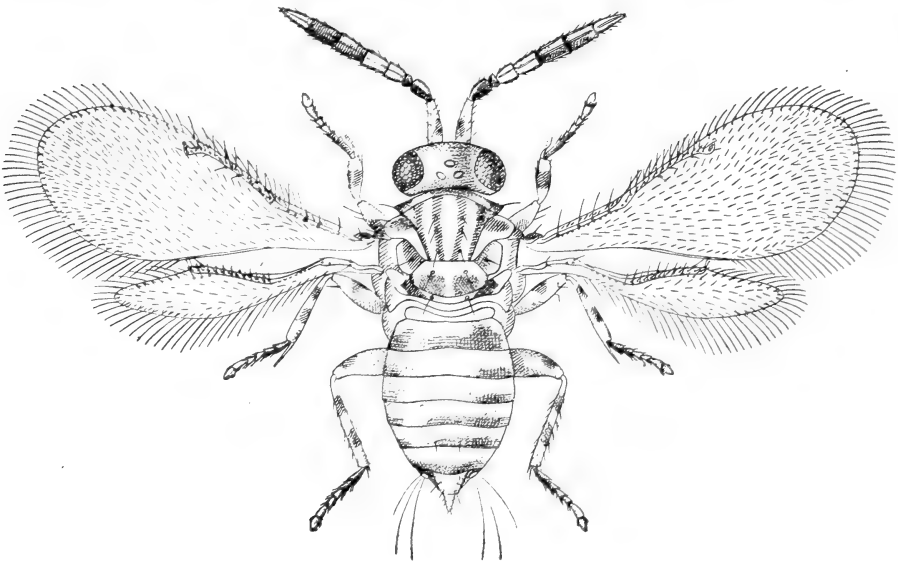

FIG. 16.—*Prospalta maculata:* Female. Greatly enlarged (original).

Type.—No. 10305, U. S. National Museum. Described from 1 female specimen bred by Mr. E. K. Carnes from *Lepidosaphes beckii* Newman (*Mytilaspis citricola* Glover), sent to California from China by Mr. George Compere.

Genus COCCOPHAGUS Westwood.

Coccophagus Westwood. Philosoph. Mag., Vol. III, 1833. (Type, (*Entedon*) *scutellaris* Dalman.)

Coccophagus subochraceus, new species.

Female.—Length 1.1 mm.; expanse 2.6 mm.; greatest width of fore wing 0.48 mm. Differs from *C. ochraceus* in having the entire body, including the mesopleura and the terminal segments of the abdomen, ochraceous.

Male.—Differs from *C. ochraceus* in having the axillæ and the entire dorsal surface of the abdomen black and the metanotum dusky.

Type.—No. 10306, U. S. National Museum. Described from 5 female and 25 male specimens bred from a *Lecanium* on *Leucospermum attenuatum*, at Zuurberg, Cape Colony, South Africa, by C. P. Lounsbury, 1897.

Coccophagus longifasciatus, new species. (Fig. 17.)

Female.—Length 0.78 mm.; expanse 1.56 mm.; greatest width of fore wing 0.26 mm. Antennæ stout, moderately clavate, with plain

longitudinal striæ. Surface of body smooth, impunctate. General color of body light lemon-yellow; eyes and ocelli bright carmine; all legs pallid; antennæ and wing veins slightly dusky; a broad lateral brown band extending down either side of the body from the pronotum to the tip of the abdomen.

Male.—In the male the brown band is not so perfect, but the pronotum, the anterior border of the mesoscutum, the axillæ, all of the metanotum, and the sides and tip of the abdomen are brown.

Type.—No. 10307, U. S. National Museum. Described from 4

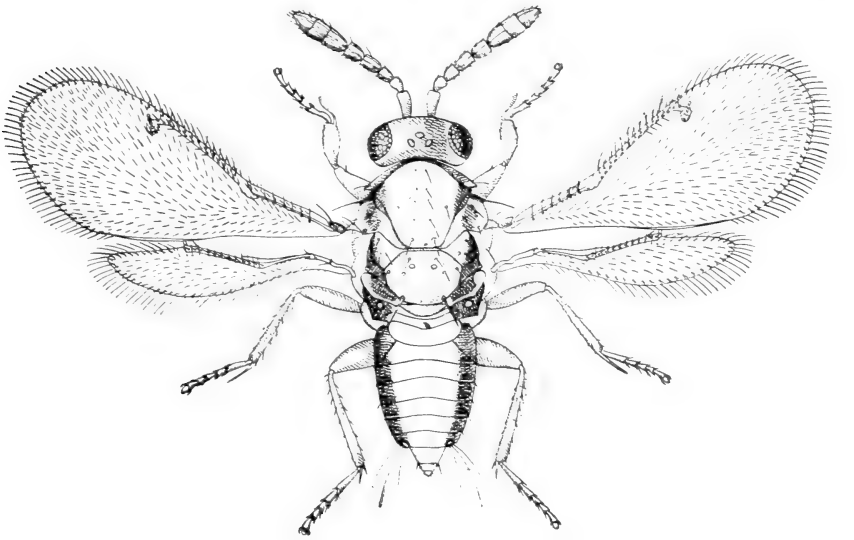

FIG. 17.—*Coccophagus longifasciatus:* Female. Greatly enlarged (original).

male and 4 female specimens bred from *Saissetia nigra* Nietner (*Lecanium nigrum*), at Manaar, Ceylon, by E. Ernest Green, 1897.

Coccophagus zebratus, new species. (Fig. 18.)

Female.—Length 1.34 mm.; expanse 2.4 mm.; greatest width of fore wing 0.32 mm. Body smooth, flat, impunctate; antennæ with only very slight indications of longitudinal striæ; hind femora and coxæ considerably swollen. Club of antennæ dark brown; scape, pedicel, and funicle joints 1 and 2 of a rather lighter brown; funicle joint 3 white. Vertex, occiput, pronotum, and mesonotum lemon-yellow, metascutum brown; face and remainder of thorax whitish; all femora and coxæ whitish and front tibiæ as well; middle and hind tibiæ slightly brownish at base; first joint of middle and hind tarsi brown. Abdomen whitish, with a broad brown transverse band on each segment. Wing veins dusky.

Male.—Unknown.

Type.—No. 10308, U. S. National Museum. Two female specimens bred from *Aclerda distorta* Green, MS., Punduloya, Ceylon, by E. Ernest Green.

Genus CALES, new genus.

Female.—Tarsi 4-jointed; first and last joints of middle tarsus much longer than second and third; middle tibial spur not as long as first tarsal joint; joints of hind tarsus subequal in length. Antennæ 5-jointed; bulla very long and slender, scape somewhat swollen; pedicel not greatly swollen, nearly three times as long as broad; funicle joint 1 short and slender, about as long as broad (this joint may possibly be found to be double on examination of additional specimens). Second funicle joint slender, more than four times as long as joint 1; club ovate, undivided, and longer than funicle and pedicel together. Eyes naked. Fore wings narrow, with subparallel fore and hind borders; marginal cilia long; discal cilia very sparse and placed in two long horizontal rows and part of a third; marginal

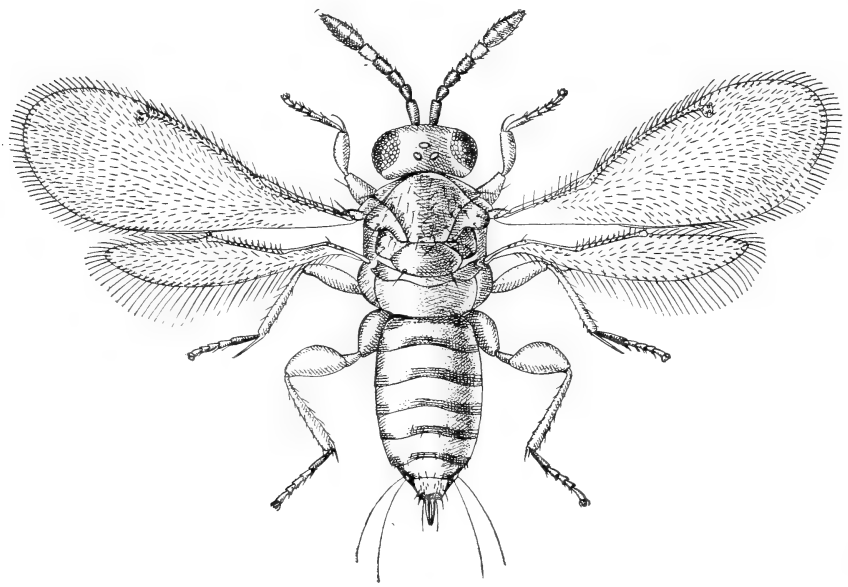

FIG. 18.—*Coccophagus zebratus:* Female. Greatly enlarged (original).

vein somewhat longer than submarginal; no differentiated stigmal. Ovipositor slightly extruded.

Male.—Unknown.

Type.—The following species:

Cales noacki, new species. (Fig. 19.)

Female.—Length 0.52; expanse 1.44 mm.; greatest width of fore wing 0.12 mm. General color lemon-yellow; eyes reddish brown; antennæ uniformly yellow; legs slightly dusky. Legs long and slender; body rather slender and graceful; abdomen rather short and triangular. Wings hyaline, veins dusky.

Type.—No. 10309, U. S. National Museum. Described from one female specimen reared by Fritz Noack, Campinas, Brazil, from an undetermined species of *Orthezia.* (Bureau of Entomology No. 818301.)

Genus CASCA, new genus.

Female.—Comes rather close to *Bardylis*, from which, however, it may be easily separated by tarsal, antennal, and wing characters. All tarsi 4-jointed, the tarsal joints of middle leg all short and subequal in length; apical spur of middle tibia as long as first two tarsal joints together; hind tarsi longer than middle tarsi, but the joints are subequal in length as with the middle. Marginal vein of fore wing rather shorter than submarginal; stigmal evident; disk uniformly ciliate, but more sparsely than with *Bardylis;* hind border of wing slightly excavate beyond anal angle, tip regularly rounded; marginal cilia long, longest at lower wing tip. Antennæ 7-jointed, somewhat clavate, the club rather long and but slightly swollen, tapering to a point and with the joints subequal in length; second funicle joint shorter than first, but of same width and only slightly longer than wide, much shorter and narrower than first club joint; first funicle joint about twice as long as wide, as long as, but narrower than pedicel. Flagellum hairy and club with longitudinal striæ. Eyes hairy.

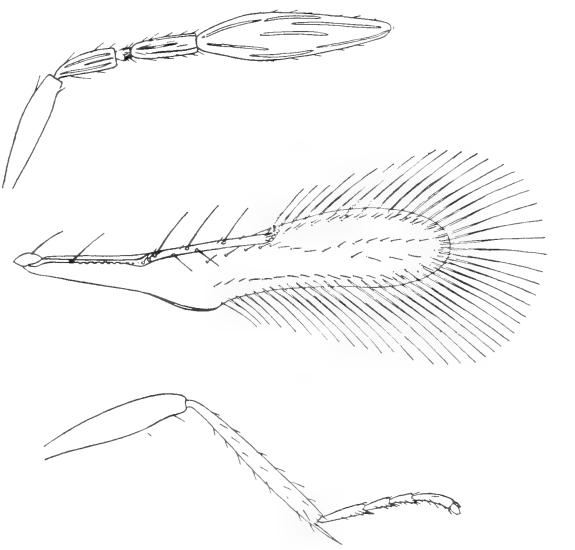

FIG. 19.—*Calcs noacki:* Antenna, fore wing, and middle leg of female. Greatly enlarged (original).

Male.—Unknown.

Type.—The following species:

Casca chinensis, new species. (Fig. 20.)

Female.—Length 0.86 mm.; expanse 1.34 mm.; greatest width of fore wing 0.16 mm. Head and face orange-yellow, occiput dusky; ocelli and eyes carmine, the eyes darker than the ocelli; antennæ light dusky yellow; all legs pallid; pronotum, abdomen, and metascutum brown; mesoscutum also brownish at anterior border; remainder of mesoscutum yellowish and remainder of mesonotum and mesopleura pallid. Fore wing with a pronounced dusky cloud below marginal vein.

Male.—Unknown.

Type.—No. 10310, U. S. National Museum. Described from 2 female specimens reared in California by Mr. E. K. Carnes from

Lepidosaphes beckii Newman (*Mytilaspis citricola* Glover) collected in China by Mr. George Compere.

Genus BARDYLIS, new genus.

Female.—All tarsi 4-jointed; first tarsal joint of middle leg nearly as long as second and third joints together; middle tibial spur not quite as long as first tarsal joint. Marginal vein of fore wing a trifle shorter than submarginal; stigmal short but evident; wing disc very closely and evenly ciliate; margin with long cilia from stigma to anal angle, gradually lengthening from stigma to lower distal point and thence rapidly decreasing in length to anal angle; margin of wing evenly curved from anal angle to costa. Antennæ 7-jointed, pronouncedly clavate; club ovate, with its joints of subequal length; the two funicle joints about equal in length and width, each slightly shorter than pedicel and first club joint; the whole surface of the flagellum furnished with minute hairs. Eyes hairy.

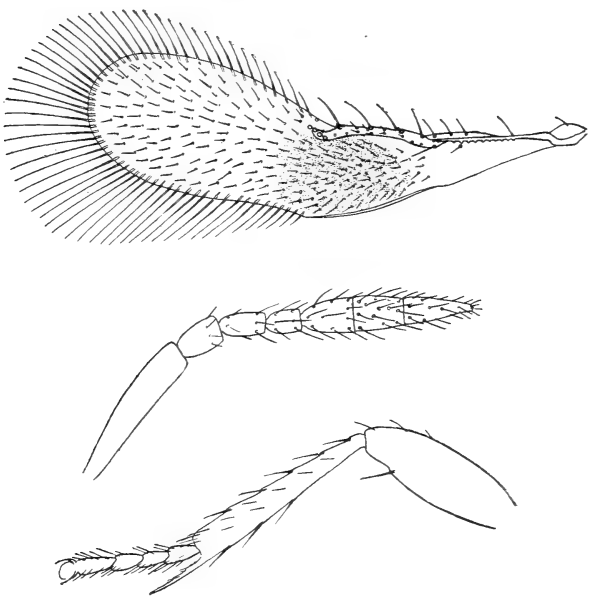

FIG. 20.—*Casca chinensis:* Fore wing, antenna, and middle leg of female. Greatly enlarged (original).

Male.—Antennæ more elongate, 8-jointed, all scape joints subequal in length and width, except terminal joint of club, which comes to a rounded point. The tarsi are longer than in the female and the first funicle joint is not as long as the second and third together.

Type.—The following species:

Bardylis australiensis, new species. (Fig. 21.)

Female.—Length 0.5 mm.; expanse 1.34 mm.; greatest width of fore wing 0.18 mm. Color: Head, pronotum, mesoscutum, tegulæ, and abdomen brown; mesoscutellum, metascutum, mesopleura, and metapleura dull orange-yellow; antennæ, coxæ, and femora light brown; wing veins dusky; fore wings with a dusky cloud below marginal vein; eyes dark red. Occiput closely and finely aciculate; mesoscutum faintly aciculate.

Male.—Differs from female only as pointed out in generic diagnosis, except that the clouded portion of the fore wing is lighter than in the female.

Type.—No. 10311, U. S. National Museum. Described from many male and female specimens reared by Mr. Geo. Compere, evidently from scale insects, at Swan River and Perth, West Australia. (Compere's numbers 774, 855, 871, 873, 923, 925, 944, and 1026.)

Also from a number of specimens reared by A. Koebele, September 29, 1899, from an *Aspidiotus* on *Hakea* sp., at Sydney, New South Wales. (Koebele's No. 1998.)

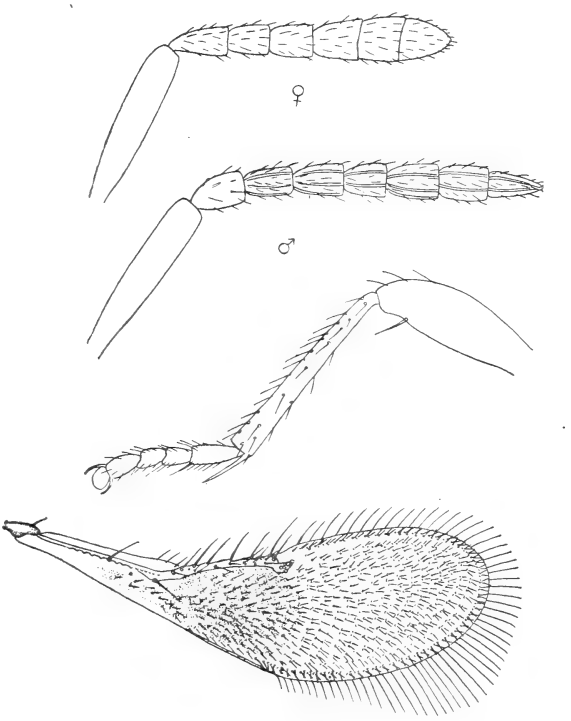

FIG. 21.—*Bardylis australiensis:* Antenna of female, and antenna, hind leg, and fore wing of male. Greatly enlarged (original).

Genus ARTAS, new genus.

Female.—Tarsi 4-jointed; antennæ 6-jointed; scape and pedicel normal, the single funicle joint about as long as the first club joint and slightly more slender; club joints subequal in length, the terminal joint tapering to a point. Fore wings very obtusely rounded and almost bare, having very few discal cilia; four long hairs arising from marginal vein, and a series of very long marginal hairs beginning at the tip of the marginal vein and extending around to the middle of the lower margin, slightly longer at lower tip; marginal vein equal in length to submarginal; stigmal lacking as in *Aspidiotiphagus.* Tarsal joints of middle tarsi subequal in length, tibial spur longer than the first two tarsal joints together.

Male.—Unknown.

Type.—The following species:

Artas koebelei, new species. (Fig. 22.)

Female.—Length 0.38 mm.; expanse 1 mm.; greatest width of fore wing 0.13 mm. General color dull yellow; mesoscutellum light

lemon-yellow; eyes and ocelli dark red; wing veins dusky; pronotum, front of mesoscutum, axillæ, and sides of metanotum dark brown; dorsum of abdomen dusky.

Male.—Unknown.

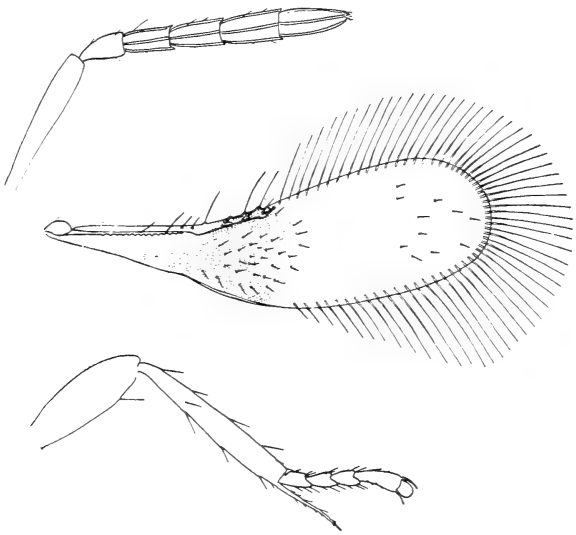

FIG. 22.—*Artas koebelei:* Antenna, fore wing, and hind leg of female. Greatly enlarged (original).

Type.—No. 10312, U. S. National Museum. Described from 11 male specimens reared from *Chionaspis vitis* Green, Hongkong, China, by A. Koebele.

Genus **PERISSOPTERUS** Howard.

Perissopterus Howard. Tech. Ser. 1, Div. Ent., U. S. Dept. Agric., 1895, pp. 20–21. (Type, *P. pulchellus* Howard.)

Male.—In the original description of this genus[a] the male is not described, the description of the male *P. pulchellus* having been made from a dry mount with shriveled antennæ. The important fact has since been discovered that with the male of *Perissopterus* the antennæ are only 5-jointed, viz, scape, pedicel, 2 ring joints, and club; the club being long, oval, and more or less flattened. With *P. pulchellus* the male in other respects resembles the female.

TABLE OF SPECIES.

1. Eyes hairy 2
   Eyes naked 3
2. Antennal club black ..... *noumeænsis*, new species.
   Antennal club pallid ..... *capillatus*, new species.

[a] Tech. Ser., No. 1, Div. Ent., U. S. Dept. Agric., pp. 21–22.

3. First four tarsal joints of middle leg white, including tibial coronet of spines ..... *busckii*, new species.
   Not white, tibial coronet black 4
4. First and fifth tarsal joints black, rest white ..... *javensis*, new species.
   First and fifth and at least part of the second tarsal joint black 5
5. General color white, tinged in spots with dark reddish orange, dotted with black ..... *pulchellus* Howard.
   General color light orange-yellow, with black dots (no red or white). *mexicanus* Howard.

Perissopterus capillatus, new species.

Female.—Length 1 mm.; expanse 2.16 mm.; greatest width of fore wing 0.36. Eyes closely and plainly hairy. Eyes well separated; ocelli at angles of obtuse-angled triangle. Vertex and occiput faintly reticulate, thorax smooth. The fore wings appear spotted with patches of dark cilia, the spots not connected in a reticulate pattern as with *P. pulchellus* and *P. mexicanus*. Head uniform orange-yellow, eyes red; mesonotum lemon-yellow, metanotum darker; abdomen marked with alternating transverse bands of light yellow and honey-yellow; antennæ light yellowish; legs very light in color, femora dusky at tip; middle and hind tibiæ dusky at tips and with two other dusky spots on bands; first and fifth tarsal joints dusky.

Male.—Unknown.

Type.—No. 10313, U. S. National Museum. Described from 11 female specimens reared by Mr. Koebele from *Lepidosaphes pallens* Maskell (*Mytilaspis pallens*) on *Xanthorrhœa*, Sydney, New South Wales, December 20, 1895.

Perissopterus noumeænsis, new species.

Female.—Length 0.86 mm.; expanse 1.9 mm.; greatest width of fore wing 0.3 mm. Eyes with numerous fine black hairs. General color dingy yellowish white; antennal club dark brown, nearly black; scape, pedicel, and funicle lighter; lower face orange; sides of mesoscutum with a thin line of brown; abdomen with alternating dark brown and whitish bands; femora slightly brownish above, tibiæ brownish at tips; middle tarsi entirely brownish yellow; hind tarsi with first joint pallid, rest yellowish.

Type.—No. 10314, U. S. National Museum. Described from one female specimen, bred October, 1899, from *Aspidiotus* sp. on cocoa palm, Noumea, New Caledonia, by A. Koebele.

Perissopterus busckii, new species.

Male.—Length 0.76 mm.; expanse 1.7 mm.; greatest width of fore wing 0.3 mm. Eyes naked. Markings of fore wings reticulate, not arranged in spots. General color uniform orange-yellow; antennal club brownish, lighter at tip; scape whitish, pedicel dark above, light below; metascutellum darker at sides; legs pallid; all femora with two dark spots below; tibiæ with four equidistant brown spots

on bands; terminal tarsal joints dusky; basal tarsal joint of hind leg also dusky.

Female.—Unknown.

Type.—No. 10315, U. S. National Museum. Described from one male reared from *Asterolecanium aureum* Boisduval, collected at San Juan, Porto Rico, February 21, 1899, by A. Busck.

Perissopterus javensis, new species.

Female.—Length 0.72 mm.; expanse 2.2 mm.; greatest width of fore wing 0.28 mm. Eyes naked. Pattern of fore wings of the reticulate type. Ovipositor well extruded. Mesoscutum and mesoscutellum delicately hexagonally reticulate-punctate. General color orange, sides of thorax and abdomen marked with whitish; abdomen with more or less perfect cross-bands of brownish. Legs pallid; femora with two narrow bands of brown; tibiæ with three broad brown bands, broader on middle than on hind tibia, and with a narrow brown tip; first and fifth tarsal joints brownish, others pallid. Antennæ with club brown, yellowish at tip; third funicle joint brown, white at tip; first and second funicle joints (ring joints) brown; pedicel brown at base, white at tip.

Male.—Smaller. Color about as with female, but with small white thorax. Entire club brown except somewhat lighter at tip; pedicel whitish at tip.

Type.—No. 10316, U. S. National Museum. Described from 7 male and 8 female specimens reared February, 1900, from a species of *Tachardia* on an ornamental plant at Singapore, Straits Settlements, by A. Koebele (Koebele's No. 2005).

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MISCELLANEOUS PAPERS.

THE MORE IMPORTANT ALEYRODIDÆ INFESTING ECONOMIC PLANTS, WITH DESCRIPTION OF A NEW SPECIES INFESTING THE ORANGE.

By A. L. Quaintance.

In Charge of Deciduous Fruit Insect Investigations.

INTRODUCTION.

Systematically the Aleyrodidæ occupy a position between the Coccidæ and Aphididæ, two families of insects containing many serious pests of agricultural and horticultural crops. Species of Aleyrodidæ are, however, with a few exceptions, not at present of especial economic importance, though many of them occur in some numbers on useful plants. Also, with few exceptions, so far as known the injurious species of this family are not yet generally distributed over the world, as are so many scale insects and aphides, possibly from the fact that the Aleyrodidæ feed exclusively on the leaves of their host plants and are thus not so likely to be distributed in shipments of trees and plants as if occurring on the twigs and branches. When once established in a locality an introduced species, as compared with scale insects, would disseminate more rapidly, since the adults of both sexes are winged, though they are not strong fliers.

The Aleyrodidæ are most abundant in tropical or semitropical regions, though species of *Aleyrodes* in the United States are fairly abundant in the Transition zone. Species of *Aleurodicus*, however, are almost exclusively tropical, and with one exception are known thus far only from the Western Hemisphere, whence it is not improbable that this species was distributed.

The family contains only two genera—*Aleyrodes* and *Aleurodicus*—and 143 species have been described to date. The literature dealing with these insects is so widely scattered that it has seemed desirable to comment briefly on the species known to infest economic plants, so that their introduction or dissemination may be better guarded against.

ECONOMIC PLANTS AND THE MORE IMPORTANT ALEYRODIDÆ INFESTING THEM.

Tobacco.—Tobacco is attacked by two species of *Aleyrodes*—namely, *A. nicotianæ* Maskell, from Mexico, and *A. tabaci* Gennadius, from Greece. The former is apparently not of much economic importance, as shown by the condition of infested leaves from Mexico. *A. tabaci* is, however, more injurious, according to Targioni-Tozzetti, who

gives a very full account of the species in his "Animali ed Ensetti del Tobacco." The insect was first noticed in 1889 on leaves from Araucania, where it was said to be spreading more and more. In the work just cited it is remarked that, save possibly for a decrease in dimensions, the leaves do not show signs of alterations, but from the quantity of insects which remain on the dry leaves the tobacco is rendered unfit for use. No method of treatment is suggested.

Sugar cane.—No aleyrodids have as yet been recorded from sugar cane in this country, but abroad certain species are pests of importance. *Aleyrodes bergii* Signoret was described in 1867 from the Isle of Mauritius, where it was found on sugar cane. In Java this same species is at present a serious pest of cane, and there it has been carefully studied by Dr. L. Zehntner and reported on in the Archief Java Suikerindustrie for 1896. Two other species infest sugar cane in Java—namely, *Aleyrodes longicornis* Zehntner and *A. lactea* Zehntner, the former being quite destructive. These species have also been fully treated by Zehntner in the "Archief" for 1899. The remedial measures practiced consist in cutting off and burning the infested leaves, and spraying with milk of lime, which is said to destroy the immature insects, but not the developed parasite within the pupa case—*Ablerus pulchriceps* Zehntner, which attacks *longicornis*. *Aleyrodes lactea* is also attacked by the fungus *Aschersonia aleyrodis* Webber, or a very similar species, which attacks *Aleyrodes citri* in this country. *Aleyrodes sacchari* Maskell occurs on sugar cane in Fiji, and *A. barodensis* Maskell was received by Maskell from Baroda, India, with the advice that the insects were rather damaging to sugar cane in those parts.

Orange.—Of the several aleyrodids attacking the orange, *Aleyrodes citri* Riley and Howard is much the most important. In Florida especially this species at the present time is doubtless the most important of all of the insect pests of this crop, and it is also the subject of frequent complaint from southern Louisiana and to a less extent from southeastern Texas. The literature of this species is considerable, and its life history has been carefully worked out. Some important papers are: "The Orange Aleyrodes," by Riley and Howard (Ins. Life, Vol. V, p. 219); "Sooty Mold of the Orange and its Treatment," by H. J. Webber (Bull. 13, Div. Veg. Phys. and Pathol., U. S. Dept. Agric.): "The White Fly," by H. A. Gossard (Bull. 67, Fla. Agric. Exp. Sta.), and "White Fly Conditions in 1906, etc.," by E. W. Berger (Bull. 88, Fla. Agric. Exp. Sta.). At the present time the insect is the subject of a special investigation by the Bureau of Entomology. *Aleyrodes floridensis* Quaintance, more common on guava in Florida, also occurs on the orange, but on this latter plant it has not yet proved to be of special economic importance. In Arizona Prof. T. D. A. Cockerell has found on orange a form of *Aleyrodes mori* Quaintance which he has given the

varietal name *arizonensis*. *Aleyrodes aurantii* Maskell was described from specimens on orange from the northwest Himalayas, the leaves received by Maskell being thickly covered with the pupa cases. *Aleyrodes marlatti* Quaintance occurs on orange in Japan, and *A. spinifer* Quaintance on *Citrus* sp. and rose in Java.

For the past three or four years the Bureau of Entomology has received from Cuba orange leaves infested with an undescribed species of *Aleyrodes*, the description of which is given herewith:

Aleyrodes howardi n. sp.

(Plate VII; text figs. 23, 24.)

Egg.—Uniform brownish in color, without reticulations, curved; size about 0.18×0.09 mm. Stalk short, eggs lying prostrate on leaf, arranged more or less in circles or curves.

Larva.—Color and structure essentially as in pupa case.

Pupa case.—Size about 0.9×0.55 mm., subelliptical in shape. Many specimens with more or less evident indentures on cephalo-lateral margin of case, with cephalic end obtusely pointed. Color on leaf under hand lens with secretion removed, yellowish brown varying to blackish; under transmitted light yellowish to brownish yellow. There is a distinct marginal rim all around, with wax-tubes distinct, the incisions acute and tubes rounded distally. From margin of case all around arises a short rim of wax, composed of individual wax threads, serrated on margin as seen under a high power of microscope. Case usually quite covered by a very copious secretion of grayish, curling wax rods, which is very conspicuous on badly infested leaves, quite hiding the insects beneath (Pl. VII, fig. 1; text fig. 23). Denuded of secretion, pupa case is seen to be at first almost flat, but later becoming rather convex as the insect develops, with segments distinct.

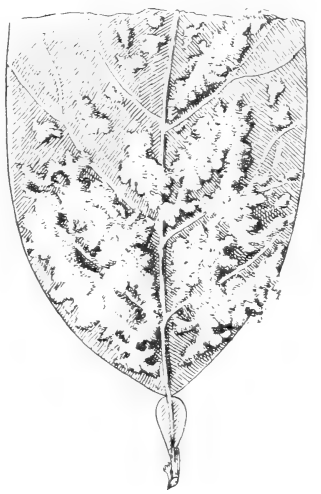


FIG. 23.—*Aleyrodes howardi*, showing copious secretion from pupæ, on lower surface of orange leaf. (Original.)

Dorsum with pair of strong setæ on first abdominal segment, a pair at vasiform orifice, and a pair at caudal margin extending some distance beyond margin of case. Vasiform orifice relatively small, subcordate, the rim dark brown, from 6 to 8 strong setæ or spines arising from caudal margin; operculum largely filling orifice, the distal margin with 2 faint notches; lingula not distinguishable (see fig. 24).

Adult female.—Usual; body yellow, wings immaculate; length of body about 0.84 mm.; hind tibiæ, 0.35 mm.; fore wing, 1 mm. long by 0.36 mm. wide. Hind tarsus, 0.16 mm.

Male.—Not seen.

Food plant.—Orange. Collected at Artamisa, Cuba, February 5, 1905, by C. L. Marlatt, and at Habana, Cuba, February 19, 1903, by E. A. Schwarz. Received from Dr. Mel. T. Cook, June 6, 1905, from Santiago de las Vegas, Cuba.

Judging from the abundance of this insect on orange leaves received from the above-mentioned sources, this is a very serious pest

of the orange, perhaps rivaling the so-called white fly of Florida (*Aleyrodes citri* Riley and Howard).

Described from numerous infested leaves, pupa cases in balsam mounts, and two females.

Type.—No. 10821, U. S. National Museum. Named for Dr. L. O. Howard.

Cotton.—*Aleyrodes gossypii* Fitch, described in Fitch's Third Report, is known only from the single type specimen on *Gossypium religiosum* from Ningpo, China. The second species is *Aleyrodes abutilonea* Haldeman, of which *A. fitchi* Quaintance appears to be a synonym. This species has been found on cotton at Harrisville, Miss.; Selma, Ala., and Columbus, Tex. At the place first mentioned the insects were very abundant, the lower surface of the leaves being covered with the pupa cases. The insect was also taken by Riley on cotton growing in his garden at Washington, D. C., and in Delaware, Maryland, and Virginia it occurs very abundantly on *Abutilon abutilon*, probably its native food plant, which it greatly injures, and is thus beneficial, since this plant is a troublesome weed.

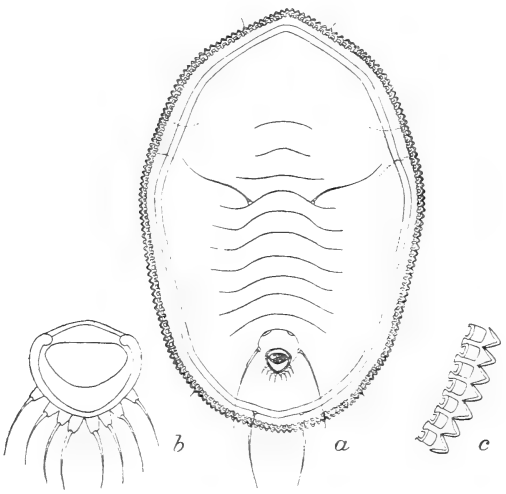
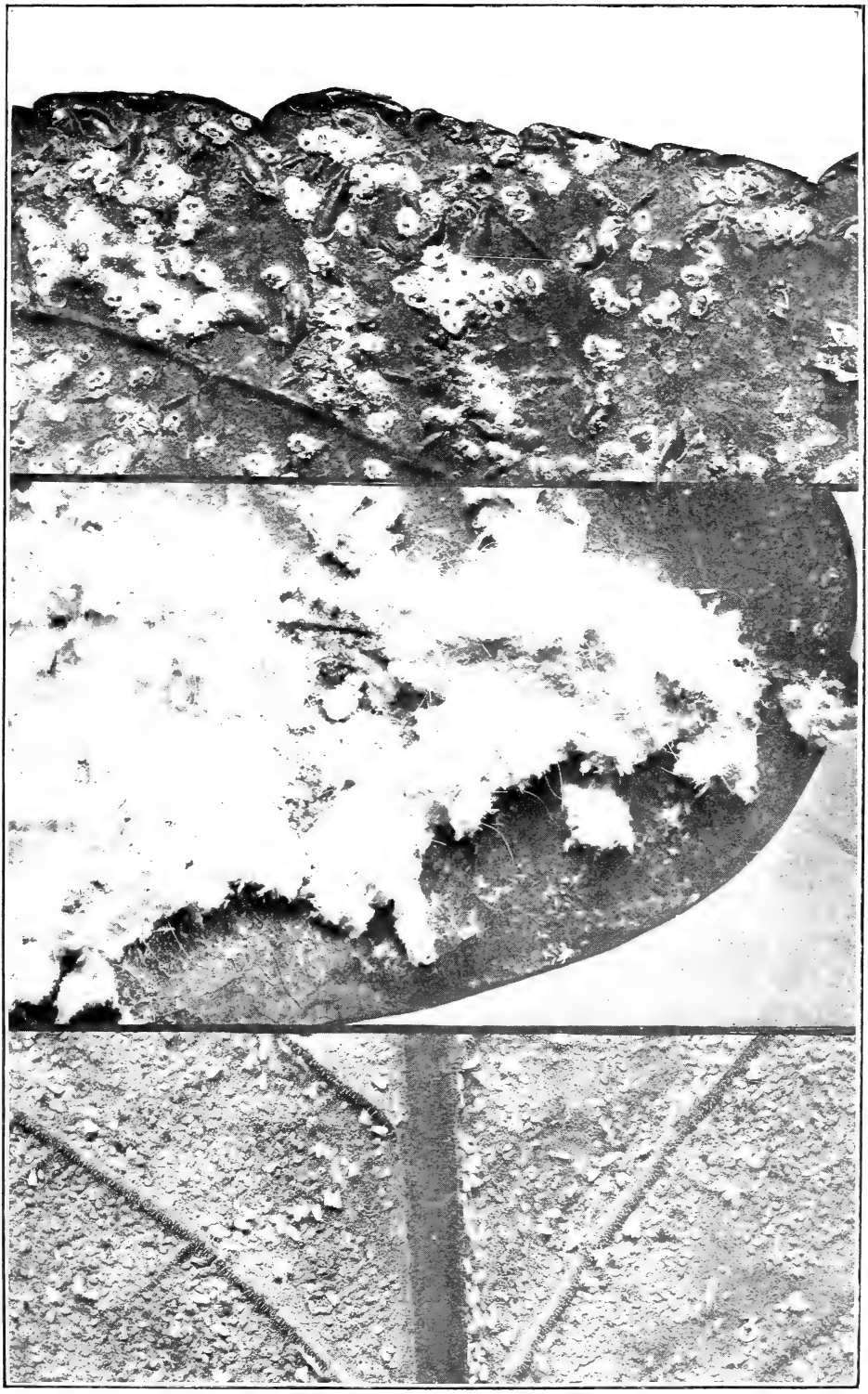


Fig. 24.—*Aleyrodes howardi:* Pupa case and details. Greatly enlarged (original).

Guava.—In Florida *Aleyrodes floridensis* Quaintance is quite common on the guava, the under surface of leaves sometimes being quite covered with the pupa cases. In Brazil *Aleyrodes horridus* Hempel and *A. goyabæ* Göldi occur on this plant, the latter often by hundreds, constituting a serious pest. *Aleurodicus cocois* Curtis infests guava in Trinidad, Venezuela, and Brazil. Guava is also infested by *A. cockerelli* in Brazil, and by *A. holmesii* Maskell in Fiji, which Cockerell thinks has there been introduced from America along with its food plant.

Cocoanut.—In Demerara and Barbados the cocoanut palm for many years has been seriously injured by *Aleurodicus cocois* Curtis, which, in company with a scale insect, was held responsible for a widespread disease of the trees on the latter island. This species was the subject of an article by Riley and Howard in Insect Life, Volume V, page 314 (1893). At the time this article was written, the introduction of this species into southern Florida on cocoanut, and guava, which it also infests, was considered only a matter of time, if not already accomplished. Thus far, however, nothing has been recorded of its occurrence in that State.



ECONOMIC ALEYRODIDÆ.

Fig. 1.—*Aleyrodes howardi*, on orange. Fig. 2.—*Aleyrodes anonæ*. Fig. 3.—*Aleyrodes vaporariorum*, on tobacco.

Custard apple (*Anona* spp.).—In Demerara *Anona muricata* and *A. squamosa*, and in Trinidad *A. reticulata*, are often seriously infested with *Aleurodicus anonæ* Morgan, and this same species has been reported on *Anona* from Pernambuco, Brazil. This species is remarkable from the large amount of cottony substance secreted, the under surface of badly infested leaves being thickly covered with it (see Pl. VII, fig. 2). *A. mirabilis* Cockerell occurs on *Anona* sp. in Mexico, and *Aleyrodes lacerdæ* Signoret is recorded from *Anona sylvatica*, the locality not being stated.

Strawberry.—*Aleyrodes packardi* Morrill is troublesome to strawberries, according to Morrill, and occurs in Ohio, Kentucky, southeastern New York, and Connecticut. Until the investigations of Doctor Morrill this species had been referred to *A. vaporariorum* Westwood, which it resembles. This and the greenhouse Aleyrodes (*A. vaporariorum*) are the subject of a valuable paper by Morrill published as Technical Bulletin No. 1 of the Massachusetts Hatch Experiment Station. *A. fernaldi* Morrill is also recorded from strawberry, though more abundant on Spireæ. In Europe *A. fragariæ* Walker occurs on strawberry, according to Walker, in myriads during July, but in France, as stated by Signoret, it is less numerous.

Cabbage.—In Europe *Aleyrodes brassicæ* Walker has long been known as more or less injurious to cabbage, kale, and other members of this family. According to C. W. Dale, and reported by J. W. Douglas, it is common on the indigenous wild cabbage which grows on the coast of the Isle of Purbeck, and the species is not to be regarded as imported and naturalized on cabbage cultivated in gardens. In Brazil, State of Sao Paulo, *Aleyrodes youngi* Hempel infests cabbage, the injury being considerable, as the infested leaves become yellow, wilted, and covered with a white powder, and are thus rendered unfit for use.

Greenhouse plants.—Several species of aleyrodids are known to infest plants in greenhouses, notably *Aleyrodes vaporariorum* Westwood, which in some sections of the North, as Massachusetts and Connecticut, constitutes a serious drawback to the growing under glass of such vegetables as tomatoes, cucumbers, and melons, and to such flowering plants as *Ageratum*, *Lantana*, and heliotrope. This species is a very general feeder, attacking plants representing several botanical families (see Pl. VII, fig. 3). An undetermined species having banded wings infests tomatoes and other vegetables under glass, and to some extent out of doors, in Florida. *Aleyrodes nephrolepidis* Quaintance occurs on a fern, *Nephrolepis*, thus far reported only from the conservatory of the Pennsylvania State College, where it evidently has been introduced. According to Professor Butz the adults were very abundant, flying around in the conservatory. Other aleyrodids occurring on ferns are *Aleyrodes filicium* Göldi, on *Asplenium cuneatum*,

and other Brazilian ferns, in the botanic gardens at Rio de Janeiro; and the same species has been reported on *Oleander articulata* and *Pteris quadriolata* in the Fern House, Kew Gardens, in England. *Aleyrodes aspleni* Maskell occurs on *Asplenium lucidum* and other ferns in New Zealand, though whether in conservatories or not is not indicated. *Aleyrodes citri* Riley and Howard is fairly common on citrus plants in greenhouses, though rarely troublesome. In Florida *A. rolfsii* Quaintance infests geranium in injurious numbers out of doors, and might become a pest to this plant in greenhouses if there introduced.

Rubus spp.—*Aleyrodes ruborum* Cockerell seriously infests a cultivated *Rubus*, *R. trivialis*, in Florida, and occurs scatteringly on a wild blackberry, *R. cuneifolius*. In France, Signoret found a species occurring in numbers on *R. fruticosus*, which he described as *A. rubi*, and in England *A. rubicola* has been described by Douglas, infesting a *Rubus* growing in a sheltered situation.

Currant.—*Aleyrodes ribium* Douglas occurs on red and black currants in England. This is possibly the same species which infests *Vaccinium uliginosum* in Germany.

Prunus spp.—Peaches and plums are at times infested with *Aleyrodes pergandei* Quaintance, the only aleyrodid recorded from these plants. It also occurs on Cratægus and wild crab-apple, though it is never injurious so far as yet reported.

Fig.—No aleyrodids are recorded from the cultivated fig, *Ficus carica*, but in India *Aleyrodes alcocki* Peal occurs very abundantly, especially after the rainy season, on young plants of *Ficus indica* and *F. religiosa*. These plants, from the fact that they take root on old buildings and similar situations, become a nuisance, and the insects are therefore regarded as beneficial by Mr. Peal, who expresses regret that the pupæ are so badly parasitized by a small yellow chalcidid fly.

Bamboo.—Various species of bamboo in the vicinity of Calcutta are infested with *Aleyrodes bambusæ* Peal. As a rule, according to Mr. Peal, only a few leaves in a bamboo clump are attacked, but the insect sometimes occurs in large numbers, killing the leaves.

Indigo.—*Aleyrodes leakii* Peal occurs on *Indigofera tinctoria* and *I. arrecta*, Behar, India, being more common on the latter plant. Need for its control is considered likely with the increased cultivation of these plants for commercial purposes.

Betel.—*Piper betle*, a pepper, the leaves of which are chewed by natives of Eastern countries with the betel nut, is attacked in Bakarganj, India, by *Aleyrodes nubilans* of Buckton, by whom it is reported as doing considerable injury.

Grape.—An undetermined *Aleyrodes* has recently been received on vinifera grape from Fred. W. Maskew, Marysville, Cal.

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U. S. D. A., B. E. Tech. Ser. 12, Pt. VI. Issued September 18, 1908.

MISCELLANEOUS PAPERS.

A RECORD OF RESULTS FROM REARINGS AND DISSECTIONS OF TACHINIDÆ.

By Charles H. T. Townsend.
Expert in Charge of Dipterous Parasites, Gipsy Moth Laboratory.

INTRODUCTION.

It seems opportune to present, for the benefit of those interested, a preliminary announcement of some of the results secured in the course of the work connected with the rearing of Tachinidæ, carried on under the direction of Dr. L. O. Howard, Chief of the Bureau of Entomology, at the Gipsy Moth Laboratory, Melrose Highlands, Mass. Credit is due to assistants for carrying out the details of much of the work, as well as for some originality on certain points. Mr. W. R. Thompson has made all the dissections and prepared all the early-stage material for permanent preservation, both microscope slides and alcoholics, all of which work has been performed most admirably. He perfected the method of bleaching the puparia so as to show the anal stigmata to the best advantage in a slide mount. He has also done all the photographic work. Mr. D. H. Clemons has been continuously employed on the investigation of the reproductive habits of the various species in the outdoor cages, in which work he has shown much ability. He made the startling discovery of the leaf-larviposition habit of *Eupeleteria magnicornis*. Mr. T. L. Patterson has attended continuously to the Japanese Tachinas, and secured from them the maximum day's record of oviposition.

As this work was entirely new, practically nothing having ever before been attempted in the way of systematically rearing tachinids from egg to fly, it called for considerable ingenuity and much originality of method. It further developed, almost at the outset, that the various species were by no means uniform in their habits of reproduction; in fact, so greatly did they differ in this respect that a method adapted to one was by no means sure to succeed with another. The first two species studied furnish an apt illustration of this point. They were *Parexorista cheloniæ* Rond. and *Blepharipa scutellata* R.–D. The former is practically confined to *Euproctis chrysorrhœa* L. and the latter to *Porthetria dispar* L. Both are single brooded.

It was found necessary, in order to secure proper mating and oviposition in confinement, to devise a cage that would approximate natural conditions. Such an one was constructed out of doors, and consisted of just enough wooden framework to support a wire-screen inclosure 7 feet in three dimensions with a canvas top for protection

FIG. 25.—Outdoor cage for rearing Tachinidæ, with vestibule. (Original.)

against sun and rain. Into this cage (see figs. 25 and 26) were put several hundred flies of the above two species. The "tanglefooted" trays devised by Mr. W. F. Fiske, containing young caterpillars of *Euproctis chrysorrhœa* and *Porthetria dispar*, were strung on wires within. The caterpillars can not get out of these trays, which

are open above, and the flies have free access to them. The invention of this tray is what made success possible with this cage. Food was provided for the flies in the shape of bananas and other fruit cut and sprinkled with sugar, and wet sponges supplied them with requisite moisture. This cage, thus furnished, proved to be a perfect success, although some supplementary devices were found necessary for certain species as the work progressed. The flies mated freely therein and were apparently as much at home as in the open.

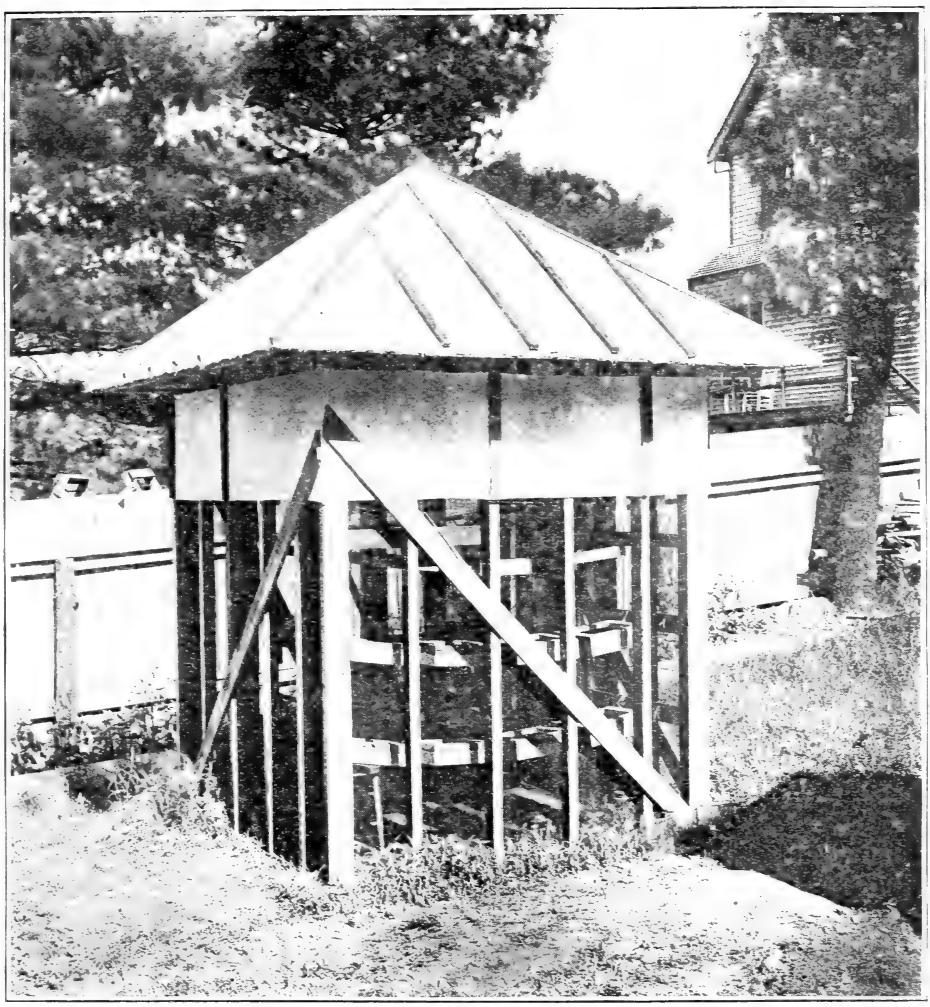

FIG. 26.—Outdoor cage for rearing Tachinidæ, showing disposition of "tanglefooted" trays within the cage. (Original.)

PAREXORISTA CHELONIÆ Rondani.

No difficulty was encountered in securing oviposition on the part of *Parexorista cheloniæ*, which deposited its elongate, cylindrical, whitish, thin-shelled, and pediceled eggs freely on the small caterpillars of *Euproctis chrysorrhœa* just out of the nests. The maggots, upon the hatching of the eggs, penetrated the caterpillars and a good

number of them were reared to the puparium in the trays. The four stages of the maggot were secured by opening some of the caterpillars from time to time. Thus the entire life-history was worked out for the species, so that now the egg, any stage of the maggot, and the puparium as well as the fly can be identified. The entrance of the newly hatched *cheloniæ* maggot into the young *chrysorrhœa* caterpillar was observed through a binocular microscope.

It must be stated here that, as a preliminary to the rearing work, the puparia of the various species were carefully studied, and it was found possible to identify them by the characters of the anal stigmata, which are very constant in the same form and furnish a variety of design in the various species that was totally unlooked for. By this means the puparia were sorted into species before the issuance of the flies.

The last stage of the maggot of *Parexorista cheloniæ* can always be told by the similarity of its anal stigmata to those of the puparium. The first stage, newly hatched from the egg, is very similar in the various forms of the true tachinids in having the body segments furnished with rows of minute, posteriorly directed spines, which aid the maggot in progression over the skin of the caterpillar and in entrance through the same. Its anal stigmata are not the same as those of the last-stage maggot. The second stage is characterized by the absence of a large proportion of the spines, especially those of the middle segments, and its anal stigmata begin to look like those of the last stage. The penultimate stage is the most interesting of all, and develops an unusual feature, hitherto not understood. The maggot of the first two stages derives no air from the outside, but in the penultimate stage it protrudes the pointed anal end through the skin of the caterpillar. This anal end of the penultimate-stage maggot is highly chitinized by virtue of its exposure to the air, and terminates in a pointed tube, which is curved in some species, and within the base of which lie the anal stigmata. Through this extruded tube the maggot procures air. Certain observers had already noted that some tachinid maggots protrude the anal end through the skin of the host, but it was supposed that certain species had this habit in all stages of the maggot, while others had not, since maggots are often found free inside the host.

The truth, however, is that the penultimate stage of many tachinid maggots, and this stage only, possesses this peculiarity. The last-stage maggots of these species live free inside the hosts, their cast, penultimate-stage, chitinized anal skins remaining *in situ* in the skin of the caterpillar at the point where they passed that stage. We have repeatedly dissected these anal skins from caterpillars containing last-stage maggots. The description of the maggot stages given above applies well to *Parexorista cheloniæ*. A few species, which will be

noted later on, not only remain as last-stage maggots within the chitinized anal skin of the preceding stage, but even transform to puparia therein, inside the caterpillar skin.

BLEPHARIPA SCUTELLATA Robineau-Desvoidy.

It was naturally inferred at this stage of the work that the reproduction of *Blepharipa scutellata* would be found as simple as that of *Parexorista cheloniæ*. Such inference was wide of the mark. All efforts to observe oviposition on the part of *scutellata* or to secure the deposited egg proved futile. The flies mated freely, remaining in copula four or five hours in some cases, but the females, unlike those of *cheloniæ*, paid no attention to the caterpillars. They even manifested alarm when the caterpillars were placed near them. In several instances they were observed to touch the ovipositor feebly to the surface or edge of the leaves upon which the caterpillars in the trays had been feeding. The supply of *scutellata* flies was limited, and it was not until this supply was exhausted that the truth dawned upon us. By dissecting dead females we secured the eggs, which were found to be minute and black, with a thin chitinized chorion, and about one-fortieth or one-fiftieth the size of those of *Parasetigena segregata* Rond., although the fly is ordinarily considerably larger than that species. The whole experiment recalled the observations of Sasaki[a] made twenty-two years ago on the Uji parasite (*Crossocosmia sericariæ* Corn.) of the silkworm in Japan. Sasaki's statements had been received with considerable incredulity by European students, but no longer seemed so improbable to us in the light of our investigation of *scutellata*, which, by the way, is extremely closely related to the Uji parasite. Every circumstance in connection with the strange behavior of the females of *scutellata* pointed directly to a habit of leaf-oviposition, the eggs to be swallowed by the caterpillars and hatched within their alimentary canal. When this conclusion had been definitely reached, no eggs of *scutellata* were on hand for experimental purposes. The conclusion had come very slowly, and was at first only doubtfully and reluctantly accepted.

PALES PAVIDA Meigen.

Soon after this, however, a similar case was encountered in *Pales pavida* Meig., a summer-issuing, two-brooded species, the flies of which began to emerge from the early-summer importations of puparia from Europe. The females of *pavida* acted in exactly the same way as did the females of *Blepharipa scutellata*. No deposited eggs could be secured, but the females were opened as they died and the eggs found

[a] Sasaki, C.—On the Life History of *Ugimya sericaria* Rondani. Journ. Coll. Sci. Imp. Univ. Japan, Vol. I, pp. 1–39, Pls. I–VI. Tokyo, 1887.

to be practically the same as those of *scutellata*. Some of these eggs, taken from a dead and dried female, were placed on pieces of leaf and fed to several species of caterpillars. The excrement of these caterpillars was carefully examined the next day and many of the eggs found therein, most of them empty, but two from the excrement of an arctian had passed through entire. The bits of leaf that this arctian (*Diacrisia virginica* Fab.) had swallowed with the eggs were in many cases six to eight times as large as the egg, conclusively demonstrating that these minute tachinid eggs can be swallowed entire by caterpillars with their food without injury to the egg. The arctian was opened nine days after, and a small *pavida* maggot, probably in its second stage, was found in the midst of a fat body next the alimentary canal. Thus the first step was gained toward a verification of the existence of this remarkable and hitherto reluctantly credited leaf-ovipositing habit in certain tachinids, including the removal from Sasaki of the stigma under which his startling observations had placed him.

ZENILLIA LIBATRIX Panzer.

A second step, which, in our opinion, practically removes all lingering doubt of the truth of our conclusions, was taken when *Zenillia libatrix* Panz. was studied. This is another summer-issuing, double-brooded species, whose eggs are quite similar in all characters to those of *Pales pavida* and *Blepharipa scutellata*. Although our supply of the flies was extremely limited, yet the very few females under observation, while they did not reach the point of actual oviposition, lived long enough to give us a decided insight into their habits.

We have found that female tachinids, when nearing their ovipositing period, will attempt oviposition and simulate with the ovipositor the action of an ovipositing female. In many instances we have observed ovipositing females make repeated attempts, thrusting the ovipositor at the caterpillars several times before actually depositing an egg. The last two of the *libatrix* females—which, by the way, had manifested the same alarm at the proximity of caterpillars as had the females of *P. pavida* and *B. scutellata*—were seen to touch the ovipositor excitedly as many as thirteen successive times to the newly eaten edge of a leaf where caterpillars had just been feeding. No egg was deposited, but the action showed the intent and, in our opinion, conclusively indicates the habit. About 150 mature eggs of *Z. libatrix* were secured from the last two females, after these died, and were fed on pieces of leaf to caterpillars of *Euvanessa antiopa* L., *Melalopha inclusa* Hbn., and *Schizura concinna* S. & A. The result of this experiment remains to be seen, but I hazard the prediction that *Z. libatrix*, *P. pavida*, and *B. scutellata* will all be found to possess the leaf-ovipositing habit.

Two other European species—as yet undetermined, but which I refer doubtfully to *Masicera* and *Phorocera*—both reared from *Euproctis chrysorrhœa*, have similar eggs and doubtless have the same habit.

PROBABILITY OF AN EXTRA MAGGOT STAGE IN LEAF-OVIPOSITING SPECIES.

It should be mentioned here that in all probability *Blepharipa scutellata*, *Pales pavida*, *Zenillia libatrix*, and the other flies belonging to this group have an additional maggot stage over other tachinids, since the newly hatched maggot is so very much smaller in size than are those of the latter. It ranges from one-tenth to one-fiftieth the size of the newly hatched maggots of those species which deposit eggs or maggots on the caterpillars, or maggots on the leaves, and yet is often much larger in the last stage than are they. In such case its second stage would correspond to the first stage of the other tachinid maggots, and would not show the last-stage type of anal stigmata. This is the case with the maggot of *P. pavida* above mentioned, which is evidently in its second stage and whose anal stigmata do not yet show the four slits of the last-stage maggot. Each anal stigma appears as a bifid plate with scalloped edge, indicating a further split of each half at the next molt, which would produce the last-stage type.

THE DEPOSITION OF LIVING MAGGOTS BY TACHINID FLIES.

We come now to another phase of tachinid reproduction. It has long been known that *Sarcophaga* and its immediate allies deposit living maggots. It was not definitely or generally understood, however, that many true tachinids do the same thing. A remark made by Lowne in his Anatomy of the Blowfly, to the effect that both *Sarcophaga* and *Tachina* (these names evidently used in the wide sense) deposit living maggots, and the records cited by Brauer in Die Zweiflügler des kaiserlichen Museums zu Wien, Volume III, that *Echinomyia grossa*, *Miltogramma conica*, and *Trixa* are larviparous, are the only references I have seen to this fact. We found before we had gone very far, however—in fact, this point developed with *Parexorista chelonia*—that female tachinids of certain species may deposit eggs practically undeveloped, or at any stage of the development of the embryo, or perhaps may even deposit living maggots.

It should be stated here that the eggs of muscoidean flies originate in tubes called the egg-tubes, a cluster of which forms an ovary. The egg-tubes of each ovary open through a single tube into the oviduct. The eggs, upon reaching full size, pass from the egg-tubes of an ovary through the single tube into the oviduct, at the lower end of which they are fertilized by the male element proceeding from the minute

long tubules which lead to the three spermathecæ or seminal vesicles. The latter receive the male fluid at the time of union of the sexes. The point of opening of the spermatic tubules marks the termination of the oviduct, immediately below which begins the long, tube-like, coiled uterus.

Upon dissecting dead females of *Parexorista cheloniæ* the uterus of certain of them was found to be packed not only with eggs but also with living maggots. The latter occurred at the lower end of the uterus next the ovipositor. As many as three hundred such eggs and maggots were found in the uterus of one *cheloniæ*. This explained why no definite period of time could be ascertained for the hatching of the egg of *cheloniæ* after its date of deposition. Some of the eggs hatched almost immediately after being laid upon the caterpillars, while others did not hatch for a week. After making this observation we realized that some of our species might be expected to deposit living maggots.

DEXODES NIGRIPES Fallen and **COMPSILURA CONCINNATA** Meigen.

The expectation that some species of Tachinidæ would deposit living maggots was immediately realized in the next species taken up, *Dexodes nigripes* Fall., a common summer-issuing species reared from both *Euproctis chrysorrhœa* and *Porthetria dispar*. The uteri of the females of *nigripes* were commonly found to contain living maggots, and these were apparently deposited, not on, but inside the skin of caterpillars of both *E. chrysorrhœa* and *Hemerocampa leucostigma* S. & A., and reared to the puparium in both. A very similar species, *Compsilura concinnata* Meig., apparently has the same habit of depositing living whitish maggots inside the skin of the caterpillars, and was reared in small caterpillars of *chrysorrhœa* from cold storage, not only to the puparium, but to the fly as well, thus proving at least three broods in one season for this species. It should also be stated that the above puparia of *Dexodes nigripes* similarly gave issuance to the flies, thus proving that it also has at least three broods.

The very remarkable point brought out in the investigation of these two species is that the females of both are provided with a long curved sheath, into the base of which the ovipositor fits, and which tapers to a microscopically sharp point. With this organ the females evidently puncture the skin of the caterpillars at the moment of larviposition, introducing the living maggot within the skin of the host. Such a habit was never suspected in the Tachinidæ. We have examined native species which are furnished with the same sheath and must have the same habit.

EUPELETERIA MAGNICORNIS Zetterstedt.

One of the next species taken up was *Eupeleteria magnicornis* Zett., which proved to be most remarkable as regards startling deviations from the previously known manner of reproduction among tachinids. The females of this species were most carefully labored with for a week or more in the attempt to secure their oviposition, using all kinds of caterpillars available. All efforts were in vain. Some dead females had been dissected and found to contain elongate, whitish, slightly curved eggs. It was not realized at the time that these females were immature so far as the development of the eggs in the uterus was concerned, and thus it was inferred that the species would deposit large elongate eggs on the caterpillars. It seemed quite inexplicable, therefore, when the females proved to be as much alarmed at the close proximity of caterpillars as were the females of *Blepharipa scutellata*, *Pales pavida*, and *Zenillia libatrix*. From the nature of the eggs it was impossible that they could be deposited on the leaves and eaten by the caterpillars. But why, then, should the females be so alarmed when brought face to face with the caterpillars? After much patient observation and experiment this question was answered. The flies were found to deposit living maggots, not on or in the caterpillars, but, most remarkable to relate, on the green shoots, leaf-stems, leaf-ribs, and even sometimes on the surface of the leaves!

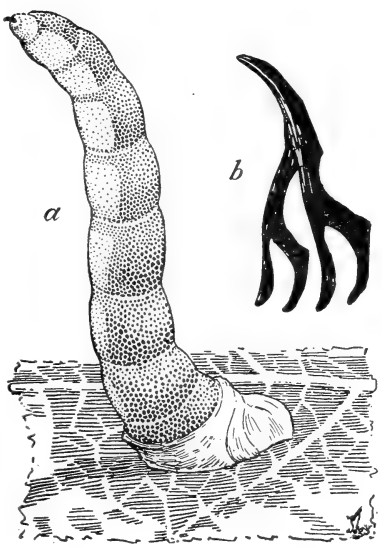

FIG. 27.—*Eupeleteria magnicornis*: *a*, First-stage maggot attached to leaf, awaiting approach of a caterpillar; *b*, enlarged mouth-hook of maggot. *a*, Greatly enlarged; *b*, highly magnified. (Original.)

The females would hover in the air about the shoots after the manner of syrphid flies, looking for caterpillars. They gave preference to the stems in depositing their maggots, and usually placed them where a silken thread had been left by a caterpillar as it climbed along a stem or over a leaf. Perhaps the sense of smell guided them in their larviposition on these silken threads. Several species of caterpillars were used with equal success, and it was found that the females would not deposit their maggots on shoots where caterpillars were not present. In fact it seemed necessary that caterpillars should have first crawled over the stems and leaves. The maggots are securely attached to the surface of the leaf or stem at the moment of deposition, by a thin membranous case, which is cup-shaped

and surrounds the anal end of the body. Attached to the leaf or stem by this base, the maggot (see fig. 27) is able to reach out in all directions as far as its length will permit—and it is much more slender and elongate than those maggots which hatch from deposited eggs. It is constantly in motion when it feels the proximity of a host. As the maggot is deposited on the silken thread with which a webworm or caterpillar of *Euproctis chrysorrhœa* marks its trail as it leaves the nest, the caterpillar is sure to pick it up in following its thread back. Doubtless the flies larviposit only on freshly laid strands, which have not lost the odor of the caterpillar. When the maggot is left undisturbed for a time it appresses its body longitudinally to the surface of the stem or leaf-rib to which it is attached. But the moment it is touched by any object it immediately becomes extremely active, striving to attach itself to the looked-for host. As soon as it lays hold on a caterpillar the motion of the latter and the exertions of the maggot itself pull it loose from the membranous cup-shaped base, which remains where it was attached.

It is probable that this habit of larviposition in *Eupeleteria magnicornis* has been developed on account of the advantage gained thereby in the certainty of attachment of the maggot to a caterpillar. Being deposited where the caterpillar must pass over it, the maggot can attach itself with great ease to the legs or underside of the caterpillar, where the hairs are few and short. It would be much less certain of attachment if the female attempted to deposit it directly on the caterpillar. The fly is large and would unduly alarm the caterpillar, which would make frantic efforts to shake the maggot off. In this it would often succeed before the maggot could find its way through the barbed hairs that protect the upper and lateral surfaces of the caterpillar's body.

The maggot of *Eupeleteria magnicornis*, as might be expected, in view of its deviation in habit from the maggots of those species previously studied, has the integument quite different in character, since it must remain for a considerable time outside the host. The species which deposit living maggots on the caterpillars, as well as those which deposit eggs, have a whitish, thin-skinned maggot. The maggot of *magnicornis*, however, has a tougher skin and is quite dark in color. In the opinion of the writer, it is one of the most specialized tachinid maggots known, although the body shows 13 very distinct segments. The integument, both dorsal and ventral, is furnished with minute, slightly chitinized, scale-like plates, save only the median ventral region. Those of the dorsal region are distinctly larger and more chitinized than are those of the lateral ventral region, but the median ventral surface of each one of the body segments except the anal is entirely without them, being furnished instead with a band of minute black spines, which are entirely lacking on the dorsal surface. Thus

it is readily seen that this maggot is especially well adapted both to remain a very considerable time in the air and to cling to and make its way over the skin of the caterpillar as soon as the latter presents itself.

This species possesses the further peculiarity of transforming to its last maggot stage inside the chitinized anal penultimate-stage skin, and also of changing to the pupa within the same, the whole remaining inclosed in the caterpillar skin. As a consequence the puparium is very thin and light colored, since it is protected from the action of both light and air by the caterpillar skin as well as by the penultimate-stage maggot skin.

ZYGOBOTHRIA NIDICOLA Townsend.

Zygobothria nidicola Towns. is another species which has exactly the same habit of last-stage maggot and puparium as that just described for *E. magnicornis*. It is an extremely interesting species in many ways. The two sexes are so different in appearance that they might be taken for distinct species or even genera. The males, in our experiments, began issuing from the puparia much in advance of the females. The species has been reared from *Euproctis chrysorrhœa* only, and then under such conditions as to indicate that the females oviposit on the young caterpillars in the fall, the young maggots hibernating in the *chrysorrhœa* nests with the young caterpillars. For this reason it was named *nidicola*. Though the sexes are so different, the fact that they belong together has been proved by their issuance from puparia having the same anal stigmata. No oviposition was secured, but by dissecting females the ovarian eggs were found to be elongate, whitish, and much like the unhatched uterine eggs of *Eupeleteria magnicornis*.

ZYGOBOTHRIA GILVA Hartig and CARCELIA GNAVA Meigen.

Zygobothria gilva Hartig is a close relative of the preceding species, but has been reared by us from *Porthetria dispar* only. Its egg, which has been found by dissecting the female, is quite similar to that of *Zygobothria nidicola*.

Of somewhat the same character is the egg of *Carcelia gnava* Meig., which has been reared from both *Euproctis chrysorrhœa* and *Porthetria dispar*. The deposited egg of *gnava* has been secured. The fly places its eggs on the caterpillar. The egg is not as slender as that of *gilva*.

PARASETIGENA SEGREGATA Rondani.

The last group of species with which we have to deal is characterized by depositing, on the caterpillars, eggs more or less oval in shape, of comparatively large size, with one exception whitish in color,

and having a moderately or quite thick chorion. The first of these species that we took up was *Parasetigena segregata* Rond., which issued from hibernating puparia along with *Blepharipa scutellata*. For a time it was confused with the latter species, since only a dozen or so specimens issued and these were not at first examined with a lens. The radical difference in the behavior of the females soon attracted our attention to their distinctness from *scutellata*. The females were not alarmed at the close proximity of large caterpillars of *Porthetria dispar*, but, on the contrary, were highly excited to oviposition by them, repeatedly and most enthusiastically and energetically ovipositing upon them whenever the caterpillars were placed near. This is apparently a single-brooded species.

TACHINA AND ALLIES.

Tricholyga grandis Zetterstedt, *Tachina larvarum* Linnæus, and *Tachina utilis* Townsend are closely related to each other and all deposit very similar eggs, which are much like those of *Parasetigena segregata*, but somewhat narrower and more elongate in shape and with a thinner chorion. They are all deposited very freely upon caterpillars. The species of *Tachina* are at least double-brooded, and the second generation of *T. grandis* has been recently reared by us to the fly, showing it to be three-brooded.

The egg of an undetermined European species, which I refer doubtfully to *Hemimasicera*, is similar to these in all characters except that it is of a decidedly light-yellow color. The eggs of this group of species are normally deposited in a practically undeveloped stage of the embryo.

Two Japanese species of *Tachina*, representing in Japan the European *T. larvarum* and *T. utilis*, but specifically distinct from them, have the same character of eggs and belong in the group with *Parasetigena segregata*, just mentioned. What has been said of this group applies to them.

TACHINA CLISIOCAMPÆ Townsend.

An American species of *Tachina*, which I identify as *clisiocampæ*, also deposits the same kind of eggs. It has been reared from both *Euproctis chrysorrhœa* and *Porthetria dispar*. An interesting point has recently been determined in connection with it. It oviposits very freely on large caterpillars of *dispar* over the greater part of the *dispar*-infested area from Rhode Island to Maine. Last season great numbers of its eggs were found on the *dispar* caterpillars, a great many of which were brought into the laboratory for rearing. Not a single tachinid puparium was secured from them. The fact that no puparia could be reared from caterpillars covered with eggs seemed inexplicable. The explanation was found this season, when many

more such caterpillars were collected for rearing. In repeated instances the newly hatched maggot was observed as it escaped from the eggshell, and in none of the observed cases was the young maggot able to penetrate the tough skin of these large *dispar* caterpillars; the maggots were watched repeatedly through a binocular in their vain efforts to do so. This species, being a native, has not yet adapted itself to *dispar*. It has been reared from it to a considerable extent, but it is quite certain that in most of the cases the egg was deposited upon the smaller and younger caterpillars, whose skins are not so tough as are those of the large ones. A very few puparia were secured this season from many thousands of *dispar* caterpillars collected, showing that hardly any of the deposited eggs of the species took hold, for these eggs were common and numerously deposited. When the species does become adapted to *dispar* as a host, which it undoubtedly will eventually, it will prove a most efficient help in checking the increase of the latter.

It is very interesting to note that the Japanese Tachinas greatly resemble *clisiocampæ*, the American form. Both differ from the European *larvarum* in having a very decided, general golden tinge to the body bloom, especially that of the head and thorax. This bloom is quite distinctly silvery in *larvarum*.

JAPANESE REPRESENTATIVES OF EUROPEAN SPECIES.

Several representatives in Japan of European species have been recognized in the puparia secured from Japanese specimens of *Porthetria dispar*, a considerable quantity of such puparia having been imported from Japan the present season. The Japanese Tachinas have been mentioned above. *Crossocosmia* sp. has been plentifully received from Japan, where it represents the European *Blepharipa scutellata* and has the same leaf-oviposition habit. The fly has been reared of a Japanese *Pales* near *pavida*, which greatly resembles the European form and has the same habit. A Japanese species corresponding to that doubtfully referred (p. 106) to *Hemimasicera* has issued from the puparium, and differs from the European form in its darker coloring and golden instead of silvery bloom. Species representing *Compsilura concinnata*, *Zygobothria gilva*, and *Carcelia gnava* have also been found in the Japanese puparia.

IMPORTANCE OF STUDYING THE UTERINE EGGS OF TACHINIDÆ.

It has developed during the progress of the work that a study of the uterine eggs of tachinids is of primary importance in the investigation of the various species. Certain very positive deductions may be drawn from them as to habit of reproduction. Before securing

oviposition—and it has been seen that one is often baffled for a considerable time in effecting this—the females can be opened and the uterine eggs obtained. Those eggs contained in the upper extent of the uterus are of course the most recently fertilized and the least developed of the uterine eggs. If they have a very thin shell it is probable that they hatch within the uterus, and that the female therefore deposits living maggots. Such is the case with *Dexodes nigripes*, *Compsilura concinnata*, and *Eupeleteria magnicornis*, and with such dexiine and macronychiid flies as we have studied; and from the character of the eggs such is possibly the case with *Zygobothria gilva* and *Z. nidicola*, though only ovarian eggs of the last have as yet been secured. Furthermore, if the hatched uterine maggot is furnished with a membranous encasement of its anal end, it shows that this maggot is not to be deposited on the caterpillars, but is to be attached to the stems or leaves. Such is the case with *magnicornis*. The uterine maggots of *nigripes* and *concinnata* have no such anal membrane of attachment, and are introduced into the caterpillars. If the uterine eggs are slender and very elongate it is quite certain that they hatch in the uterus. Such is the case with the dexiine and macronychiid flies.

If, however, a thin-shelled egg is furnished with a pedicel, this is proof positive that the egg is intended to be deposited as such, but the thin shell indicates that it is normally deposited at an advanced stage of development of the embryo. Such is the case with *Parexorista cheloniæ*, whose eggs have a pedicel, and should normally hatch soon after deposition. The few occurrences of hatched maggots in the uterus of *cheloniæ* were doubtless due to an abnormal hatching of the eggs after the death of the females. No doubt, however, *cheloniæ* is in process of transition from an ovipositing to a larvipositing habit. It is greatly to the advantage of the species that the egg should hatch shortly after deposition, for this guards against its loss by molting. We have found that a large percentage of the eggs are molted off by the caterpillars. Those species which deposit living maggots derive a still greater advantage in this direction. Those eggs which have a thick shell are intended to withstand atmospheric conditions for some time, and may be deposited a week or more before the embryo is fully developed. Such is the case with *Parasetigena segregata*, *Hemimasicera* sp. (?), *Tricholyga grandis*, *Tachina larvarum*, *T. utilis*, *T. clisiocampæ*, and the Japanese Tachinas. That the eggs of these are large shows that they are to be deposited on the caterpillars.

Again, if the eggs are minute it is quite certain that when matured they will be black and highly chitinized, and each character points directly to a habit of leaf-oviposition. The chitinization indicates that the eggs are intended to withstand exposure to the elements and

to be swallowed. Equally indicative is minuteness, for otherwise the eggs could not be swallowed entire. It is probable that such eggs, deposited on leaves and intended to be swallowed, remain unchanged without losing their vitality for a very considerable period of time, until they are swallowed by the caterpillars. It is equally probable that such eggs are not deposited until the embryo is nearly or quite fully developed, and that the digestive juices and conditions which the egg encounters in the alimentary canal of the caterpillar act upon the chitin and cause the shell to weaken so as to release the maggot. It is certain that such eggs must hatch within a very few hours after being swallowed, otherwise they will pass out with the excrement. One of the fed eggs of *Pales pavida*, above noted, passed through a *dispar* caterpillar in about four hours. A minute egg can not have a thick chorion and is therefore provided with a chitinized thin one, which withstands atmospheric conditions equally as well as, or better than an unchitinized thick one. Furthermore, the chitinization strengthens the egg and thus lessens the chance of injury to it while being swallowed. Still further, we have found that the chorion of all these eggs possesses a minute raised reticulation, which we consider is intended as a framework to strengthen it so as to protect the egg still more fully from injury in being swallowed. Such are the eggs of the *Blepharipa scutellata* group above described, which includes *Pales pavida* and *Zenillia libatrix*. The chorion reticulation of *cheloniæ* and other tachinid eggs is not so thickened and raised.

Enough has been said to show how very largely the reproductive history of the species may be read from the uterine eggs, which can be dissected from almost any female fly, collected or otherwise. It is only necessary that the female be fertilized. Even the ovarian eggs from unfertilized females show a great deal, for we have noted that the ovarian eggs of *Parexorista cheloniæ* show the pedicel while still enclosed within the egg-tubes.

REPRODUCTIVE CAPACITY OF TACHINIDÆ.

The capacity for reproduction in the females of the various species of Tachinidæ is another very interesting subject, of which surprisingly little is known. The greatest number of eggs that we have noted in the uterus of *Parexorista cheloniæ* is about 300, but this number may not represent the full capacity of the females for reproduction. After the uterus is well filled, further eggs may reach it from the ovaries until its extreme limit of distension is finally attained, and still more may follow as the contents are deposited. The uterus of a female of *Eupeleteria magnicornis* which had begun larviposition was found to contain, at a conservative estimate made from actual count of a portion, 3,200 eggs and maggots. This did not represent the full capacity of the female, for the egg-tubes in the

ovaries still contained ova. The uterus in this specimen was very long and coiled, and greatly distended by its contents. This is a high record of reproductive capacity. It is quite probable, however, that *Blepharipa scutellata* exceeds even this record, for the fly is large and the egg minute. Besides, a habit of leaf-oviposition would presuppose a lavish productiveness of eggs. Sasaki estimates a capacity of over 5,000 for *Crossocosmia sericariæ*, and some of our native species having the same habit equal this estimate. *Tachina* and its close allies deposit a great many of their comparatively large eggs, but their capacity does not seem to much exceed 100, judging from those we have opened. The other species that we have so far studied have, upon dissection, shown from 100 to 5,000 uterine eggs. The uterus of a native macronychiid fly, *Microphthalma trifasciata* Say, which deposits living maggots, was found by us to contain some 2,000 eggs and maggots. Native species having the leaf-larviposition habit commonly show from 2,000 to 3,000 uterine eggs and maggots, and those having the leaf-oviposition habit run up to 5,000 uterine eggs. The genera of these are given farther on.

THE REARING OF TACHINIDÆ IN CONFINEMENT.

It had currently been supposed that the oviposition of tachinids in confinement was a most difficult thing to secure. With proper facilities at hand, such is by no means the case. The Riley rearing cage, large or small, is not at all adapted to the work, yet some species may be induced to oviposit in it, and even in the very restricted space under a jelly glass. The proper cage for this work is our large out-of-doors wire-screen cage, which is shown in figures 25 and 26. For indoor rearing of single caterpillars bearing eggs or containing maggots we have adopted the glass cylinders shown in figure 29. These have the top covered with cheesecloth, and are placed on a stand which consists of a simple cloth-covered frame 5 inches square. Two opposite sides of the frame are made higher than the other two, for the completed stand to rest on, so as to allow circulation of air beneath. Cheesecloth will not do for the covering of the frame, since the mesh will permit tachinid eggs and small maggots, or even small caterpillars, to escape. For the same reason cheesecloth will not do for the bottom of the " tanglefooted " trays. We have known full-grown maggots to work through it with ease. For both frames and trays a more closely-woven cloth should be used. Flies also can be placed in the glass cylinders, but a little dry sugar and a bit of wet sponge should be included with them. Many species will live for two or three weeks in this way. These cylinders are especially adapted to rearing tachinid maggots in single caterpillars, either indoors, or, during warm weather, in one of the large cages outdoors, which may advantageously be furnished with shelves for this purpose.

In our large outdoor cages we have been greatly struck with the extreme docility of the ovipositing female tachinids. They can be handled and caused to oviposit quite at the will of the operator in most cases.

AN IMPROVEMENT IN THE METHOD OF COLONIZING TACHINIDÆ.

The extreme ease with which oviposition was secured in the cases of *Tricholyga grandis* and the Japanese and European Tachinas in the outdoor cages suggested the feasibility of an improvement in the method of colonization hitherto practiced. Until this season only the flies themselves had been liberated, but recently the plan has been adopted of colonizing caterpillars upon which the tachinids have been induced to oviposit, in conjunction with the liberation of the flies. Egg colonization, or the colonization of the caterpillars with the eggs on them, is a step in advance of fly colonization, and thus gives greater assurance of success in the establishment of the species. It has proved very easy of accomplishment. Over 1,000 webworms were colonized in July with eggs of the Japanese Tachinas on them. Oviposition was secured in an outdoor cage by one assistant at the rate of 200 to 300 eggs per day during favorable weather, these being furnished by but little over a dozen ovipositing females. These flies were afterwards liberated. The cage used is shown in figure 28.

Early in August a new lot of Japanese Tachinas had become ready for oviposition in this cage, and one assistant in one day, working six hours, secured 335 eggs from them on young caterpillars of *Euproctis chrysorrhœa* from cold storage, one egg on a caterpillar. This lot of eggs came from not over 20 ovipositing females. This is a very high record of oviposition—almost an egg a minute—for it must be remembered that the caterpillars had to be exposed, one at a time, to the flies. These eggs, with others secured on other days, were colonized by placing the caterpillars on new oak growth near the laboratory, where defoliation by *Porthetria dispar* had occurred early in the season. This second lot of Japanese flies was afterwards liberated, over a thousand eggs having been secured from them on young *chrysorrhœa*, and colonized. Some of the advantages of egg colonization before liberation of the flies are the provision in the outdoor cages of food and caterpillars for oviposition, and protection from enemies preceding and during a part of the ovipositing period. Furthermore, after fly colonization, if we find eggs of the flies in question on caterpillars in the vicinity, we naturally consider the establishment of the species to be more or less assured. If, however, we colonize the caterpillars themselves with the eggs of the flies already on them, we have this assurance at the moment of colonization, which must be considered a very great advantage.

NEW ALTERNATE HOSTS FOR INTRODUCED TACHINID FLIES.

An important problem in the process of establishment of imported summer-issuing species of tachinids is that new alternate hosts must be found for them in this country. The caterpillars of *Porthetria dispar* and of *Euproctis chrysorrhœa* have mostly pupated by midsummer, both here and abroad, and are thus not available as hosts after that time. Therefore the late summer generations of these tachinids develop in certain alternate hosts which occur in their native country. Those alternates are not present here, and new alternates must be provided for them from our native species. Fortunately tachinids are quite amenable to a change of host. Gratifying results have been obtained in this direction. Tussock caterpillars (*Hemerocampa leucostigma* S. & A.), have proved very acceptable to *Dexodes nigripes*, *Compsilura concinnata*, *Tricholyga grandis*, and other species, but they are not sufficiently abundant after midsummer to be of use for egg colonization on a large scale. Caterpillars of *Datana*, *Basilarchia*, *Euvanessa*, *Anisota*, *Schizura*, *Melalopha*, and others have been found acceptable to the flies in most instances, but likewise none of these is sufficiently abundant at the right time. We were at first very much at a loss for suitable alternate host caterpillars in sufficient number. It was therefore most gratifying to find that the newly hatched fall webworms (*Hyphantria cunea* Dru.) just coming on, which were abundant and easily obtained, were admirably suited to the purpose. Profuse oviposition was secured on these from the Japanese Tachinas, and also from *Tricholyga grandis*, *Tachina larvarum*, and others. The webworms, as soon as they had been oviposited on, were put back in the webs in large colonies to insure their prosperity. The females of *Eupeleteria magnicornis* industriously deposited their maggots on webworm-infested shoots, placed with the flies inside the wire-screen receptacle shown in figure 29.

To make success more certain in the egg colonization of the Japanese and European Tachinas, oviposition was also secured on young *chrysorrhœa* caterpillars that had been kept in cold storage until about the 1st of August. Had it not been for the fact that a great amount of new and tender oak foliage was available, where complete defoliation by *dispar* had occurred during the early summer, these *chrysorrhœa* caterpillars could not have been used. The old and matured leaves are not suited to the young caterpillars just out of the nests, but the latter flourish on the new oak growth.

Thus the question of alternate hosts in this country was satisfactorily answered, not only for purposes of egg colonization, but also for the needs of the liberated flies. The flies of *Tricholyga grandis* and the first lot of flies of Japanese *Tachina*, all of which had, so to speak, been trained to webworms through much oviposition on them, were colonized in separate webworm localities. Thus it was certain

not only that their wits had been sharpened for webworms but that they would find plenty of these on which to oviposit.

Similarly, the second lot of flies of Japanese *Tachina*, which had been trained to oviposition on *chrysorrhœa* entirely, was furnished at the time of liberation with a good supply of native cold-storage *chrysorrhœa* caterpillars of fair size, placed on new and tender oak growth, the *chrysorrhœa* of the vicinity being little more than hatched

FIG. 28.—Outdoor cage for securing oviposition of Japanese *Tachina*, covered about door with paper to prevent the flies from congregating at that point. (Original.)

at the time and too small to furnish it with proper host material. Some of these caterpillars were dissected about a week later and 20 per cent of them showed living maggots of *Tachina*.

IMPROVEMENTS IN THE OUTDOOR REARING CAGE.

Experience with the outdoor cage described on page 96 has suggested two improvements, which will be put into practice the coming season. It is often highly desirable to be able to admit all the sunlight and warmth available in the Massachusetts climate. For this

purpose the canvas roof should be capable of being shifted completely to one side, so as to admit the sun, and swung back over the cage again during bad weather and at night. The cage used for the Japanese *Tachina* was made without any roof, being open to the sky through the wire screening. Tarred roofing was placed over it when needed. This proved to be a very great advantage.

The second improvement will consist in a raised cement floor to extend a foot all around outside the wire screen, this outside portion to contain a shallow trench that should be kept constantly supplied with a little kerosene on water. This will obviate all difficulty from ants, carabids, and spiders, which will often kill the flies if not care-

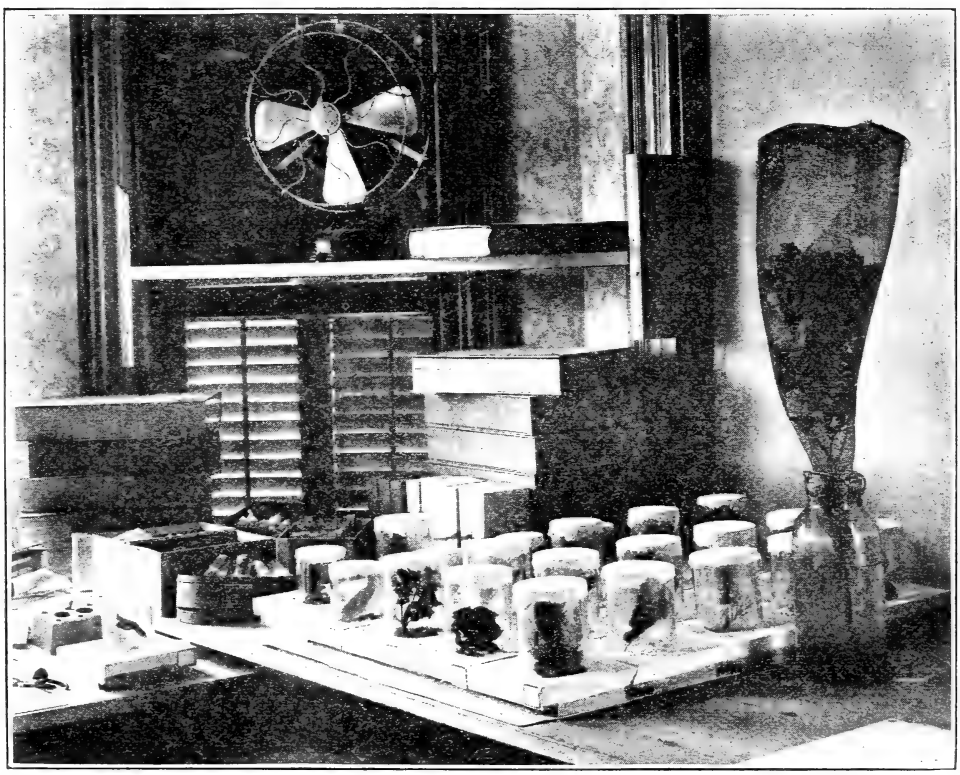

FIG. 29.—Glass cylinders in use in rearing Tachinidæ, and wire-screen receptacle for inclosing flies with caterpillars on foliage. (Original.)

fully watched. The floor can be sloped slightly inside the cage, so as to drain off through a pipe to be carried beneath the kerosene trench. Next season there will also be erected a separate cage of this description fitted with shelving to accommodate the numerous glass cylinder stands necessary for the rearing of the different stages of tachinids separately in caterpillars, which can be accomplished much better under out-of-door conditions.

Attention should be called to the wire-screen vestibule with which our first outdoor cage was furnished (shown in fig. 25). This was found quite necessary in order to prevent the flies from escaping while the experimenter is going in and out of the door, certain species being

extremely active during warm, sunny weather. Figure 26 is introduced to show the disposition of the "tanglefooted" trays within this cage. Figure 28 shows the outdoor cage used in securing oviposition of Japanese *Tachina*, which, in default of a vestibule, was covered about the door with paper to prevent the flies from congregating there. Figure 29 shows the glass cylinders in use and the wire-screen receptacle for inclosing flies with caterpillars on foliage that can be kept green for a considerable time.

We further have in mind for next season a compound outdoor cage on these lines, 30 by 15 feet floor space, arranged with five compartments on each side of a passageway, each compartment to be 6 by 6 by 6 feet, so as to allow one experimenter to work separately with 10 species of flies at a time. The whole will be fitted with canvas roof and drop curtains, in sections, capable of being completely rolled up or lowered, as desired. A small table, with microscope and work materials for the use of the experimenter, will be placed at one end of the passageway. The other end of the latter will open outside by a screen door, and each compartment will open into the passageway only. The vestibule can thus be dispensed with, since the passageway will serve the purpose.

BLEACHING THE PUPARIA OF TACHINIDÆ.

One point connected with the preparation of early-stage tachinid material for permanent preservation deserves mention. It has already been stated that the anal stigmata of the puparia show excellent characters for the separation of the various forms. It is highly desirable to present photomicrographs of these along with the taxonomic results derived from a study of them, but no practical mounts for this purpose can be made of them in their natural condition. A series of bleaching experiments has therefore been instituted, and the puparia have been successfully bleached with chlorine water to any desired degree. The result is a slide mount from which either drawings or photographs may be made with ease.

RESULTS FROM DISSECTIONS OF NATIVE TACHINIDÆ.

I am able to include here some interesting results obtained from dissections of females of native tachinids. We have secured the uterine eggs of some seventy species, and the results are a revelation. *Bombyliomyia abrupta* Wiedemann, *Echinomyia algens* Wiedemann, 3 species of *Peleteria*, 3 species of *Archytas*, *Panzeria* sp., *Varichæta* sp., *Copecrypta* (*Trichophora*) *ruficauda* van der Wulp, and *Micropalpus* sp. show uterine maggots similar to those of *Eupeleteria magnicornis*, thus proving the abundant presence of the leaf-larviposition habit in our native fauna. The maggots of some of the forms differ in the details of the spines and plates. We now know thirteen species, therefore, that have this habit.

The great fecundity and consequent importance of *Blepharipa scutellata* and *Crossocosmia* sp. as parasites of *Porthetria dispar* is strongly suggested in a native species of *Parachæta*, whose uterus we found to contain some 5,000 minute black eggs similar to those of *scutellata*. Some of these uterine eggs, upon being slightly pressed beneath a cover glass, disclosed the fully formed maggots, which fact proves our supposition that eggs of the leaf-ovipositing species are ready to hatch at the time of deposition. Sasaki has shown this to be the case with the Uji parasite. Furthermore, the structure of the maggot itself, as well as that of the chorion, shows that the former may remain quiescent within the latter for a considerable period until the egg is swallowed by a caterpillar. The newly-hatched maggots of this group are quite as specialized as are those of the *magnicornis* group, but in a totally different direction. Those above mentioned were found to be broad-oval, considerably flattened, the anterior end slightly narrowed and pointed, and with the spines chiefly disposed on the anterior segments. There are 12 rows of spines, each segment except the last having a row, but the rows of the middle segments are very short. The first four rows, on segments 1 to 4, are complete and continuous on all sides; the next seven rows, on segments 5 to 11, are incomplete, showing from 4 to 8 spines in the middle on the ventral surface only, segments 6 to 9 having the least; the last row, on the preanal segment, is complete. The spines of the first three dorsal rows are especially strongly hooked and claw-like, the hook process of each pointing backward so as to hold the maggot in piercing the walls of the alimentary canal of the caterpillar. The spines of the other rows are also claw-like, but the hooks are less strongly developed. Last, but especially suggestive, is the fact that the lateral portions of the maggot show a row of large fat globules on each side just inside the skin, which are no doubt designed to sustain the maggot until the egg is swallowed. (See fig. 30.)

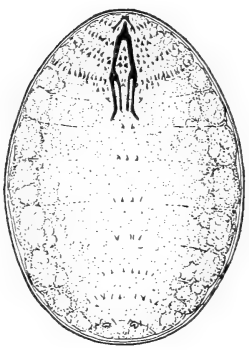

FIG. 30.—*Parachæta* sp.: Uterine egg with chorion removed, showing structure of the fully formed maggot from below. Highly magnified (original).

Gonia frontosa Say, *Pseudogermaria* sp., *Blepharipeza leucophrys* Wiedemann and a second species, *Parachæta* sp., *Latreillimyia* sp. (aberrant form from Pennsylvania), *Triachora unifasciata* Desvoidy, two species doubtfully referred to *Masicera*, *Exorista* sp., *Eusisyropa blanda* Osten Sacken, *Sisyropa* sp., and two species near *Eusisyropa* (Laboratory Nos. 1979, 2322) have all been found to have minute eggs similar in size to those of *Blepharipa scutellata*. Thus, at the very first examination of our native species we find fourteen different forms that we can say positively have the leaf-oviposition habit. Five of

the two dozen European species that we have studied are to be added to these, making a total of nineteen American and European species now known to have this habit. It is therefore evident that, while European and American students were industriously engaged in criticising and discrediting Sasaki's statements, abundant proof of them was right at hand on both continents, had anyone stopped to look for it.

The uterine eggs of the other native forms dissected indicate a habit of oviposition on, or larviposition in or on the host. The dexiine flies appear so far to deposit living maggots, slender and pointed like those of the macronychiid flies. *Theresia tandrec* Coquillett (*non* Robineau-Desvoidy) deposits the same kind of a maggot, except that its anal end is bifid into two slender processes in which the tracheæ terminate. The pseudodexiine flies deposit a maggot somewhat less elongate, and some of the masiceratine and phoroceratine flies, one still more shortened. One species near *Masicera*, but with stout discal macrochætæ, was found to contain uterine maggots that were shortened and plump, with strongly marked complete rows of spines on the segments, greatly resembling certain œstrid maggots (*Œstrus* and *Gastrophilus*). *Hemyda aurata* Desvoidy gave us only ovarian eggs, which are elongate but do not seem to indicate larviposition. So far the leaf-oviposition habit seems confined to certain masiceratine, willistoniine and goniine flies and their near relatives, which seem to form two or three compact taxonomic groups. The habit of leaf-larviposition seems confined to the echinomyiine and hystriciine flies. An immense amount of this dissecting work must yet be done, however, before any generalizations can be made.

As might be expected, there is considerable diversity of type in the structure of the chorion of the minute eggs. This may, or may not, imply independence of origin. For example, the European species doubtfully referred to *Phorocera* (p. 101) has the exposed chorion (the part not attached to the leaf surface) limpet-shaped and showing concentric rings instead of the ordinary reticulation; and the exposed chorion of *Sisyropa* sp. (Laboratory No. 1975) is reticulate, but shows a remarkable, irregular, light-colored fringe around the edge, pierced with microscopic shot-holes. Both of these forms of egg, placed on the leaves, would greatly resemble extremely small miniatures of certain coccids!

SUMMARY OF REPRODUCTIVE HABITS NOW KNOWN IN THE TACHINIDÆ.

From what has been recorded in this paper it will be seen that we now know five different styles of reproductive habit in the Tachinidæ. These may be summarized as follows:

Reproductive habits.	Examples.
(1) Host-oviposition	*Tachina larvarum.*
(2) Leaf-oviposition	*Blepharipa scutellata.*
(3) Supracutaneous host-larviposition	Dexiine flies and allies.
(4) Subcutaneous host-larviposition	*Compsilura concinnata.*
(5) Leaf-larviposition	*Eupeleteria magnicornis.*

This is certainly an excellent showing for adaptation and variety of habit in a family as compact in character as the Tachinidæ, which does not include the macronychiids, muscids, or phasiids, and in which a certain unity of habit was long supposed to obtain. It may be further remarked that we have in one instance dissected two female specimens, separated with difficulty on slight external characters, and appearing at first to be the same species, and have found one to have the habit of leaf-oviposition and the other, a habit of either host-oviposition or host-larviposition. This aptly illustrates the necessity for a most careful study of external adult characters and a nice sense of discrimination—in other words, the zoological sense—in order to distinguish the many distinct but often closely similar forms of these flies. Slight differences in shade of pollinose covering, in width of front, in strength of frontal bristles, in hairiness of eyes, and in thoracic and abdominal lines—all of these easily overlooked—were the only external characters that enabled us to pronounce the two specimens distinct species. The character of the uterine eggs, however, at once demonstrated the very marked distinctness of the two forms, which can not be referred to the same genus, nor even to the same tribe, and perhaps not even to the same subfamily.

The five classes of reproductive habit mentioned above are arranged in the order of their probable antiquity, host-oviposition being considered the oldest and leaf-larviposition the most recent. This order not only seems natural from the reproductive standpoint, but is borne out by a study of the external characters of the flies themselves, principally the character of the facial plate.

CONCLUSION.

The results of all this work on European, Japanese, and American tachinids point to the very great importance of *Blepharipa scutellata* and *Crossocosmia* sp. as parasites of *Porthetria dispar*. The great capacity for reproduction, possessed by these species, and the fact that all of their eggs must be eaten by the caterpillars wherever *dispar* is abundant, place them in the lead of parasites.

No two species can be so relied upon as parasites of *Euproctis chrysorrhœa*, but the Japanese Tachinas, *Tricholyga grandis*, *Compsilura concinnata*, *Dexodes nigripes*, and *Parexorista cheloniæ* seem to be among the most important here.

All of the other imported species mentioned will prove of much importance as aids in the control of one or both of these moths. The great majority of them are parasitic on both hosts.

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U. S. D. A., B. E. Tech. Ser. 12, Pt. VII. Issued February 11, 1909.

MISCELLANEOUS PAPERS.

THE ORANGE THRIPS.

By Dudley Moulton,

Engaged in Deciduous Fruit Insect Investigations.

INTRODUCTORY.

The orange thrips, *Euthrips citri*, a new species, described in this article, has become a very important orange-tree pest in the southern San Joaquin Valley of California and has been the subject of special investigation. The writer has been able to talk with many orange growers and packers, and with men who have developed extensive nurseries, and the following notes have been gathered largely from these sources.

DISTRIBUTION.

The San Joaquin orange belt extends along the western border of the Sierra foothills from a point about east from the city of Fresno, southward to a short distance below Porterville, with some orchards as far south as Bakersfield. The belt is not at all continuous, but is broken in many places because of improper soil conditions, frosts, and the lack of water for irrigation. The thrips is distributed everywhere throughout this belt, but is not found, so far as I have been able to learn, in any other orange section of California.

EXTENT AND NATURE OF INJURY.

The orange groves in the San Joaquin belt are wonderfully profitable, for as much as $2,000 per acre has been realized in a single year from full-bearing orchards. This thrips problem is, therefore, a very important one when we consider the large area which is planted and is being planted.

Curled and thickened leaves and marked oranges, the characteristic signs of the thrips, have been known for from ten to fifteen years, but only recently have these injuries been attributed to the thrips. The thrips has been increasing rapidly in numbers, until now the annual loss to the orange growers amounts to many thousands of dollars.

The writer recently visited a packing house where oranges from thrips-infested orchards were being graded and boxed, and found that about 30 per cent were passed from fancy (first grade) to choice (second grade), which means a difference in price of about 40 cents per box; and that about 5 per cent of the crop was being passed out as culls, due entirely to the scablike markings of the thrips. While the quality of the fruit is not noticeably impaired, as the injury is present only on the surface of the skin, oranges are graded and also sold largely on appearance, and this scab produces a very unpresentable fruit. (See Pl. VIII, figs. 3, 4.)

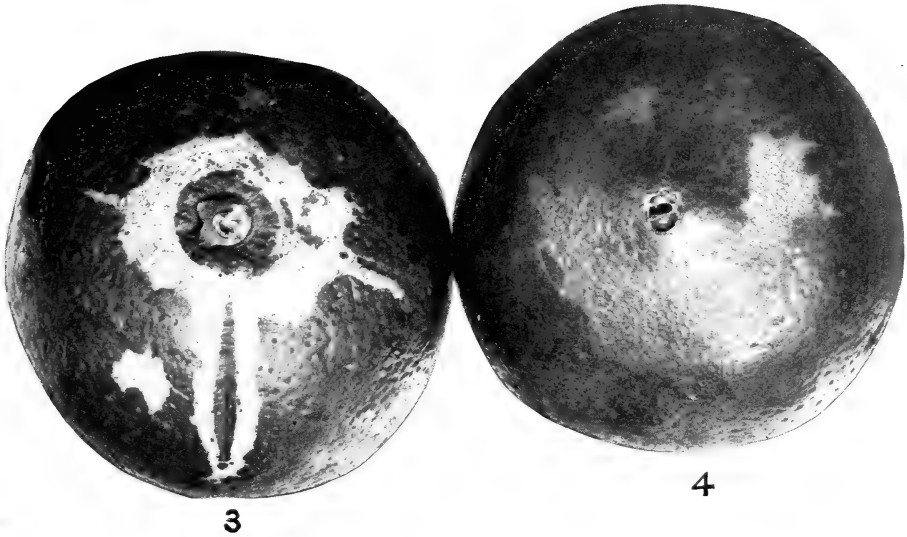
The thrips feeds also on the foliage and tender branches, and the damage to these is serious, although not so noticeable as on the fruit. Only newly unfolding and tender leaves and buds are attacked; as the feeding is mostly confined to the surface no part of the leaf tissue is killed outright, but there follows the "silvering," characteristic of thrips and other surface-feeding insects. The leaves become cup-shaped and wrinkled and the tissues noticeably thickened. (Pl. VIII, figs. 1, 2.) Orange trees in this section have four growths annually, so that there is always an abundance of new foliage present when the thrips is above ground.

LIFE-HISTORY NOTES.

There are apparently two broods of this species. Adults of the first brood appear just before the blossoms in February, March, and April, and a second brood appears in July, August, September, and October. Adults and larvæ of the first brood feed on the small oranges just as the petals are being thrown off, the larvæ usually under the protection of the sepals, and on the first growths of the foliage. The second brood feeds on the nearly mature oranges and on the third and fourth growths of the foliage. All varieties of oranges and lemons are attacked, but the very noticeable scabbing on the fruit is common only on the navel orange; it is less conspicuous on the Valencia.

SOIL CONDITIONS AS AFFECTING PREVALENCE.

It has been noticed that the thrips is not so prevalent on trees planted in sedimentary or loam soils as where the soil is of a clayey or adobe texture. This fact may be explained as follows: This thrips, like most others of its group, presumably spends the last of its larval, its pupal, and its early adult life in the soil underneath the trees, and would naturally, then, be more or less affected by the texture of the soil and by cultivation. Orange groves are usually irrigated several times during the summer and are cultivated throughout the year. Sedimentary soils break to pieces readily



WORK OF THE ORANGE THRIPS (EUTHRIPS CITRI, N. SP.).

Fig. 1.—Injury to tender orange shoot. Fig. 2.—Orange buds in axils of leaves killed back as fast as formed, preventing further growth. Fig. 3.—Scab injury at stem end of orange, due to work of thrips shortly after blossoms fell. Fig. 4.—Scab injury at distal end of orange, due to work of thrips late in season. (Original.)

when thus moistened and cultivated, and thrips in this ground would probably be broken from their small cells, if indeed they were able to make cells at all in this soil, and many of them would be killed by the cultivator and by the grinding together of the soil particles during cultivation. On the other hand, in clay lands the particles of soil pack closely together and form clods, and during cultivation any number of thrips within these clods might be repeatedly turned over and over without injury. In this soil, too, it would be possible for the thrips to make a strong, well-lined cell.

Another fact in the cultivation of orange groves should be mentioned in this connection. After the trees have become large and the fruit-laden limbs hang over and drag on the ground it seems impossible to cultivate thoroughly close up to the tree, and there may be an area of several square feet that is not disturbed during the entire summer. This offers an ideal breeding place for the thrips.

REMEDIES.

We are not able at this time to say what spray can be used to control this thrips, but a strong tobacco extract will doubtless prove effective and will not hurt the tree. Some of the cheaper soap washes ought also to be effective.

ENEMY.

It may be mentioned that a *Triphleps*, presumably *T. insidiosus* Say, is found everywhere feeding on the larvæ of this thrips.

DESCRIPTION.

The following description of the female of *E. citri* has been made after examination of many specimens. No males have yet been collected. The insect is called *citri* because, so far as we know, it feeds on citrus trees only.

Euthrips citri n. sp.

Measurements: Head, length 0.75 mm., width 0.15 mm.; prothorax, length 0.09 mm., width 0.18 mm.; mesothorax, width 0.24 mm.; abdomen, width 0.25 mm.; total body, length 0.86 mm. Antennæ: 1, 12μ; 2, 36μ; 3, 39μ; 4, 39μ; 5, 36μ; 6, 34μ; 7, 6μ; 8, 12μ; total, 0.205 mm. *Color*, yellow to orange-brown, with thorax and segment 2 of antennæ more noticeably orange-brown.

Head twice as wide as long, retracted considerably into the prothorax, broadly rounded in front, with only slight depressions to receive the basal joints of the antennæ; two spines on anterior margin, other spines not conspicuous; cheeks almost straight and parallel. *Eyes* large, occupying almost one-half the length of the head,

prominent; pigment deep red to purple; facets of eyes large, eyes pilose. Ocelli subapproximate, margined inwardly with yellow-brown crescents. *Mouth-cone* short, reaching almost to posterior margin of prothorax, broadly rounded and with black stop at tip; maxillary palpi 3-segmented. *Antennæ* 8-segmented, with segment 2 orange-yellow, other segments uniformly light brown; segments 2, 4, 5, 6 almost equal in length; style about one-half the length of segment 6. All spines inconspicuous; sense cones transparent.

Prothorax about twice as wide as long, posterior angles broadly rounded; with long brown and outer small spine at each posterior angle, other spines not conspicuous. *Mesothorax* largest and with anterior angles broadly rounded. *Legs* light yellow-brown, with tarsi lighter but dark brown at the tips; spines on legs brown. *Wings* present and fully developed, fore-wings broadest near base and pointed at tips; with a ring vein and a single longitudinal vein which divides at about one-third the length of the wing from the base, the anterior part running parallel and approximate to the anterior part of the ring vein and ending abruptly near the tip, the posterior paralleling and approaching the posterior part of the ring vein and ending about one-half the wing's length from the end, each branch with a dark-brown marking immediately at its tip. The costa bears a row of about 29 regularly placed spines. Other spines placed as follows: A group of 5 near base of median longitudinal vein; 2 on either side of where second vein branches from the first, and 3 scattered spines about equidistant on each branch vein and in each case one of these spines immediately at the end of the vein; several rather long spines on scale. Veins of the fore-wing unusually strong and conspicuous, somewhat orange colored near base but fading to yellow near tip. Membrane of wings transparent.

Abdomen ovoid, tip conical, all spines, excepting a very few at tip, inconspicuous.

Described from many female specimens collected from orange foliage and fruit at Exeter, Tulare County, Cal.

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MISCELLANEOUS PAPERS.

BIOLOGICAL STUDIES ON THREE SPECIES OF APHIDIDÆ.

By JOHN JUNE DAVIS,

Of the University of Illinois, Urbana, Ill.

INTRODUCTION.

This paper deals principally with the biology of three of our commoner species of aphides, and includes descriptions of the different forms in all their various stages, as well as a complete bibliography of these species.

I have carried on these rearing experiments for the past two years in the insectary of the State entomologist of Illinois, Dr. S. A. Forbes. Practically all of the data here given, however, were obtained in 1906.

I am especially under obligations to Doctor Forbes, under whose direction I have made the experiments—those relating to *Aphis maidi-radicis* while serving as his assistant; to Dr. J. W. Folsom, who has aided me on all parts of this paper, and to Prof. F. M. Webster, who read the manuscript and made helpful suggestions.

THE CORN ROOT-APHIS.

(*Aphis maidi-radicis* Forbes.)

GENERAL ACCOUNT.

The corn root-aphis was first recognized by Benjamin Dann Walsh, who found it, in 1862, at Rock Island, Ill., where it was doing considerable damage to a small field of corn. At that time it was supposed by Mr. Walsh to be a root form of the common corn leaf-aphis (*Aphis maidis* Fitch), which lives on the upper parts of the corn plant, while the corn root-aphis, as the name would indicate, lives on the roots.

Dr. S. A. Forbes first began the study of this root-aphis in 1883, and most of the facts now known relating to its life history, ecology,

and economic control have been obtained by him or under his supervision. When he began the study of this aphis, it was believed to be merely the root form of the corn leaf-aphis. Failing after many elaborate experiments to breed either from the other, and repeatedly tracing the complete life history of the root-aphis year after year with no appearance of the leaf-aphis at any time in the series, he regarded the corn root-aphis as a distinct species, and described it as such in 1891, in the Seventeenth Report of the State Entomologist of Illinois.

The insect has, of late years, become of great economic importance, not only in Illinois, but also in many other States of the corn belt. Outside of Illinois it has been reported as injuring corn in New York, New Jersey, Maryland, Virginia, West Virginia, Ohio, Indiana, Minnesota, Iowa, Missouri, Nebraska, Kentucky, Mississippi, Louisiana, and Colorado.

FOOD PLANTS.[a]

Although corn is its principal food plant, the corn root-aphis attacks also sorghum and broom corn; has been reported as attacking the roots of squash vines in Delaware and Ohio, and what is at present considered as this species has been found on the roots of numerous weeds and grasses, namely, smartweed (*Polygonum incarnatum*), knotweed (*P. persicaria*), crab grass (*Panicum*), purslane (*Portulaca oleracea*), dock (*Rumex crispus* and *R. altissimus*), *Setaria glauca*, *S. viridis*, *S. germanica*, fleabane (*Erigeron canadense*), mustard (*Brassica nigra*), sorrel (*Oxalis stricta*), plantain (*Plantago major* and *P. rugellii*), pigweed (*Amarantus hybridus*), and ragweed (*Ambrosia trifida*). In May, 1907, Mr. E. O. G. Kelly found it on wheat roots in a field which had been in corn the previous year. It has also been collected on the roots of cultivated aster, upon which I have found it to be of much economic importance in Illinois.

LIFE HISTORY.

Last year (1906) I obtained the complete life history of this corn root-aphis from the egg stage in spring to the egg in autumn. The vivaria which I used for the rearing and observation of this root aphis consisted of 8-dram or 10-dram glass vials, each containing a ball of moist cotton in the bottom and plugged at the top with a piece of cotton. In this cage a sprouting corn plant was placed, a reserve supply of these food plants being constantly kept for use. The first young and the last young of each generation were placed on corn roots in separate vials, and these vials were kept in closed boxes to exclude

[a] The scientific names of plants throughout this paper are given according to the nomenclature of Gray, in deference to the author's wishes.—Ed.

light, thus giving conditions probably most favorable to the optimum development of the aphis. As soon as the plant began to wilt it was replaced by a fresh one, the aphides being transferred thereto by means of a camel's-hair brush.

During the life cycle of this aphis there appear five different forms, namely, winged viviparous females, wingless viviparous females, oviparous females, males, and eggs. Briefly, the life history is as follows: From the eggs, which have been found hatching in the field between April 8[a] and May 22, from 10 to 22 generations may follow. These generations are all viviparous from spring until the latter part of September or in October, according to conditions of temperature, etc. The last generation of the season is known as the oviparous generation, and consists of males—wingless only, so far as known—and oviparous wingless females. The males and females pair, and the females lay eggs, usually during the months of October and November, the eggs not hatching until the following spring.

Now follows a detailed account of the life history as worked out by me in 1906. Eggs collected at Elliott, Ill., April 12, 1906, in the nests of the common brown ant (*Lasius niger* L., var. *americanus* Emery) were placed in a cage in our insectary April 16. They were first noticed to be hatching April 17. Young aphides hatching April 18 and 19 were placed on corn roots in the previously-described vials, and two lines of generations were thus started, both of which were carried through to the egg in the fall. These stem mothers—that is, the aphides hatching from the egg—produced their first young May 1 and 4, respectively, and their last young May 18 and 14, respectively. Taking the *first young of the first young* all the way through the series, 22 generations were obtained, counting the oviparous generation as the last. (See Tables I and II.)

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[a] In 1906 Mr. E. O. G. Kelly, a field assistant of the State entomologist of Illinois, searched for eggs and young of *A. maidi-radicis* in the fields, beginning the 1st of April. He did not find eggs until April 12, and on April 17 he found the young stem mothers in the field. The following year Mr. Kelly first found eggs March 24 (these hatched in the insectary March 26), and young stem mothers were found in ants' nests as early as March 29. April 15 he found the young with their beaks inserted in old corn roots, this probably being occasioned by the fact that large numbers of the weeds upon which the aphis usually feeds at this season had been killed by the very cold weather of the preceding week.

TABLE I.—*Line of generations of Aphis maidi-radicis from egg to oviparous generation, 1906.*

Generation (from egg).	Date of birth.	Date it became adult.	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.*
1	Apr. 18	Apr. 30	May 1	13	May 18	17	2	96	5.6	10	May 20	32
2	May 1	May 12	May 13	12	May 27	14	6	74	5.3	10	June 2	32
3	May 13	May 19	May 21	8	May 30	9	1	53	6.6	9	May 31	18
4	May 21	May 27	May 29	8	June 4	6	0	31	5.3	7	June 6	14
5	May 29	June 5	June 6	8	June 24	18	8	89	4.9	9	July 2	34
6	June 6	June 14	June 15	9	July 2	17	9	76	4.4	7	July 11	35
7	June 15	June 22	June 23	8	July 25	2	0	7	3.5	4	June 25	10
8	June 23	.....	June 30	7	July 15	15	0	74	4.9	7	July 15	22
9	June 30	July 7	July 8	8	July 11	3	0	22	7.3	7	July 11	11
10	July 8	July 14	July 15	7	July 23	8	0	53	6.6	7	July 23	15
11	July 15	July 22	July 22	7	July 24	2	0	7	3.5	.....	July 24	9
12	July 22	July 29	July 30	8	Aug. 8	9	1	51	5.1	8	Aug. 9	17
13	July 30	Aug. 5	Aug. 5	6	Aug. 9	5	0	24	4.8	6	Aug. 9	15
14	Aug. 5	Aug. 12	Aug. 12	7	Aug. 16	4	0	17	4.2	6	Aug. 16	11
15	Aug. 12	Aug. 18	Aug. 19	7	Aug. 24	6	0	33	5.5	8	Aug. 24	13
16	Aug. 19	.....	Aug. 27	8	Sept. 9	14	0	66	4.7	10	Sept. 9	22
17	Aug. 28	.....	Sept. 5	8	Sept. 8	3	0	13	4 +	6	Sept. 8	11
18	Sept. 5	.....	Sept. 12	7	Sept. 20	9	1	28	3 +	6	Sept. 21	17
19	Sept. 13	Sept. 19	Sept. 20	7	Sept. 27	8	1	41	5 +	9	Sept. 28	16
20	Sept. 21	Sept. 28	Sept. 30	9	Oct. 2	3	0	10	3 +	4	Oct. 2	12
21	Sept. 30	Oct. 13	Oct. 14	14	Nov. 2	19	5	29	1.5	.....	Nov. 7	38
22 [a]	Oct. 14	Oct. 27	.....	.....	.....	.....	.....	.....	.....	.....	{Nov. 22– {Nov. 23	39

[a] Oviparous generation.

TABLE II.—*Line of generations of Aphis maidi-radicis from egg to oviparous generation, 1906.*

Generation (from egg).	Date of birth.	Date of becoming adult.	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.*
1	Apr. 19	May 2	May 4	15	May 14	10	1	36	3.6	6	May 15	26
2	May 4	May 15	May 16	12	June 4	19	5	64	3.4−	8	June 9	36
3	May 16	May 23	May 24	8	June 2	9	0	50	5.5+	8	June 2	17
4	May 24	June 1	June 2	9	June 9	7	1	41	5.8−	7	June 10	17
5	June 2	June 8	June 9	7	June 17	8	1	40	5.	8	June 18	16
6	June 9	June 17	June 18	9	June 29	11	0	58	5.2+	8	June 29	20
7	June 18	June 26	June 27	9	July 8	11	0	65	5.9+	8	July 8	20
8	June 27	July 3	July 4	7	July 13	9	0	38	4.2+	5	July 13	13
9	July 4	July 11	July 11	7	July 14	3	0	12	4.	6	July 14	11
10	July 11	July 18	July 19	8	July 31	12	0	66	3.3	8	July 31	20
11	July 19	July 25	July 26	7	Aug. 10	15	3	70	4.7−	8	Aug. 13	25
12	July 26	Aug. 1	Aug. 2	7	Aug. 10	9	1	46	5.1+	8	Aug. 11	16
13	Aug. 2	Aug. 8	Aug. 9	7	Aug. 21	14	1	63	4.5	6	Aug. 22	22
14	Aug. 9	Aug. 15	Aug. 16	7	Aug. 27	12	0	58	3. +	8	Aug. 27	19
15	Aug. 16	.....	Aug. 22	6	Aug. 24	3	0	13	4. +	6	Aug. 24	9
16	Aug. 22	Aug. 29	Aug. 30	8	Sept. 7	9	1	42	4.6+	7	Sept. 8	18
17	Aug. 30	Sept. 6	Sept. 7	8	Sept. 23	17	0	40	2. +	5	Sept. 23	25
18	Sept. 7	Sept. 13	Sept. 14	7	Sept. 21	8	2	13	1. +	5	Sept. 23	17
19	Sept. 14	Sept. 21	Sept. 22	8	Sept. 23	2	0	4	2.	2	Sept. 23	10
20	Sept. 22	Oct. 1	Oct. 2	10	Oct. 22	13	16	29	2. +	4	Nov. 7	39
21	Oct. 2	Oct. 15	Oct. 17	15	Oct. 29	15	.....	29	1. −	8	.....	(*d*)
22 [a]	Oct. 17	{[b]Oct. 24 {[c]Nov. 5	}	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Oviparous generation. These aphides were removed to other cages when they became adult.
[b] 1 oviparous female. [c] 2 male. [d] Not less than 30 days.

On the other hand, beginning with the last to be borne by the aphis which hatched April 18, and following down the series of the last borne of each generation, there were but 11 generations. From this it

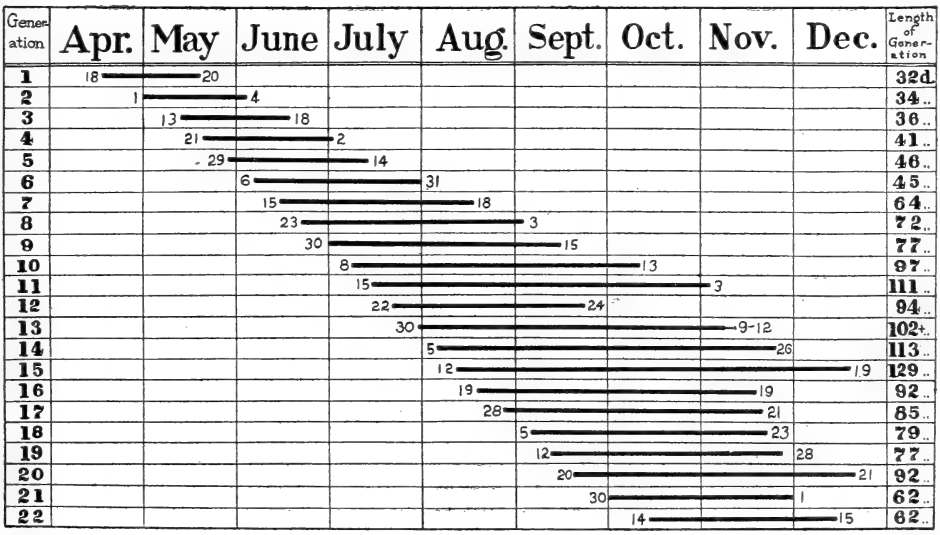

FIG. 31.—Periods and succession of generations in *Aphis maidi-radicis*, 1906.

follows that the mean number of complete generations for the year is 16½. The first generation extended over a period of 31 days, from April 18 to May 20; the second, 34 days; and the third, 36 days (figs.

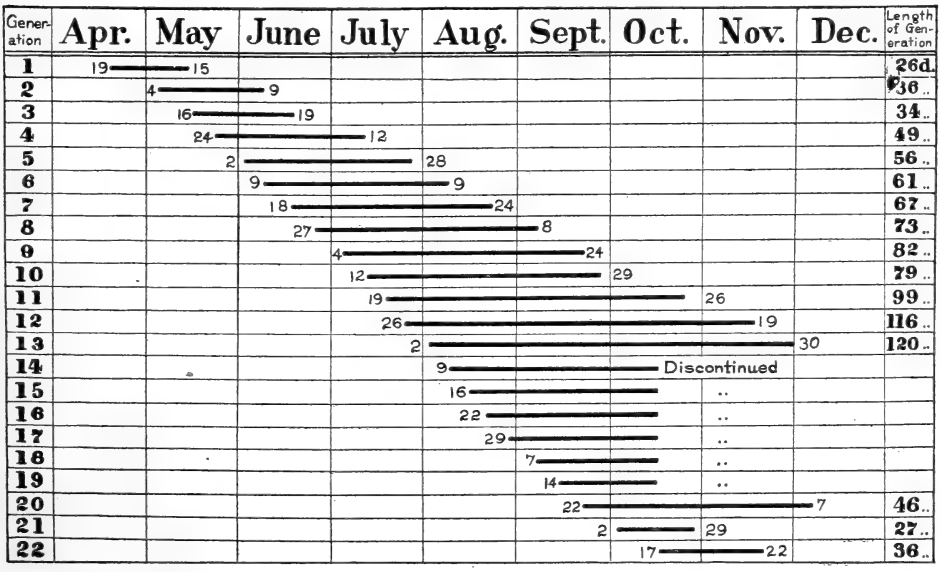

FIG. 32.—Periods and succession of generations in *Aphis maidi-radicis*, 1906.

31, 32). The fifteenth generation proved to be the longest, continuing for 129 days. Then the period of each generation diminished gradually. These data, however, were taken from only one line of genera-

tions—that is, the generations obtained from a single stem-mother, isolated in the spring. If we take into consideration the time during which eggs have been found hatching in the field—from April 8 until May 22, a period of 44 days—it will be seen that each of the generations might occur in the field much longer than my insectary experiments would indicate. On May 1 individuals of the first 2 generations coexisted in the insectary; on June 1, 4 generations, from the second to the fifth, inclusive; on July 1, 6 generations, from the fourth to the ninth; on August 1, 7 generations, from the seventh to the thirteenth; on September 1, 10 generations, from the eighth to the seventeenth; on September 12, 11 generations, from the ninth to the nineteenth; and between September 30 and October 24 there were 12 generations in existence, from the tenth to the twenty-first, this being the largest number of generations in existence at any one time. (See figs. 31, 32.) From that date on, the number of generations in existence at any one time rapidly diminished until December 21, at which time all of the aphides were dead. The latest date of birth in a viviparous generation was October 7, and the last survivor of this generation died November 28. The first record of the bisexual oviparous generation in the insectary, in 1906, was October 2, and eggs were found a few days later. Young of this generation were born as late as November 4, and aphides were still alive December 21. However, in 1905 I found individuals of this oviparous generation as early as September 5; also, they were observed in copula, and eggs were found as early as September 30. Bisexual forms may appear in any generation, providing the environmental conditions are such as to favor their development. Thus, in the insectary sexual forms appeared in October and November from 12 different generations, varying from the eleventh to the twenty-second, inclusive, thus indicating that the appearance of the sexes may be conditioned by the temperature. This is illustrated by the occurrence of sexual forms on September 5, 1905, at which time the weather was quite cool for that time of the year, although in 1906 the sexual forms did not appear until October 2, the weather up to that time being milder than in 1905. Between April 2, 1890, and January 17, 1893, Prof. M. V. Slingerland carried *Myzus achyrantes* Monell through 62 generations by keeping the temperature uniform. Although further experiments would be necessary for positive proof, still, from what is now known, it appears that with the necessary conditions for the development of young—food and heat—the aphides would be able to reproduce parthenogenetically for an indefinite period. Numerous records were made by me of instances in which the first young were viviparous and the last oviparous. In these cases it was noticed that after the production of viviparous forms the aphis would rest a few days before beginning to produce the sexual forms.

VIVIPAROUS GENERATION.

In 1906, between April 18 and October 3, 128 individual experiments were carried on with viviparous females, and the following averages are taken from the entire number of experiments (see Table III):

TABLE III.—*Data of individual experiments with Aphis maidi-radicis, viviparous generation, 1906.*

Date of birth.	Date of becoming adult.	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 for one day.	Date of death.	Total length of life.
			Days.		*Days.*	*Days.*					*Days.*
Apr. 18	Apr. 30	May 1	13	May 18	17	2	96	5.6 +	10	May 20	32
Apr. 19	May 2	May 4	15	May 14	10	1	36	3.6	6	May 15	26
May 1	May 12	May 13	12	May 27	14	6	74	5.3 −	10	June 2	32
May 4	May 15	May 16	12	June 4	19	5	64	3.4 −	8	June 9	36
May 13	May 19	May 21	8	May 30	9	1	53	6.6 +	9	May 31	18
May 14	May 23	May 24	10	June 1	8	1	35	4 −	7	June 2	19
May 16	...do.....	...do.....	8	June 2	9	0	50	5.5 +	8	...do.....	17
May 18	.....	May 26	8	June 4	9	0	42	4.6 +	10	June 4	17
May 21	May 27	May 29	8	...do.....	6	0	31	5.3 +	7	June 6	14
May 24	.....	June 2	9	June 15	13	0	58	4.4 +	7	June 15	22
Do.....	June 1	...do.....	9	June 9	7	1	41	5.8 −	7	June 10	17
May 26	June 4	June 4	9	...do.....	5	0	33	6.6	8	June 9	14
May 29	June 5	June 6	8	June 24	18	8	89	4.9 +	9	July 2	34
May 31	.....	June 8	8	June 19	11	0	34	3 +	7	June 19	19
June 2	June 8	June 9	7	June 17	8	1	40	5	8	June 18	16
June 3	June 9	June 10	7	June 16	6	2	24	4	5	...do.....	15
June 4	June 12	June 14	10	June 29	15	2	73	4.8 +	10	July 1	27
June 6	June 14	June 15	9	July 2	17	9	76	4.4 +	7	July 11	35
June 8	June 17	June 18	10	...do.....	14	0	62	4.4 +	9	July 2	24
June 9	...do.....	...do.....	9	June 29	11	0	58	5.3 −	8	June 29	20
June 10	.....	...do.....	8	...do.....	11	2	51	4.6 +	7	July 1	21
Do.....	June 19	June 20	10	July 1	11	8	48	4.3 +	7	July 9	29
Do.....	June 18	June 19	9	June 30	11	2	72	2	11	July 2	22
June 14	June 21	June 22	8	...do.....	8	0	53	6.6 +	10	June 30	16
June 6	June 16	June 18	12	June 25	7	0	21	3	6	June 25	19
June 18	June 27	June 27	9	July 4	7	3	37	5.2 +	8	July 7	19
Do.....	June 26	...do.....	9	July 8	11	0	65	5.9 +	8	July 8	20
Do.....	.....	June 26	8	July 2	6	1	45	7 +	9	July 3	15
Do.....	June 25	...do.....	8	July 1	5	0	29	5.8	10	July 1	13
June 19	June 26	June 28	9	July 13	15	0	44	3 −	8	July 13	24
Do.....	...do.....	June 27	8	July 5	8	1	51	6.3 +	10	July 6	17
June 20	.....	June 28	8	July 8	10	1	50	5	8	July 9	19
June 22	June 29	June 30	8	July 11	11	0	62	5.6 +	8	July 11	19
June 23	.....	...do.....	7	July 15	15	0	74	4.9 +	7	July 15	22
June 27	.....	July 4	7	July 10	6	0	29	4.8 +	8	July 10	13
Do.....	July 3	...do.....	7	July 13	9	0	38	4.2 +	8	July 13	13
Do.....	July 2	July 3	6	July 16	13	0	59	4.5 +	9	...do.....	19
June 28	July 6	July 6	8	July 15	9	1	48	5.3 +	7	July 16	18
June 30	July 7	July 8	8	July 11	3	0	22	7.3 +	7	July 11	11
July 3	July 10	July 11	8	July 20	9	0	44	4.9 +	7	July 20	17
July 4	July 11	July 12	8	...do.....	8	1	42	5.2 +	8	July 21	17
July 6	July 12	July 13	7	July 24	11	1	52	4.7 +	7	July 25	19
July 8	July 13	July 14	6	July 27	13	10	64	4.9 +	8	Aug. 6	29
Do.....	July 14	July 15	7	July 23	8	0	53	6.6 +	7	July 23	15
Do.....	...do.....	July 14	6	July 25	11	0	56	5 +	9	July 25	17
July 11	July 17	July 18	7	July 24	7	1	49	7	10	...do.....	14
Do.....	July 18	July 19	8	July 31	12	0	66	3.3	8	July 31	20
July 12	...do.....	...do.....	7	July 28	9	0	54	6	8	July 28	16
July 13	July 21	July 21	7	July 29	8	1	44	5.5	7	July 30	16
Do.....	July 18	July 19	6	...do.....	10	2	45	4.5	7	July 31	18
July 14	July 21	July 21	7	July 27	6	0	25	4.1 +	8	July 27	13
Do.....	...do.....	July 22	8	Aug. 1	10	0	62	6.2	10	Aug. 1	18
July 18	July 23	July 24	6	July 29	5	0	29	5.8	8	July 29	11
July 19	July 25	July 26	7	Aug. 10	15	3	70	4.7	8	Aug. 13	25
Do.....	...do.....	...do.....	7	Aug. 4	9	1	55	6.1 +	7	Aug. 5	17
Do.....	...do.....	...do.....	7	Aug. 5	10	0	51	5.1	7	...do.....	17
July 21	July 28	July 28	7	Aug. 6	9	2	47	5.2 +	8	Aug. 8	18
Do.....	...do.....	July 29	8	Aug. 3	5	0	30	6	9	Aug. 3	13
July 22	...do.....	...do.....	7	Aug. 6	8	0	46	5.7 +	8	Aug. 6	15
Do.....	July 29	July 30	8	Aug. 8	9	1	51	5.1	8	Aug. 9	17

TABLE III.—*Data of individual experiments with Aphis maidi-radicis, viviparous generation, 1906*—Continued.

Date of birth.	Date of becoming adult.	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 for one day.	Date of death.	Total length of life.
			Days.		*Days.*	*Days.*					*Days.*
July 26	Aug. 1	Aug. 2	7	Aug. 10	9	1	46	5.1 +	8	Aug. 11	16
Do	do	do	7	Aug. 8	7	0	49	7	8	Aug. 8	14
Do	do	do	7	Aug. 9	8	0	43	5.3 +	9	Aug. 9	15
July 27	Aug. 2	do	6	do	8	0	46	5.7 +	10	do	14
July 28		Aug. 5	8	Aug. 14	9	0	46	5.1 +	6	Aug. 14	17
July 29	Aug. 4	do	7	Aug. 11	6	1	35	5.8 +	8	Aug. 12	14
July 30	Aug. 5	do	6	Aug. 9	5	0	24	4.8	6	Aug. 9	15
July 29	Aug. 4	do	7	Aug. 18	13	0	55	4.2 +	9	Aug. 18	20
Aug 1	Aug. 7	Aug. 7	6	Aug. 13	6	1	37	6 +	8	Aug. 14	13
Aug. 2	Aug. 8	Aug. 9	7	Aug. 21	14	1	63	4.5	6	Aug. 22	22
Do	Aug. 7	Aug. 8	6	Aug. 15	7	0	45	6.4 +	9	Aug. 15	13
Aug. 5	Aug. 13	Aug. 13	8	Aug. 22	9	0	44	4.8 +	8	Aug. 22	17
Do	Aug. 12	do	8	Aug. 19	7	0	31	4.4 +	5	Aug. 19	14
Do	Aug. 11	Aug. 12	7	Aug. 22	10	0	54	5.4	8	Aug. 22	17
Do	do	do	7	Aug. 18	6	1	35	5.8 +	8	Aug. 19	14
Aug. 7	Aug. 15	Aug. 15	8	Aug. 26	11	0	50	4.5 +	9	Aug. 26	19
Aug. 9	do	Aug. 16	7	Aug. 24	8	0	41	5.1 +	8	Aug. 24	15
Do	do	do	7	Aug. 27	12	0	58	3 +	8	Aug. 27	19
Do	Aug. 17	Aug. 17	8	Aug. 23	6	0	31	5.1 +	7	Aug. 23	14
Aug. 12	Aug. 19	Aug. 19	7	Aug. 29	10	0	48	4.8	7	Aug. 29	17
Aug. 13	do	Aug. 20	7	do	9	0	60	6.6 +	9	do	16
Aug. 12	Aug. 18	Aug. 19	7	Aug. 24	6	0	33	5.5	8	Aug. 24	13
Aug. 15	Aug. 21	Aug. 22	7	Sept. 2	11	0	51	4.6 +	9	Sept. 2	18
Aug. 16	Aug. 22	Aug. 23	7	do	10	0	56	5.6	7	do	17
Aug. 17	Aug. 23	do	6	do	10	0	47	4.7	7	do	16
Do	do	do	7	Sept. 3	11	0	49	4.4 +	6	Sept. 3	18
Aug. 19	Aug. 26	Aug. 26	7	Sept. 5	10	0	47	4.7	7	Sept. 5	17
Do	do	Aug. 27	8	Sept. 15	19	0	48	2.5 +	8	Sept. 15	27
Do		do	8	Sept. 9	14	0	66	4.7 +	10	Sept. 9	22
Aug. 20	Aug. 25	Aug. 26	6	Sept. 3	8	0	42	6	7	Sept. 3	14
Aug. 22	Aug. 29	Aug. 30	8	Sept. 8	9	1	50	5.5 +	6	Sept. 9	18
Do	do	do	8	Sept. 7	9	1	42	4.6 +	7	Sept. 8	18
Aug. 23	Aug. 31	Aug. 31	8	Sept. 10	10	2	51	5.1	7	Sept. 12	20
Do	do	do	8	Sept. 6	7	2	34	4.8 +	7	Sept. 8	17
Do		Sept. 2	10	Sept. 15	13	1	56	4.2 +	7	Sept. 16	24
Aug. 24		do	9	Sept. 8	6	0	27	4.5	6	Sept. 8	15
Aug. 26		do	7	Sept. 10	8	0	40	5	8	Sept. 10	15
Aug. 28	Sept. 4	Sept. 4	7	Sept. 9	5	0	24	4.8	5	Sept. 9	12
Aug. 30	Sept. 7	Sept. 7	8	Sept. 12	5	0	22	4.5	7	Sept. 12	13
Do	Sept. 6	do	8	Sept. 23	16	0	40	2.4 +	5	Sept. 23	24
Aug. 31	Sept. 7	Sept. 8	8	Sept. 19	11	0	23	2 +	6	Sept. 19	19
Do	Sept. 8	Sept. 9	9	Sept. 21	12	0	23	2 −	5	Sept. 21	21
Sept. 2	Sept. 10	Sept. 11	9	Sept. 16	5	0	23	4.6	5	Sept. 16	14
Do	do	do	9	Sept. 17	6	1	33	5.5	7	Sept. 18	16
Sept. 4	Sept. 11	do	7	Sept. 28	17	2	49	2.8 +	6	Sept. 30	26
Do	do	do	7	Sept. 19	8	1	37	4.6 +	6	Sept. 20	16
Sept. 5		Sept. 12	7	Sept. 20	9	1	28	3 +	6	Sept. 21	17
Sept. 7	Sept. 14	Sept. 15	8	Sept. 25	10	0	41	4.1	7	Sept. 25	18
Sept. 11	Sept. 18	Sept. 19	8	Sept. 26	7	0	35	5	9	Sept. 26	15
Do	Sept. 19	do	8	Sept. 24	6	0	30	5	9	Sept. 24	14
Sept. 13	do	Sept. 20	7	Sept. 27	8	1	41	5 +	9	Sept. 28	16
Sept. 15	Sept. 22	Sept. 23	8	Oct. 6	14	0	32	2.2 +	5	Oct. 6	22
Sept. 16	do	Sept. 22	6	Oct. 7	16	6	23	1.4 +	4	Oct. 13	28
Sept. 17	Sept. 25	Sept. 25	8	Oct. 15	20	6	28	1.5	4	Oct. 22	34
Sept. 18	Sept. 24	do	7	Oct. 8	14	2	25	1.7 +	4	Oct. 10	23
Sept. 19	Sept. 25	Sept. 26	7	do	13	3	20	1.5 +	5	Oct. 11	23
Do	Sept. 26	Sept. 27	8	Oct. 17	20	7	56	2.8	7	Oct. 27	35
Sept. 20	Sept. 27	do	7	Oct. 15	18	1	52	2.8 +	5	Oct. 16	26
Sept. 22	Oct. 1	Oct. 2	10	Oct. 22	20	18	29	1.4 +	4	Nov. 7	48
Do	Sept. 30	Oct. 1	9	Oct. 17	16	3	21	1.3 +	7	Oct. 21	28
Do	Sept. 29	do	9	Nov. 2	32	1	35	1 +	4	Nov. 3	42
Sept. 27	Oct. 7	Oct. 9	12	Oct. 31	22	8	26	1.1 +	4	Nov. 9	42
Sept. 30	Oct. 13	Oct. 14	14	Nov. 2	18	5	29	1.6 +	4	Nov. 7	36
Sept. 26	Oct. 5	Oct. 6	10	Oct. 24	14	3	21	1.5	3	Oct. 27	27
Oct. 2	Oct. 15	Oct. 17	15	Oct. 29	12	.....	29	2.4 +	8	.....	27
Do	Oct. 13	Oct. 15	13	Oct. 24	9	2	22	2.4 +	4	Oct. 26	24
Do	Oct. 14	do	13	do	9	0	23	2.5 +	5	Oct. 24	22
Oct. 3	Oct. 16	Oct. 17	14	Nov. 26	40	2	49	1.2 +	3	Nov. 28	56
Total			1,044		1,367		5,651	570.82			2,573
Average			8.1+		10.6+		44.1+	4.4+			20.1+

The immature stage was found to be quite variable in length, covering from 6 to 15 days, with an average of 8.1+ days. This is approximately the same as that obtained from experiments of 1905, in which, from 97 records, the average length of this nymphal period was 8.3+ days. During the first few generations and also the last generation the time from the birth of an aphis until the birth of its first young was much longer than it was during the warmer summer months. The time between the birth of the first and that of the last young likewise varied considerably, being from 3 to 40 days, the period being noticeably longer in early spring and in the fall. The average for the entire year was 10.6+ days. Usually the female would live several days after the production of her last young. The entire length of life of the aphis varied between 11 and 56 days, with an average for the year of 20.1+ days. During the summer months the aphides, as a rule, had a shorter life and produced more young than in the cooler days of the year. The average number of young per female for the year was 44.1+. The variation in the number of young was from 20 to 96, the latter number being the largest number produced by a single female. For the year the average number of young brought forth by an individual female in a single day was 4.4+, the largest number being 11. However, in 1905 as many as 12 were born in one day from one female. The average number of young from April 18 until September 1 was, in 102 experiments, 4.9+; from September 1 to October 3 the average for 26 experiments was 2.4+ young per day, or one-half as many. It may be noted, in passing, that, as the records made in 97 experiments in 1905 vary only slightly from those obtained in the 128 experiments of 1906, the figures here given are probably sufficiently accurate for any year.

In 1905 a very interesting incident was observed. A wingless aphis taken in the field June 23 was placed in an insectary cage, and within the next few days gave birth to 6 young. It then discontinued the production of young for several days, then molted, became winged, and produced 21 more young.

Buckton, in his "Monograph of British Aphides," Volume I, page 87, says:

> Several early observers have erroneously stated that the female aphis is at different periods of her life both viviparous and oviparous. The acuteness of Newport failed him when he concluded "that aphides"—meaning the same individual—"deposit at one time true ova and at others produce living young." * * * It may be pretty certainly asserted that the viviparous aphis is never oviparous, and that the converse also is true.

In one experiment in 1906 an aphis born October 6 became adult October 24 and gave birth to a single young November 2, but did not produce any more young, and soon died. Upon an examination of her body only eggs were found.

All my aphides which were reared individually, in vials, were wingless. Other aphides, however, of the same mothers, and placed in cages containing many other aphides as well as a less abundant food supply, often became winged. In Science, Volume XXI, January 27, 1903, pages 48–49, Prof. M. V. Slingerland gives an account of rearing individually 62 generations of *Myzus achyrantes* during a period of 2 years and 10 months, only wingless agamic females being produced. From these and other evidences obtained it may be inferred that the development of the winged forms among aphides is largely caused by an insufficient food supply.

The number of molts is invariably four, the time of occurrence of the different molts being shown in Table IV.

TABLE IV.—*Periods of molts of Aphis maidi-radicis, viviparous generation, 1906.*

Date of birth.	Age at first molt.	Age at second molt.	Age at third molt.	Age at fourth molt.	Age at birth of first young.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*
April 18	4	8	10	12	13
April 19	5	8	10	13	15
May 1	2	4	7	11	12
May 4	3	6	8	11	12
May 13	2	3	4	6	8
May 21	2	3	4	6	8
June 27	1	2	4	6	7
June 28	1	3	6	8	8

As a rule, reproduction did not begin until the next day after the fourth molt, though it sometimes occurred within a few hours after the molt. Often in the last generations, in autumn, reproduction did not begin until two days after the last molt.

OVIPAROUS GENERATION.

The oviparous generation was found in the insectary, in 1906, from October 2 to December 21. Records of 47 individuals of this generation were obtained (Table V); the records, however, are not complete in all cases. The length of the immature stage—from birth to adult—varied from 10 to 39 days, this latter being a very exceptional record.

TABLE V.—*Data of individual experiments with Aphis maidi-radicis, oviparous generation, 1906.*

Date of birth.	Date of maturity.	Age at maturity.	Date of death.	Age at death.	Number of eggs laid.	Number of eggs in body at death.	Total number of eggs.	Sex.
		Days.		*Days.*				
October 6	Oct. 21	15	Nov. 5	30	10	1	11	Female.
Do	Oct. 22	16	...do	30				Male.
October 8	Oct. 24	16	Nov. 14	37	4	2	6	Female.
Do	...do	16	Nov. 10	33				Male.
October 9	Oct. 22	13	[a]Oct. 26	[b]17				Female.
Do	...do	13	[a]Nov. 2	[b]24				Do.
October 15	Oct. 31	16	Nov. 28	44	7	2	9	Do.
October 7	Oct. 20	13	Oct. 22	15				Do.
October 15	Nov. 3	19	[a]Nov. 23	[b]39				Male.
October 17	Nov. 5	19	Nov. 8	22				Do.
October 15	Oct. 31	16	[a]Oct. 31	[b]16				Do.
Do	...do	16	[a]Nov. 2	[b]18				Do.
Do	Nov. 1	17	[a]Nov. 9	[b]25				Do.
October 13	Oct. 27	14	Nov. 12	30				Do.
October 29	Nov. 24	26	Dec. 11	43				Female.
October 15	Oct. 29	14	Nov. 15	31	3	2	5	Do.
October 22	Nov. 11	20	Nov. 26	35				Male.
October 13	Oct. 23	10	[a]Oct. 29	[b]16				Female.
Do	...do	10	..do.[a]	[b]16				Do.
October 20	Nov. 7	18	Nov. 12	23				Male.
October 19	Oct. 29	10	[a]Nov. 2	[b]13				Female.
October 20	Nov. 1–2	12–13	..do.[a]	[b]13				Do.
October 21	...do	12–13	..do.[a]	[b]13				Do.
October 26	Nov. 17	22	Dec. 1	36				Male.
Do	Dec. 4	39	Dec. 15	50				Female.
October 24	Nov. 7	14	Nov. 30	37				Do.
October 21	Nov. 8–9	18–19	[a]Nov. 14	[b]24				Do.
Do	...do	18–19	..do.[a]	[b]24				Do.
October 24	Nov. 10–11	17–18	..do.[a]	[b]21				Do.
Do	Nov. 16–17	23–24	Dec. 5	43				Do.
November 2	Nov. 21	19	Dec. 5	33				Do.
Do	...do	19	Dec. 19	47				Do.
October 6	Oct. 20	14	[a]Oct. 25	[b]19				Do.
Do	...do	14	[a]Oct. 26	[b]20				Do.
Do	...do	14	[a]Oct. 27	[b]21				Do.
Do	...do	14	..do.[a]	[b]21				Do.
October 7	...do	13	Nov. 21	43				Do.
October 9	Oct. 21	12	[a]Oct. 28	[b]19				Do.
Do	...do	12	Nov. 12	34	3	8	11	Do.
Do	Oct. 24	15	[a]Oct. 29	[b]20				Do.
Do	...do	15	..do.[a]	[b]20				Do.
Do	...do	15	..do.[a]	[b]20				Do.
Do	...do	15	Oct. 31	22				Do.
Do	...do	15	[a]Nov. 3	[b]25				Do.
Do	...do	15	..do.[a]	[b]25				Do.
October 12	...do	12	Nov. 23	42	4	6	10	Do.
October 16	Oct. 31	15	...do	38	3	5	8	Do.
October 18	Nov. 3–4	16–17	Dec. 1	44	2	5	7	Do.

[a] Removed. [b] Age when removed.

The average of 47 records is 16+ days. The average total life of 38 individuals was 30.9+ days, with a maximum (1906) of 50 days. In 1905 one aphis of this oviparous generation lived to the age of 61 days. A few records were made as to the number of eggs laid by individual females, and this was found to vary up to 10, which was probably not far from the actual number that is ordinarily laid, though 4 was the average number in the counts made. Eggs were found in the bodies of nearly all the females after death; the potential reproductive capacity of the female seems to exceed her vitality.

It is easy to distinguish immature males from oviparous females after the second molt by their color. The males have a distinct reddish hue, while the females have a greenish color.

The number of molts in the oviparous generation is four, as in the viviparous generation. From Table VI, showing the periods between the molts, it appears that the males are more deliberate in their growth and require a longer time than the females for their full development.

TABLE VI.—*Periods of molts of Aphis maidi-radicis, oviparous generation, 1906.*

Date of birth.	Age at first molt.	Age at second molt.	Age at third molt.	Age at fourth molt.	Period from birth to adult.	Sex.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	
October 11	3	5	9	13	13	Female.
Do	3	5	9	13	13	Do.
Do	3	5	9	14	14	Do.
October 16	4	6	11	20	20	Do.
October 17	2	5	9	13	13	Do.
Do	3	6	10	21	21	Male.
October 21	4	9	14	21	21	Do.
Do	3	8	14	23	23	Do.
October 22	5	9	13	16	16	Female.

DESCRIPTIONS.[a]

Aphis maidi-radicis Forbes.

VIVIPAROUS GENERATION.

Before first molt and less than 1 hour old.—General color pale pea-green. Legs and antennæ colorless and transparent. Eyes red. Measurements: Length of body, 0.882 mm.; width, 0.400 mm.; antenna, 0.327 mm.

After first molt and not more than 24 hours old.—General color pea-green. Antennæ almost transparent, excepting last segment, which is darker. Only 5 noticeable segments in the antennæ. Eyes red. Tip of beak darkened. Legs almost transparent, excepting tarsi, which are almost black. Cornicles small, slightly darkened at tip. Measurements: Length of body, 0.927 mm.; width, 0.509 mm.; antenna, 0.339 mm.

After second molt and 72 to 96 hours old.—General color pea-green. Ultimate segment of antennæ dark. Eyes reddish brown. Legs darker than body color. Tip of abdomen dark. Cornicles dark, being darkest at apex, short and very slightly incrassate in middle. Measurements: Length of body, 1.418 mm.; width, 0.709 mm.;

[a] In giving the number of segments of the antennæ I have not, as most writers do, counted the filament as a separate and distinct segment. There is certainly no articulation between the thickened basal portion and the filament of this last segment; and, thus, they can not be referred to as distinct segments.

The measurements, and the observations on colors, were taken from live specimens unless otherwise stated. Color terms are according to Ridgway's "Nomenclature of Colors."

antenna (alcoholic specimen), I, 0.040 mm.; II, 0.040 mm.; III, 0.101 mm.; IV, 0.050 mm.; V, basal, 0.061 mm.; filament, 0.098 mm.; total, 0.390 mm.

After third molt.—General color light chromium-green. Head with pale brownish tint. Ultimate and part of the penultimate segments of the antennæ darkened. Antenna with only 5 distinct segments; a slight constriction in the third shows the commencing of the formation of another segment. Eyes reddish brown. Legs dark, the tarsus and distal ends of the femur and tibia being almost black. Tip of abdomen dark, as are also the cornicles, which are darkest at the apex. Cornicles noticeably longer than in preceding stages; basal half more or less swollen and the tip slightly dilated. Measurements: Length of body, 2.063 mm.; width, 0.981 mm.; cornicles, 0.127 mm.; antenna (alcoholic specimens), I, 0.064 mm.; II, 0.064 mm.; III, 0.183 mm.; IV, 0.067 mm.; V, basal, 0.071 mm.; filament, 0.112 mm.; total, 0.561 mm.

Adult wingless viviparous female.—Head black. Thoracic and first abdominal segments with median transverse black markings, the prothorax being almost entirely black. On each side of the abdomen are 2 parallel rows of minute black markings—one on each side of the cornicle. These rows are not constant, the upper one sometimes being indistinct or wanting. Posterior 3 segments of abdomen with black transverse median markings. Eyes reddish brown. All of antenna dusky except the third segment. Cornicles and tips of style black. Coxæ, most of the femora, apex of tibiæ, and the tarsi black. Measurements: Length of body, 2.09 mm.; width, 1.036 mm.; antenna, I, 0.036 mm.; II, 0.054 mm.; III, 0.181 mm.; IV, 0.091 mm.; V, 0.091 mm.; VI, basal, 0.109 mm.; filament, 0.118 mm.; total, 0.680 mm.

Winged viviparous female.—Head black, thorax blackish, abdomen pale green, with a black marking on each side of the second, third, and fourth segments; transverse black markings on the last 2, and sometimes last 3, segments; a black ring around each cornicle, and a few small black markings irregularly scattered over abdomen. Antennæ dark; usually 7 or 8 sensoria on the third segment, sometimes only 6; 1 sensorium near the apex of each of the fourth and fifth segments; several more or less distinct sensoria at the apex of the basal portion of the sixth. Eyes dark reddish-brown. Cornicles and style as in wingless pseudogynes. Measurements (alcoholic specimens): Length of body, 1.468 mm.; width, 0.605 mm.; length of wing, 2.33 mm.; antenna, I, 0.036 mm.; II, 0.055 mm.; III, 0.187 mm.; IV, 0.095 mm.; V, 0.106 mm.; VI, basal, 0.099 mm.; filament, 0.194 mm.; total, 0.772 mm.

OVIPAROUS GENERATION.

Before first molt and less than 24 hours old.—General color pea-green. Beak not reaching beyond the coxæ of the third pair of legs, apical segment dark. Antennæ colorless, except last segment, which is darker than the remainder. Eyes black. Legs pale, except the tarsi, which are black. Measurements: Length of body, 0.954 mm.; width, 0.486 mm.; antenna, I, 0.038 mm.; II, 0.038 mm.; III, 0.114 mm.; IV, 0.153 mm.; total 0.343 mm.

After first molt and 5 to 6 days old.—General color dirty pea-green, with very slight tinge of red. Last segment of antenna dark. Tarsi black. Measurements: Length of body, 1.145 mm.; width, 0.573 mm.

Oviparous female after third molt.—Color of head and first thoracic segment very dark green. Remainder of body slate-gray, with a reddish tint. The bloom which covers the body gives to the aphis the grayish color. Tips of antennæ dark. Tarsi black. Cornicles darker than body color, with a black ring at the base of each. Measurements: Length of body, 1.985 mm.; width, 1.050 mm.

Adult wingless oviparous female.—General color plumbeous, which is due to the bloom covering the body. Head black, and first thoracic segment very dark beneath the bloom. Abdomen tinged with pink. In alcoholic specimens from which the bloom has been removed, the markings as in the pseudogynes, except that the black markings on the last 3 abdominal segments are not present. Antennæ dark, with one large circular sensorium near the apical end of the fifth segment, and several at the apical end of the thickened base of the sixth. Beak reaching beyond the middle coxæ. Eyes black. Legs dark; the hind tibiæ noticeably swollen and thickly covered with small circular sensoria. Cornicles black and of the same shape as in the pseudogynes. Apical half of style dark. Measurements: Length of body, 2.201 mm.; width, 1.218 mm.; antenna, I, 0.038 mm.; II, 0.047 mm.; III, 0.172 mm.; IV, 0.076 mm.; V, 0.095 mm.; VI, basal, 0.100 mm.; filament, 0.154 mm.; total, 0.682 mm.

Male after third molt.—Head and first thoracic segment pale green, between pea-green and sage-green. Abdomen drab. Measurements: Length of body, 1.546 mm.; width, 0.687 mm.

Adult wingless male.—Head black. Thoracic segments each with a transverse black marking, this giving the thorax a blackish appearance. Similar but shorter markings occur on the first 3 and the last 3 abdominal segments. The spots on the sides of the body are arranged in more or less uniform rows. Third antennal segment with 12 or more sensoria irregularly distributed, most numerous near the apex; fourth with 5 to 7 sensoria; fifth with 2 to 4 similar sensoria and a larger one near the apex; and several at apex of the basal part of the sixth. Eyes black. Antennæ, legs, and cornicles

black. Measurements (alcoholic specimens): Length of body, 1.636–1.745 mm.; width, 0.909–0.945 mm.; antenna, I, 0.081 mm.; II, 0.054 mm.; III, 0.200 mm.; IV, 0.136 mm.; V. 0.100 mm.; VI, basal, 0.109 mm.; filament, 0.181 mm.; total, 0.861 mm.; cornicle, 0.082 mm.

Eggs.—Elliptical-oval, yellow or greenish when first laid, gradually darkening to a jet-black. In spring just before hatching the eggs change from black to pale green. Length, 0.782 mm.; width, 0.391 mm.

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Aphis maidis (?) infests the roots of young Indian corn as well as the stems of the roasting ears. This is the first notice of the occurrence of the root form.

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1878. THOMAS, CYRUS.—List of the Aphidini of the United States. <Ill. State Lab. Nat. Hist., Bloomington, Vol. I, Bul. 2, p. 12.

Lists *Aphis maidis* as being found on the tassel, ear-stalks, and roots of Indian corn.

1878. THOMAS, CYRUS.—Seventh Report of the State Entomologist of Illinois. <App.: Trans. Dept. Agr. Ill. for 1877, Springfield, Vol. XV, pp. 75–78, fig. 18 (I, III, IV). Separate: Springfield, Ill., 1878.

Gives characteristics of the aerial and root forms as presented by Fitch and Walsh, and also a description of specimens which he obtained the previous summer from a different part of the plant (tassels). Possible treatment against aphides in small patches of corn is given. Appends notes from correspondents concerning serious damage done to corn in 1874 and 1877 in Menard and Stark counties, Illinois.

1879. THOMAS, CYRUS.—Eighth Report of the State Entomologist of Illinois. <App.: Trans. Dept. Agr. Ill. for 1878, Springfield, Vol XVI, pp. 89–91, fig. 14 (I, III, IV). Separate: Springfield, Ill., 1879.

Same as in Seventh Report of the State Entomologist of Illinois, except that no remedies are mentioned (*loc. cit.*).

[a] This bibliography is practically complete, and contains a number of references not found in the Bibliography of Economic Entomology, by Henshaw and Banks. Those titles which have been inaccessible are marked with an asterisk. Those which are considered the most important have the date preceding them in italics.

1880. Thomas, Cyrus.—Ninth Report of the State Entomologist of Illinois. <App.: Trans. Dept. Agr. Ill. for 1879, Springfield, Vol. XVII, pp. 2–3.

Mentions both aerial and root forms (especially the latter) of the corn aphis as being quite injurious the past season (1879). Recommends rotation of crops, thorough fall plowing, and turning under strong lime.

1882. Boardman, E. R.—Corn-aphis. <Stark County (Ill.) News, December 21, 1882.

General life history of the root form; remedies.

1882. Boardman, E. R.—Economic Entomology. <Stark County (Ill.) News, December 28, 1882.

Additional notes on the life history of the corn root-aphis.

1883. Forbes, S. A.—A lecture on insects affecting corn. <Bloomington, Ill., pp. 12–14, figs. I, III, IV.

Gives known life history of both aerial and root forms of the corn aphides; also relation of ants to the corn root-aphis.

1883. Forbes, S. A.—Twelfth Report of the State Entomologist of Illinois <App.: Trans. Dept. Agr. Ill. for 1882, Springfield, Vol. XX, pp. 5–6, 44.

The corn plant-louse (probably referring to the root form) was destructive to corn the previous year (1883). Transferring of *Aphis maidis* by ants is mentioned.

1884. Forbes, S. A.—Thirteenth Report of the State Entomologist of Illinois. <App.: Trans. Dept. Agr. Ill. for 1883, Springfield, Vol. XXI, pp. 46–50, Pl. IV, fig. 13. Separate: Springfield, Ill., 1884.

The root-aphis makes its first appearance upon corn underground late in May or early in June, attacking not only the roots, but likewise the sprouting stem underground. Winged root form was collected May 22 and at several dates in June. It continues to be abundant throughout the month of July. Obtained on sorghum roots July 26 and 31. October 8 was the last date at which it was found. Next year (1883) the first winged root-aphides were obtained June 7 and again July 29. Rotation is given as a remedy.

1884. Forbes, S. A.—Circular on the corn root-aphis and Hessian fly. <Ill. Crop Prospects, Springfield, May, 1884, p. 48. Reprint: Farmers' Review, Chicago, Ill., June 5, 1884. See Prairie Farmer, Chicago, Ill., June 14, 1884.

Requests for information concerning injuries by *Aphis maidis* (?), root form.

1885. Garman, H.—A contribution to the life history of the corn plant-louse. <Fourteenth Rep. State Ent. Ill., Springfield, pp. 23–33. Same: Trans. Dept. Agr. Ill., Springfield, Ill., Vol. XXII, 1885.

Previous literature, descriptions of the root and aerial forms, life history, parasitic and predaceous insects, and artificial remedies.

1886. Forbes, S. A.—Notes on the past year's work. <Can. Ent., London, Ont., Vol. XVIII, p. 176. Also: Ent. Amer., Brooklyn, N. Y., December, 1886, Vol. II, p. 175.

Notes on *Aphis maidis*, root form.

1886. Garman, H.—A second contribution to the life-history of the corn plant-louse, *Aphis maidis* Fitch. Miscellaneous Essays on Economic Entomology by the State Entomologist and his Assistants. <Trans. Dept. Agr. Ill. for 1885, Springfield, Vol. XXIII, pp. 46–48.

First record of the occurrence of the oviparous female (October 7), root form, and descriptions of it. Also notes on relation of the root-aphis and ants.

1886. HUNT, THOMAS F.—Partial economic bibliography of Indian corn insects. Miscellaneous Essays on Economic Entomology by the State Entomologist and his Assistants. <Trans. Dept. Agr. Ill., Springfield, Vol. XXIII, pp. 117–118. Separate: Springfield, Ill., 1886.

Gives a bibliography, partially analytical, of *Aphis maidis* (root and aerial forms).

1886. WEBSTER, F. M.—Insects affecting the corn crop. <35th Ann. Rep. Ind. State Bd. Agr. for 1885, Indianapolis, Vol. XXVII, pp. 183–184.

Bibliography of the corn aphis, *Aphis maidis* Fitch (root and aerial forms). Notes and general discussion, including observations on the relation of corn root-aphis and ants.

1887. COMSTOCK, J. H.—Relations of ants and aphids. <Amer. Nat., Philadelphia, Pa., Vol. XXI, p. 382.

Reference to the dependence of the corn root-aphis upon the ant.

1887. FORBES, S. A.—Relations of ants and aphids. <Amer. Nat., Philadelphia, Pa., Vol. XXI, pp. 579–580.

Eggs of *Aphis maidis* (?), root form, found in a nest of *Lasius alienus*. Ants rear young aphides, before ground is planted to corn, upon the roots of *Setaria* and *Polygonum*, transferring them afterwards to corn.

*1887. WEED, C. M.—Insects affecting corn. <Weekly Press, Philadelphia, Pa., September 21, 1887.

Aphis maidis (?), root form, hibernates in the egg stage.

1888. COMSTOCK, J. H.—An introduction to entomology. <Ithaca, N. Y., pp. 168–169.

Mentions observations of Forbes with regard to the relations of ants and corn root-aphides.

1888. WEBSTER, F. M.—Report on the season's observations, and especially upon corn insects. <Ann. Rep. U. S. Comm. Agr. for 1887, Washington, D. C., pp. 148–149.

Rhopalosiphum maidis; considerable damage done by the root form in Louisiana and Mississippi. Found it on roots of grass (*Setaria glauca*). Three species of ants attend these aphides, viz. *Lasius flavus, Formica schaufussii,* and *F. fusca.* Remedies: Proper fertilizers applied to the soil are a general preventive.

1888. WEBSTER, F. M.—Relation of ants to the corn aphis. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. I, pp. 152–153.

Reply to an article by Professor Comstock in American Naturalist. Explains in detail the part played by the ant in the distribution of the corn root-aphis and the care of the eggs of the latter by the ant.

1888. WEED, C. M.—On the occurrence of apterous males among the Aphididæ. <Amer. Nat., Philadelphia, Pa., Vol. XXII, p. 70.

Aphis maidis, root form, has apterous males.

1889. ALWOOD, W. B.—The corn plant-louse. <The Southern Planter, Richmond, Va., August, 1889, pp. 116–117.

Article in response to an inquiry from a farmer in that State (Virginia) who had found the aerial and root forms of the corn aphis troubling his crops. Gives life history, and suggests remedy by destruction of fodder and stalks, the plowing up of all stubble in the fall, and the putting of the field to small grain next year.

1889. Forbes, S. A.—Fifteenth Report of the State Entomologist of Illinois for 1885–1886. <Trans. Dept. Agr. Ill. for 1885, Springfield, Vol. XXIII, pp. 5–6. Separate: Springfield, Ill., 1889.

Brief notes on the injuriousness of *Aphis maidis*, and observations made on the winter history of the root form.

1889. Marten, J.—The corn-root aphis. <Prairie Farmer, Chicago, Ill., October 12, 1889, p. 660, 4 figs.

Short general account of *Aphis maidis* (root and aerial forms).

1889. Weed, C. M.—The corn root louse. <Amer. Nat., Philadelphia, Pa., Vol. XXIII, pp. 1105–1106.

Reference to articles on *Aphis maidis* (?), root form, in the Fifteenth and Sixteenth Reports of the State Entomologist of Illinois.

1890. Forbes, S. A.—Sixteenth Report of the State Entomologist of Illinois for 1887 and 1888. <Trans. Dept. Agr. Ill., Springfield, Vol. XXVI, p. XII. Separate: Springfield, Ill., 1890.

Notes on injuries done by corn root-aphis.

1890. Weed, C. M.—Corn insects: An important matter. <Ohio Farmer, Cleveland, Ohio, January 25, 1890, p. 57.

Notes on damage by the corn root-aphis.

1890. Weed, C. M.—Insects affecting corn. <Ohio Agr. Exp. Sta., Columbus, second series, Vol. III, No. 4, pp. 135–136, fig. 20.

Brief notes on the life history of the corn root-aphis.

1891.—Forbes, S. A.—Seventeenth Report of the State Entomologist of Illinois for 1889 and 1890. <Trans. Dept. Agr. Ill., Springfield, Vol. XXVIII, pp. 64–70, colored plate "B," figs. 1, 2, 3, 4. Separate: Springfield, Ill., 1891.

Aphis maidi-radicis, n. sp. Proposes name for the root form of the corn aphis, and gives a full account of the life history, covering, as points of special interest, time and place of oviposition, stage and place of hibernation, relations of root-aphis to leaf-aphis of corn, other food plants, and the relations of the root-aphis to ants. Economic measures are suggested.

1891. Forbes, S. A.—A summary history of the corn root-aphis. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. III, pp. 233–238.

Covers the same points in the life history of the corn root-aphis as in the citation above.

* 1891. Osborn, H.—The corn root-aphis. <Orange Judd Farmer, Chicago, Ill., April 25, 1891, p. 260.

Gives suggestions made by Doctor Forbes as to the methods to be used in diminishing the injury by this aphis.

1891. Pearson, J.—Destructiveness of the corn-root plant-louse in Nebraska. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. IV, p. 142.

In Nebraska some farmers lost as much as one-third of their crop. He suggests rotation of corn with small grain.

1891. Weed, C. M.—Sixth contribution to a knowledge of the life history of certain little-known Aphididæ. <Bul. Ill. State Lab. Nat. Hist., Urbana, Vol. III, art. 12. (Written December, 1887.)

Aphis maidis (?), root form. Summary of known life history. Hatching of aphides from eggs in spring. True sexes produced in fall and eggs are laid which are cared for by ants through the winter. Descriptions of the wingless male and the egg.

1891. WEED, C. M.—Insects and Insecticides. <Hanover, N. H., pp. 209–210, fig. 110.

The corn root-aphis (*Aphis maidis* ?). General life history; gives the rotation of crops as the only known successful remedy.

1891. WILLIAMS, T. A.—Host-plant list of North American Aphididæ. <Special Bul. 1, Univ. Nebr., Dept. Ent., Lincoln, pp. 10, 14, 16, 21, 23.

Lists of food plants of *Aphis maidis*, feeding on roots, as dock (*Rumex altissimus*), *Setaria glauca*, *S. viridis*, knotweed (*Polygonum persicaria*), plantain (*Plantago major*), ragweed (*Ambrosia trifida*), and smartweed (*Polygonum* sp.).

1892. BRUNER, L.—Report of Entomologist. <Ann. Rep. Nebr. State Board Agr. for 1891, Lincoln, pp. 300–304, fig. 77.

Aphis maidi-radicis Forbes. Gives descriptions of all forms. Quotes the life history from that given by Professor Forbes.

1892. RILEY, C. V., and HOWARD, L. O.—Review of Professor Forbes's Sixth Report. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. IV, Nos. 9 and 10, p. 293.

Mentions that it contains a summary history of the corn root-aphis and a colored plate of same.

1892. WEBSTER, F. M.—Early published references to some of our injurious insects. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. IV, Nos. 7 and 8, p. 264.

Gives references to the original descriptions of *Aphis maidis*, root and aerial forms. Gives reference to a note in American Farmer, Vol. IV, p. 71, May 24, 1822, from Mr. Tho. Emory, of Poplar Grove (State not given), relating to a disease of wheat known as "sedging," who says, "I believe this insect is the same as that known by the name of the root-louse in corn, so frequently found in that plant," etc.

1892. RILEY, C. V., and HOWARD, L. O.—The corn root-aphis. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. IV, Nos. 7 and 8, p. 285.

Short review of Doctor Weed's article on the corn root-aphis, published as a bulletin of the Illinois State Laboratory of Natural History.

1893. RILEY, C. V., and HOWARD, L. O.—The corn-root plant-louse. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. VI, p. 32.

Crop of corn in Maryland owned by E. P. Thomas was damaged 50 per cent last year by this aphis; also injury this year (June 27, 1893).

1894. FORBES, S. A.—Eighteenth Report of the State Entomologist of Illinois. <Trans. Dept. Agr. Ill. for 1893, Springfield, Vol. XXXI, pp. 57, 58–85, Pl. VII, figs. 5, 6, Pl. VIII, figs. 1, 2, 3, 4, 5. Separate: Springfield, Ill., 1894.

The corn root-aphis (*Aphis maidi-radicis* Forbes). Injury to corn and to other plants; life history; relation to the corn leaf-aphis; natural enemies; economic procedure; discusses in full (1) rotation, (2) fertilizers and insecticides, (3) breaking up the ants' nests in fall by plowing, etc., (4) early spring plowing, etc. Descriptions of wingless, winged, and pupa of viviparous female, wingless oviparous female, wingless male, and egg.

1894. OSBORN, H.—Corn insects: Their injuries and how to treat them. <Iowa Agr. Exp. Sta., Des Moines, Iowa, Bul. 24, pp. 994–995, fig. 1.

Mentions *Aphis maidi-radicis* as an important corn insect, although as yet it hardly seems probable that the species has become very much distributed in Iowa.

1894. SEMPERS, F. W.—Injurious insects and the use of insecticides. <Philadelphia, Pa., p. 157.

Short account of the corn root-aphis, with remedies. "No artificial remedy is known for this pest. In small garden patches kerosene emulsion might be used for drenching about the roots, but treatment with this insecticide has not been regarded as practicable on a large scale."

1895. COMSTOCK, JOHN HENRY, and COMSTOCK, ANNA BOTSFORD.—Manual for the Study of Insects. <Ithaca, N. Y., p. 158.

Mentions dependence of root-aphis upon ants as given by Forbes.

1896. FORBES, S. A.—Insects injurious to the seed and root of Indian corn. <Ill. Agr. Exp. Sta., Urbana, Bul. 44, pp. 237–257, figs. 33–37.

Largely a recapitulation of the account given in the Eighteenth Report of the State Entomologist of Illinois.

1896. SMITH, J. B.—Economic entomology. <Philadelphia, Pa., p. 134.

Mentions the corn root-aphis and methods to be used against it.

1896. HOPKINS, A. D., and RUMSEY, W. E.—Practical entomology. <W. Va. Agr. Exp. Sta., Charleston, Bul. 44, p. 279.

Short and general account of the life history of *Aphis maidi-radicis*. It was found to be exceedingly common and destructive to corn in Jackson, W. Va., in May, 1891. Remedies are given.

*1898. WEBSTER, F. M.—Entomology. <Ohio Farmer, Cleveland, Ohio, September 1, 1898, p. 143.

Notes on *Aphis maidi-radicis*.

1899. KING, GEO. B.—China asters infested by a coccid. <Psyche, Cambridge, Mass., Vol. VIII, p. 312.

Reports that *Aphis maidi-radicis* is found on roots of asters in Massachusetts.

1900. LUGGER, O.—Bugs injurious to cultivated plants. <Minn. Agr. Exp. Sta., St. Paul, Bul. 69, pp. 184–185, fig. 154½.

Quotes Osborn in regard to the corn root-aphis.

1900. SMITH, J. B.—Insects of New Jersey. <Supplement to Twenty-seventh Ann. Rep. State Board Agr. N. J. for 1899, Trenton, p. 104.

Lists *Aphis maidis* Fitch and speaks of it as often causing serious injury to the young plants by its attacks on the roots.

1901. BRUNER, L.—Corn-root insects. <Nebraska Farmer, Lincoln, Nebr., February 14, 1901, figs.

General account of the life history of the corn root-aphis, with suggested remedies.

1901. HUNTER, W. D.—The Aphididæ of North America. <Ia. Agr. Exp. Sta., Ames, Bul. 60, pp. 98–99.

Lists *Aphis maidi-radicis* from Iowa; gives other States in which it is found; food plants and bibliography of literature.

1901. SANDERSON, E. D.—The corn root-louse. <Twelfth Ann. Rep. Del. Agr. Exp. Sta. for 1900, Wilmington, p. 211.

Sweet and sugar corn worse affected than field corn. Aphides common on weeds early in the season and were found on squash roots in June.

1902. SANDERSON, E. D.—Insects injurious to staple crops. <New York, N. Y., pp. 134–141, figs. 74–76.

The corn root-louse (*Aphis maidi-radicis* Forbes). A general description of the aphis; distribution; food habits; life history; care by ants; remedies.

1902. WASHBURN, F. L.—Insects notably injurious in 1902. <Seventh Ann. Rep. State Ent. Minn., St. Anthony Park, p. 64, fig. 155. Also as Bul. 77, Minn. Agr. Exp. Sta., November, 1902.

Brief notes on *Aphis maidis* Fitch (root and aerial forms) as occurring in Minnesota; remedies.

*1904. STEDMAN, J. M.—Common corn insects. <Mo. State Board Agr., Bul. 3, No. 11, pp. 11–17.

Notes on the corn root-aphis in Missouri.

1905. FORBES, S. A.—Field experiments and observations on insects injurious to corn. <Ill. Agr. Exp. Sta., Urbana, Bul. 104, pp. 102–123.

Discuss experiments made in 1904–1905 to control the corn root-aphis by means of treatment of the soil before planting. Also gives additional notes on the life history.

1905. FORBES, S. A.—Injurious insects of corn. A conference on the corn insects of Illinois, at the Tenth Ann. Meeting of the Ill. Farmers' Institute, at Joliet, Ill. <Springfield, Ill. Plate. Also in Rep. Ill. Farmers' Institute, Springfield, Vol. X, pp. 35–45.

Gives account of the corn root-aphis and experiments made in the past year. Questions and answers. One colored plate of the corn root-aphis and the root-aphis ant.

1905. FORBES, S. A.—The principal insects injurious to the corn plant. <Report Ill. Farmers' Institute, Springfield, Vol. X, pp. 240–251, figs. 17–22.

Injury to corn and to other plants; life history; relation to ants; economic procedure.

1905. KOHLER, A. R.—Insects injurious to corn. <Iowa Agriculturist, Ames, Iowa, Vol. VI, No. 3, pp. 84–85.

Short account of the corn root-aphis.

1905. PETTIT, R. H.—Insects of the garden. <Mich. Agr. Exp. Sta., Agricultural College, Bul. 233, p. 53. Also in Nineteenth Ann. Rep. Mich. Agr. Exp. Sta., Agricultural College, 1906, p. 204.

Mentions *Aphis maidi-radicis* as a corn insect, but that thus far it has not been observed in Michigan.

1905. SYMONS, T. B.—Common injurious and beneficial insects in Maryland. <Md. Agr. Exp. Sta., College Park, Bul. 101, pp. 160–161.

The corn root-aphis. Short notes and remedies.

1906. DAVIS, J. J.—The corn root-louse (*Aphis maidi-radicis* Forbes). <Illinois Agriculturist, Urbana, Vol. X, March, pp. 213–218, 6 figs. Abstract: Wallace's Farmer, Des Moines, Iowa, Vol. XXXI, May 11, 1906, p. 637, 6 figs.

General account of habits, life history, etc., and remedies.

1906. FORBES, S. A.—The corn root-aphis and its attendant ant. <U. S. Dept. Agr., Bur. Ent., Washington, D. C., Bul. 60, pp. 29–41.

A complete account of the corn root-aphis. Discusses economic importance, life history, the attendant ant, relation of ant and aphis, injury to corn, natural checks on increase, practical economic measures, and a preventive routine.

1906. KIRKALDY, G. W.—Catalogue of the hemipterous family Aphidæ, with their typical species, together with a list of the species described as new from 1885 to 1895. <Can. Ent., London, Ont., Vol. XXXVIII, p. 13.

Lists *Aphis maidi-radicis* Forbes.

1906. SANBORN, C. E.—Kansas Aphididæ, with catalogue of North American Aphididæ, and with host-plant and plant-host list. Part 2. <Kansas Univ. Sci. Bul., Lawrence, Vol. III, No. 8, p. 258.

Lists food plants of *Aphis maidi-radicis* Forbes as *Amarantus hybridus, Erigeron canadensis, Oxalis stricta, Plantago major, Portulaca oleracea, Rumex crispus, Setaria italica germanica ochloa,* and corn.

1907. CHITTENDEN, F. H.—Insects injurious to vegetables. <New York, pp. 189–190, fig. 121.

Short account of the corn root-aphis, including economic treatment.

1907. FORBES, S. A.—The corn root-louse. <Fayette County Democrat, Effingham, Ill., Vol. XLVII, No. 19, March 6, 1907; Bureau County (Ill.) Record, March 6; The Weekly Pantagraph, Bloomington, Ill., Vol. XC, No. 12, March 22. Also in many other Illinois newspapers.

Gives detailed accounts of the new oil-of-lemon treatment, which he has found to be the most effective method of controlling the corn root-aphis.

1907. STOUT, J. P.—Control of the corn root-aphis. <Illinois Agriculturist, Urbana, April, pp. 245–247, 4 figs.

Gives methods which have been successfully used to combat the corn root-aphis, including the oil-of-lemon treatment, which Doctor Forbes has proved to be the most practical method of controlling this root-aphis.

1907. WEBSTER, F. M.—The corn leaf-aphis and corn root-aphis. <U. S. Dept. Agr., Bur. Ent., Washington, D. C., Cir 86, May 6, 1907, figs. 3, 4.

Gives general description and discusses: Root-aphis and the little brown ant; life history and habits; natural enemies; preventive and remedial measures.

1907. FORBES, S. A.—Insects in relation to health. <Rept. Ill. Farmers' Inst., Springfield, vol. 12, pp. 263–265.

In a few introductory remarks, preceding a lecture on "Insects in relation to health," Doctor Forbes reports on the success of the oil-of-lemon treatment for corn seed to protect it from the attacks of the corn root-aphis. Methods of treating the seed are given.

1908. FORBES, S. A.—Experiments with repellents against the corn root-aphis. <Journ. Econ. Ent., Concord, N. H., vol. 1, No. 2, pp. 81–83.

Abstract of a paper read by Doctor Forbes at the 20th annual meeting of the Association of Economic Entomologists. Gives in detail results of field experiments, in 1906, against the corn root-aphis by treatment of the seed with oil of lemon, carbolic acid, formalin, and kerosene.

1908. FORBES, S. A.—Experiments with repellents against the corn root-aphis. <Orange Judd Farmer, Chicago, Ill, vol. 44, No. 16, April 15, pp. 501, 504.

Gives results of field experiments, in 1906, against the corn root-aphis by a treatment of the seed with oil of lemon, carbolic acid, formalin, and kerosene. Several farmers who used the oil-of-lemon treatment in 1907 reported injury by the treatment. Mentions that further experiments will be made in Illinois in 1908.

THE CORN LEAF-APHIS.

(*Aphis maidis* Fitch.)

GENERAL ACCOUNT.

The corn leaf-aphis was first found injuring corn by Dr. Asa Fitch, and in his Second Report of the Insects of New York (1856) he describes it, and proposes for it the name of *Aphis maidis*, giving an

account of its injuries to corn. Although since that time considerable work has been done on this aphis, we do not yet know how it spends the winter. In 1862 Mr. Benjamin D. Walsh found an aphis living on the roots of corn about Rock Island, Ill., and, although he was doubtful as to its identity, he distinguished it by calling it the root form of *Aphis maidis*. From that time until 1891 these two forms were supposed to be the same species, until Doctor Forbes, who had, since his first knowledge of them, regarded them as probably two distinct species, named the subterranean form *Aphis maidi-radicis* in the Seventeenth Report of the State Entomologist of Illinois.

Aphis maidis has always been considered more or less injurious to corn, sorghum, and broom corn, although it seldom becomes seriously so. In some cases, however, it injures the corn ears by sucking the sap from the silk and killing it, thus preventing fertilization of the kernels. Only rarely, however, does it stunt the growth of the plant, at least in Illinois, the reason probably being that in this State the aphis does not commence its attacks upon the plant until the last part of June or the first of July, at which time the plant is strong enough to withstand the drain made upon its sap supply by the aphis. This aphis sometimes does considerable injury to the quality of the brush of broom corn by discoloring it, the discoloration being "due to a bacterial affection following upon the plant-louse punctures" (Forbes).

This aphis has a very wide distribution, being found in all parts of the United States where corn is grown; that is, from Maine to California and Texas. Prof. F. M. Webster has reported finding it on sorghum in Australia, where, he says, it is sometimes quite obnoxious, and in a recent circular he says that "the insect is also known from Japan."

FOOD PLANTS.

Though the usual food plants are corn, sorghum, and broom corn, this species feeds also on various other plants, as barley, *Setaria glauca*, and *Oxalis*. At Urbana, Ill., September 7, 1906, in an infested cornfield, I found *Aphis maidis* also breeding on *Panicum crus-galli* and *Panicum sanguinale*.

In our insectary, in 1906, plants of *Panicum crus-galli* and *Panicum sanguinale*, which had accidentally grown up in some unused pots, became almost covered with *Aphis maidis*. Numbers of these aphides were placed in a Comstock cage containing the common weeds found around cornfields, namely, *Setaria glauca*, *Panicum crus-galli*, *Polygonum pennsylvanicum*, *Panicum proliferum*, *Panicum sanguinale*, broom corn, sorghum, and corn. When examined two days later (September 10, 1906) the aphides were breeding freely on all plants except corn, which was at that time just sprouting. November 4, aphides were on all plants except *Panicum crus-galli*, *Polygonum*

pennsylvanicum, and *Panicum proliferum*, which plants were then dead. December 9, there were a few on the sorghum and corn, these being the only plants alive at that time. When examined about a week later all plants in the cage were dead and no aphides could be found. It might be mentioned that this cage was kept at the outdoor temperature. This aphis shows a decided preference for broom corn over Indian corn and sorghum. Both in the field and in the insectary aphides which had been living on sorghum plants for a number of generations always changed to broom-corn plants when these were placed in the cages.

LIFE HISTORY.

As stated above, we do not know where and how this aphis passes the winter. In Illinois it first appears in midsummer, the earliest date being June 26, 1906, at which time Mr. E. O. G. Kelly found it quite numerous on broom corn at Mattoon, in central Illinois. We know that it reproduces parthenogenetically from the time of its first appearance in the fields until its disappearance in the fall. In the fall, so far as has yet been observed, these aphides gradually die off as freezing weather comes, leaving neither eggs nor hibernating adults upon or about the corn plants. I did not make any observations in the field in 1906, but in 1905 (a more severe season than 1906) I found living *Aphis maidis* on sorghum as late as October 28, and all found at that date were either winged or the pupæ of winged viviparous females. Numerous experiments have been made by Doctor Forbes and his assistants to determine the manner in which this species hibernates, and whether or not there is a sexual generation in the fall, as is usually the case with aphides. Since these investigations were thorough, it seems possible that the aphides may not spend the winter in the egg stage, at least in central or northern Illinois. There are at least two permissible suppositions as to the winter history of these insects. They may hibernate as adults in the warmer States, or even in southern Illinois, and, as the summer progresses, gradually diffuse themselves to the North with the advance of the season and infest the plants in these northern States. This supposition is plausible, inasmuch as this species has been found in Mississippi on barley in January; but the fact that aphides are probably unable to travel great distances is against it. No work has been done as yet on this line of investigation, and it is possible that if one began his search for this aphis in the far South—even in the southern part of Illinois—he would find it at a much earlier date than it has heretofore been reported, and that he could follow its gradual diffusion northward. The other and more likely theory is that, like many aphides, it has an alternate food plant on which it passes the winter and spring.

I have worked out in the insectary (1906) the summer history as regards the number of generations, rate of multiplication, number of young, etc. *Aphis maidis* was collected by Mr. Kelly June 26, and specimens sent in by him were reared on sorghum and broom corn. From that date until killed by the cold weather in the fall a maximum of 17 generations was obtained. (See Table VII and fig. 33.)

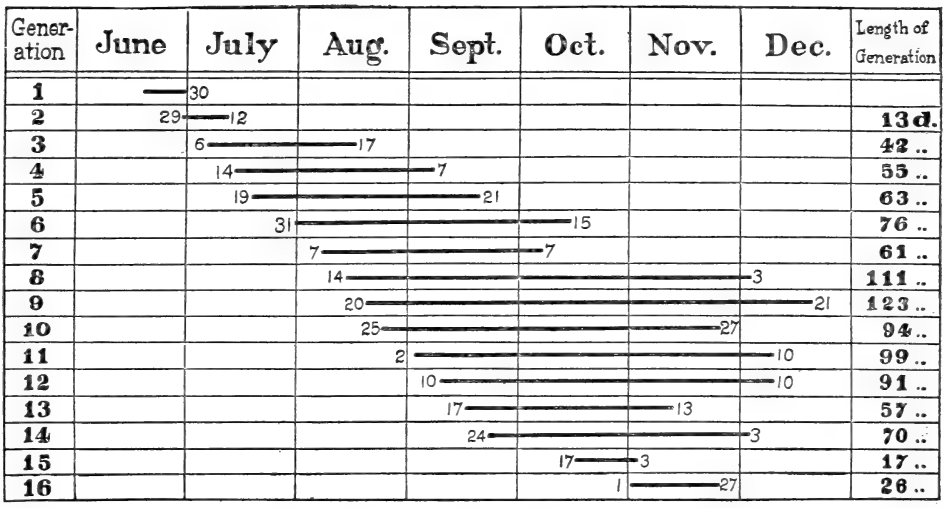

FIG. 33.—Periods and succession of generations in *Aphis maidis*, 1906.

TABLE VII.—*Line of generations of Aphis maidis, June 26–November 22, 1906.*

Generation in insectary.	Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Productive period.	Number of young.	Average young per day of productive period.	Largest number of young in 1 day (at least).	Period after last young.	Date of death or disappearance.	Total length of life.	Food plant used.
	1906.		*Days.*		*Days.*				*Days.*		*Days.*	
1	[a]June 26	June 28–June 29	.....	.....	.....	6	.....	.....	.....	.....	.....	Sorghum.
2	June 29	July 6	7	July 12	7	18	2.6–	3	0	July 12....	14	Do.
3	July 9-11	July 15	5-6	Aug. 4	20	38	1.9	5	13	Aug. 17 ...	39	Broom corn.
4	July 15	July 21	6	Aug. 8	18	44	2.4+	5	11	Aug. 19 ...	35	Do.
5	July 25	July 31	6	Aug. 18	18	35	2 –	3	6	Aug. 24 ...	30	Do.
6	July 31	Aug. 7	7	Sept. 2	26	38	1.5–	4	0	Sept. 2....	33	Do.
7	Aug. 7	Aug. 13	6	Sept. 6	24	47	1.9+	5	1	Sept. 8....	31	Do.
8	Aug. 13	Aug. 19	6	Aug. 30	12	36	3	4	0	Aug. 30 ...	18	Do.
9	Aug. 19	Aug. 25	5	Sept. 6	12	29	2.4+	4	0	Sept. 7....	17	Do.
10	Aug. 25	Sept. 2	8	Sept. 12	10	17	1.7	2	0	Sept. 12...	18	Do.
11	Sept. 2	Sept. 9	7	Oct. 11	32	52	1.6+	4	4	Oct. 15....	43	Do.
12	Sept. 9	Sept. 16	7	Sept. 23	7	20	2.8+	3	0	Sept. 23...	14	Do.
13	Sept. 16	Sept. 24	8	Oct. 15	21	33	1.5+	3	0	Oct. 15....	29	Do.
14	Sept. 24	Oct. 4	10	Oct. 4	2	1	.5	.....	0	Oct. 4.....	11	Do.
15	Oct. 4	Oct. 16	12	Oct. 17	2	4	2	.....	.....	Oct. 17-22.	14	Do.
16	Oct. 16	Nov. 1	15	Oct. 2	1	2	2	.....	.....	Nov. 3....	16	Do.
17	[b]Nov. 1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Collected on broom corn.
[b] Became adult November 22, but disappeared before giving birth to any young.

TABLE VIII.—*Data of individual experiments with Aphis maidis, viviparous generation, 1906.*

Date of birth.	Date of first young.	Age at birth of first young.	Date of last young.	Productive period.	Number of young.	Average young per day of productive period.	Largest number of young in one day (at least).	Period after last young.	Date of death or disappearance.	Total length of life.	Food plant used.
		Days.		*Days.*				*Days.*		*Days.*	
June 28–29	July 6	7–8	July 12	7	18	2.6 −	3	0	July 12	14	Sorghum.
July 9–10	July 15	5–6	Aug. 4	20	38	1.9	5	13	Aug. 17	39	Broom corn.
July 6	July 14	8	Aug. 6	23	33	1.4 +	3	5	Aug. 11	36	Sorghum.
July 9	do	5	July 30	16	22	1.3 +	2	11	do	32	Do.
July 14	July 20	6	Aug. 3	13	38	2.9 +	6	0	Aug. 3	19	Broom corn.
July 15	July 21	6	Aug. 8	18	44	2.4 +	5	11	Aug. 19	35	Do.
July 27	Aug. 1	5	Aug. 22	21	49	2.4 −	5	6	Aug. 28	32	Do.
July 25	July 31	6	Aug. 18	18	35	2 −	3	6	Aug. 24	30	Do.
July 31	Aug. 7	7	Sept. 2	26	38	1.5 −	4	0	Sept. 2	45	Do.
August 1	do	6	Aug. 11	5	13	2.6	4	0	Aug. 11–13	[a] 11	Do.
August 7	Aug. 13	6	Sept. 6	24	47	1.9 +	5	1	Sept. 8	31	Do.
Do	Aug. 14	7	Aug. 20	7	26	3.7 +	6	0	Aug. 20	[a] 14	Do.
August 10	Aug. 16	6	Sept. 13	28	49	1.7 +	4	8	Sept. 21	42	Do.
August 13	Aug. 19	6	Aug. 30	12	36	3	4	0	Aug. 30	18	Do.
August 14	Aug. 20	6	Sept. 16	27	47	1.7	6	10	Sept. 26	43	Do.
August 17	Aug. 22	5	do	25	64	2.5 +	4	19	Oct. 6	49	Do.
August 20	Aug. 25	5	Sept. 6	12	29	2.4 +	4	0	Sept. 7	17	Do.
Do	Aug. 27	7	Sept. 23	27	65	2.4 +	5	7	Sept. 30	41	Do.
August 3–4	Aug. 10	6–7	Sept. 2	23	32	1.3 +	3	5	Sept. 7	34	Do.
August 22	Aug. 29	7	Sept. 9	11	14	1.2 +	3	0	Sept. 9	18	Do.
August 25	Sept. 2	8	Sept. 12	10	17	1.7	2	0	Sept. 12	18	Do.
August 27	Sept. 7	11	Sept. 8	2	5	2.5	.....	0	Sept. 8	13	Do.
September 7	Sept. 14	7	Sept. 26	12	28	2.3 +	4	0	Sept. 26	19	Do.
September 2	Sept. 9	7	Sept. 11	32	52	1.6 +	4	4	Oct. 15	43	Do.
August 31–September 2	Sept. 8	6–8	Sept. 18	10	23	2.3	3	0	Sept. 18	16–18	Do.
September 7	Sept. 14	7	Sept. 23	9	26	2.8 +	.....	0	Sept. 23	16	Do.
September 9	Sept. 16	7	do	7	20	2.8 +	3	0	do	14	Do.
Do	Sept. 15	6	Oct. 5	20	38	1.9 +	5	10	Oct. 15	36	Do.
September 14	Sept. 21	7	Nov. 8	48	59	1.2	4	.....	Nov. 8–13	55	Do.
September 16	Sept. 24	8	Oct. 15	21	33	1.5 +	3	0	Oct. 15	29	Do.
September 24	Oct. 4	10	Oct. 4	[a] 2	(a)	.....	.....	.....	Oct. 5	[a] 11	Do.
September 21	Sept. 28	7	Sept. 30	[a] 3	7	2.3 +	.....	.....	Sept. 30	[a] 10	Do.
October 4	Oct. 16	12	Oct. 17	[a] 2	[a] 4	2	.....	.....	Oct. 17–22	14	Do.
September 23	Oct. 2	9	Oct. 28	26	[a] 35	1.3 +	4	37–44	Dec. 3–10	72	Do.
Do	do	9	Nov. 13	42	31	[a] 0.7 +	4	14	Nov. 27	65	Do.
October 1	Oct. 11	10	Oct. 12	[a] 1	[a] 1	[a] 1 +	.....	.....	Oct. 11–13	[a] 11	Do.
October 17	Nov. 1	15	Oct. 2	[a] 1	[a] 2	[a] 2	.....	.....	Nov. 3	16	Do.
October 20	Oct. 28–Nov. 1	8–12	Nov. 27	26–30	14+	(a)	.....	6	Dec. 3–10	44	Do.
October 25	Nov. 18	24	Nov. 22	[a] 4	[a] 3	[a] 0.7 +	.....	.....	Nov. 22	28	Do.
November 1	Nov. 22–27	22–27	Dec. 3–10	(a)	(a)	(a)	.....	.....	Dec. 10	40	Do.
Average	.....	8.15	.....	19.0+	33.5	2.04+	.....	.....	.....	31.6+	

[a] Not counted in making averages.

Although no exact figures can be given as to the minimum number of generations (breeding always from the last born of each generation), still, from my experiments, it may be definitely said that there were not more than 9 generations after June 26. The aphides were kept in the unheated insectary greenhouse, and thus the temperature was approximately the same as that out of doors. The last date recorded for living aphides was December 21. The immature stage covered from 5 to 24 days, varying with the season; thus, in the warmer parts of the year, from the last of June until the middle of September, the average for 30 experiments was 6.6 days, while from the middle of September until the 1st of November for 10 experiments the average was 12.8 days. The average for the entire 40 experiments was 8.1+ days. (Table VIII.)

The length of the period for producing young varied up to 48 days, with an average, for the entire series of experiments, of 19 days. The mother usually lived a few days after the birth of her last young. The entire length of life averaged 31.6+ days. The average number of young produced by a single aphis, in the 33 experiments of which record was kept, was 33.5+, while the largest number was 65. Individual aphides in some cases produced as many as 6 or 8 young per day, but the usual number was 2. The number of molts is invariably 4. Table IX gives the records of a few individuals, showing the number of molts and the time between each molt.

TABLE IX.—*Periods of molts of Aphis maidis, viviparous generation, 1906–7.*

Date of birth.	Age at first molt.	Age at second molt.	Age at third molt.	Age at fourth molt.	Age at birth of first young.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*
July 23, 1905	2	3	5	8	9
Do	2	4	5	6	7
July 24, 1905	1	3	5	7	7
July 27, 1905	2	3	4	6	7
August 4, 1905	1	3	4	6	6
August 5, 1906	1	2	4	6	6
August 14, 1906	2	3	4	6	6

DESCRIPTIONS.

Aphis maidis Fitch.

VIVIPAROUS GENERATION.

Before first molt and less than 1 hour old.—General color light pea-green. Eyes red. Antennæ transparent, only 4 distinct segments, or 5 if the filament be counted, the third having a slight contriction, which is the beginning of a division of that segment. Legs transparent. Cornicles vasiform. Measurements: Length of body, 0.545 mm.; width, 0.236 mm.

After first molt and 24–48 hours old.—General color between pea-green and chromium-green. Eyes red. Antennæ as in the earlier

stages, but not transparent, while the constriction of the third segment is more distinct, and there is a sensorium at the apical end of the third segment. Fore part of head darker than body color. Legs paler than body color, except parts of the femur and tarsus, which are darker; the tip of the abdomen also is darker. Cornicles longer and more distinct than before first molt. Measurements: Length of body, 0.927 mm.; width, 0.363 mm.; antennæ, 0.325 mm.

After second molt and 48–72 hours old.—General color chromium-green, the sides being slightly darker. Head and first thoracic segment bottle-green. Eyes dark red. Antennæ pale green, with black tips. What was spoken of in the earlier stages as the third segment is now divided into two distinct segments; otherwise, except as to size, the antennæ are the same as in the earlier stages. Tips of legs black. Tip of abdomen dark chromium-green. The black cornicles are surrounded at their bases by dark green patches. Measurements: Length of body, 1.090 mm.; width, 0.454 mm.; antennæ, 0.342 mm.

After third molt and 96–120 hours old.—General color chromium-green. Head and first thoracic segment darker green. Eyes dark red. First and last segments of the antennæ black. As yet only 5 distinct segments, or 6 if the filament be counted. Tarsi black; femora of the posterior pairs of legs partly black. Tip of abdomen dark green; penultimate segment with a stripe of dark green nearly covering the entire segment. Cornicles black, with dark-green basal spots. Measurements: Length of body, 1.254 mm.; width, 0.527 mm.; antennæ, I, 0.044 mm.; II, 0.037 mm.; III, 0.132 mm.; IV, 0.061 mm.; V, basal, 0.057 mm.; filament, 0.117 mm.; total, 0.448 mm.

Adult wingless female.—Head black. Antennæ black, excepting third segment. Eyes very dark reddish brown. Beak dark, its apex black, shading to brown. General color of body blue-green. Fore segments and tip of abdomen very dark green. Legs black, excepting middle portion of femur. Cornicles black, slightly incrassate at the base and with a dark-green basal patch. The adult gradually becomes darker in color as it grows older, and when it has about finished with the production of young it is almost black in color, having a slightly greenish and brownish tint. Measurements (from alcoholic specimens collected on broom corn at Mattoon, Ill., July 6, 1906): Length of body, 2.363 mm.; width, 1.091 mm.; antennæ, I, 0.067 mm.; II, 0.054 mm.; III, 0.193 mm.; IV, 0.115 mm.; V, 0.111 mm.; VI, basal, 0.077 mm.; filament, 0.176 mm.; total, 0.793 mm.; cornicles, 0.203 mm.; style, 0.101 mm. The specimens reared in the insectary were somewhat smaller than the above.

Adult winged female.—Head black. Antennæ black, and with 6 segments, or 7 if the filament be counted. Antennal sensoria circular, 16 to 20 on III, 4 on IV, several at apical end of V, and also at apical end of the basal part of VI. Eyes dark brown or

black. Thorax and legs black. Abdomen pale bluish green. Three black spots on each side of the body and anterior to the cornicles, and a black basal spot surrounding each cornicle. Posterior to the cornicles are 2 black spots, one on each side, and also 3 more or less distinct transverse black bands. Cornicles black, slightly incrassate at middle, dilated at apex. Distal half of dorsally curved style black, and the remainder margined with black to the base. Measurements (alcoholic specimens): Length of body, 1.709 mm.; width, 0.618 mm.; wing expanse, 5.786 mm.; antennæ, I, 0.065 mm.; II, 0.057 mm.; III, 0.293 mm.; IV, 0.154 mm.; V, 0.154 mm.; VI, basal, 0.106 mm.; filament, 0.228 mm.; total, 1.057 mm.; cornicles, 0.130 mm.; style, 0.081 mm.

Pupa of winged female.—Body pale green. Head dark brown, with a more or less distinct median white line. Antennæ darker at either end. Antennæ with a sensorium at the end of V, and 2 or more at the distal end of the basal portion of VI. Wing-pads, tip of abdomen, and cornicles black. Legs dark, almost black. Cornicles noticeably incrassate at middle and slightly dilated at the tip. Measurements (alcoholic specimens): Length of body, 1.999 mm.; width, 0.799 mm.; antennæ, I, 0.067 mm.; II, 0.057 mm.; III, 0.183 mm.; IV, 0.125 mm.; V, 0.098 mm.; VI, basal, 0.084 mm.; filament, 0.159 mm.; total, 0.773 mm.; cornicles, 0.155 mm.

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Brief account of known life history of *Aphis maidis,* with insects parasitic upon it. Remedies.

1891. Williams, T. A.—Host plant list of North American Aphididæ. <Univ. Nebr. Dept. Ent., Lincoln, Spec. Bul. 1, pp. 9, 19, 23.

Lists the food plants of *Aphis maidis* Fitch as corn, cultivated *Oxalis,* and cultivated sorghum.

1892. Bruner, L.—Report of the Entomologist. <Ann. Rep. Nebr. State Board Agr. for 1891, Lincoln, pp. 299–300, fig. 75.

Aphis maidis Fitch attacks corn in overwhelming numbers at times. Gives characters distinguishing it from the root-aphis (*Aphis maidi-radicis*).

1892. Osborn, Herbert.—Catalogue of the Hemiptera of Iowa. <Proc. Ia. Acad. Sci., Des Moines, Vol. I, pt. 2, p. 129.

Lists *Aphis maidis* Fitch and mentions that it has been reported to him as infesting corn in Iowa.

1892. Webster, F. M.—Early published references to some of our injurious insects. <Insect Life, U. S. Dept. Agr., Washington, D. C., Vol. IV, Nos. 7 and 8, p. 264.

Gives references to the original descriptions of *Aphis maidis,* root and aerial forms.

1893. OSBORN, H., and SIRRINE, F. A.—Notes on Aphididæ. <Proc. Iowa Acad. Sci. for 1892, Des Moines, Vol. I, pt. 3, p. 98.

Aphis maidis Fitch, abundant on corn, broom corn, and sorghum in Iowa.

1894. FORBES, S. A.—Eighteenth Report of the State Entomologist of Illinois. <Trans. Dept. Agr. Ill. for 1893, Springfield, Vol. XXXI, pp. 69, 70, 73, 74, 82. Separate: Springfield, Ill., 1894.

Aphis maidis Fitch. Distinguishes between this and the corn root-aphis; disappearance in the fall; earliest appearance (July 23, 1883); relation to the corn root-aphis; transferring to roots of plants.

1894. OSBORN, H.—Corn insects, their injuries, and how to treat them. <Iowa Agr. Exp. Sta., Des Moines, Bul. 24, pp. 991–1005, fig. 9.

Brief notes on the corn leaf-aphis, with suggestions as to remedies.

1895. COWEN, J. H.—A preliminary list of the Hemiptera of Colorado. <Colo. Agr. Exp. Sta., Fort Collins, Bul. 31, Tech. Ser. 1, p. 120.

Aphis maidis Fitch. Collected at Fort Collins, Colo., September 14, on maize, and at Hotchkiss, Colo., July 27.

1895. WEED, H. E.—Insects injurious to corn. <Miss. Agr. Exp. Sta., Agricultural College, Bul. 36, p. 158.

Mentions that *Aphis maidis* can generally be found in the cornfields, though it rarely occurs in numbers sufficient to cause extensive damage.

1896. HOPKINS, A. D., and RUMSEY, W. E.—Practical entomology. <W. Va. Agr. Exp. Sta., Charleston, Bul. 44, pp. 281, 308–309.

Mention of the leaf-aphis, and remedial measures.

1900. HARVEY, F. L.—Notes on the insects of the year 1899. <Sixteenth Ann. Rep. Maine Agr. Exp. Sta., Augusta, p. 30.

The corn aphis (*Aphis maidis*) was abundant on sweet corn in some parts of the State.

1900. LUGGER, O.—Bugs injurious to cultivated plants. <Minn. Agr. Exp. Sta., St. Paul, Bul. 69, December, 1900, p. 184, fig. 154.

Mentions the corn leaf-aphis as infesting the upper parts of corn plants, with notes on the relations of the ants and root aphides. (Quotes Comstock.)

1901. HUNTER, W. D.—The Aphididæ of North America. <Iowa Agr. Exp. Sta., Ames, Bul. 60, September, 1901, p. 98.

Lists *Aphis maidis* Fitch from Iowa; gives bibliography; States in which it has been found; food plants.

1902. WASHBURN, F. L.—Insects notably injurious in 1902. <Minn. Agr. Exp. Sta., St. Anthony Park, Bul. 77, p. 64, fig. 155. Also as Seventh Ann. Rep. State Ent. Minn.

Brief notes on *Aphis maidis* Fitch (root and aerial forms) as occurring in Minnesota; remedies suggested.

1903. CLARKE, W. T.—A list of California Aphididæ. <Can. Ent., London, Ont., Vol. XXXV, p. 25.

Lists *Aphis maidis* from Berkeley and Watsonville, Cal., on corn and sorghum.

1904. SANBORN, C. E.—Kansas Aphididæ, with a catalogue of North American Aphididæ, and with host-plant and plant-host list. <Kans. Univ. Sci. Bul., Lawrence (pt. 1), Vol. III, No. 1, July, 1904, p. 58, fig. 66; (pt. 2) Vol. I, No. 8, April, 1906, p. 258.

Description of winged viviparous female of *Aphis maidis*. Gives food plants as *Setaria glauca, Sorghum halepense,* and *Zea mays.*

1904. SANDERSON, E. D.—Insects of 1903 in Texas. <U. S. Dept. Agr., Div. Ent., Washington, D. C., Bul. 46, p. 93.

Aphis maidis received upon barley from Texas, which it had damaged in January and May. In August it becomes abundant on corn, and later on sorghum, and it sometimes does considerable damage.

1905. FORBES, S. A.—Twenty-third Report of the State Entomologist of Illinois. <Chicago, pp. 123–133, figs. 115, 117.

The corn leaf-aphis (*Aphis maidis* Fitch). General descriptions of this aphis and its effects on plants. Reported as a corn insect from New York to Texas, Minnesota, and California. Gives in detail field observations and insectary experiments made to determine the winter history, alternate food plants, if any, etc., of the leaf aphis.

1905. PETTIT, R. H.—Insects of the garden. <Mich. Agr. Exp. Sta., Agricultural College, Bul. 233, December, p. 55. Also Nineteenth Ann. Rep. Mich. Exp. Sta., 1906, p. 206.

Mentions *Aphis maidis* as being sometimes injurious to sweet corn in Michigan.

1907. WEBSTER, F. M.—The corn leaf-aphis and corn root-aphis. <U. S. Dept. Agr., Bur. Ent., Washington, D. C., Cir. 86, pp. 1–3, May 6, figs 1, 2.

Short review of the history; appearance and habits; field experiments. Reports the occurrence of the leaf-aphis in Japan.

THE SORGHUM APHIS.

(*Sipha* [*Chaitophorus*] *flava* Forbes.)

The sorghum aphis was first described by Dr. S. A. Forbes in 1883, in the Thirteenth Report of the State Entomologist of Illinois. Doctor Forbes has further mentioned it in several of his reports as State entomologist, but so far as I know nothing else has been written about it.

LIFE HISTORY.

The life history was, until 1905, unknown, but during that year I made some studies upon this insect and found, among other things, that it passed the winter in the egg stage. In 1906 this aphis was first collected June 28 at Mattoon, Ill., by Mr. E. O. G. Kelly, on sorghum and *Panicum crus-galli*, and the life history from that date until the egg stage in the fall was obtained. Eggs thus obtained were carried through the winter and young hatching from them were reared. The generations were continued during the entire summer until the egg stage in the fall. During my absences in the summer of 1907 the experiments were carried on by Messrs. M. C. Tanquary and E. L. Dillon. June 28 is not the earliest at which this aphis has been collected in the field, as Doctor Forbes has found it on grass as early as May 7. I found 4 young aphides on timothy May 23, 1907, and these were bred on grass. They became winged adults as follows: One on May 30, 2 on June 2, and 1 on June 4. Inasmuch as I found these young aphides separately, and as no mother aphis was found after a careful search, I had supposed them to be stem-mothers, but, so far as I am able to learn, no record of stem-mothers

being winged has ever been made. The eggs began to hatch in the insectary March 16 (1907), and it is probable that in the field the hatching period is chiefly the month of April.

Sorghum and broom corn are the usual plants infested by this species, and upon these it is sometimes abundant and destructive. Doctor Forbes has reported it from sorghum, broom corn, Indian corn, *Setaria*, *Panicum*, and wheat. Mr. Kelly first reported its occurrence on *Panicum crus-galli*, and in 1906 I reared it through a number of generations on *Panicum sanguinale*, and collected it in the field from blue grass, oats, and timothy. Mr. Paul Hayhurst, of the Bureau of Entomology, U. S. Department of Agriculture, wrote me of finding it on *Setaria glauca*. Thus, so far as known, *Sipha flava* feeds only on plants of the grass family (Gramineæ). In Europe there are at present 8 or 9 known species of the genus *Sipha*, and, according to Del Guercio,[a] all, with the exception of one species, *Sipha bignonæ* Macch., feed only upon the grasses of the families Gramineæ and Juncaceæ. *Sipha bignonæ* is probably not a typical *Sipha*, and it was originally doubtfully placed under the genus *Lachnus* by Macchiati.[b] In America two species (*S. rubifolii* and *S. flava*) have been placed under the genus *Sipha*. *S. rubifolii* is found only on blackberry (*Rubus*), but this species probably belongs to an undescribed genus, and undoubtedly does not properly belong under the genus *Sipha* of Passerini.

Heretofore this aphis has never been positively reported outside of Illinois, but this year (1907) Mr. Hayhurst sent me specimens from Minnesota, Virginia, and Oklahoma, and wrote me that he found it also in New York, West Virginia, and Texas. It seems likely, therefore, that it is distributed over the United States, more or less generally, east of the Mississippi River. It will probably be found to be more generally distributed in the South, because all of the known facts regarding the distribution of this species, as well as of the European species of *Sipha*, indicate that they are probably of subtropical origin.

Young hatching from eggs March 18 were reared to adults and successive generations obtained. In one case the *first young of the first young* was taken all the way through the series, 16 generations being obtained. (Table X.)

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[a] Guercio, G. Del.—Contribuzione alla Conoscenza della Sipha Pass. ed alla loro posizione nella Famiglia degli Afidi. <Redia, Firenze, Italy, Vol. II (1904), pp. 127–153.

[b] Macchiati, Luigi.—Fauna e flora degli Afidi di Calabria. <Bul. Soc. Ent. Ital., Vol. XV (1883), p. 262.

TABLE X.—*Line of generations of Sipha flava from egg to oviparous generation, 1907.*

Generation (from egg).	Date of birth.	Date of first young.	Age at birth of first young.	Last young.	Productive period.	Number of young.	Average young per day of productive period.	Largest number of young in one day.	Life after last young.	Date of death or disappearance.	Total length of life.	Plant used.
			Days.		*Days.*				*Days.*		*Days.*	
1	Mar. 18	Apr. 15	28	June 6	52	48	0.9+	4	12	June 19	92	Sorghum.
2	Apr. 15	May 16	31	June 24	39	81	2.0+	5	6	June 30	76	Broom corn.
3	May 16	May 29	13	June 22	24	73	3.0+	6	8	June 30	45	Do.
4	May 29	June 11	13	July 9	28	80	2.8+	7	9	July 18	50	Do.
5	June 11	June 21	10	July 11	20	80	4	7	10	July 21	40	Do.
6	June 22	July 1	9	Aug. 12	42	56	1.3+	5	0	Aug. 12	51	Do.
7	July 1	July 8	7	July 19	11	37	3.3+	4	0	July 19	18	Do.
8	July 8	July 16	8	Aug. 16	31	63	2.0+	5	17	Sept. 2	56	Do.
9	July 16	July 24	8	Aug. 20	27	57	2.1+	5	3	Aug. 23	38	Do.
10	July 24	Aug. 5	12	Sept. 8	34	69	2.0+	6	4	Sept. 12	50	Do.
11	Aug. 5	Aug. 13	8	Sept. 16	34	81	2.3+	6	15	Oct. 1	57	Do.
12	Aug. 18	Aug. 28	10	Sept. 20	23	69	3	6	0	Sept. 20	33	Do,
13	Aug. 28	Sept. 6	9	Oct. 7	31	74	2.3+	7	23	Nov. 1	63	Do.
14	Sept. 6	Sept 17	11	Oct. 16	29	55	1.9−	5	47	Dec. 2	87	Do.
15	Sept. 17	Oct. 2	15	Oct. 22	20	17	0.8+	5	2	Oct. 24	37	Do.
[a]16	Oct. 2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Sexual generation.

On the other hand, beginning with the last to be borne by the aphis which had hatched March 18, and following down the series of the last born of each generation, there were but 7 generations in all. From this it follows that the mean number of complete generations

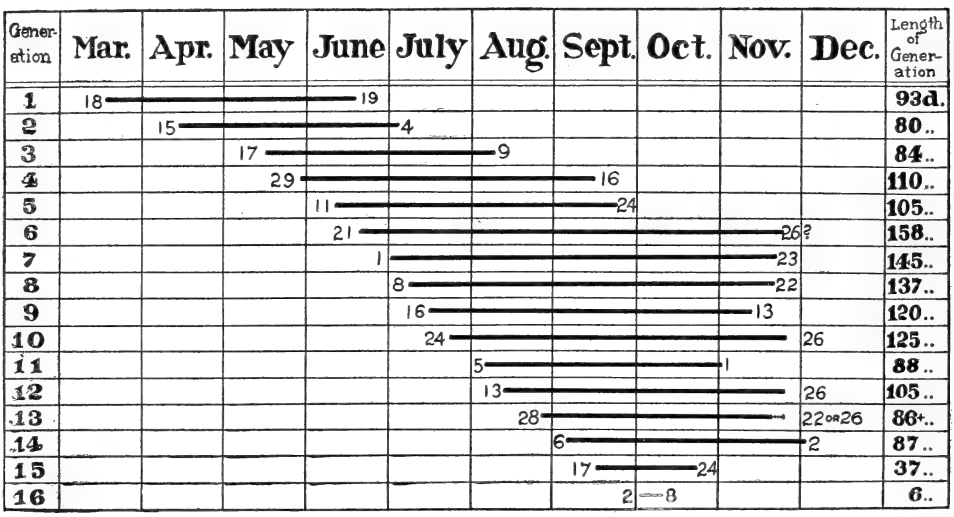

FIG. 34.—Periods and succession of generations in *Sipha flava*, 1907.

for the year is 11½. The first generation lasted for 93 days, from March 18 to June 19, the second extended over a period of 80 days, the third 84 days, and the fourth 110 days. The sixth generation was the longest-lived, continuing for 158 days, the period of the latest generations diminishing gradually. (See fig. 34.) As in the case of *Aphis maidi-radicis*, if the time during which eggs are probably hatching in the field is taken into consideration, it will be

seen that each of the generations might occur in the field much longer than these artificial experiments would indicate.

On April 15 individuals of the first 2 generations coexisted in the insectary; on May 15, the first 3 generations; on June 15, the first 4 generations; on July 1, 6 generations, from the second to the seventh, inclusive; on August 1, 8 generations, from the third to the tenth; on September 1, 10 generations, from the fourth to the thirteenth, and between September 6 and October 8 there were 11 generations in existence, this being the largest number of generations in existence at any one time. From that date on, the number of generations in existence at any one time rapidly diminished until December 2, at which time all of the aphides were dead. (See fig. 34.)

The vivaria used in rearing these aphides were simple, each consisting of a pot of earth containing a young sorghum plant, over which was placed a lamp chimney closed at the top with a fine-meshed cloth. Individuals were transferred from one plant to another by means of a soft camel's-hair brush, and these would usually remain in the same place, even though the leaf became wilted or dying, and thus it was an easy matter to keep track of them and to obtain the numbers of young from day to day. Likewise, in the field this species migrates from one part of the plant to another only to a slight extent. The individuals are usually found on the lower surface of the older and lower leaves, in groups, and the young are almost always found feeding on the leaf around the mother aphis. Another peculiarity of this species is that it is not attended by ants, as are most of the aphides found in the field.

VIVIPAROUS GENERATION.

All the following data were obtained in 1906 and 1907, unless otherwise stated. The length of time between the birth of an aphis and that of its first young was between 7 and 31 days, and the average for 79 experiments was 13.3 days.

TABLE XI.—*Data of individual experiments on Sipha flava, viviparous generation, 1906–7.*

Date of birth.	Date of first young.	Age at birth of first young.	Last young.	Productive period.	Number of young.	Average young per day of productive period.	Length of life after last young.	Total length of life.
1906.	1906.	*Days.*	1906.	*Days.*			*Days.*	*Days.*
July 1	July 12	11	July 18	6	14	2.3+	0	17
July 9–10	July 19	9–10	July 25	6	15	2.5	0	15–16
July 12–15	July 21	8–9	...do.....	4	9	2.2+	0	12–13
July 18	July 27	9	Aug. 16	20	49	2.5−	2	29
July 19	...do.....	8	Aug. 4	8	28	3.5	0	16
July 21	July 31	10	Aug. 24	24	68	2.8+	1	34
July 27	Aug. 4	8	Aug. 26	22	65	2.9+	13	43
Do	...do.....	8	Aug. 28	24	65	2.7+	27	59
July 31	Aug. 8	8	Aug. 30	22	59	2.7+	2	32
August 4	Aug. 13	9	...do.....	27	80	3 −	10	46

TABLE XI.—*Data of individual experiments on Sipha flava, viviparous generation, 1906–7*—Continued.

Date of birth.	Date of first young.	Age at birth of first young.	Last young.	Productive period.	Number of young.	Average young per day of productive period.	Length of life after last young.	Total length of life.
1906.	1906.	*Days.*	1906.	*Days.*			*Days.*	*Days.*
August 6	Aug. 15	9	Sept. 9	25	73	2.9+	13	47
August 8	Aug. 16	8	Sept. 16	31	77	2.5+	14	53
August 13	Aug. 21	8	Sept. 13	23	78	3.3+	0	31
August 15	Aug. 23	8	Sept. 20	28	89	3.1+	8	44
August 16	Aug. 24	8	Sept. 13	20	49	2.5—	0	28
August 14–16	Aug. 22	6–8	Sept. 11	20	60	3	14	42
August 21	Aug. 30	9	Sept. 23	24	83	3.4+	21	54
August 22	Sept. 2	11	Oct. 4	32	83	2.6—	15	58
August 23	Sept. 1	9	Sept. 28	27	79	2.9+	27	63
August 24	Sept. 4	10	Oct. 3	29	67	2.3+	11	50
August 30	Sept. 9	10	Oct. 14	35	63	1.8	31	76
September 2	Sept. 10	8	Oct. 6	26	75	2.8	27	61
Do	Sept. 11	9	Sept. 30	19	58	3 +	1	29
September 6	Sept. 14	8	Oct. 7	23	69	3	13	44
September 9	Sept. 18	9	Nov. 8	51	58	1 +	38	98
September 10	Sept. 19	9	Sept. 29	10	35	3.5	2	21
September 10–11	Sept. 23	12–13	Sept. 29	6	16	2.6+	0	18–19
September 11	Sept. 21	10	Oct. 31	40	50	1.2+	51	101
September 14	Sept. 24	10	Nov. 3	40	44	1 +	24–25	74–75
September 18	Oct. 2	14	Nov. 17	46	32	.6+	28	94
September 19	Sept. 30	11	Nov. 20	51	56	1 +	31	93
September 21	Oct. 4	13	Nov. 10	37	56	1.5+	41	91
1907.	1907.		1907.					
March 18	Apr. 15	28	June 6	52	48	.9+	12	92
March 19	Apr. 16	28	May 14	28	33	1.1+	2	58
April 15	May 16	31	June 6	39	81	2 +	5	76
May 13	May 26	13	July 11	46	78	1.6+	0	59
April 16	May 14	28	June 28	45	50	1.1+	5	78
May 17	May 29	12	June 22	24	73	3 +	8	44
May 28	June 11	14	July 18	37	76	2 +	14	65
May 29	June 13	15	July 8	25	80	3.2	11	51
May 30	June 11	12	July 9	28	80	2.8+	9	49
June 11	June 21	10	July 11	20	80	4	10	40
June 13	June 23	10	Aug. 3	41	70	1.7+	2	53
June 24	July 5	12	...do	29	59	2 +	13	54
June 17	June 27	10	July 17	20	52	2.6	22	52
June 23	July 1	8	Aug. 12	42	56	1.3+	0	50
June 28	July 6	8	July 29	23	70	3 +	14	45
July 2	July 9	7	July 28	19	66	3.4+	9	35
July 4	Aug. 11	7	Aug. 12	32	77	2.4+	10	49
July 5	July 12	7	Aug. 8	27	85	3.1+	17	51
July 7	July 15	8	Aug. 5	21	63	3	2	31
July 8	July 16	8	Aug. 16	31	63	2 +	17	56
July 10	July 19	9	Aug. 8	20	67	3.3+	16	45
July 11	July 19	8	Aug. 16	28	58	2 +	17	53
July 11	July 20	9	Aug. 27	38	50	1.3+	10	57
July 13	July 21	8	Aug. 23	33	67	2 +	7	48
July 15	July 22	7	Aug. 24	33	72	2.1+	14	54
July 16	July 24	8	Aug. 20	27	57	2.1+	4	39
July 19	July 27	8	Aug. 27	31	69	2.2+	16	55
Do	July 28	9	Aug. 20	23	57	2.4+	0	32
July 22	July 29	7	Aug. 27	29	75	2.6—	9	45
Do	July 30	8	Aug. 22	23	68	2.9+	2	33
July 24	Aug. 4	11	Sept. 8	35	69	2 —	4	50
July 28	Aug. 6	9	Aug. 27	21	70	3.3+	19	49
July 27	...do	10	Sept. 9	34	57	1.6+	3	47
July 29	Aug. 7	9	Sept. 1	25	80	3.2	17	51
July 31	Aug. 9	9	Aug. 29	20	68	3.4	0	29
July 20	Aug. 28	8	Aug. 29	32	68	2.1+	17	57
August 5	Aug. 13	8	Sept. 15	33	81	2.4+	15	56
August 6	Aug. 14	8	Sept. 9	26	86	3.3+	15	49
August 9	Aug. 18	9	Sept. 8	21	63	3	0	30
August 18	Aug. 28	10	Sept. 20	23	69	3	0	33
August 19	Aug. 29	10	...do	22	51	2.3+	0	32
August 24	Sept. 1	8	Sept. 24	23	52	2.2+	4	35
August 28	Sept. 6	9	Oct. 7	31	74	2.3+	24	64
August 31	Sept. 11	11	Oct. 22	41	69	1.6+	0	52
September 3	Sept. 14	11	Oct. 4	20	61	3 +	3	34
September 6	Sept. 17	11	Oct. 16	29	55	1.9—	39	79
September 14	Sept. 23	9	Oct. 30	37	41	1.1+	2	48
Averages		13.29+		27.63+	61.97+	2.5+	11.5+	49.6+

As shown in Table XI, a longer time was required to reach maturity in the cooler parts of the season. The average number of days required for development during the first of the season—that is, to July 1—was 15.9+; during the warmer part of the year (July 1 to September 1) it was 8.6+; while during the period between September 1 and 21 it was 10.3 days. Both the length of life and the productive period vary in relation to temperature and season, being longest in the cooler parts of the year. The maximum period for the production of young, in my 79 experiments, was 52 days, while the average was 27.6+ days. The maximum length of life of individuals in these same experiments was 101 days and the average was 49.6+ days. Larger numbers of young are produced per day in the warmer parts of the year than in the cooler and later months. The total number of young produced by 79 females was 4,896—an average of 61.9+. The largest number of young per single female was 89, and the average number produced in one day was 2.5+. The largest number of young produced in one day by a single aphis was 9. Almost without exception, the mother aphis lived several days after the production of the last young. The number of molts was invariably 4, and, as will be seen in the accompanying table, they occurred, almost without exception, every two days.

TABLE XII.—*Periods of molts of Sipha flava, viviparous generation, 1906.*

Date of birth.	Age at first molt.	Age at second molt.	Age at third molt.	Age at fourth molt.	Age at birth of first young.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*
August 9	2	4	6	7	8
August 4	1	3	5	6	7
Do	2	4	6	8	9
August 12	2	4	6	7	8
Do	2	4	6	8	8

OVIPAROUS GENERATION.

The first individuals of the oviparous generation to be noticed were born September 24, 1906, although in 1905 aphides of this generation were found as early as August 25. In all cases it required a longer time for the individuals of this generation to become adults than it did for those of the viviparous generations, excepting the stem-mothers, this presumably being largely due to temperature, growth being slower in the cooler parts of the year. The length of the immature stages varied from 15 to 40 days, the latter time, however, being very exceptional in length.

TABLE XIII.—*Oviparous generation of Sipha flava, 1906.*

When born.	Date it became adult.	Period from birth to adult.	Dates of copulation, if obtained.	Date of death or disappearance.	Total length of life.	Sex.	Remarks.
		Days.		1906.	*Days.*		
Oct. 16...	Nov. 3....	18	Nov. 7..... Nov. 17.....	Dec. 13....	57	Male.....	
Do.....	Nov. 7....	22	Nov. 27 (55° F) Nov. 28 (54° F)	Dec. 17....	61	Female....	At least 5 eggs.
Oct. 12 ..	Oct. 28....	16	Nov. 4..... Nov. 15..... Nov. 16.....	Nov. 23...	42	.....do	At least 9 eggs.
Oct. 14...	Oct. 30....	16	.....	Nov. 1....	18	Male.....	
Do.....	Nov. 2....	19	.....	Nov. 28...	45	Female....	
Oct. 15...	Oct. 31....	16	Nov. 8.....	Dec. 5.....	51	Male.....	
Do.....	Nov. 1....	17	Nov. 18.....	Dec. 5.....	51	Female....	
Oct. 13...	Oct. 28....	15	Nov. 4.....	Dec. 21....	69	.....do	12 eggs.
Oct. 29...	Dec. 8.....	40	.....	Dec. 19....	51	.....do	
				1907.			
Oct. 19...	Nov. 16...	28	.....	Jan. 10....	83	.....do	
				1906.			
Do.....	Nov. 17...	29	.....	Dec. 21....	63	.....	
Oct. 9....	Oct. 23–27.	14–18	.....	Nov. 3....	25	Female....	
Sept. 24..	Oct. 8–15..	14–21	Oct. 18..... Nov. 22.....	Dec. 12....	79	.....do	14 eggs.
Do.....	.....	.....	.....	Oct. 26....	32	.....	10 eggs.
Do.....	.....	.....	Oct. 23..... Oct. 27..... Nov. 7.....	Nov. 2....	39	Female....	All three aphides laid at least 22 eggs and 8 were found in their bodies.
Do.....	.....	.....	Oct. 28..... Nov. 1.....	Oct. 18....	55	.....do	
Do.....	.....	.....	Nov. 5..... Dec. 3 (45° F)	Dec. 12....	79	.....do	
Oct. 2....	Oct. 18....	16	Oct. 25..... Oct. 30..... Nov. 5..... Nov. 18.....	Dec. 21....	81	.....do	At least 11 eggs.
Oct. 4 (4). Oct. 5 (1). Oct. 6 (1).	Oct. 21 (5). Oct. 22....	17 (4) 16 (1) 16 (1)	Nov. 3..... Nov. 12.....	Nov. 3 (4). Dec. 21 (2).	30 (4) 77 (1) 76 (1)	Female (6)	Figures in parentheses refer to number of individuals. Total number of eggs laid, 31. One individual laid at least 10 eggs.
Average..	.....	19+	.....	.....	52+	.....	

The average time for the 21 cases in which an exact record was kept was 19.5 days. The sexes were first observed in copula October 18, and this was noted occasionally until December 3. At this latter date the temperature in the room where the aphides were kept was 45° F. In 1905 the earliest record of copulation was October 17, and the first eggs were found soon after. As a rule the eggs were laid on the underside of the sorghum leaf, but as might be expected there were some exceptions to this; for example, eggs were sometimes laid on the side of a cage and on the stem of a plant. November 21, 1907, at Urbana, Ill., I found oviparous females on grass, but eggs were not found. This, with the fact that the earliest spring records of finding them out of doors have been on grass, indicate that grass is the alternate food plant to which the sexuparæ migrate in the fall to produce the sexual forms. The number of eggs laid by this species varied, according to my observations, up to 14, and in 19 cases the average was 8.3 eggs per female. There was no uniform period from the laying of

one egg to that of another. Usually, however, the interval was one of several days, temperature being the controlling factor. My aphides always laid eggs until the temperature got down to 42° F. In a number of cases, upon the death of an oviparous female the body was examined, and with only one or possibly two exceptions, eggs were found therein. These facts show that there is no definite number of eggs for a sexual female to lay, but that eggs continue to be laid as long as she lives, provided the temperature is not too low. Some individuals of this sexual generation lived until January 17, 1907, though most of them died in November and December, 1906. During most of the month of December the temperature was down to the freezing point, and consequently the females were in a dormant state; as the food plants were dead they certainly obtained no food during this time. The length of life was found to vary up to 83 days, the average, however, in 17 cases, being 57.4 days. The number of molts is 4, the same in this generation as in the viviparous. Table XIV shows the periods between molts in the 7 cases of which record was made.

TABLE XIV.—*Periods of molts of Sipha flava, oviparous generation, 1906.*

Date of birth.	Age at first molt.	Age at second molt.	Age at third molt.	Age at fourth molt.
	Days.	*Days.*	*Days.*	*Days.*
October 12	3	6	10	16
October 13	3	5	9	15
October 14	3	7	12	19
Do	3	6	10	16
October 19	6	11	17	28
Do	6	12	18	29
October 29	6	11	23	40
Average				23+

DESCRIPTIONS.

Sipha (Chaitophorus) flava Forbes.

This aphis does not belong to the genus *Chaitophorus*, which has 6 antennal segments (or 7, counting the filament), and should doubtless be placed in the genus *Sipha* of Passerini, which is described as having 5 antennal segments, or 6 with the filament, the third segment and filament longest; the cornicles tuberculiform.

VIVIPAROUS GENERATION.

Before first molt and less than 24 hours old.—Citron-yellow throughout. Legs and antennæ somewhat transparent and of a lighter tint than the body color. Antennæ apparently only 4-segmented. One sensorium is present at the extremity of the third segment. Eyes brownish red. Numerous tuberculate spines on the

body, which are regularly distributed in longitudinal rows, there being 6 conspicuous rows in all, 4 dorsal and 2 lateral. Measurements when not more than 2 hours old: Length of body, 0.618 mm.; width, 0.290 mm.; antenna, 0.270 mm.; lateral spines, 0.072 mm. Not more than 24 hours old: Length of body, 0.690 mm.; width, 0.309 mm.; antenna, 0.290 mm.; lateral spines, 0.072 mm.

The young from eggs differ from the above (those born alive) in that the general color is a dark green, with black spinal markings and with black rings around the cornicles.

After first molt and 48–72 hours old.—General color citron-yellow. Eyes brownish red. Antennæ as before molt, except that there is now a slight constriction near the distal end of the third segment, where it later divides into 2 distinct segments; also, the circular sensorium of the distal end of the third is on a tubercle or short stalk-like process, and at the apex of the thickened base of the fourth segment is another circular sensorium. Five dark lines occur around the openings of the inconspicuous cornicles. Markings as before. Measurements: Length of body, 1.05 mm.; width, 0.49 mm.

After second molt and 60–84 hours old.—General color canary-yellow. Eyes brownish red. There are still only 4 distinct segments of the antennæ, and the constriction of the third segment is more distinct. Cornicles more distinct than in the earlier stages. Measurements: Length of body, 1.45 mm.; width, 0.56 mm.; antenna, 0.43 mm.

After third molt and 124–148 hours old.—General color canary-yellow. Eyes brownish red. The constriction of the third antennal segment becomes more distinct. Cornicles more distinct and almost as fully developed as in the adult. Measurements: Length of body, 1.96 mm.; width, 0.74 mm.; antenna, 0.63 mm.; abdominal bristles, 0.127 mm.

Adult wingless viviparous female.—General color canary-yellow. Eyes brownish red. Antennæ of the same general tint as the body, excepting the last segment, which is darkened; 5-segmented and sparsely hairy, but the few hairs or bristles present conspicuous. Beak short, not extending farther than the coxæ of the middle pair of legs. Six conspicuous bristles project forward from the front of the head and between the bases of the antennæ. Several less conspicuous hairs are found below those just mentioned. Dorsally are 4 longitudinal curving rows of black transverse markings, 2 rows on each side of the median line. Ten longitudinal rows of erect tubercular bristles are present on the dorsal and dorso-lateral sides of the thorax and abdomen. Cornicles short truncated cones, inconspicuous except for the dark ring around the opening. Measurements: Length of body, 1.818 mm.; width, 0.763 mm.; antenna, I,

0.049 mm.; II, 0.049 mm.; III, 0.236 mm.; IV, 0.147 mm.; V, basal, 0.130 mm.; filament, 0.244 mm.; total, 0.855 mm.

Pupa of winged viviparous female.—Head and thoracic segments olive-yellow; abdomen pale yellow, with greenish tint. Eyes dark red. Antennæ 5-segmented, all except last segment concolorous with head. Antennæ and head with bristles, as in other forms. Thorax with several dark-green patches from which arise tuberculate bristles. Legs, excepting tarsi, which are black, concolorous with body. Wing-pads light brown. Abdomen with 8 longitudinal rows of tuberculate spines, each spine with a basal patch of dark green. A longitudinal row of small transverse dashes occurs on each side between the first and second rows of spines, counting from the median line. Cornicles as in the other forms, and with dark-green basal patches. Measurements: Length of body, 1.953 mm.; width, 0.863 mm.; antenna, I, 0.058 mm.; II, 0.048 mm.; III, 0.194 mm.; IV, 0.135 mm.; V, basal, 0.107 mm.; filament, 0.214 mm; total, 0.750 mm.

Winged viviparous female.—Head and abdomen lemon-yellow, with the thoracic segments brownish. Eyes red. Antennæ with several more or less noticeable hairs, much less conspicuous than in the wingless pseudogyne; all except the two basal segments and the basal half of the third segment are dark; a single circular sensorium at apex of fourth segment and several at the apex of the basal portion of the fifth segment. Beak hardly reaching to the coxæ of the second pair of legs. Head and thorax with spinous tubercles much as in the wingless pseudogyne. Legs concolorous with body, excepting tips of tarsi, which are darkened. Stigma and cubitus pale yellow, other wing-veins dusky. Abdomen with 8 longitudinal rows of dark-green spots from which arise conspicuous tuberculate spines. Between the first and second rows of spots from the median line, on each side, is a row of small dark dashes. Cornicles tuberculiform, and with dark-green basal patches. Style slightly constricted in the middle. Measurements: Expanse of wings, 5.744–6.477 mm.; length of body, 1.641 mm.; width, 0.734 mm.; antenna, I, 0.065 mm.; II, 0.065 mm.; III, 0.277 mm.; IV, 0.196 mm.; V, basal, 0.147 mm.; filament, 0.293 mm.; total, 1.043 mm.; style, 0.088 mm.

OVIPAROUS GENERATION.

Before first molt and 24–48 hours old, male or female.—Color sulphur-yellow. Head with a dark patch covering it almost entirely. Eyes red. Antennæ and legs transparent until a day old, gradually darkening until they become concolorous with the darker markings of the body. Antennæ apparently only 4-segmented, a constriction in the apical half of the third segment showing where this segment later divides into two. At the distal end of the third segment is a

distinct sensorium, while at the apex of the thickened base of the fourth are one or more indistinct sensoria. Thorax with dark patches covering about one-half of the dorsal surface. Abdomen with dark markings which appear only after the aphis is at least one day old. Abdomen with 4 distinct dorsal rows of tuberculate spines, 2 on either side of the median line, and at least 1 lateral row on each side. At the base of each of these spines is a small darkened area. The small indistinct cornicles are surrounded with dark circular patches. The opening also is marked by a dark ring. Measurements: Length of body, 0.763 mm.; width, 0.362 mm.

Female after second molt and 7 or 8 days old.—General color light apple-green. Antennæ lighter than body color excepting second segment and tip of last segment. Spine spots bice-green in color. Tarsi black. Measurements: Length of body, 1.331 mm.; width, 0.581 mm.; antenna, 0.537 mm.

Female after third molt.—General color apple-green, becoming paler and with a yellowish tinge at the caudal end. Head lighter than body color. Eyes reddish brown. Antennæ pale, excepting the last segment, which is darkened. That segment which in the earlier stages represents the third is now indistinctly separated into 2 segments. The sensorium at the distal end of the fourth (the third of the earlier stages) is quite distinct. The apex of the thickened base of the last segment has numerous distinct sensoria. Legs pale, excepting tarsi, which are black. Cornicles more distinct. Measurements: Length of body, 1.775 mm.; width, 0.725 mm.

Adult wingless oviparous female.—Head, first 2 thoracic segments, and tip of abdomen oil-green in color. Abdomen parrot-green, shading at extremities to oil-green. Eyes dark reddish-brown. Antennæ 5-segmented; 1 sensorium at distal end of fourth and several at the end of basal part of the fifth; bristles few but conspicuous, there being 2 on each of the 2 basal segments, 3 or 4 on the third, and 1 on the fourth. Projecting forward from the head and between the bases of the antennæ are 6 distinct bristles. Beak short, not extending farther than the coxæ of the second pair of legs. On the dorsal surface of the body are 4 rows of small transverse dashes, 2 on each side of the median line; also 8 rows of tuberculate bristles, 4 on each side of the median line. Hind tibiæ noticeably swollen and bearing numerous circular sensoria. Style upcurved. Cornicles as in all the other forms of this species. Measurements (alcoholic specimens): Length of body, 1.67–1.92 mm.; width, 0.72–0.83 mm.; antenna, I, 0.065 mm.; II, 0.065 mm.; III, 0.244 mm.; IV, 0.130 mm.; V, basal, 0.106 mm.; filament, 0.236 mm.; total, 0.846 mm.; style, 0.078 mm.

Male after second molt and 8 or 9 days old.—General color citron-yellow. Antennæ 5-segmented. Sensoria at end of fourth and at

distal end of the thickened base of the fifth segment. Measurements: Length of body, 1.098 mm.; width, 0.469 mm.

Male after third molt.—General color sulphur-yellow, shading to greenish at extremities. Eyes brownish red. Other markings as in earlier stages. Measurements: Length of body, 1.603 mm.; width, 0.744 mm.; antenna, I, 0.067 mm.; II, 0.057 mm.; III, 0.162 mm.; IV, 0.133 mm.; V, basal, 0.095 mm.; filament, 0.191 mm.; total 0.705 mm.

Adult male.—General color bright lemon-yellow. Eyes dark reddish brown. Antennæ usually as long as body, the two basal segments concolorous with the body and the others dark; antennæ with a few conspicuous hairs, there being 2 on each of the two basal segments, 5 on the third, and either 1 or 2 on the fourth; circular sensoria numerous (at least 40) and irregularly placed on the third, 15 to 20 on the fourth, and a number at the distal end of the thickened base of the fifth segment. Beak short, not reaching farther than the coxæ of the second pair of legs; its tip dark, the rest concolorous with the body. Six distinct bristles project forward from the front of the head and between the bases of the antennæ. On the dorsal surface of the body are 8 rows of tuberculate bristles, 4 on each side of the median line. There are also 2 rows of dark oval markings on each side of the median line. Measurements (alcoholic specimens): Length of body, 1.12–1.30 mm.; width, 0.45–0.50 mm.; antenna, I, 0.081 mm.; II, 0.065 mm.; III, 0.407 mm.; IV, 0.220 mm.; V, basal, 0.106 mm.; filament, 0.350 mm.; total, 1.229 mm.

Eggs.—Color, when first laid, pale green, with a small dark spot of obscure form showing through the egg-shell at one end. The egg gradually darkens until it becomes a jet-black. There is no noticeable change in color just before the young hatch. Form elliptical-oval. Measurements: Length, 0.652 mm.; width, 0.3015 mm.

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Chaitophorus flavus, n. sp. Describes wingless and winged viviparous females and pupa; also injuries and natural enemies. Observed chickens feeding on these plant-lice.

1885. Forbes, S. A.—Fourteenth Report of the State Entomologist of Illinois, for 1884. <App. Trans. Ill. Dept. Agr. for 1884, Springfield, Vol. XXII, p. 70, pl. 6, figs. 1–4. Separate: Springfield, Ill.

Slight contribution to life history. Could find no root form.

1887. Oestlund, O. W.—Aphididæ of Minnesota. <Geol. and Nat. Hist. Survey of Minn., St. Paul, Bul. 4, p. 40.

Mentions it as *not* having been found in Minnesota.

1891. WILLIAMS, T. A.—Host-Plant List of North American Aphididæ. <Univ. Nebr. Dept. Ent., Lincoln, Spec. Bul. 1, pp. 9, 23.

Lists of food plants of *Chaitophorus flavus* Forbes as corn and cultivated sorghum.

1892. BRUNER, L.—Report of the Entomologist. <Ann. Rept. Nebr. State Board Agr. for 1891, Lincoln, p. 304.

Makes following note: "*Chaitophorus flavus* Forbes: This sorghum and broom-corn louse has been taken while working on the roots of Indian corn; at least a louse found here in the State was so determined at the time." In a letter from Professor Bruner he tells me that he has no further information concerning this aphis, and that he does not have the specimens so determined.

1901. HUNTER, W. D.—The Aphididæ of North America. <Ia. Agr. Exp. Sta., Ames, Bul. 60, p. 87.

Lists it as being found in Illinois on sorghum and *Zea mays*.

1905. FORBES, S. A.—Twenty-third Report of the State Entomologist of Illinois. <Chicago, pp. 210–211, figs. 220, 221.

Gives food plants as sorghum, corn, broom corn, foxtail grass (*Setaria*), crab-grass (*Panicum*), and wheat. Latest date observed was in September.

1906. SANBORN, C. E.—Kansas Aphididæ with host-plant and plant-host list, Pt. 2. <Kans. Univ. Sci. Bul., Lawrence, Vol. III, No. 8, pp. 236, 250, 263.

Food plants of *Chaitophorus flavus* Forbes given as cultivated corn, cultivated sorghum, and *Sorghum halpense* L.

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MISCELLANEOUS PAPERS.

A NEW GENUS OF ALEYRODIDÆ, WITH REMARKS ON ALEYRODES NUBIFERA BERGER, AND ALEYRODES CITRI RILEY AND HOWARD.

By A. L. Quaintance,
In Charge of Deciduous Fruit Insect Investigations.

In 1900 the writer described[a] as *Aleyrodes perseæ* a species of white fly found in the Bureau of Entomology collection, received from Fort George, Fla., and collected April 22, 1880, on *Persea carolinensis*. The adult of this species was at the time unknown. The so-called pupa-case, however, exhibited the essential structural characters of this stage for the genus *Aleurodicus*, and it was ventured in the description that the adult when found would show the insect to belong to this genus. Professor Cockerell,[b] for the reasons given, referred this species to *Aleurodicus*, and this assignment seemed to the writer well warranted.

Dr. A. W. Morrill, in the course of his orange white-fly investigations in Florida during the past two or three years, has frequently met with this insect on orange and other plants and has been able to obtain the adult in quantity. He has kindly furnished the writer with abundant specimens of all stages and copies of his notes. The adult, contrary to what had been expected from the structure of the pupa-case, is not an *Aleurodicus*, and presents certain peculiarities not found in other genera of the family, thus necessitating the establishment of a new genus, as follows:

PARALEYRODES, new genus.

With wing venation of Aleyrodes. Pupa-case of Aleurodicus type. Fore wings with but a single vein, and a rudimentary branch near basal fifth. Hind wings with a single unbranched vein. Antennæ four-jointed, apparently due to coalescence into two segments

[a] Tech. Ser. 8, Div. Ent., U. S. Dept. Agr., p. 32.

[b] Catalogue of the Aleyrodidæ of the World (Proceedings Academy Natural Sciences, Philadelphia, 1902, p. 279).

of joints 3 to 7. Pupa-case with the compound wax pores and large protruding lingula of *Aleurodicus*.

Type, the following species:

Paraleyrodes (Aleurodicus) perseæ Quaintance.

REVISED DESCRIPTION.[a]

Egg.—Elliptical, size about 0.24 mm. by 0.12 mm., with stalk unusually long; smoky in color, the shell smooth; eggs deposited promiscuously in the white, flocculent secretion of the adults.

Larva, first stage.—Size about 0.338 mm. by 0.18 mm., subelliptical, very slightly narrowed caudad; yellowish white, with more or less rectangular spots of orange in the abdominal regions, eye spots reddish. There is a fringe all around of white wax; on the margin, cephalad of eyes, are six setæ, and on lateral margins of thoracic region are three on each side. On caudal margin are six setæ, the middle pair of which is considerably longer than others. On ventral surface, just within margin, all around, is a series of sparsely set, small, tubercled setæ. Legs and antennæ well developed. Vasiform orifice practically as in pupa-case.

Pupa-case.[b]—Size about 0.86 mm. by 0.53 mm. (figs. 35, *a* and *b*). Subelliptical in shape, with slightly undulate outline. Color, under hand lens, yellowish brown; empty pupa-case colorless, very fragile, soon falling from the leaf. On the margin, all around, is a fringe of more or less curled, short, white wax ribbons, and over the case and adjacent leaf area are many fragments of white wax rods, of variable length, profusely produced from the seven pairs of dorsal compound pores, which are situated, a pair on cephalic end and six pairs on the abdominal segments, the cephalic two pairs of which are smaller and nearer the median line. The margin, or rim, of each compound pore

[a] Extended and corrected from Tech. Ser. 8, Div. Ent., U. S. Dept. Agr. (1890), p. 32.

[b] In the description of the waxy secretion, as originally given (l. c.), this was described as follows:

"There is a profuse dorsal exudation: First, a rather short, downward-curving fringe of pearly white wax, all around, arising from just within margin and curling outward and downward over margin to near surface of leaf. This fringe is hardly continuous but is more or less split apart into ribbons or bands. Second, more dorsally curving columns. These occur in a triangle, one on each side and one at end. These columns of white wax are about as high as pupa case is wide. The pupa-case is almost obscured by this exudation, when viewed from above."

According to Doctor Morrill's observations the secretion, as above described, is abnormal to this species and is due to the effect of parasitism. Of many specimens examined by him, showing the secretion of this character, all were found to be parasitized; and, on the other hand, this type of secretion was never found on pupa-cases not attacked by parasites. The normal secretion therefore is as described in the text.

(fig. 35, *a*) is thickened, and from within the cup there arises a rather large, fluted, cylindrical tube, extending upward about one-half its length beyond the rim of cup. Within tube, at base, is a short conical

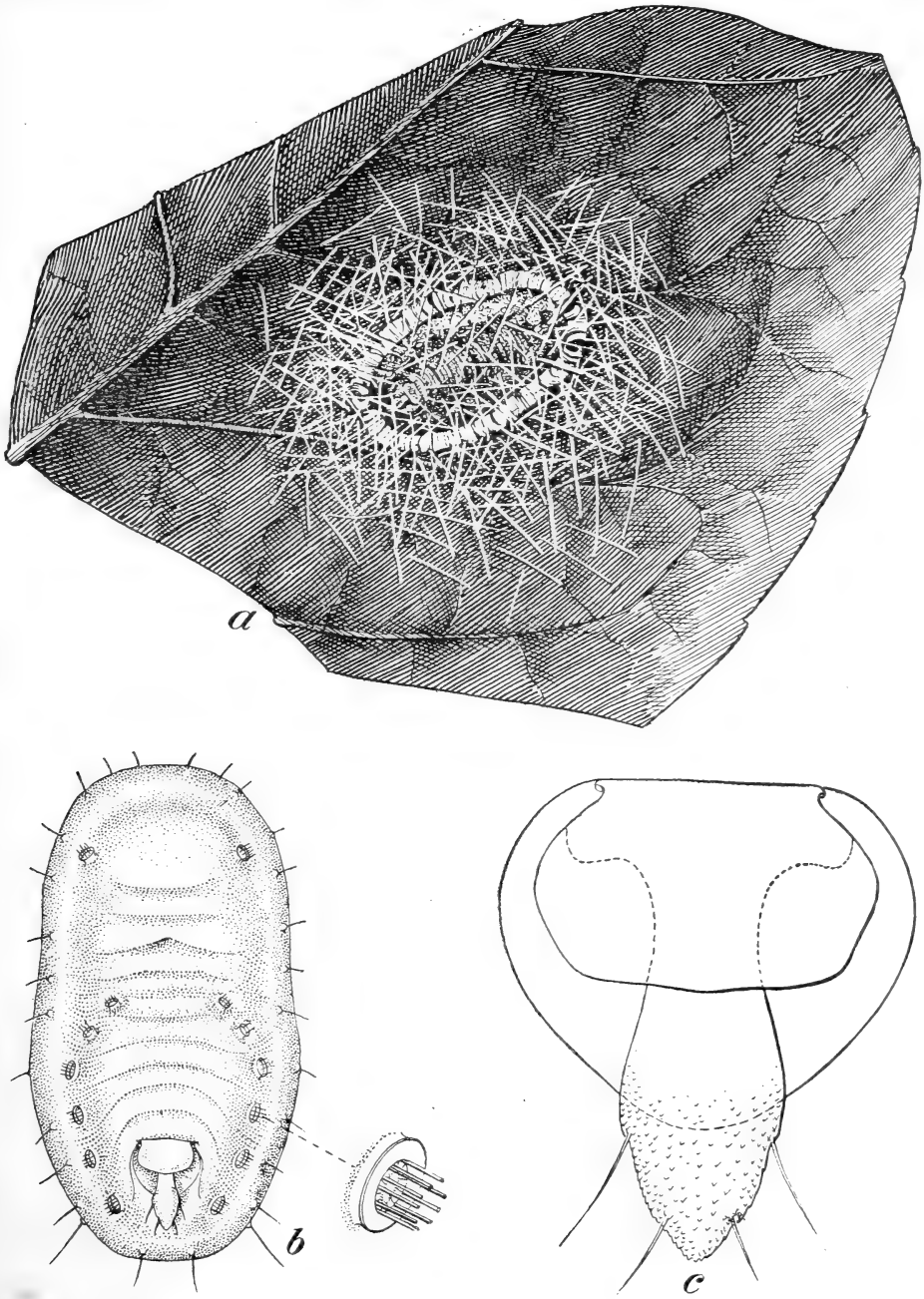

FIG. 35.—*Paraleyrodes perseæ: a,* Pupa on leaf, showing fragments of wax rods from dorsal compound pores, enlarged; *b,* pupa-case, much enlarged, with highly magnified compound pore at right; *c,* vasiform orifice, operculum, and lingula of pupa-case, highly magnified. (Original.)

elevation. The entire structure is brownish in color. Dorsum void of well-developed setæ, save a pair just within caudal margin. A pair of minute setæ occurs on margin near caudal end of case. There is,

however, just within margin on case, all around, a row of brownish-colored, tubercled setæ. Vasiform orifice subcordate (fig. 35, *c*), about as long as wide. Cephalic margin straight, coinciding with cephalic margin of operculum. Operculum subrectangular, the lateral margins somewhat rounded; considerably wider than long and with caudal margin almost straight. Lingula relatively large, particularly distally, where it becomes broadly spatulate; longer than orifice, and bearing distally two pairs of setæ. Abdominal segments moderately distinct. Rudimentary feet and antennæ very evident.

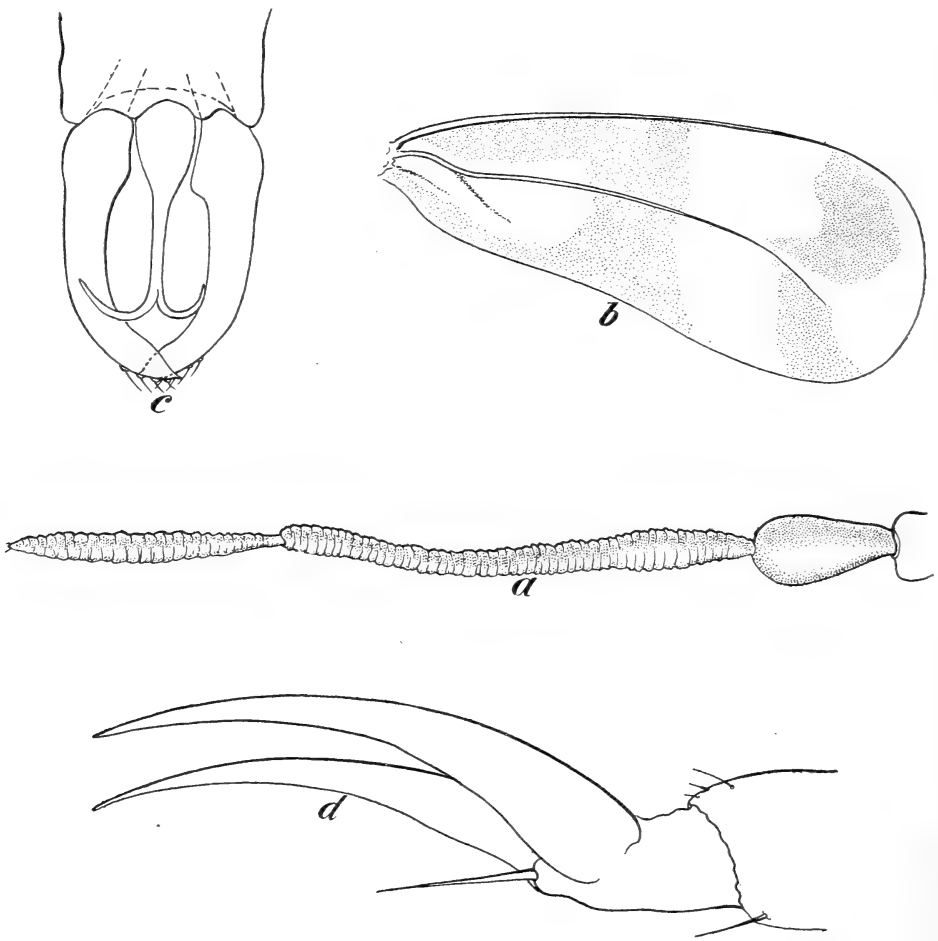

FIG. 36.—*Paraleyrodes perseæ: a,* Antenna of adult; *b,* right fore wing of adult; *c,* male genitalia; *d,* claw of third leg of adult. Highly magnified. (Original.)

Adult.—Body of living specimens buff or pinkish in color, marked with white. Wings whitish, but clouded with dusky. These are held almost flat along the dorsum, and do not meet along the middle line. A copious amount of flocculent white wax is secreted, which becomes scattered over the leaf surface, the sluggish adults resting in little depressions here and there in the waxy covering. Antennæ peculiar and apparently of but four joints (fig. 36, *a*), due to the evident

coalescence into two joints of the ringed segments 3 to 7. In the fore wing there is a single vein, as in *Aleyrodes* (fig. 36, *b*), with a rudimentary branch or fold near basal fifth and a very obscure rudimentary vein at very base of wing. Hind wings with but a single vein. Genitalia in male forcipate, penis bifurcate (fig. 36, *c*). Claws long and slender, with central spinous process (fig. 36, *d*). In female, length of body, 0.8 to 0.9 mm.; length of fore wing, 0.8 to 0.9 mm.; width of fore wing, 0.3 to 0.38 mm.; length of antenna, 0.38 to 0.45 mm.; length of hind tibia, 0.25 to 0.3 mm. Male proportionately smaller.

Food plants.—Orange, *Persea carolinensis*, persimmon (?), avocado pear. On orange this insect infests the older leaves, rarely or never occurring on the new growth as is the case with *Aleyrodes citri.*

Doctor Howard has given to the parasite of this species, reared by Doctor Morrill, the manuscript name *Encarsia variegatus.*

Remarks on ALEYRODES NUBIFERA Berger, and ALEYRODES CITRI Riley and Howard.

The recent interesting discovery by Dr. E. W. Berger, entomologist of the Florida Agricultural Experiment Station, that the so-called orange white fly (*Aleyrodes citri*) of Florida represents two distinct though closely related species, led the writer to go carefully over the material in the Bureau of Entomology collection in order to determine to what extent the new species *Aleyrodes nubifera* Berger might possibly be found. The results have been interesting, and, as showing the distribution of the new species, are worth recording. Specimens of *nubifera* are in the collection from the following localities:

Pass Christian, Miss., August 23, 1889, on orange.
Raleigh, N. C., September 25, 1889, on orange.
Raleigh, N. C., October 7, 1889, on orange.
New Orleans, La., March 10, 1890, on orange.
Baton Rouge, La., February 23, 1895, on orange.
Crescent City, Fla., January, 1895, on gardenia.
Crescent City, Fla., January 30, 1895, host not indicated.
Crescent City, Fla., February 24, 1895, on orange.
Crescent City, Fla., March 1, 1895, on orange.
Santiago de las Vegas, Cuba, March 7, 1905, on orange.
Santiago de las Vegas, Cuba, May 6, 1905, on orange and other citrus fruits.
Santiago de las Vegas, Cuba, June 6, 1905, on tangerine orange.
Waco, Fla., October 21, 1908, on orange.
Florida (locality not given), November 23, 1908, on orange.
Florida (locality not given), January 18, 1909, on orange.

As will be noted, specimens of this species have been received at different times since 1889. The material from Crescent City, Fla., was collected by Prof. H. G. Hubbard, and labeled by him as *citri*. In fact, all of the Hubbard specimens in the Bureau collection are *nubifera*, and it thus seems possible that Mr. Hubbard did not see the true *Aleyrodes citri* at all.

The material from Cuba, collected by Mr. C. L. Marlatt, and also sent in by Dr. Mel T. Cook, and provisionally referred by the writer to *citri*, belongs, in fact, to *nubifera*, and our record of *citri* for Cuba is incorrect. So far as we are aware, the insect does not occur on the island at all. As to the origin of *nubifera* and the time of its introduction, if from abroad, we have no information. Its affinities are with Oriental species, and it is not improbable that it was introduced into Florida along with or about the time of the introduction of *citri*.

Recently additional information has been obtained relative to the occurrence of *Aleyrodes citri* in eastern Asia. The writer, at a meeting of the Washington Entomological Society, October 4, 1908, exhibited a specimen of *Aleyrodes citri* from Canton, China, on orange, which had been found in the Bureau collection, without other data. In June, 1908, specimens of lemon leaves from Peking, China, infested with an aleyrodid were received by the Bureau from Mr. F. N. Meyer. Eggs, pupa, and one adult were present, and with this series of stages it was possible to definitely determine the insect as *citri*. In July of the same year leaves of Gardenia from Japan, also infested with *Aleyrodes citri*, were received through Mr. E. M. Ehrhorn, and somewhat later, in 1908, six lots of material, all infested with *Aleyrodes citri*, were received through Mr. E. H. Carnes, four of the sendings being from Nagasaki, Japan, and two from Shanghai, China. Four lots were on orange, one on a citrus plant, and one on an unnamed plant—possibly a Viburnum. The material from Nagasaki had been collected in 1903; the balance in 1908.

In Maskell's collection of Aleyrodidæ, recently secured with his coccid collection by Doctor Howard from the New Zealand Institute, was found what is evidently the type slide of Maskell's *Aleyrodes aurantii*, originally described in the New Zealand Transactions (1896), page 431, as a variety of *engeniæ*. Careful comparison of this insect with *Aleyrodes citri* proves it to be the same species, and Maskell's name hence becomes a synonym of *citri* Riley and Howard. Maskell's material was from the northwestern Himalayas in India, on *Citrus aurantium*. The great similarity of *eugeniæ* to *citri* was noted by Mr. Maskell, but he attributed undue importance to the presence of the three radiating patches, which, while occurring in *citri*, were not mentioned in the description by Riley and Howard.

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INDEX.

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY.

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

MISCELLANEOUS PAPERS.

CATALOGUE

OF

RECENTLY DESCRIBED COCCIDÆ.

By J. G. SANDERS, M. A.,

Assistant.

ISSUED JUNE 5, 1906.

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1906.

LETTER OF TRANSMITTAL.

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Bureau of Entomology,
Washington, D. C., April 16, 1906.

Sir: I have the honor to transmit herewith the manuscript of a Catalogue of Recently Described Coccidæ (Scale Insects), prepared by Mr. J. G. Sanders, of this Bureau. Owing to the economic importance of this group of insects and the scientific interest attached thereto, I recommend that it be published as Technical Series No. 12, Part I, of the Bureau of Entomology.

Respectfully,

C. L. Marlatt,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

TECHNICAL SERIES NO. 12, PART II.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

HABITS AND LIFE HISTORIES

OF SOME

FLIES OF THE FAMILY TABANIDÆ.

By JAMES S. HINE,
Of the Ohio State University, Columbus, Ohio.

ISSUED AUGUST 29, 1906.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

TECHNICAL SERIES, NO. 12, PART III.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE THYSANOPTERA OF CALIFORNIA.

By DUDLEY MOULTON,
Engaged in Deciduous-Fruit Insect Investigations.

ISSUED APRIL 5, 1907.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., February 5, 1907.

Sir: I have the honor to transmit herewith the manuscript of a paper by Mr. Dudley Moulton, special agent in this Bureau, entitled "A Contribution to our Knowledge of the Thysanoptera of California." This paper embodies the results of some work carried on by Mr. Moulton while a student at the Leland Stanford Junior University, Palo Alto, Cal., and forms part of a thesis for the degree of Master of Arts in the Department of Entomology at that institution. It contains keys and descriptions for the identification of the various species of thrips found to occur in California. The group of insects treated is one of economic importance, containing, as it does, species which are injurious to various field crops, fruit trees, and ornamental plants. I recommend the publication of the paper as Technical Series, No. 12, Part III, of this Bureau.

Respectfully,

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

Hon. James Wilson,
Secretary of Agriculture.

TECHNICAL SERIES NO. 12, PART IV. (Supplement to Technical Series No. 1.)

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

NEW GENERA AND SPECIES OF APHELININÆ,

WITH A

REVISED TABLE OF GENERA.

By L. O. HOWARD, PH. D.

ISSUED JULY 12, 1907.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., April 9, 1907.

Sir: I have the honor to transmit the manuscript of a paper concerning certain important parasites of scale insects, which, on account of its technical character, I recommend for publication as Part IV of Technical Series No. 12 of this Bureau.

Respectfully,

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

Hon. James Wilson,
Secretary of Agriculture.

TECHNICAL SERIES, NO. 12, PART V.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY.

L. O. HOWARD, Entomologist and Chief of Bureau

MISCELLANEOUS PAPERS.

THE MORE IMPORTANT ALEYRODIDÆ INFESTING ECONOMIC PLANTS.

WITH DESCRIPTION OF A NEW SPECIES INFESTING THE ORANGE.

By A. L. QUAINTANCE,

In Charge of Deciduous Fruit Insect Investigations.

ISSUED OCTOBER 21, 1907.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1907.

TECHNICAL SERIES, NO. 12, PART VI.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

A RECORD OF RESULTS FROM REARINGS AND DISSECTIONS OF TACHINIDÆ.

By CHARLES H. T. TOWNSEND,
Expert in Charge of Dipterous Parasites, Gipsy Moth Laboratory.

ISSUED SEPTEMBER 18, 1908.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

TECHNICAL SERIES, NO. 12, PART VII.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY.

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

MISCELLANEOUS PAPERS.

THE ORANGE THRIPS.

By DUDLEY MOULTON,

Engaged in Deciduous Fruit Insect Investigations.

ISSUED FEBRUARY 11, 1909.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1909.

CONTENTS.

ILLUSTRATIONS.

PLATE.

TECHNICAL SERIES, No. 12, PART VIII.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY.

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

MISCELLANEOUS PAPERS.

BIOLOGICAL STUDIES ON THREE SPECIES OF APHIDIDÆ.

By JOHN JUNE DAVIS,

Of the University of Illinois, Urbana, Ill.

ISSUED FEBRUARY 20, 1909.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1909.

CONTENTS.

ILLUSTRATIONS.

TECHNICAL SERIES, NO. 12, PART IX.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY.

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

MISCELLANEOUS PAPERS.

A NEW GENUS OF ALEYRODIDÆ,

WITH REMARKS ON ALEYRODES NUBIFERA BERGER, AND ALEYRODES CITRI RILEY AND HOWARD.

By A. L. QUAINTANCE,

In Charge of Deciduous Fruit Insect Investigations.

ISSUED SEPTEMBER 1, 1909.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1909.

CONTENTS.

ILLUSTRATIONS.

TECHNICAL SERIES, No. 12.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.
L. O. HOWARD, Entomologist and Chief of Bureau.

MISCELLANEOUS PAPERS.

CONTENTS AND INDEX.

ISSUED DECEMBER 31, 1912.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.