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This issue mailed November 29, 1979

EFFECTS OF LARVAL DIET ON *CHRYSOPA RUFILABRIS*[1]

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Abstract

Larvae of the polyphagous predator *Chrysopa rufilabris* Burmeister were reared at constant temperature on several prey regimes including: *Phthorimaea operculella* (Zeller) (Lepidoptera), *Drosophila melanogaster* Meigan (Diptera), *Tribolium castaneum* (Herbst) (Coleoptera), and several aphid species. As adults the test lacewings were all maintained on a similar diet comprised of a water paste of Wheast® and sucrose. Larval diet significantly affected larval mortality, developmental rate, and adult weight, but did not affect adult body length. Under the test conditions, the aphid and *Phthorimaea* regimes were superior to either *Drosophila* or *Tribolium* as larval diets for *C. rufilabris*. Apparently, prey species which stimulate a high feeding rate in *C. rufilabris* may even so be nutritionally inadequate.

Chrysopids, or green lacewings, are important predators of arthropods in various crops, both in the context of indigenous natural enemies as well as in inundative release programs (Doutt and Hagen 1950, Lingren et al. 1968, Ridgway and Kinzer 1974, Whitcomb and Bell 1964).

Hydorn (1971) found that *Chrysopa rufilabris* Burmeister, a lacewing distributed throughout much of the United States and into Canada, was abundant in the vicinity of Gainesville, FL, where it occurred commonly in citrus, cereal, forage and row crops. The major predatory impact of this species occurs during the larval stage, the larvae preying on a wide spectrum of soft-bodied insects and other arthropods (Ewing and Ivy 1943; Griffiths 1951; Putman 1937, 1955; Smith 1922; Wilson and Simberloff 1969).

Putman (1932, 1937) found that *C. rufilabris* reared on certain prey species thrived better than it did on others, in terms of larval survival and development rate. Thompson (1951) stressed the importance of investigating host specificity of predacious insects, and it is increasingly apparent that polyphagous predators are more specific in their host relations than was formerly believed (Hagen et al. 1976). Clearly, investigations of the effects of different prey species on predator development and reproduction are prerequisites for successful utilization of these predators in biological control programs.

The present study evaluates performance of *C. rufilabris* on several larval prey regimes in terms of juvenile mortality, developmental rate, adult size, and longevity and fecundity of adult females.

Methods and Materials

Chrysopa rufilabris was reared and maintained as described by Hydorn

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[1] Neuroptera: Chrysopidae. Florida Agricultural Experiment Station Journal Series No. 1334.

and Whitcomb (1972). To minimize error due to variation in parental diet, progeny of field collected lacewings were maintained on a larval diet of *Tribolium castaneum* (Herbst), and their progeny (F_2) were used as the test specimens. The F_1 adults were maintained in groups of 15 or fewer specimens per adult maintenance unit and were fed an artificial diet of Wheast®, sucrose, and sufficient water to give a paste consistency. Eggs produced within 3 weeks following the onset of oviposition were removed from the adult units at 48 h intervals and placed individually in 7 dram plastic snap-cap vials for rearing.

Upon eclosion, the F_2 larvae were randomly placed on these prey regimes in the numbers indicated: *Drosophila melanogaster* adults freshly killed by freezing (n = 34), pupae and prepupae of *Tribolium castaneum* (n = 85), *Phthorimaea operculella* eggs and coddled mature larvae (Doutt and Finney 1947) (n = 42), and nymphs and adults of the aphids *Myzus persicae* (Sulzer), *Acyrthosiphon pisum* (Harris), *Aphis spiraecola* Patch, *A. rhamni* Fonscolombe, and *A. craccivora* Koch (total reared on aphids = 56).

The test specimens were maintained in a controlled light and temperature chamber under conditions of 14 h L: 10 h D, and 26 ± 2°C. Humidity was kept more or less uniform among the various diet treatments with the inclusion of moist cellu-cotton in vials with the drier prey types, *Drosophila* and *Tribolium* (Hydorn 1971). Prey was provided in excess amounts and was renewed as necessary at 12 to 48 h intervals until the onset of cocoon production.

Immediately following emergence from the cocoon, adults were sexed and weighed on an automatic analytic balance, and body length from labrum to abdominal apex was measured against a straight edge. Females were coded with acrylic paint on the wings to allow identification of individual specimens. Test adults were confined in adult maintenance units and fed Wheast®-based artificial diet. To permit mating and facilitate handling, adults were maintained together in small bisexual groups of 5 or fewer specimens per unit, segregated according to larval diet. Adults were transferred to new units at 24 to 48 h intervals, depending on number of eggs deposited. Daily fecundity rate for each female in units containing more than 1 female was estimated by dividing the number of eggs deposited/day by an estimated number of females ovipositing each day. Additional information concerning procedures is given by Hydorn (1971).

Statistical methods are given in the text; results are expressed according to the 5% level of significance.

RESULTS

Larval diet exerted a marked effect on juvenile mortality of *C. rufilabris* (Fig. 1). Analysis of number of instars survived by ANOVA and Scheffe's test indicated that survival was significantly less in specimens reared on *Tribolium* than in those given any other diet.

Aphids and *Phthorimaea*, the prey regimes associated with the highest survival to maturity in test specimens, promoted rapid larval development especially in early instar lacewings (Fig. 2). Analysis of the duration of the post-ecolosion juvenile period by ANOVA and Scheffe's test for all specimens surviving to maturity indicated that development in lacewings reared on *Tribolium* was significantly prolonged as opposed to those fed *Phthorimaea*.

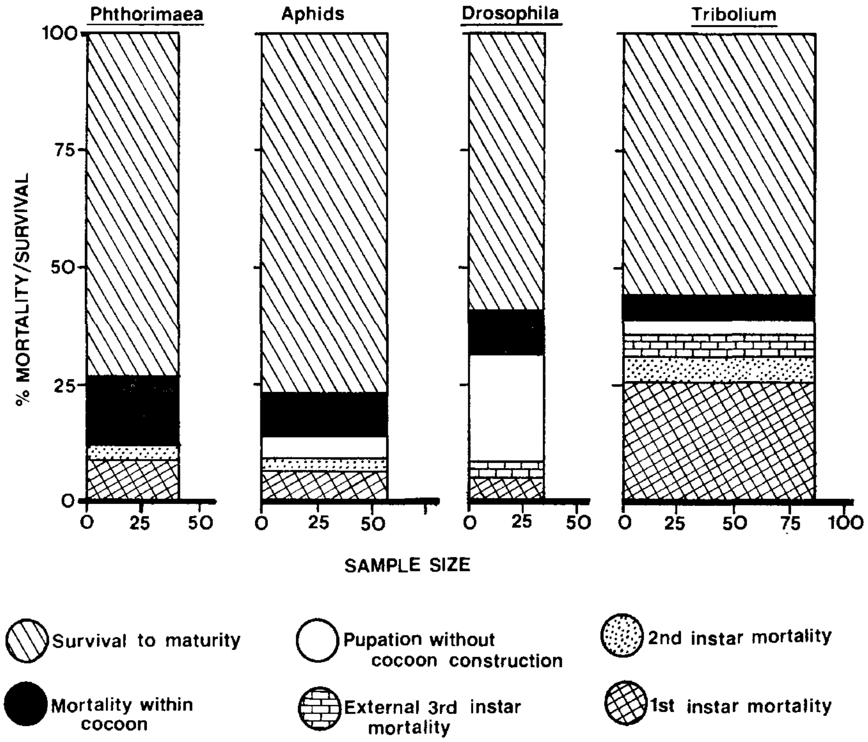

Fig. 1. Analysis of juvenile mortality of *Chrysopa rufilabris* reared on 4 basic prey regimes.

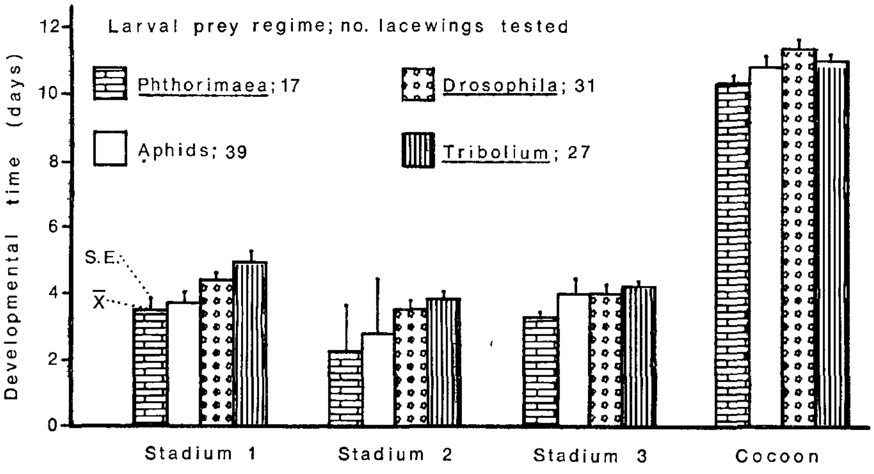

Fig. 2. Mean durations of larval stadia and the cocoon period in *Chrysopa rufilabris* reared at 26.0 ± 2°C on 4 basic prey regimes. S.E. = standard error, $\overline{X}$ = mean.

The prolongation of larval development in lacewings reared on *Tribolium* may have contributed to increased adult size (Table 1). Although analysis by ANOVA and Scheffe's test of the body length data did not indicate significance, similar analysis of weight data indicated that specimens given *Tribolium* weighed significantly more as adults than did those reared on *Drosophila*.

The longevity of mated females reared on aphids was significantly prolonged relative to that of females reared on *Drosophila*, as determined by ANOVA and Scheffe's test (Table 2). Similar analysis indicated that the average estimated duration of the oviposition period was significantly longer for lacewings reared on aphids than for those reared on either *Drosophila* or *Tribolium*. Estimated total fecundity/female (Table 2) was derived by summation of all estimated daily fecundity values for each specimen. Subjection of the estimated total fecundity data to the above statistical procedures indicated that the fecundity of the specimens reared on aphids was significantly greater than for those reared on *Drosophila*.

DISCUSSION

Smith (1922) proposed that *C. rufilabris* is primarily aphidophagous, and results of the present study tend to support this hypothesis. The adequacy of the aphid regimes as prey for *C. rufilabris* did not result from a mixed species effect, since most specimens reared on aphids received only 1 species as prey. Data obtained from specimens reared on various aphid species were combined for the purpose of analysis, since differences in results obtained with specimens reared under the stated conditions on the given aphid species were small.

The adequacy of the *Phthorimaea* regime as a diet for *C. rufilabris* and the frequency of feeding records on various Lepidoptera indicate that mem-

TABLE 1. INFLUENCE OF LARVAL PREY REGIME ON SIZE OF NEWLY EMERGED *Chrysopa rufilabris* ADULTS, AS INDICATED BY TOTAL BODY LENGTH AND FRESH WEIGHT.

Larval prey regime	No. reared	Sex	Body length (mm) ($\bar{X}$ ± S.E.)	Adult weight (mg) ($\bar{X}$ ± S.E.)
Phthorimaea	5	♂♂	10.3 ± 0.37	5.8 ± 0.22
	7	♀♀	10.6 ± 0.34	6.5 ± 0.30
	12	Total	10.5 ± 0.27	6.3 ± 0.28
Aphids	10	♂♂	10.6 ± 0.25	5.7 ± 0.12
	17	♀♀	10.9 ± 0.25	6.6 ± 0.25
	27	Total	10.8 ± 0.18	6.2 ± 0.20
Drosophila	7	♂♂	10.4 ± 0.05	5.3 ± 0.06
	11	♀♀	10.7 ± 0.18	5.8 ± 0.41
	18	Total	10.5 ± 0.13	5.6 ± 0.22
Tribolium	9	♂♂	10.5 ± 0.16	6.1 ± 0.23
	11	♀♀	10.9 ± 0.14	7.1 ± 0.31
	20	Total	10.7 ± 0.12	6.7 ± 0.22

TABLE 2. INFLUENCE OF LARVAL PREY REGIME ON ADULT LONGEVITY AND OVIPOSITION IN MATED FEMALES OF *Chrysopa rufilabris* MAINTAINED AT 26.0 ± 2°C ON AN ARTIFICIAL WHEAST®-BASED DIET.

Larval prey regime	No. mated ♀♀	Adult longevity-days ($\overline{X}$ ± S.E.)	Estimated oviposition period-days ($\overline{X}$ ± S.E.)	Eggs/female ($\overline{X}$ ± S.E.)
Phthorimaea	7	56.2 ± 10.9	38.8 ± 9.3	111.5 ± 37.2
Aphids*	12	71.6 ± 9.0	59.3 ± 8.2	188.7 ± 26.5
Drosophila	7	29.1 ± 4.0	14.7 ± 3.7	29.3 ± 13.25
Tribolium	11	45.6 ± 7.0	24.6 ± 3.3	72.2 ± 7.75

**Aphis craccivora, Acyrthosiphon pisum.*

bers of this order may be important prey of this lacewing under natural conditions. Putman (1932) found that survival to maturity of larvae of *C. rufilabris* and *C. plorabunda* Fitch reared on eggs of oriental fruit moth was higher than that for specimens given other (unspecified) diets.

Reduced survival to maturity and decreased fecundity of specimens reared on *Tribolium* and *Drosophila* regimes indicated these to be relatively inferior as prey sources for *C. rufilabris*. Performance of the lacewings reared on *Tribolium* apparently was uninfluenced by a second generation effect, since juvenile mortality and rate of development did not differ statistically by the t test from corresponding data for first generation lacewings given the same diet. Relative inadequacy of *Tribolium* as prey for the lacewings may have derived in part from its low acceptability as prey for the young larvae; several first instar specimens given this regime died of apparent starvation. However, the majority of lacewings reared on this regime that failed to survive to maturity appeared to have fed normally, and died as a result of molting distress.

Avid consumption by *C. rufilabris* of any prey species did not necessarily indicate that such prey was nutritionally adequate. This was clearly shown when 10 specimens that were given *Drosophila* during the first instar were changed after molting to a diet of *Tetranychus gloveri* Banks. Although the lacewings fed avidly upon the mites, this diet failed to support development and all larvae died before undergoing a second molt.

The situation was similar although less extreme in specimens reared only on *Drosophila*. Observations indicated this to be highly acceptable prey for the lacewings throughout the larval feeding period, yet specimens reared on *Drosophila* suffered a high incidence of pupal mortality, and surviving adults were small and shortlived with low fecundity.

The results of this study indicate that efficiency of pest control programs involving mass releases of rapid-developing, general predators such as *C. rufilabris*, may be increased with adequate preliminary research. This should confirm nutritional adequacy of target species, as well as their acceptability as prey to the predator in question. This would especially be important in situations where alternative prey is scarce, and the target species remains susceptible to predation for sufficient duration to permit effective numerical response by the predator.

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IDENTITY OF *SILVIUS RUFIPES*[1] (DIPTERA: TABANIDAE)

SIXTO COSCARON[2] AND G. B. FAIRCHILD[3]

ABSTRACT

Restudy of the holotype of *Silvius rufipes* Macquart 1850 proves that it belongs in *Protodasyapha* Enderlein. The species was described from Cor-

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IDENTITY OF *SILVIUS RUFIPES*[1] (DIPTERA: TABANIDAE)

SIXTO COSCARON[2] AND G. B. FAIRCHILD[3]

ABSTRACT

Restudy of the holotype of *Silvius rufipes* Macquart 1850 proves that it belongs in *Protodasyapha* Enderlein. The species was described from Cor-

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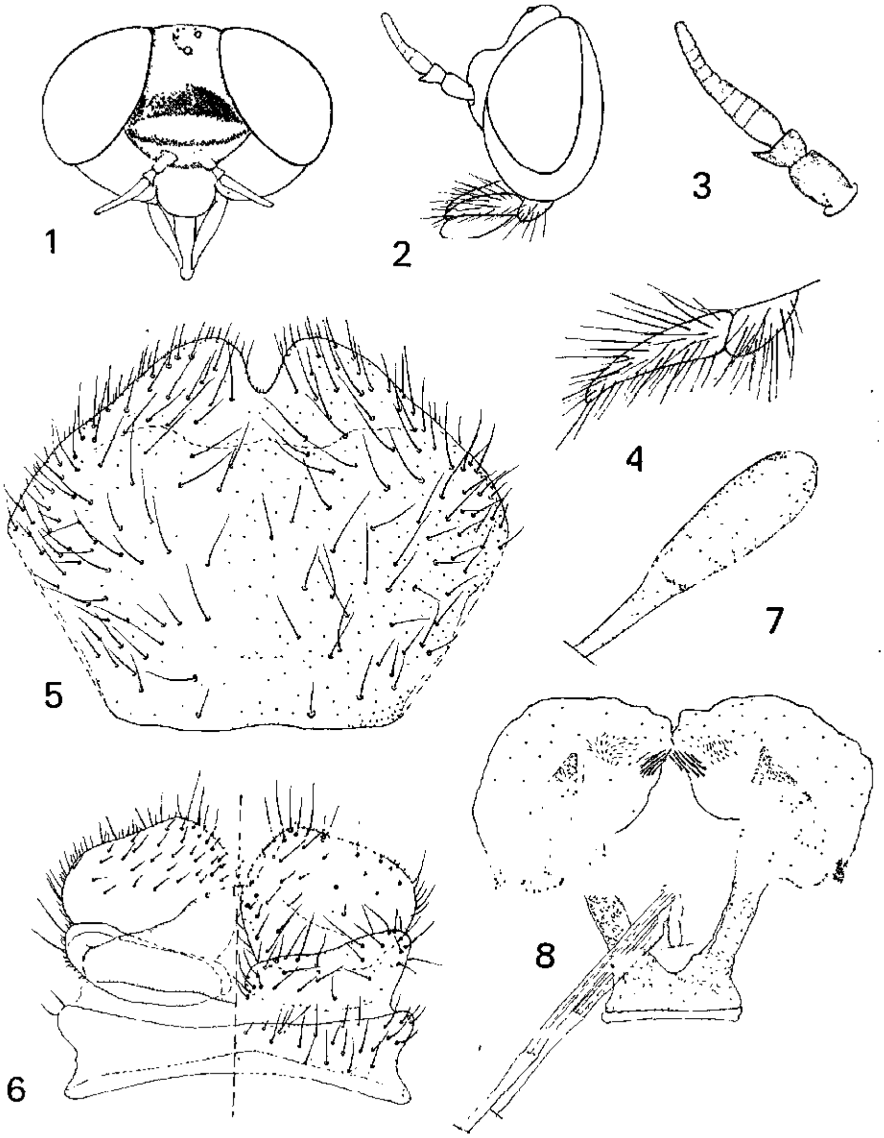
rientes, Argentina in error; it is actually Chilean. Genitalia and head structures of the unique female type are figured.

This species was described by Macquart in 1850 as from "Bresil, Corrientes, d'Orbigny." Kröber (1934) did not recognize it or study the type. Fairchild (1956) studied the ♀ type in Paris, but due to its exceedingly



Figs. 1-8. *Protodasyapha rufipes* (Macquart), holotype ♀. 1, head in front view; 2, head in side view; 3, antenna; 4, palpus; 5, sternite VIII and gonapophysis; 6, cerci, tergites IX, X and hypoproct; 7, spermatheca; 8, genital fork and bases of spermathecal ducts.

dirty condition and his unfamiliarity with the temperate Neotropical fauna, he placed it in *Veprius* with a query, a treatment repeated in the Neotropical Catalogue (Fairchild 1971). Neither of us was satisfied with this tentative placement; Coscaron in particular was intrigued by the locality, since Corrientes is mostly a plains region in northeastern Argentina, far from the known habitat of other species of *Veprius.* Fortunately, a restudy of the type in Paris by Luis Alberto Pereira, an assistant of Coscaron's and a competent entomological illustrator, has enabled us to present here illustrations of the type which clarify its position. Sr. Pereira with admirable acuity also checked the number 15/43 on the type with the old registers of the Museum, which Fairchild had neglected to do, and discovered that the specimens under this number were Chilean insects given to the Museum by Claudio Gay. The D'Orbigny, Corrientes locality published by Macquart thus seems to be an error. The collector, Gay, according to Papavero (1971: 148) spent many years in Chile, but is not known to have visited Argentina or Brazil, except in passing.

In spite of the dirt-encrusted condition of the type, it agrees structurally with *Protodasyapha hirtuosa* Philippi 1865, as figured by Coscaron (1976: 82), except for the curious ventral apical spur on the 2nd antennal segment, and the apparently more protuberant frontal callus and ocellar tubercle when seen in side view. Should further detailed comparisons prove the 2 names synonymous, *rufipes* would have priority by 15 years. We prefer merely to place *rufipes* in *Protodasyapha,* leaving for the future the determination of its possible conspecificity with *hirtuosa.* We present Figs. 1-8 of head structures and genitalia of the holotype for comparison with those of *P. hirtuosa* given by Coscaron (1976, Fig. 2).

We are most grateful to Dr. Loic Matile of the Laboratoire d'Entomologie of the Museum National d'Histoire Naturelle in Paris for allowing us to study and dissect the unique type of *Silvius rufipes.*

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FURTHER NOTES ON THE PANGONIINI OF THE AUSTRAL REGION OF SOUTH AMERICA (DIPTERA: TABANIDAE)[1]

SIXTO COSCARON[2], CORNELIUS B. PHILIP[3] AND G. B. FAIRCHILD[4]

ABSTRACT

The study of new material available since Coscaron's publication on the same subject (1976) enables us to describe 2 new species of *Veprius* from Chile, and to furnish additional records, also from Chile, for 2 species of *Protodasyapha* and 1 of *Chaetopalpus.*

The primitive Pangoniini occurring in the southern part of South America are of particular interest on account of possible transantarctic relationships with Australia and Southern Africa. The present publication completes and supplements work previously published by the senior author (Coscaron 1976).

Veprius apatolesteus Coscaron, Philip, and Fairchild, NEW SPECIES

A blackish species with grayish pollinosity on head and its appendages. Frons laterally elevated. Hairs of ventral part of body and eyes grayish, tibiae yellowish brown.

HOLOTYPE ♀: Body length 11.5 mm, wing 9.0 mm. Head (Figs. 1 and 2) blackish, eyes black with greenish reflections but no bands (relaxed). Frons black, shiny laterally; subcallus, face, occiput, palpi, and scape and pedicel of antenna black with grayish pollinosity. Third antennal segment with style black, basal plate grayish brown basally. Proboscis black, fleshy. Hairs of frons, basal antennal segments, and proboscis black; hairs of eyes, occiput, palpi, and beard light gray. Thorax and abdomen black with brownish-gray tones dorsally and grayish pollinosity ventrally; hairs whitish gray, as are those on legs. Wings with veins dark brown and membrane brown tinted. Coxae, femora, apices of tibiae and tarsi blackish, tibia otherwise light brown. Frons divergent below, with basal portion elevated, 3 large ocelli at vertex, subcallus elevated, frontal index 1.3 (height/basal width).

Antennae with robust scape, basal plate well-differentiated, with indistinct annulations; style 4-segmented. Palpi subcylindrical, quite straight, apically pointed and similar to those of *Veprius presbiter* Rond. Proboscis short and membranous. Wings with short appendix on vein R_4.

Paratype females of similar coloration with body lengths 11 to 11.5 mm and wing lengths 10 mm.

Genitalia (♀): Very similar to *Veprius presbiter*, but showing differences in the genital fork, which has the base and lateral arms less sclerotized in the new species. Sternite VIII is darker on the posterior border and paler on the midline.

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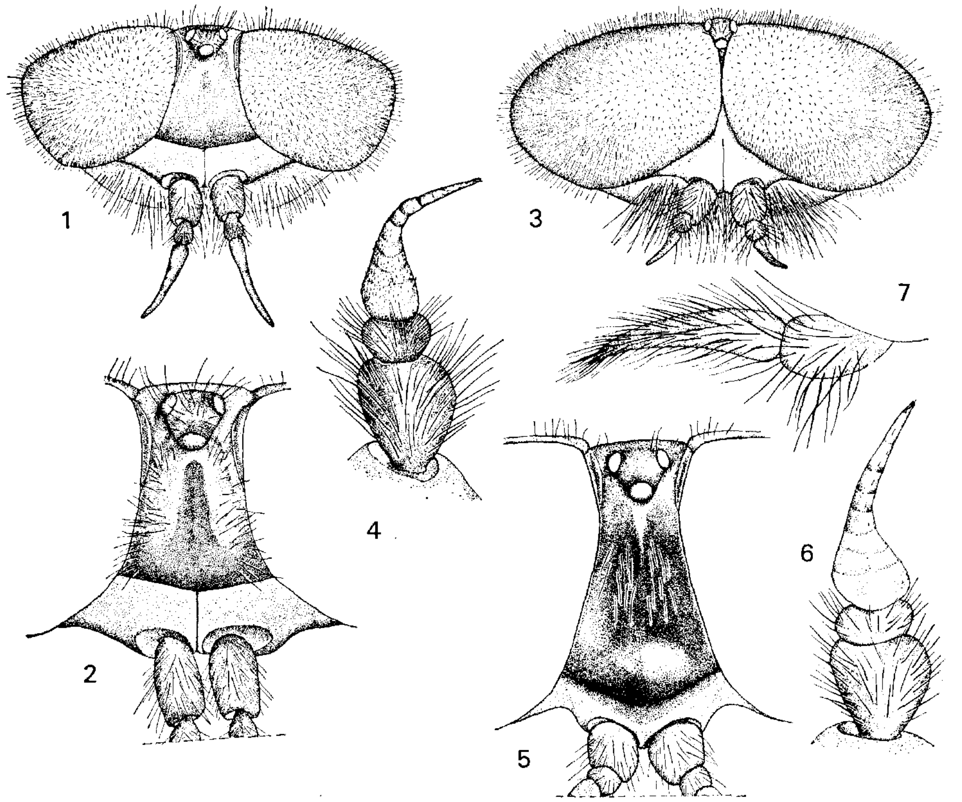

Figs. 1-7. *Veprius apatolesteus* n. sp. 1) ♀ head, front view; 2) ♀ frons; 3) ♂ head, front view; and 4) ♂ antenna. *Veprius fulvus* n. sp. 5) ♀ frons; 6) ♀ antenna; and 7) ♀ palpus. Figures of heads, fronts, and appendages are each to the same scale; the heads are least enlarged, and the antennae and palpus are most enlarged.

ALLOTYPE ♂: Body length 12 mm, wing 11 mm. Agrees in color with the female, but since dorsal pilosity is denser, the lighter colors are more apparent. Eyes iridescent violet black with more bluish tones in the area of small facets, with abundant gray pilosity. Head structures (Figs. 3, 4), in profile flatter than illustrated for *Veprius presbiter* (Coscaron 1967, Fig. 5). Antennae with scape and pedicel robust (Fig. 4) and basal plate relatively slender with pseudoannulations. Shape of palpus as in *Veprius presbiter*. Paratype males show no differences from the allotype except for small differences in size. Body lengths 10.5 to 12 mm and wing lengths 10 to 11 mm. *Genitalia* (♂): No appreciable differences from *Veprius presbiter* observed. MATERIAL EXAMINED: CHILE, Coquimbo, Peñon, 8-XII-1952, holotype ♀. Illapel, Canela Baja, 23, 24-X-1961, Peña coll., allotype ♂, plus 2 ♀ 1 ♂ paratypes; other paratypes, Illapel, El Calabazo, 21, 22-XI-1961, Peña coll., 1 ♂; 8 km N San Pedro, 16, 17-XI-1961, Peña coll., 2 ♀ 4 ♂, Fray Jorge, 15 km SW Ischingo, 100-200 m elev., 20-X-1966, Schlinger and Irwin colls., 1 ♀. ARGENTINA, Neuquen, Domuyo, 17-I-1974, de Ferraris coll., 1 ♂.

Holotype and 1 ♂, 1 ♀ paratypes to be deposited in California Academy of Sciences, CAS Ent. Type No. 13131; allotype and 4 ♂, 1 ♀ paratypes in collection of L. L. Pechuman; and remaining paratypes, 2 ♀, 1 ♂ in

Canadian National Collection and in Museo de la Plata, La Plata, Argentina, 1 ♂ 1 ♀.

Veprius presbiter differs from the present new species in being darker, the pilosity of eyes and body dark greyish brown, body and appendages black. The face and head appendages with blackish pollinosity, legs wholly black, and wings darker. The head is relatively narrower with the frons flatter. The scape and pedicel of the male antennae are less robust and the basal plate without pseudoannulations. There are also slight differences in the sclerotization of the female genital fork and 8th sternite.

Veprius fulvus Coscaron, Philip, and Fairchild, NEW SPECIES

A dark brown species with antennae, legs and anterior border of wings yellowish.

HOLOTYPE ♀: Body length 10 mm, wing 9 mm. Eyes violaceus black. Frons blackish brown; occiput, subcallus and face brown with dark gray pollinosity. Antennae yellowish, palpi and proboscis dark brown. Hairs on the eyes, occiput and antennae light brown, on face and palpi blackish brown. Frons divergent below, elevated meso-basally and with smooth, transverse median depression. Ocelli prominent (Fig. 5). Frontal index 1.6. Basal plate of 3rd antennal segment with pseudoannulations (Fig. 6), the style not clearly distinguishable from basal plate. Palpus subcylindrical (Fig. 7). Thorax, abdomen, coxae and femora dark brown, with concolorous hairs. Tibiae and tarsi yellow with yellowish brown hairs. Wing membrane lightly tinted with veins C, Sc, R_1 and M yellowish, the remainder brown.

Genitalia (♀): Very similar to *Veprius presbiter*, with slight differences in sternite VIII which shows a deeper concavity in the distal border, and cerci with the internal sides somewhat longer, giving a subtriangular appearance.

MATERIAL EXAMINED: "CHILE, Valparaiso, November, 1900" (from Reed coll.). Holotype ♀ deposited in California Academy of Sciences, CAS Ent. Type No. 13132.

Veprius fulvus differs in color from *V. presbiter*, the latter being totally blackish brown, without yellowish tones in antennae, legs and wings. The frons of *fulvus* is somewhat narrower and with darker sublateral spots well-differentiated. *Veprius apatolesteus* may be separated from *fulvus* by having blackish antennae with grayish scape and pedicel, frons shorter without median depression, the legs blackish with the exception of the distal portions of the tibiae, which are light brown, and wing without yellowish veins.

We have examined another female from "Valparaiso, December, 1916, Reed coll." which is similar in some respects, but whose darker coloration does not permit it to be placed with *fulvus*, nor with any other known species; the fact that it is not well preserved and is somewhat discolored does not allow us to decide its identity.

Protodasyapha (*P.*) *hirtuosa* (Philippi)

Two specimens in CAS, 1 ♂ 1 ♀ collected by Reed with "Chile" as only locality, are paler (perhaps more faded with age) than other material seen by us. The frontal callus of the ♀ is light brown and the body light grayish brown. Since the specimens are not in good condition, it seems better for the present to retain them in the above species.

Protodasyapha (*Curumyia*) *lugens* (Philippi)

A single additional ♂ in the collection of L. L. Pechuman has been seen. It is labelled "Chile, Linares, Estero De Leiva, 8/12-I-1953, Peña coll."

Chaetopalpus annulicornis (Philippi)

A single ♂ from "Ercilla, 22-XII-1949, J. Levis R. coll." is smaller than any previously seen. It has a wing length of 5.5 mm, and is somewhat paler than usual. The anterior borders of the abdominal tergites have narrow gray margins with gray hairs. The antennae show 5 well-differentiated, apical annuli in the flagellum and pseudoannulations basally. However, the genitalia show no differences from *C. annulicornis.* Due to the great morphological variation in this species, we do not believe it advisable to separate this specimen as a distinct taxon.

We thank Miss Nelida Caligaris for making the accompanying figures.

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A NEW SPECIES OF WATER MITE[1] PARASITIZING THE BACKSWIMMER *BUENOA SCIMITRA*[2]

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Abstract

Hydrachna virella (Acari: Hydrachnellae), a new species of water mite that parasitizes backswimmers of the species *Buenoa scimitra* Bare (Hemiptera: Notonectidae), is described. Adults and nymphs are characterized by a pronounced elongation of the posteromedial portion of the 4th coxae. Larvae are distinguished by the relative sizes of the coxal plates and by the positions and relative sizes of the coxal plate setae.

Water mites of the genus *Hydrachna* are common, usually red mites that inhabit mostly standing bodies of water. The nymphs and adults are predatory on insect eggs (Davids 1973, Lanciani 1978) but the larvae are ectoparasitic on aquatic Coleoptera and Hemiptera (Smith and Oliver 1976). This paper presents information on a new species of *Hydrachna* (subgenus *Hydrachna*) that parasitizes backswimmers of the genus *Buenoa.*

Measurements, except those on the body dimensions of live mites, were made on a sample of 5 specimens. The mean is presented first and is followed in parentheses by the minimum and maximum values.

Holotypes, allotypes, and paratypes have been deposited in the Florida State Collection of Arthropods, Gainesville, FL.

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[1] Acari: Hydrachnellae.
[2] Hemiptera: Notonectidae.

Protodasyapha (*Curumyia*) *lugens* (Philippi)

A single additional ♂ in the collection of L. L. Pechuman has been seen. It is labelled "Chile, Linares, Estero De Leiva, 8/12-I-1953, Peña coll."

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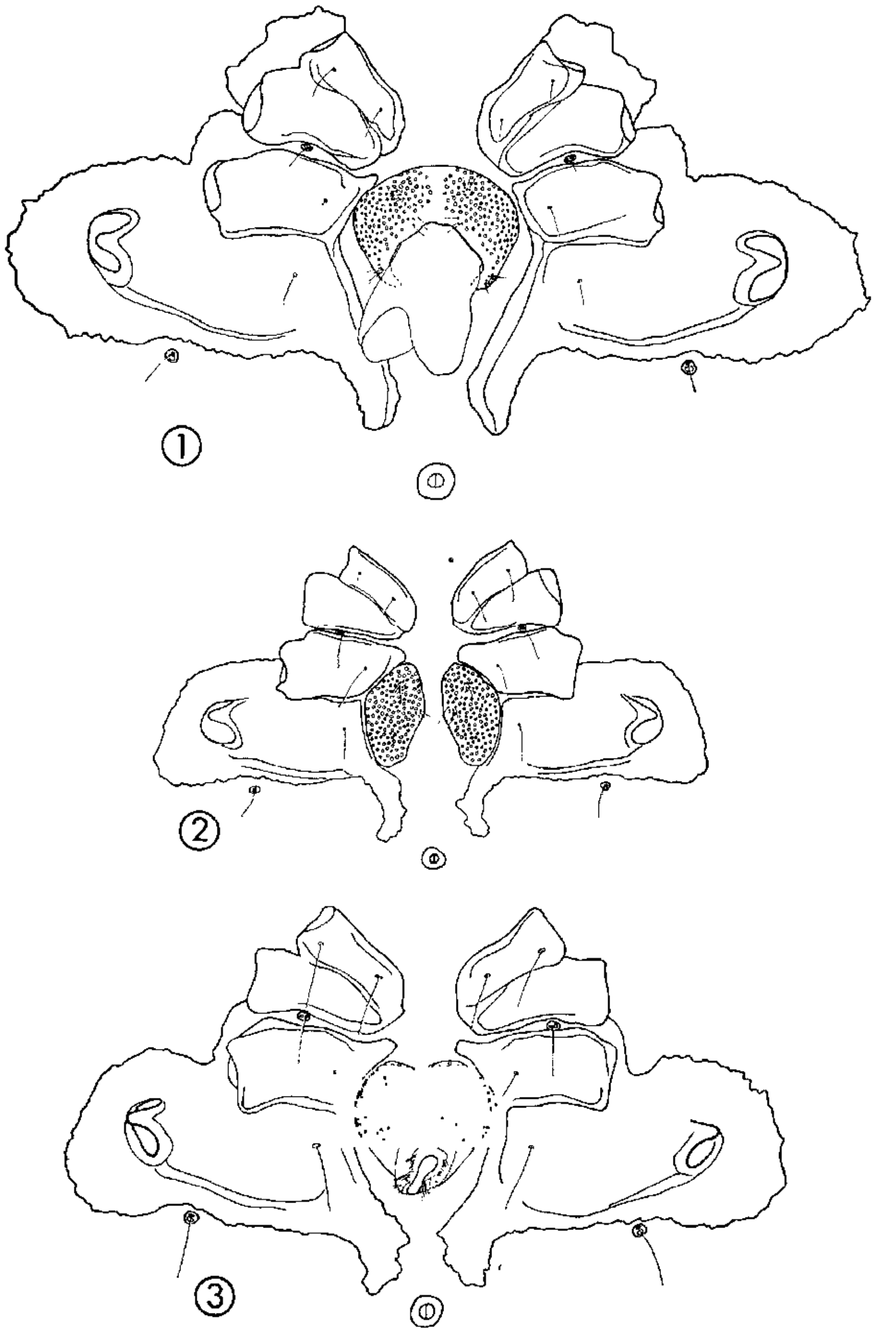


Figs. 1-3. *Hydrachna virella* Lanciani, new species. 1) venter of ♀; 2) venter of nymph; 3) venter of ♂.

Hydrachna virella Lanciani, NEW SPECIES

MALE: (Figs. 3, 4, and 8). Color of live mite usually green but occasionally red; live mite 1700μ (1500-1930μ) long and 1520μ (1360-1780μ) wide just after metamorphosing to adult stage (sample size =N= 4).

Length between anterior end of 1st coxa and posterior end of 4th coxa 725μ (591-806μ); posteromedial portion of 4th coxa greatly extended; chaetotaxy of coxae as in Fig. 3; genital field 244μ (203-274μ) long and 266μ (228-304μ) wide, with many acetabula and small setae, with a conspicuous projection surrounding the gonopore.

Dorsum with a single anterior plate 712μ (524-883μ) long and 1030μ (823-1300μ) wide; chaetotaxy of dorsal plate as in Fig. 4, but pair of setae in membrane adjacent to plate is incorporated into plate in some specimens.

Proportions and chaetotaxy of palp as in Fig. 8, but number of setae on P-I varying from 1 to 2 and number on P-II varying from 6 to 8; dorsal setae on P-II finer than corresponding setae of ♀; dorsal lengths of palpal segments: P-I, 191μ (155-225μ); P-II, 134μ (107-153μ); P-III, 150μ (130-165μ); P-IV, 71μ (61-80μ); P-V, 38μ (35-41μ); chelicera 647μ (585-696μ) long.

FEMALE: (Figs. 1, 6, and 10). Color of live mite usually green but occasionally red; live mite 1900μ (1780-2040μ) long and 1740μ (1660-1810μ) wide just after metamorphosing to adult stage (N= 3) but growing to at least 2500μ long and 2270μ wide in nature.

Length between anterior end of 1st coxa and posterior end of 4th coxa 771μ (657-867μ); posteromedial portion of 4th coxa greatly extended; chaetotaxy of coxae as in Fig. 1; genital field 203μ (168-221μ) long and 315μ (268-353μ) wide, with many acetabula and small setae.

Dorsum with a single anterior plate 842μ (795-938μ) long and 1124μ (983-1325μ) wide; chaetotaxy of dorsal plate as in Fig. 6, but pair of setae in membrane adjacent to plate is incorporated into plate in many specimens.

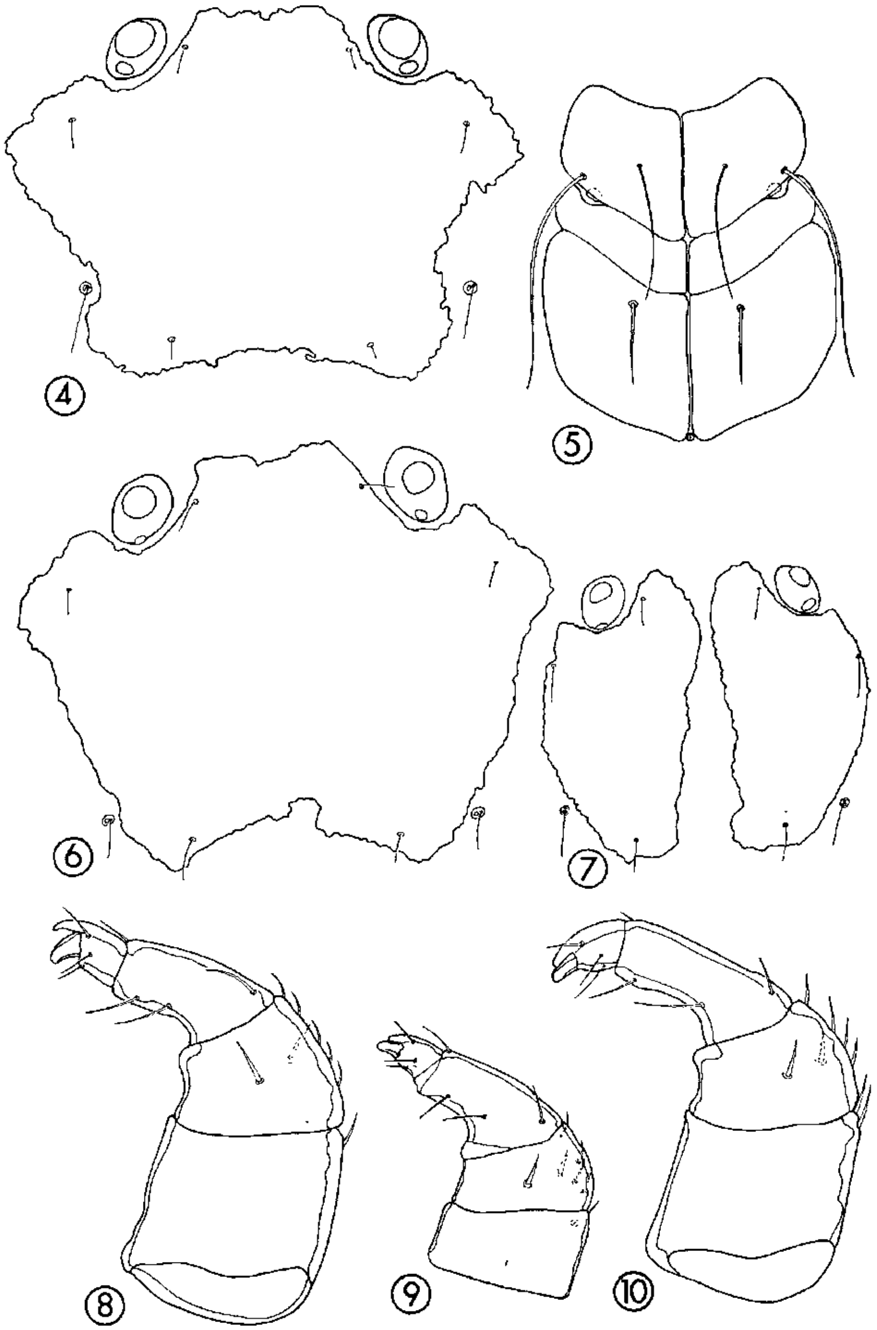
Proportions and chaetotaxy of palp as in Fig. 6, but number of setae on P-I varying from 1 to 2 and number on P-II varying from 6 to 10; all but the most distal 1 of dorsal setae of P-II much thicker than corresponding setae of ♂; dorsal lengths of palpal segments: P-I, 200μ (168-236μ); P-II, 122μ (108-146μ); P-III, 190μ (168-214μ); P-IV, 77μ (68-87μ); P-V, 38μ (34-41μ); chelicera 708μ (635-715μ) long.

NYMPH: (Figs. 2, 7, and 9). Color of live mite green; live mite 1120μ (770-1630μ) long and 940μ (640-1400μ) wide just after emerging from host (N = 26).

Length between anterior end of 1st coxa and posterior end of 4th coxa 553μ (442-690μ); posteromedial portion of fourth coxa greatly extended; chaetotaxy of coxae as in Fig. 2; immature genital field composed of 2 separate acetabular plates, each having a length of 189μ (160-226μ) and a width of 111μ (89-144μ).

Dorsum with 2 anterior plates, each having a length of 510μ (420-718μ) and a maximum width of 260μ (204-403μ); chaetotaxy of dorsal plates as in Fig. 7, but 2nd pair of setae located in membrane instead of plate in 1 specimen.

Proportions and chaetotaxy of palp as in Fig. 9, but number of setae on P-II varying from 6 to 7; dorsal lengths of palpal segments: P-I, 107μ (87-



Figs. 4-10. *Hydrachna virella* Lanciani, new species. 4) dorsal plate of ♂; 5) venter of idiosoma of larva; 6) dorsal plate of ♀; 7) dorsal plates of nymph; 8) left palp of ♂; 9) left palp of nymph; 10) left palp of ♀.

155μ); P-II, 88μ (81-98μ); P-III, 141μ (125-163μ); P-IV, 55μ (47-65μ); P-V, 28μ (23-35μ); chelicera 511μ (458-607μ) long.

LARVA: (Fig. 5). Length of idiosoma 198μ (182-203μ); length of gnathosoma 142μ (133-149μ); length of coxal plates along midline: I, 49μ (47-50μ); II, 22μ (19-23μ); III, 59μ (57-61μ); positions and sizes of coxal plate setae as in Fig. 5.

HOLOTYPE: Adult ♂, reared from the host insect *Buenoa scimitra* Bare collected from a temporary pond in Gainesville, FL on 13-V-1978.

ALLOTYPE: Adult ♀, same data as holotype.

PARATYPES: 1 ♂, same data as holotype; 1 ♀, offspring of parents reared from *Buenoa scimitra* collected from a temporary pond in Gainesville, FL on 13-V-1978.

HABITAT: Ponds.

HOST: Parasitic larvae were found in nature attached to a variety of sites on the notonectid *Buenoa scimitra*. In the laboratory, the larva also sucessfully developed on *B. confusa* Truxal.

DIAGNOSIS: *Hydrachna virella* can be distinguished from other North American species of the subgenus *Hydrachna* by the posteromedial elongations of the 4th pair of coxae in nymphs and adults and by the pronounced projection surrounding the male gonopore. The only other known species of this subgenus possessing the elongated 4th coxa is *H. analis* Viets, a species described by Viets (1935) from Sumatra on the basis of nymphal characteristics. The nymph of *H. virella* differs from that of *H. analis* in having much larger acetabular plates.

The diagnostic importance of the larval coxal plates of *Hydrachna* has been emphasized by Davids (1973). Although the larva of *H. virella* is somewhat similar to that of *H. magniscutata* Marshall (Prasad and Cook 1972) and *H. cruenta* Müller (Davids 1973) in ventral aspect of the idiosoma, it can be distinguished from the larvae of these and other species by the relatively large size of the 3rd pair of coxal plates, the relatively small size of the 2nd pair of coxal plates, and the size and position of the coxal plate setae.

ACKNOWLEDGMENTS

I thank Dr. David R. Cook for his helpful advice concerning the taxonomic status of this mite and Esta Belcher for her assistance in the preparation of the illustrations.

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SURVIVAL OF *DIAPREPES ABBREVIATUS*[1] LARVAE ON SELECTED NATIVE AND ORNAMENTAL FLORIDA PLANTS

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ABSTRACT

Of 65 ornamental nursery and 6 native plant species examined during 1976-7 at Plymouth, FL, only 9 species of nursery plants and 1 native plant species other than citrus and sugarcane appeared suitable for the development of larvae of *Diaprepes abbreviatus* (L.). Transport of infested ornamental plants could convey the weevil within and outside of the regulated area in south and central Florida. Native host species could contribute to local weevil populations in Florida.

Diaprepes abbreviatus (L.) is an important agricultural pest in the West Indies, where it attacks a wide variety of economically important plant species (Martorell 1976). This weevil was first observed attacking citrus in central Florida in 1964; presently it is found in ca. 2000 ha of citrus in that general area. The present study was done in 1976-7 to identify tropical and subtropical plant species growing in Florida that would support the development of the larvae. The test species included ornamental nursery plants produced in Florida for distribution throughout North America and native plant species found adjacent to citrus groves that could be a source of incipient local weevil populations.

MATERIALS AND METHODS

All ornamental tropical foliage and landscape plants were held in 15-cm-diam pots in a medium of 1 part peat and 1 part sand (v/v); potted plants were maintained on raised benches under shade or in a fiberglass-covered screenhouse. There was a minimum of 10 plants/species examined during 1976-7 at Plymouth, FL. Each species was exposed to neonate larvae (September-October) reared from the eggs of field-collected adults at a rate of 100 larvae/pot. In general, from 10 to 50 larvae were placed in a pot on a given day, and additional larvae were introduced over a period of 2 weeks or more. Three months after introduction of larvae, the plants were removed from the pots; the soil was examined for larvae, and the roots were examined for feeding damage. Citrus rootstocks grown in Florida, rough lemon (*Citrus limon* (L.) Burm. f.), sour orange (*C. aurantium* (L.)), Carrizo citrange (*C. sinensis* (L.) Osb. X *Poncirus trifoliata* Raf.), Milam rough lemon (*C. limon* (hybr. ?)), and Cleopatra mandarin (*C. reticulata* Blanco), that are not resistant to damage by *D. abbreviatus* (Norman et al. 1974) were included as a check for each group of plants.

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[1] Coleoptera: Curculionidae.
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The following native plants were challenged with more than 10,000 neonate larvae/plant during September-October 1976 in the field: Common persimmon, *Diospyros virginiana* L.; Chinaberry, *Melia azedarach* L.; chokecherry, *Prunus virginiana* L.; laurel oak, *Quercus imbricaria* Michx.; live oak, *Q. virginiana* Mill.; and smooth sumac, *Rhus glabra* L. All larvae were placed adjacent to the main stem. There were 10 plants/species. Plants were removed from the soil and examined for feeding damage 3 months after the last larval introduction. Although *D. abbreviatus* has a 1-year life cycle, 3 months would be sufficient time for larval development and root damage. No attempt was made to recover larvae. Also, neonate larvae were placed on 6-year-old grapefruit, *Citrus paradisi* Macf., grafted on rootstock of sour orange for checks; the results are reported as part of another study (Schroeder and Sutton 1977).

RESULTS AND DISCUSSION

The ornamental potted-plant species challenged with neonate larvae were divided into 2 groups: those with >1% larvae recovered and those with <1% larvae recovered (Table 1). The plants classified as hosts, i.e., >1% larvae recovered, were dead or in a state of decline when examined. If there were adequate plant material available, these hosts would probably be suitable for development of *D. abbreviatus* to the adult stage. Conversely, the few larvae recovered from poor hosts were small; poor hosts probably would not support development to the adult stage. Consequently, infested species listed as hosts could be transported outside of the regulated area; the probability of transporting *D. abbreviatus* as larvae on poor or nonhost plant species would be less.

TABLE 1. SCIENTIFIC AND COMMON NAMES OF ORNAMENTAL PLANT SPECIES CHALLENGED WITH NEONATE *Diaprepes abbreviatus* LARVAE (100/PLANT) AND PERCENTAGE LARVAE RECOVERED AFTER 3 MONTHS.

Scientific name	Common name	% Larvae recovered
Plants that support larval development (>1% larvae recovered)		
Aloe barbadensis Mill.	Aloe	5.4
Ardisia crenata Sims	Coralberry	11.8
Citrus sp.	Citrus	19.2
Codiaeum variegatum var. *pictum* (Lodd.) Müll. Arg.	Croton	1.2
Dizygotheca elegantissima (Hort. ex. Vietch) R. Vig. & Guill.	False-aralia	1.1
Hoya carnosa (L.f.) R. Br.	Waxplant	1.2
Juniperus conferta Parl.	Shore juniper	2.4
Juniperus virginiana L.	Red cedar	2.5
Liriope sp.	Lilyturf	1.5
Maranta leuconeura E. Morr.	Prayerplant	9.4
Saccharum officinarum L.	Sugarcane	15.3

Plants that do not support larval development (<1% larvae recovered)

Scientific name	Common name	Scientific name	Common name
Aechmea fasciata (Lindl.) Bak.	Urnplant	*Hemerocallis fulva* (L.) L.	Day lily
Aglaonema commutatum Schott	Silver evergreen	**Hibiscus* sp.	Hibiscus
Aphelandra squarrosa Nees 'Dania'	Zebra plant	*Howeia forsterana* (C. Moore & F. J. Muell.) Becc.	Kentia palm
**Araucaria heterophylla* (Salisb.) Franco	Norfolk Island pine	*Iris* sp.	Iris
Asparagus densiflorus (Kunth) Jessop 'Sprengeri'	Sprengeri fern	*Ixora* sp.	Ixora
Begonia rex Putz.	Rex begonia	*Ligustrum lucidum* Ait.	Privet
**Brassaia actinophylla* Endl.	Schefflera	*Maranta leuconeura* var. *erythroneura* Bunt.	Redveined prayer-plant
Calathea lancifolia Boom	Calathea	*Monstera deliciosa* Liebm.	Split-leaf philodendron
**Chamaedorea elegans* Mart.	Parlor Palm		
Chrysalidocarpus lutescens H. Wendl.	Areca palm	*Nephrolepis exaltata* (L.) Schott	Swordfern
Cissus rhombifolia Vahl	Grape ivy	**Peperomia obtusifolia* (L.) A. Dietr.	Baby rubber-plant
Cordyline terminalis (L.) Kunth	Ti plant	*Philodendron scandens* subsp. *oxycardium* (Schott) Bunt.	Heart-leaf philodendron
Cordyline terminalis L.) Kunth 'Tricolor'	Tricolor Madagascar dragon-tree	*Philodendron selloum* K. Koch.	Selloum
Crassula argentea Thunb.	Jade plant	*Pilea cadierei* Gagnep. & Guill.	Aluminum plant
Dieffenbachia X 'Exotica'	Exotic dumbcane	*Pittosporum tobira* (Thunb.) Ait.	Japanese pittosporum
Dieffenbachia maculata (Lodd.) G. Don	Dumbcane	*Podocarpus macrophyllus* (Thunb.) D. Don	Japanese yew
Dracaena fragrans (L.) Ker-Gawl. 'Massangeana'	Cornplant	*Polyscias balfouriana* (Hort. ex Sander) L. H. Bailey 'Marginata'	Variegated Balfour aralia
Dracaena marginata Lam.	Madagascar dragon-tree	*Pteris ensiformis* Burm. f. 'Victoriae'	Silver-leaf fern
**Dracaena sanderiana* Hort. ex Sander ex. M.T. Mast.	Belgian evergreen	**Rhododendron indicum* (L.) Sweet	Azalea

TABLE 1. CONTINUED

Scientific name	Common name	Scientific name	Common name
Duranta repens L.	Golden-dewdrop	**Rosa* sp.	Rose
Epipremnum aureum (Linden & André) Bunt.	Pothos	*Rumohra adiantiformis* (G. Forst) Ching	Leatherleaf fern
Episcia cupreata (Hook.) Hanst.	Flame violet	*Saintpaulia ionantha* H. Wendl.	African violet
**Ficus benjamina* L.	Weeping-fig	*Sansevieria trifasciata* Prain 'Hahnii'	Birds-nest sansevieria
Ficus elastica Roxb. ex Hornem. 'Decora'	Broad-leaved Indian rubber-plant	**Schlumbergera bridgesii* (Lem.) Löfgr.	Christmas cactus
Fittonia verschaffeltii (Lem.) Coëm.	Nerve plant	*Spathiphyllum* X 'Mauna Loa'	Mauna Loa peace lily
Gardenia sp.	Gardenia	*Stromanthe amabilis* (Linden) E. Moor.	Stromanthe
Gynura procumbens (Lour.) Merrill	Purple-passion vine	*Syngonium podophyllum* Schott	Nepthytis
Hedera helix L.	English ivy	*Viburnum odoratissimum* Ker-Gawl.	Viburnum
		Yucca elephantipes Regel	Spineless yucca

*From 0.1 to 0.5% recovery of *Diaprepes* larvae for these species; for all other plants no larvae were recovered.

Of the native species challenged with neonate larvae, only common persimmon had root-feeding damage. The 2 species of oak that were tested are the most common tree species other than citrus found in the central Florida weevil area; they had no sign of root feeding.

Citrus rootstock is the primary host tree for *D. abbreviatus* larvae in central Florida. When grown near citrus, persimmon would probably contribute to the weevil population. None of the other tree species examined had larval-feeding damage and, therefore, would not contribute to a weevil infestation.

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PSEUDOSCORPIONS FROM FLORIDA AND THE CARIBBEAN AREA. 8. A NEW SPECIES OF *BITUBEROCHERNES* FROM THE VIRGIN ISLANDS (CHERNETIDAE)[1]

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ABSTRACT

A new species, *Bituberochernes jonensis*, from St. John, U.S. Virgin Islands, is described. It has a protuberance only on the palpal chela, and none on the tibia. The generic diagnosis is revised to reflect this and other differences.

Among the pseudoscorpions which I collected in 1974 and 1975 on St. John, U.S. Virgin Islands, were some chernetids which appeared similar to the genus *Bituberochernes* Muchmore (1974) but differed in that the male had a protuberance only on the palpal chela and none on the tibia. Both sexes were taken, but as *B. mumae*, the type species of *Bituberochernes*, was known from the male only, it was impossible to make complete and accurate comparisons. More recently, Dumitresco and Orghidan (1977) reported *B. mumae* from Cuba and described the female in detail; and I also studied some females from Cuba and the Cayman Islands. It is now obvious that the 2 species are very similar in most respects and can be considered congeneric.

Genus *Bituberochernes* Muchmore

The original generic diagnosis of *Bituberochernes* Muchmore (1974: 77) required some revision as a result of the description of the female of *B. mumae* Dumitresco and Orghidan (1977) and the description of *B. jonensis* n. sp. below. The following changes and additions must be made:

—carapace may have 1 or 2 transverse furrows.

—11th sternite may be entire or divided.

—11th tergite may have 2 or 4 distinct tactile setae.

—genitalia generally as shown by Dumitresco and Orghidan (1977, Figs. 11 and 12).

—palpal tibia of male with or without a distinct rounded, setiferous protuberance on medial side.

—palpal chela of male with a small, bare, conical protuberance on medial side at base of finger.

—palp of female unspecialized, but with tibia nearly equal to femur in length.

—number of "sense spots" on chelal hand varying from 50 to ca. 100.

—nodus ramosus of venom duct in movable finger of chela at or proximal to level of trichobothrium *t*.

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—trichobothrium *ist* at level of or proximal to *est*.

—leg I of male may have some specially long setae on tibia and tarsus in addition to the short, specialized sensory setae.

—leg I of female unspecialized.

Bituberochernes jonensis Muchmore, NEW SPECIES

Figs. 1-4

MATERIAL: Holotype male (WM 3706.03001) and many paratypes of both sexes and all 3 nymphal stages collected from under bark of fallen trees along the Reef Bay Trail, Virgin Islands National Park, St. John, U.S. Virgin Islands, 11-VI-1974 (W. B. Muchmore); many others found at same location on 20-VII-1975. The types are in the Florida State Collection of Arthropods, Gainesville.

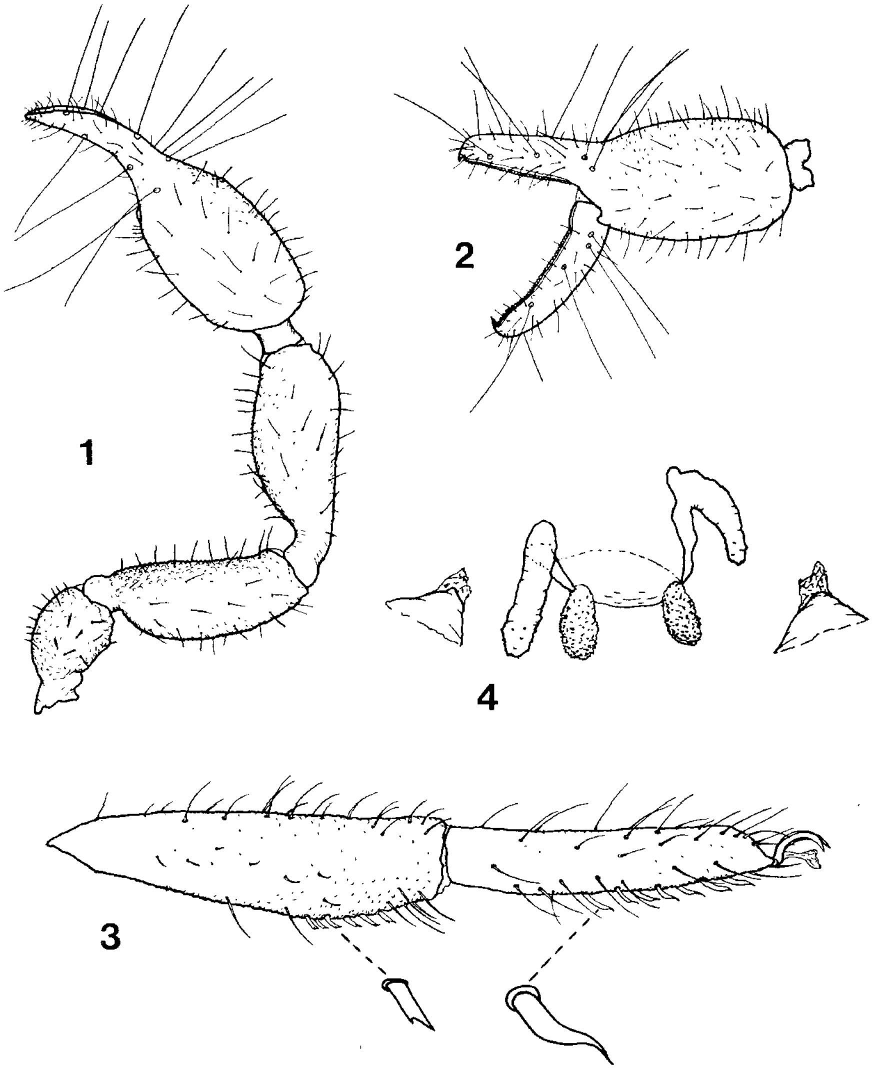
DIAGNOSIS: Generally similar to *B. mumae*, but male with a protuberance only on the chelal hand, none on the palpal tibia.

Description of Male: With the revised generic characters as outlined above, and with the following particular features. Carapace longer than broad; with a shallow median furrow only; surface granulate; 2 distinct eyespots present; 65-70 short, dentate vestural setae, with 4 at anterior and 8 at posterior margin. Tergites 1 and 11 entire, 2 partly divided, 3-10 divided; sternites 4-11 divided. Tergal chaetotaxy of holotype 10:9:9:10:12:13:13:14:12:11:T11T:2; sternal chaetotaxy 59:(2)4-5/9(2):(1)7(1):12:15:18:17:15:15:T3T5T3T:2; setae generally as in *B. mumae*, but anterior genital operculum with 10 long, heavy setae centrally, flanked by 49 smaller ones, and 11th tergite with only 2 clearly tactile setae (T), laterally situated.

Chelicera 1/3 as long as carapace; hand with 5 setae, *sb* and *b* terminally denticulate, *es* long, acuminate; flagellum of 3 setae, the distal one dentate; galea slender, with 3-4 very small subterminal rami; serrula exterior with 23 blades.

Palp relatively slender; tibia longer than femur (Fig. 1). Trochanter 1.75-1.8, femur 2.75-2.9, tibia 2.65-2.7, and chela (without pedicel) 2.9 times as long as broad; hand (without pedicel) 1.5-1.6 times as long as deep; movable finger 0.85-0.87 as long as hand. All surfaces heavily granulate, except chelal fingers, which are smooth. Tibia normal, that is, without any medial protuberance. Chelal hand with a small, conical, bare protuberance on medial side at base of finger; without any special setae flanking the protuberance; with a field of about 100 conspicuous "sense spots" on the medial surface behind the protuberance. Each chelal finger with 50-55 marginal teeth, the distal 6-8 larger and sharper than the others and borne on a projecting, curved ridge; each finger with 10-12 external accessory teeth; only fixed finger with an internal accessory tooth. Only movable finger with well developed venedens and venom duct; nodus ramosus distinctly proximal to trichobothrium *t*. Trichobothria positioned as shown in Fig. 2, much as in *B. mumae*, but *ist* proximal to *est* rather than at same level.

Legs moderately slender; leg IV with entire femur 2.7-2.8 and tibia 3.9-4.0 times as long as deep. Leg I with tibia bearing 5-6 short, truncate, sensory (?) setae along ventral side toward distal end, and tarsus with 12-15 short, heavy, acuminate setae similarly placed toward the distal end (see



Figs. 1-4. *Bituberochernes jonensis* Muchmore, new species. 1) Dorsal view of palp; 2) Lateral view of chela; 3) Tibia and tarsus of Leg I, showing sensory setae; 4) Female, spermathecae and related structures.

Fig. 3). Leg IV: tarsus with very long tactile seta 1/3 length of segment from proximal end.

Description of Female: Much like male in most respects, but with the following particular measurements or features. Slightly larger overall. A few more setae on abdominal segments; anterior genital operculum with about 35 setae arranged in a broad triangular field (as shown in Dumitresco and Orghidan, Fig. 12A); posterior operculum with a row of about 10 setae. Internal genitalia as illustrated in Fig. 4; this is similar to the situation in *B. mumae* (as shown by Dumitresco and Orghidan in their Fig. 12B) and is also basically similar to the situation in *Pachychernes shelfordi* (cf. Muchmore, 1975, Fig. 9). Cheliceral galea slightly longer and with longer rami than in male. Palp much like that of male, but without a protuberance or "sense spots" on the chelal hand, and tibia about equal in length to femur. Leg I not modified, that is, without sensory setae on tibia and tarsus.

MEASUREMENTS (mm): Figures for males given first, followed in parentheses by those for females. Body length 3.12-3.25 (3.20-4.30). Carapace length 1.00-1.02 (1.04-1.16). Chelicera 0.325-0.34 (0.33-0.37) long. Palpal femur 0.89-0.95 (0.88-0.98) by 0.325 (0.32-0.36); tibia 0.96-1.00 (0.89-0.99) by 0.36-0.38 (0.37-0.42); chela (without pedicel) 1.35-1.42 (1.45-1.64) by 0.46-0.49 (0.495-0.55); hand (without pedicel) 0.75-0.79 (0.83-0.95 by 0.49-0.51 (0.47-0.51); pedicel ca. 0.09 long. Leg IV: entire femur 0.82-0.835 (0.84-0.96) by 0.30-0.31 (0.31-0.355); tibia 0.64-0.67 (0.67-0.73) by 0.16-0.17 (0.17-0.19).

ETYMOLOGY: The species is named for St. John (Jon), where it is found.

REMARKS: In spite of the fact that the new species lacks a protuberance on the palpal tibia, it certainly is closely related to *Bituberochernes mumae.* All other characters of the male and the genitalia of the female are so similar that the 2 species can be considered congeneric, as above. It would be possible to recognize 2 genera, based upon the presence or absence of the prominent tibial protuberance, but I feel that such splitting is unwarranted in the face of the large number of similarities.

In all of the male specimens of *Bituberochernes* I have examined (from Florida, Cuba, Little Cayman Island, and St. John), the characteristic protuberance on the chelal hand is bare, contrary to the assertion of Dumitresco and Orghidan that it is provided with setae like that on the tibia of *B. mumae* (1977: 109). In fact, there are setae inserted around the base of the elevation, but not *on* it.

The "sense spots" on the chelal hand are undoubtedly some sort of sensory organs. It is not clear that they are the same as the "poroides" recognized by Athias in gamasid mites (see Dumitresco and Orghidan 1977: 109). The exact nature of these and other such organs must await more detailed study using electron microscopy.

Along with *B. jonensis* under the loose bark were a few specimens of *Aphelolpium* sp. and *Olpiolum* sp. and a single specimen of *Peripatus* sp.

ACKNOWLEDGMENTS

I would like to express appreciation to Mr. William Webb, Superintendent of the Virgin Islands National Park, for permission to collect pseudoscorpions within the boundary of the Park. Many thanks are also due to C. H. Alteri, who prepared the illustrations.

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PSEUDOSCORPIONS FROM FLORIDA AND THE CARRIBBEAN AREA. 9. *TYPHLORONCUS*, A NEW GENUS FROM THE VIRGIN ISLANDS (IDEORONCIDAE)[1]

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ABSTRACT

The genus *Typhloroncus* is defined with *T. coralensis* Muchmore, new species, from St. John, U.S. Virgin Islands, as the type species. This is the first ideoroncid pseudoscorpion reported from the West Indies.

Among pseudoscorpions which I collected recently on St. John, U. S. Virgin Islands, was a single specimen of a new genus and species belonging to the Ideoroncidae. As this family has not heretofore been reported from the West Indies, it seems appropriate to describe the new taxa at this time.

Typhloroncus Muchmore, NEW GENUS

TYPE SPECIES: *Typhloroncus coralensis* Muchmore, NEW SPECIES.

DIAGNOSIS: The genus is defined by the characters of the type species (female only) as described below. It is typical of the family Ideoroncidae except that it has no eyes. Tergites and sternites entire, middle ones bearing 8 or 9 setae. Both fingers of chelicera bear marginal teeth; flagellum of 4 dentate setae; galea a long, slender stylet. Venom apparatus well developed in both fingers of palpal chela; chela bearing many more than 12 trichobothria, with 5 on dorsum of hand, the 3 more proximal ones close together at the base of a slight elevation and describing an obtuse triangle (Fig. 2), and with 3 on lateral side of hand in a vertical row (Fig. 3). Pedal tarsi with subterminal setae dentate near tip; arolia undivided and shorter than claws.

In being eyeless, *Typhloroncus* differs from all other genera in the Ideoroncidae, which typically have 2 well developed eyes with bulging corneas. This character is considered very important, because the eyes are retained (though reduced) even in otherwise distinctly modified cavernicolous ideoroncids such as *Negroroncus aelleni* Vachon (1958) and *Albiorix bolivari* Beier (1963). Aside from the lack of eyes, the new genus appears most similar to *Negroroncus* Beier (1932) from Africa and *Dinoroncus* Beier (1932) from Chile, especially in the close grouping of 3 trichobothria on the dorsum of the chelal hand; however, in neither of these genera are the trichobothria accompanied by an elevation of the surface of the hand as in *Typhloroncus*. Geographically the nearest reported representatives of the family are species of *Albiorix* in Mexico and Central America (Hoff 1945); from these *Typhloroncus* differs particularly in having the arolia on pedal

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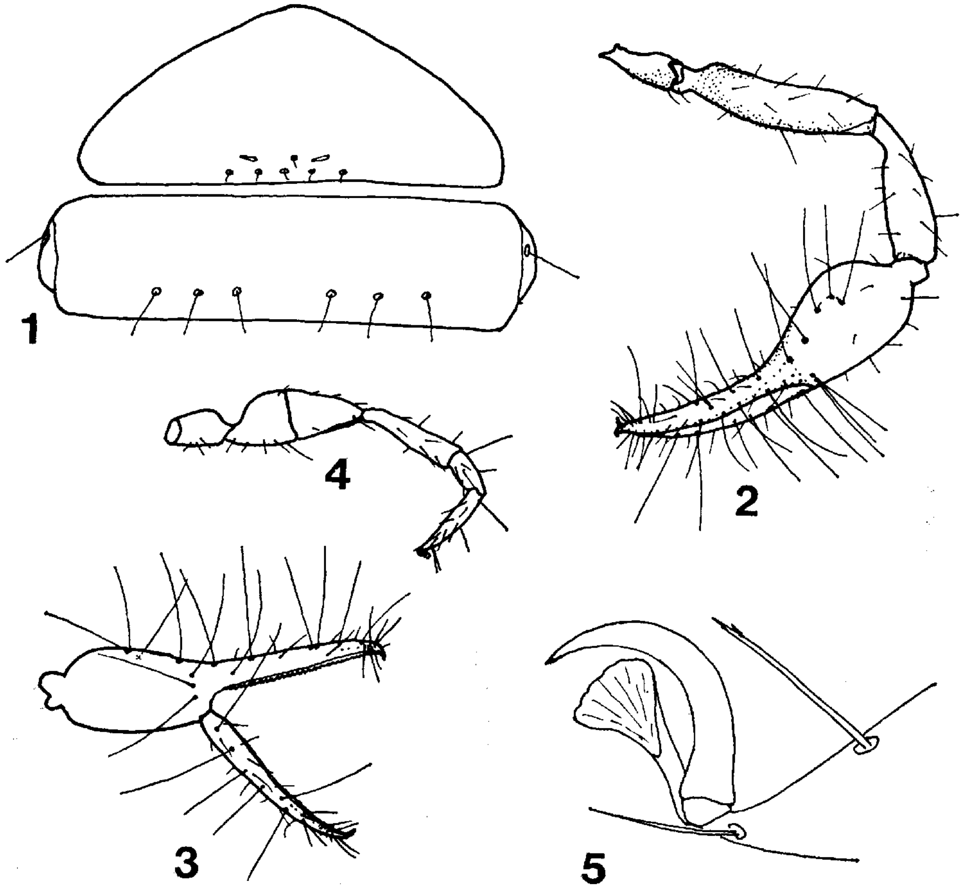
tarsi shorter than the claws rather than longer, and entire rather than bifid (Hoff 1956).

Typhloroncus coralensis Muchmore, NEW SPECIES

MATERIAL: Holotype female (WM 4982.03001), found under a rock on a wooded hillside above Coral Bay, St. John, U. S. Virgin Islands, 12-III-1978, by the author. The type is deposited in the Florida State Collection of Arthropods, Gainesville.

DESCRIPTION: A small species, generally light tan in color. Carapace longer than broad; anterior margin with a small triangular epistome; no eyes present; surface finely reticulated, especially at sides; a distinct transverse furrow near the posterior margin; with about 16 fine setae, 4 at both anterior and posterior margins. Coxal area typical. Abdomen elongate; tergites and sternites entire, weakly sclerotized, smooth; pleural membranes smoothly, longitudinally striate. Tergal chaetotaxy 4:4:6:8:8:8:9:9:8:13: T1TT1TT2T:2; sternal chaetotaxy 6:(1)6(1):(1)7(1):9:8:9:8:11:14:T1T3 T1T:2; genital opercula as in Fig. 1.



Figs. 1-5. *Typhloroncus coralensis* Muchmore, new genus and new species. 1) Genital opercula of female; 2) Left palp, dorsal view; 3) Right chela, lateral view; 4) Leg IV, lateral view; 5) Tip of telotarsus showing arolium, and claw and subterminal seta on 1 side.

Chelicera a little more than half as long as carapace; hand with 6 setae, *es* very long, straight; flagellum of 4 subequal setae, all dentate along 1 edge; fixed finger with 8-10 and movable finger with 5-6 irregular teeth; galea long, slender, gently curved.

Palp fairly slender (Fig. 2); femur 1.2 and chela 1.95 times as long as carapace. Trochanter 2.3, femur 4.35, tibia 3.2 and chela (without pedicel) 3.5 times as long as broad; hand 1.75 times as long as deep; movable finger 1.32 times as long as hand. Surfaces are smooth except for small granulations over trochanter, on the proximal and medial parts of femur, medial side of tibia, and medial side of chelal hand and bases of fingers. Trichobothria of chela as shown in Fig 2 and 3; as there are many of varied sizes, it is difficult to distinguish between some trichobothria and some vestural setae and to make an exact count of the former; however, there are 5 prominent trichobothria on the dorsum of the hand and 3 on the lateral side of the hand; the 3 proximal ones on the dorsum are somewhat isolated, and describe an obtuse triangle around the base of a low, but distinct, elevation of the surface; movable finger with 46 low, flat, contiguous teeth, becoming obsolescent proximally; fixed finger with 54 contiguous teeth, low and rounded distally, but with distinct cusps proximally; both fingers with well developed venom apparatus, the nodus ramosus in each finger ca. 1/3 of the distance from the distal end.

Legs rather robust; leg IV with entire femur 2.6 and tibia 4.6 times as long as deep (Fig. 4); metatarsus and telotarsus each with a prominent tactile seta; subterminal tarsal setae dentate near tip; arolia not divided, shorter than claws (Fig. 5).

MEASUREMENTS (mm): Body length 2.37. Carapace length 0.59. Chelicera 0.33 by 0.16. Palpal trochanter 0.32 by 0.14; femur 0.695 by 0.16; tibia 0.56 by 0.175; chela (without pedicel) 1.14 by 0.325; hand (without pedicel) 0.49 by 0.28; pedicel 0.075 long; movable finger 0.65 long. Leg IV: entire femur 0.495 by 0.19; tibia 0.37 by 0.08; metatarsus 0.185 by 0.065; telotarsus 0.29 by 0.06.

ETYMOLOGY: The species is named for Coral Bay on St. John where it was found.

REMARKS: This is the 1st representative of the Ideoroncidae to be reported from the West Indies if *Bochica* Chamberlin is excluded from the family, as I believe correct. However, it might be expected that others will be found, because several species of *Albiorix* occur in Mexico and Central America, and an unidentified ideoroncid from Cuba is at hand.

Under similar rocks on the same hillside were found specimens of as yet unidentified species of *Olpiolum* and *Planctolpium* (Olpiidae).

ACKNOWLEDGMENT

Many thanks are due to C. H. Alteri who prepared the figures.

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ARID-GRASSLAND SOLPUGID POPULATION VARIATIONS IN SOUTHWESTERN NEW MEXICO[1,2]

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ABSTRACT

This paper extends and corrects the arid-grassland solpugid population data for southwestern New Mexico. Can-trapping has been continuous, April through November, from 1972 through 1977. Data analysis indicates that solpugid populations vary in gross levels from year to year and seasonally within years. Such fluctuations may be the result of variations in the populations of 4 arid-grassland species of *Eremobates* which undoubtedly are influenced by abiotic factors such as temperature, rainfall, and humidity, and biotic factors such as seasonal adult activity, fall immature activity, and food supply.

Several studies have demonstrated solpugid population variations in North America. Muma (1963) tabulated seasonal variations of the abundance of specimens and species of adult solpugids at Mercury, Nevada, from 1960 through 1962 as estimated by pit traps (large, dry cans). He also cited apparent habitat associations of 8 common species. Allred and Muma (1971) tabulated seasonal and habitational variations on the abundance of specimens and species of immature and adult solpugids at the National Reactor Testing Station in Idaho for 15 months in 1966 and 1967 as estimated by pit traps. Brookhart (1972) cited abundance of adult specimens and species of solpugids in Colorado as estimated by pit traps and miscellaneous collecting. Muma (1974a) discussed seasonal and habitational variations of adult solpugids that affected reproductive isolation of common North American species, all estimated by pit traps, can traps (large cans containing a killing-preserving medium), and miscellaneous collecting. Muma (1974b, 1975a) tabulated and discussed seasonal, annual, and habitational variations of specimens and species of immature and adult solpugids in southern New Mexico during 1972 and 1973 as estimated by can traps.

Although not specifically stated, all of the above studies were conducted on the premise that solpugids actively running over the surface of the

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ABSTRACT

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Although not specifically stated, all of the above studies were conducted on the premise that solpugids actively running over the surface of the

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ground or hiding under ground-surface debris, either artificial or natural, were representative of the entire population, active or inactive, subterranean or ground-surface, and ground-surface or arboreal. This is also true of the present paper. No one has attempted, as yet, to estimate or compare the total populations of solpugid species in a given area.

This paper is an extension and correction of the arid-grassland solpugid population data published by Muma (1974b). Can-trapping of grassland solpugids now has been continuous, April through November from 1972 through 1977. Accumulated data permit analyses, discussions, and speculations that previously were unwarranted.

METHODS

Two arid-grassland study areas, 1 near Lordsburg, NM and 1 near Hurley, NM, were utilized in this study. The topography and plant associations of the 2 plots were adequately described by Muma (1974b).

Can traps provided with a killing-preserving medium of a 1:1 mixture of 70% isopropyl alcohol and commercial ethylene glycol were utilized as collecting devices. These are the traps statistically evaluated by Muma (1975b).

On 1 April 1972, 10 traps were set in each study area; 5 in a north-south transect at ca. 10 m intervals and 5 in an east-west transect at similar intervals. Since Muma (1975b) demonstrated that 10 traps per plot were inadequate for evaluating solpugid populations, 2 traps were added to each of the north-south transects on 1-IV-1974.

Traps were visited every 2 weeks, 1-IV to 1-XII, from 1-IV-1972 to 1-XII-1977. At each visit, the specimens were screened from the killing-preserving medium, the medium reconstituted with a 3:1 mixture of alcohol-glycol, and the trap collections pooled into a plot per period (e.g. Lordsburg 1-15-IV-1972) sample. Solpugid specimens were sorted, identified, and counted in the laboratory at 10X magnification.

Early instar immatures, those with 3 pairs of malleoli, were identified only to family. Middle and late instar immatures were identified only to genus, but if the genus proved to be represented in the area by only 1 species, they were relegated later to that species. Only adults or easily recognized and sexed penultimate instars were identified to species.

RESULTS

Table 1 presents the accumulated data summarized on plot, annual, and total bases. Figure 1 presents the same data summarized on a seasonal basis, for each year compared, to means for the 6 year period. Table 2 cites the seasonal distribution of recorded adult solpugids.

DISCUSSION

Prior to discussion of the population data presented here, identification errors committed by Muma (1974b) should be corrected. The species referred to in that paper as *Eremobates* new species (*palpisetulosus*-group) is in reality 2 species, *E.* n. sp. #1 and *E.* n. sp. #2. The species referred to as *Eremobates pallipes* (Say) is a newly recognized New Mexican species *E.* n. sp. #3. Taxonomic papers involving these species are presently being prepared for publication.

TABLE 1. ANNUAL VARIATIONS IN NUMBER AND SPECIES OF ARID-GRASSLAND SOLPUGIDS COLLECTED IN CAN TRAPS IN SOUTHWESTERN NEW MEXICO 1972 THROUGH 1977.

Study areas and years	Eremobatidae (instars with 3 pr malleoli)	*Eremorhax* n. sp. #1	*Eremobates* sp. (instars with 5 pr malleoli)	*Eremobates* n. sp. #1	*Eremobates* n. sp. #2	*Eremobates hessei* (Roewer)	*Eremobates* n. sp. #3	*Eremochelis bilobatus* (Muma)	*Ammotrechula peninsulana* (Banks)	Total for plots and years
Hurley										
1972	2	—	74	—	5	17	13	1	—	112
1973	2	—	29	—	2	—	2	1	—	36
1974	—	2	61	1	5	5	10	—	—	84
1975	—	1	9	—	2	—	5	—	—	17
1976	1	—	20	1	1	3	6	—	—	32
1977	—	—	14	2	4	3	5	2	—	30
Totals	5	3	207	4	19	28	41	4	—	311
$\overline{X}$	0.83	0.5	34.5	0.67	3.17	4.67	6.83	0.67	—	
±30% $\overline{X}$	0.25	0.15	10.35	0.20	0.95	1.40	2.05	0.20	—	

TABLE 1. CONTINUED

Study areas and years	Eremobatidae (instars with 3 pr malleoli)	*Eremorhax* n. sp. #1	*Eremobates* sp. (instars with 5 pr malleoli)	*Eremobates* n. sp. #1	*Eremobates* n. sp. #2	*Eremobates hessei* (Roewer)	*Eremobates* n. sp. #3	*Eremochelis bilobatus* (Muma)	*Ammotrechula peninsulana* (Banks)	Total for plots and years
Lordsburg										
1972	5	7	40	3	7	9	6	—		77
1973	8	2	32	—	—	12	2	—	—	56
1974	10	3	32	12	17	8	8	—	2	92
1975	10	4	35	14	24	16	9	1	—	113
1976	14	—	59	18	27	7	2	—	—	127
1977	1	3	33	1	12	13	10	—	—	73
Totals	48	19	231	48	87	65	37	1	2	537
$\overline{X}$	8.0	3.17	38.5	8.0	14.5	10.83	6.17	0.17	0.33	
±30% $\overline{X}$	2.4	0.95	11.55	4.35	4.35	3.25	1.85	0.85	0.10	

TABLE 1. CONTINUED

Study areas and years	Eremobatidae (instars with 3 pr malleoli)	*Eremorhax* n. sp. #1	*Eremobates* sp. (instars with 5 pr malleoli)	*Eremobates* n. sp. #1	*Eremobates* n. sp. #2	*Eremobates hessei* (Roewer)	*Eremobates* n. sp. #3	*Eremochelis bilobatus* (Muma)	*Ammotrechula peninsulana* (Banks)	Total for plots and years
Totals										
1972	7	7	114	3	12	26	19	1	—	189
1973	10	2	61	—	2	12	4	1	—	92
1974	10	5	93	13	22	13	18	—	2	176
1975	10	5	44	14	26	16	14	1	—	130
1976	15	—	79	19	28	10	8	—	—	159
1977	1	3	47	3	16	16	15	2	—	103
Grand Totals	53	22	438	52	106	93	78	5	2	849
% Total pop.	6.24	2.59	51.59	6.12	12.48	10.95	9.19	0.59	1.24	
$\overline{X}$	8.83	3.67	73.0	8.67	17.7	15.5	13.0	0.83	0.33	
±30% $\overline{X}$	2.65	1.10	21.9	2.60	5.3	4.65	3.90	0.25	0.10	

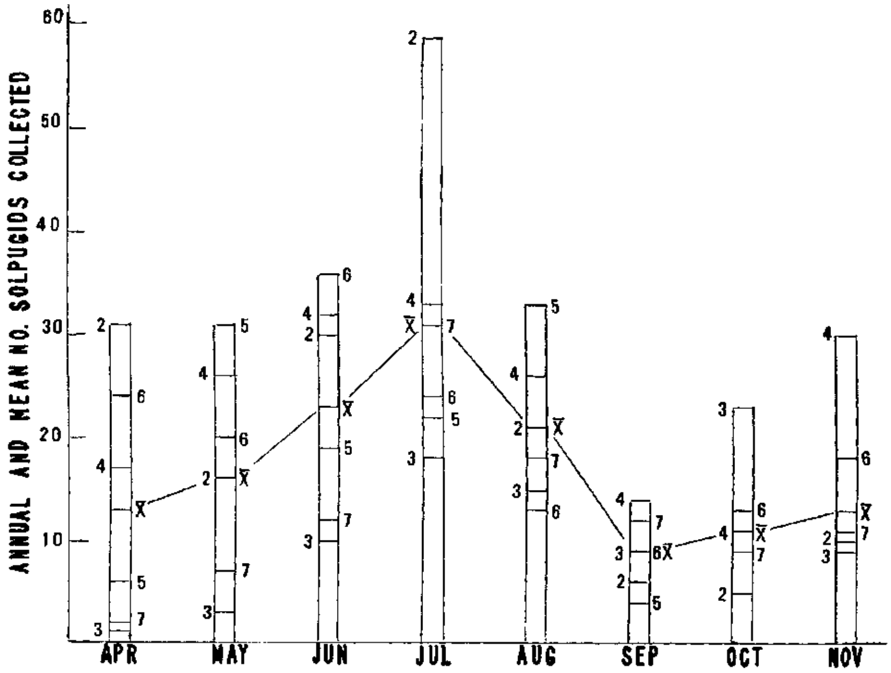

Fig. 1. Seasonal variations in annual and mean solpugid populations on arid-grasslands near Hurley and Lordsburg, NM from 1-IV-1972 through 1-XII-1977. Numbers 2-7 represent the last digit in the years 1972-1977; lack of particular numbers for monthly data indicate no collections were made in that year.

The most obvious population phenomenon exhibited by the data shown in Table 1 is an apparent alternate year fluctuation in the level of the local, gross, solpugid population. This variation is related directly to a similar variation, on both the Hurley and Lordsburg plots, in the number of trapped young and adult *Eremobates* which represented more than 40% of the total trapped population from both plots. Alternate year fluctuation in population levels of other immatures and specific adults did not occur consistently on either of the 2 plots. Muma (1974b) noted the drastic, gross, population decreases between 1972 and 1973 on the Hurley study area and speculated that heavy rains in late 1972 and early 1973 were indicated as the causal factor. Such rains did not occur in 1974-75 or 1976-77, so an additional complicating factor must be involved. This factor presently remains an enigma, but may be associated with or responsible for a gradual shift from a predominance of termites reducing ground-surface litter at Hurley to a predominance of ants in and under such litter during 1974 and 1975. At the Lordsburg study area termites have remained the predominant invertebrate involved in the reduction of ground-surface litter, and the gross solpugid populations on that plot have not drastically decreased or increased during the past 4 years.

Another obvious population variation is exhibited among the 4 species of *Eremobates* found in the local arid-grasslands. At the Hurley study area, *E.* hessei (Roewer) and *E.* n. sp. #3 were the most common species in 1972,

TABLE 2. SEASONAL DISTRIBUTION OF RECORDED, ADULT, ARID-GRASSLAND SOLPUGIDS IN SOUTHWESTERN NEW MEXICO FROM 1 APRIL 1972 THROUGH 1 DECEMBER 1977.

Solpugid species	April		May		June		July		August		September		October		Ratio of sexes collected
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂ : ♀
Eremorhax n. sp. #1	—	—	3	1	—	3	—	1	—	—	—	—	0	0	3-5
Eremobates n. sp. #1	17	13	14	12	—	1	—	—	—	—	—	—	0	0	31-26
Eremobates n. sp. #2	5	—	18	17	16	27	16	7	—	3	—	—	0	0	55-54
Eremobates hessei (Roewer)	—	—	—	1	1	6	31	33	8	20	—	—	0	0	40-60
Eremobates n. sp. #3	—	—	—	—	—	1	14	8	38	16	1	8	0	0	53-33
Eremochelis bilobatus (Muma)	—	—	—	—	—	—	1	1	—	1	—	1	0	0	1-3
Ammotrechula peninsulana (Banks)	—	—	—	—	—	—	—	—	—	—	—	1	0	0	0-1

E. n. sp. #3 and *E.* n. sp. #2 were the only species collected in 1973, and *E.* n. sp. #3 was the only common species in 1974. No species was significantly more common from 1975 through 1977. At the Lordsburg study area, *E.* n. sp. #2, *E. hessei,* and *E.* n. sp. #3 were equally common in 1972; only *E. hessei* was common in 1973; *E.* n. sp. #1 and *E.* n. sp. #2 were common in 1974; *E.* n. sp #3 was distinctly more common in 1975 and 1976; and *E. hessei, E.* n. sp. #2 and *E.* n. sp. #3 were equally common in 1977. The above statements are based on the statistical findings of Muma (1975b). On the basis that the mean populations can be considered different only if they differ by greater than 30% of their own values, the total sampled populations were not significantly different from each other. Despite obvious differences then, it appears that although 1 or more species of *Eremobates* may be more abundant than others on any given plot during any given year, they also may be equally abundant, and over a series of years probably are complementary in abundance.

Another apparent variation should be noted and discussed. That concerns *E.* n. sp. #1 and *E.* n. sp. #2. Although they are closely related, *E.* n. sp. #1 is a smaller, paler, more slender, distinctive species that lives in the foothills and pinyon-juniper plant association; it matures in April and May with females living into June. *Eremobates* n. sp. #2 is a larger, darker, more robust species that lives on the bajadas and open plains in grassland communities and matures in May, June, and July, with females living into August. This accounts for the fact that 48 of 52 specimens of sp. #1 taken in the study were from the Lordsburg study area, which is adjacent to the Burro Mountains, whereas only sp. #2 was collected regularly from the Hurley plot, which is considerably farther from the Cook Mountains.

The preponderant abundance of *Eremobates* spp. over the other genera and species of solpugids confirms Muma's (1974b) conclusion that members of this genus in this area are predominantly arid-grassland species.

Seasonal variations within years, although unquestionably moderated by abiotic factors such as temperature, rainfall, humidity, etc., appear to be largely an expression of differences and similarities in the annual life cycles of the common species of solpugids in the area. In most years, population peaks are attained in late May or early June, in July and August, and in late October or November. The May-June increase is the result of the maturation and sexual activity of *E.* n. sp. #1 and *E.* n. sp. #2. The July and August peak coincides with the maturation and sexual activity of *E.* n. sp. #2, *E. hessei,* and *E.* n. sp. #3, (Muma 1974a, 1974b). The October-November increase is the result of unexplainable ground-surface activity of *Eremobates* young. A population depression consistently occurred in late September or early October. The September-October depression is obviously the result of the death of adult *E.* n. sp. #2, *hessei,* and n. sp. #3, and the egg incubation and subsurface development of the early instars of these species (see Muma 1966). In 1972, samples were collected at 2-week intervals during the entire year, but only 6 immatures were taken, 5 in December and 1 in March, indicating that there are no periods of extensive activity through the winter.

Seasonal variations between years may be caused by year to year variations in rainfall, humidity, and temperature which may act directly or indirectly upon solpugid populations. Direct influence of rainfall seems to have been the case in 1973 when heavy rains in the late fall of 1972 and in the spring of 1973 appear to have depressed populations of most species, especially on the Hurley study area where extensive flooding occurred (Muma 1974b). It should be pointed out that fall immature activity was as great or greater that year than in any other year except 1974. Indirect influence of abiotic factors is much more difficult to ascertain. Since immatures of the genus *Eremobates* feed predominately upon termites, the sharp reduction of solpugid populations on the Hurley plot during 1975 may have been due to a decrease in food supply. However, termite food, dead plant materials, has not decreased noticeably on the study area. So it is possible that the 1975 shift from a predominance of termites to a predominance of ants was caused by an increase in soil moisture brought about by the flooding of 1972 and 1973. The sudden increase in the populations of *E.* n. sp. #1 and *E.* n. sp. #2 on the Lordsburg study area during 1974 and 1975 and, equally as sudden, decrease in 1977 may have been either the result of an indirect influence of an abiotic factor or possibly some inherent biotic factor common to these 2 species.

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A NEW SPECIES OF *PROTEINUS* LATREILLE (COLEOPTERA:STAPHYLINIDAE) FROM FLORIDA[1]

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ABSTRACT

A new species, *Proteinus thomasi*, from Ocala, FL, is described on the basis of the structures of a series of adult individuals. The structures (including the aedeagus) and color of these individuals are used to distinguish them from individuals of other New World species of *Proteinus*. Illustrations of adult habitus and of the aedeagus are provided.

Proteinus parvulus LeConte is redescribed and removed from synonymy with *P. atomarius* Erichson. *Proteinus collaris* Hatch is redescribed.

No key for the identification, nor comparative study of adults of all New World species of *Proteinus* has been published. Keys were prepared for some geographical areas by Fauvel (1878) and Hatch (1957). No species of *Proteinus* are catalogued by Moore and Legner (1975) as occurring in the southeastern United States. Catalogued ranges nearest to Florida appear to be Massachusetts and California (loc. cit), and Costa Rica (Blackwelder 1944). A revision of the subfamily Proteininae of the world, begun by Steel (1966), was completed for only 2 of the 3 tribes (Anepiini and Nesoneini) before his death (Anon. 1970, Southwood 1970), and the tribe Proteinini was not revised.

When Michael C. Thomas (Ocala, FL) asked me to identify some staphylinids he had collected in 1977 at Ocala, and some of these proved to belong to *Proteinus*, I was unable to comply.

HABITAT

According to Scheerpeltz & Höfler (1948), *Proteinus* almost exclusively inhabits strongly redolent or decaying fungi, and is seldom found in other decaying plant material; its food appears to be the fungi. Steel (1963) reported that adults of *Proteinus* are saprophagous, feeding readily on dead material of both animal and vegetable origin, while the food of the larvae has yet to be ascertained. Steel (1966) and Kasule (1966) reviewed published descriptions of *Proteinus* larvae.

GENERIC NOMENCLATURE

The generic name *Proteinus* Latreille, 1796, was originally published without any species included. A type species, *P. pulicarius* (Linnaeus), was fixed by Latreille (1802) by subsequent monotypy; however, *P. brachypterus* (Fabricius) was cited by Latreille (1810) as the "genotype", and this cita-

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tion was followed by subsequent authors. Blackwelder (1952) noted that, because *P. pulicarius* (Linnaeus) must be considered the type species under the International Rules of Zoological Nomenclature and because *P. pulicarius* (L.) belongs to the family Nitidulidae, then *Proteinus* Latreille, 1796, 1802, must also belong to the Nitidulidae. Thus, the staphylinid genus formerly known as *Proteinus* Latreille, 1810, was left without a name, and the new generic name *Pteronius* Blackwelder, 1952, with type species *Pteronius brachypterus* (Fabricius) was proposed to fill this need (Blackwelder 1952, Arnett 1961). Subsequently, following a request by Jelinek and Steel (1966), the generic name *Proteinus* Latreille, 1796, was placed on the "Official List of Generic Names in Zoology", and *Dermestes brachypterus* Fabricius, 1792, was designated type species, under Opinion 876 of the International Commission on Zoological Nomenclature. Thus *Pteronius* Blackwelder became a synonym of *Proteinus* Latreille, 1796.

COMPLEXITIES OF NOMENCLATURE AND DISTRIBUTION OF NEW WORLD SPECIES

Proteinus brachypterus (Fabricius), 1792: 235, a Palearctic species, was recorded as occurring in North America (British Columbia) by Hamilton (1894b: 376) and Keen (1895: 172); both authors indicated that this identification was made by James Fletcher of Ottawa or by a specialist enlisted by Fletcher. Fletcher, *in* Keen (1895: 166), acknowledged help from T. L. Casey, C. A. A. Fauvel, and G. H. Horn among others, but did not state who had identified what material. Fauvel (1872: 30) noted that *P. brachypterus* had been confused in collections (? whose) with *P. limbatus* Mäklin. Hatch (1957: 106) stated that he had not seen any examples of *P. brachypterus* from the Pacific Northwest. Leng (1920: 93) catalogued the species as occurring also in Alaska (? on what evidence), while no additional localities were listed by Moore and Legner (1975: 176).

Proteinus atomarius Erichson, 1840: 904, a Palearctic species, appears 1st to have been recorded as occurring in North America in the following way: (1) *P. parvulus* LeConte, 1863: 58, was described from the vicinity of Lake Superior; (2) *P. parvulus* and *P. atomarius* were placed together as synonyms of the Palearctic *P. clavicornis* Stephens by Fauvel (1872: 31) without discussion; (3) evidently realizing that the synonymy with *P. clavicornis* had been at fault as a result of misidentification of *P. clavicornis,* Fauvel (1878: 196) corrected the former synonymy and placed *P. parvulus* together with *P. clavicornis* Fauvel (not Stephens) as synonyms of *P. atomarius,* again without discussion. Hubbard and Schwarz (1878: 632) reported *P. basalis* Mäklin from Michigan, but Fauvel (1878: 195) attributed this record to *P. atomarius*. Additional records of the occurrence of *P. atomarius* in North America were provided by Hamilton (1889: 121) for Ontario and Massachusetts, and by Stace-Smith (Hatch 1957: 106) for British Columbia. No additional localities were catalogued by Moore and Legner (1975: 176). Mention of the occurrence of *P. atomarius* in Canada is made by Scheerpeltz and Höfler (1948: 150); however, this mention, without indication that a new collection record is involved and without attribution to earlier authors, appears to be only an indication that Scheerpeltz and Höfler were aware of some of the North American literature. Brimley (1938: 138) recorded it in North Carolina.

Proteinus limbatus Mäklin, 1852: 323, was described from Alaska with "varieties" "b" and "c" in addition to the typical form "a". The original, brief description suggested that the "varieties" are distinguishable from the typical form only by differences in adult coloration. Fauvel (1869: 494) named "variety b" as *Proteinus maeklini,* but later (1878: 195) placed it as a synonym of *P. limbatus,* indicating that he "preferred to maintain it as a race of *P. limbatus* . . . because he possessed only a single example". Yet later, Fauvel (1889: 128) had apparently changed his mind again, and listed *P. maeklini* as distinct from *P. limbatus;* the former was distributed in Alaska, California, and Nevada, and the latter in Alaska, British Columbia, and New Hampshire, but he did not indicate the origin of these records. Both Hamilton (1894a, b) and Keen (1895) kept up with these changes in status of "variety b", and Keen (1895: 172) reported the collection of specimens of both *P. limbatus* and *P. maeklini* in British Columbia. Later North American cataloguers (Leng 1920, Moore and Legner 1975) listed *P. maeklini* as merely a "variety" of *P. limbatus,* while Hatch (1957: 106) added Washington, Idaho, and Oregon to the distribution of *P. limbatus* without discriminating between the forma typica and "var. *maeklini*" and without discussion of the status of the name *P. maeklini* beyond its mention as a "variety". Meanwhile, *P. crenulatus* Pandellé (Palearctic) was placed as a synonym of *P. limbatus* by Fauvel (1872: 30) without discussion, thus suggesting a Holarctic distribution of *P. limbatus;* he further noted that *P. limbatus* was confused in collections with *P. brachypterus.* Although Bernhauer (1912: 678) and Horion (1963: 28) indicated *P. limbatus* and *P. crenulatus* to be distinct species, thus removing any suggestion of a Holarctic distribution of *P. limbatus,* some subsequent authors overlooked this and continued to state that *P. limbatus* has a Holarctic distribution. Another synonymy possibly causing confusion, is that of *P. oblongus* Petri (Palearctic), a synonym of *P. crenulatus,* but which has been variously confused in the literature as a synonym of both *P. limbatus* and *P. atomarius.*

Proteinus nigriceps Fauvel, 1868: 55, was described from Santiago (Chile), and no additional records appear to have been published. Steel (1966: 300) removed *P. nigriceps* from the genus *Proteinus* and made it the type species of the monotypic new genus *Alloproteinus,* placing it in the new tribe Nesoneini along with 5 other genera.

As presently defined, all other New World species described in the genus *Proteinus* remain in that genus and, because of the few references to them, present no confusion of nomenclatural or distributional records. They are listed in Table 1 according to the current published synonymies and distributional records. The list includes all New World *Proteinus* species heretofore known to me and has been checked by reference to several abstracting journals.

As presently defined, adults of *Proteinus* are separated from adults of *Metopsia* Wollaston and *Megarthrus* Stephens by the simple (vs. excised) hind angles of the pronotum. It seems to me that alternative classifications, based on more than a single structure, could be devised.

Proteinus parvulus LeConte 1850: 221 is a *nomen nudum.* Coiffait and Saiz (1968: 456) stated that there are 14 species of *Proteinus* in North America and 1 in Venezuela, but the list above indicates only 10 species

TABLE 1. SYNONYMY AND DISTRIBUTION OF NEW WORLD *Proteinus* SPECIES ACCORDING TO THE LITERATURE.

Species	Distribution
1. *P. atomarius* Erichson 1840: 904 (*P. parvulus* LeConte 1863: 58)	Canada: Ontario, British Columbia; USA: Massachusetts, Michigan, North Carolina (and Palearctic region)
2. *P. basalis* Mäklin 1852: 324	Canada: British Columbia; USA: Alaska, Washington, Idaho, Oregon
3. *P. brachypterus* Fabricius 1792: 235	?Canada: British Columbia: ?USA: Alaska (and Palearctic region)
4. *P. collaris* Hatch 1957: 107	USA: Washington
5. *P. densipennis* Bernhauer 1912: 678	USA: California
6. *P. flavocaudatus* Bierig 1940: 374	Costa Rica: Heredia
7. *P. limbatus* Mäklin 1852: 323 (*P. maeklini* Fauvel 1869: 494)	Canada: British Columbia; USA: New Hampshire, Alaska, Washington, Idaho, Oregon, California (not in Palearctic region)
8. *P. salebrosus* Casey 1885: 323	USA: California
9. *P. sulcatus* Fauvel 1878: 195	USA: California

names (reduced to 8 by synonymy) for North American species, 1 species in Costa Rica, and none known to me in Venezuela.

This article describes an additional species, *P. thomasi* Frank, removes *P. parvulus* LeConte, 1863, from synonymy with *P. atomarius*, and raises doubts on the occurrence of *P. atomarius* in the New World.

MATERIAL EXAMINED

The keys to adults of European *Proteinus* species by Tottenham (1954) and Lohse (1964) have used size, color pattern, presence or absence of a basal pronotal raised margin, structure of the antennal club, relative length and width of the pronotum, structure of the aedeagus, and distribution of peg setae, in specific determination. The structure of the aedeagus is generally highly diagnostic in Staphylinidae. Hammond (1972) noted that Steel considered the distribution of peg setae to be highly diagnostic in Proteininae. However, the aedeagus of none of the species described from the New World has been illustrated nor, except by Blackwelder (1936) for *P. limbatus*, has the distribution of peg setae been recorded.

In the expectation that specificity of size, pronotal proportions, and color pattern would reduce the number of described New World species to be considered in attempting to identify the Ocala specimens, I was able to remove from close consideration all except *P. collaris* and *P. atomarius* (= *P. parvulus*) by reading the published descriptions. It seemed necessary to examine reliably identified material of these 2 species. Comparisons of the aedeagi of several of the Ocala specimens indicated that this structure did not match the illustrations for the aedeagus of *P. atomarius* provided by Tottenham (1954) and Lohse (1964). The question of the possibly uncertain synonymy of (the Nearctic) *P. parvulus* with (the Palearctic) *P. atomarius* remained. Therefore I requested loans of type material of *P. parvulus* and of *P. collaris*, and made comparisons with the Ocala specimens.

Proteinus thomasi Frank, NEW SPECIES

The type series consists of 25 specimens with the following collection labels: "U.S.A., Fla., Marion Co., Ocala, 1-6-III-1977 yeast-baited pitfall trap, coll. M. C. Thomas". The holotype is a male and is labelled: "*Proteinus thomasi* Frank, J. H. Frank, HOLOTYPE". All other specimens are paratypes and are labelled: "*Proteinus thomasi* Frank, J. H. Frank PARATYPE". The holotype and 1 paratype are deposited in the Museum of Comparative Zoology, Harvard University and have been allotted M.C.Z. Type No. 32404; 2 paratypes in the U. S. National Museum; 2 in the Department of Entomology, Oregon State University; 2 in the Canadian National Collection; 2 in the British Museum (Natural History); 2 in the Florida State Collection of Arthropods; 2 in the Field Museum (Chicago); 2 in the American Museum of Natural History, the remainder in my collection. A description follows based on the holotype but checked by reference to the remainder of the type series. The habitus is illustrated by Fig. 1.

Length 1.5 mm. Pronotum 1.70x broader than long. Elytra 1.25x broader than pronotum. Antenna with penultimate article 2.75x broader than long. Protarsus with articles successively narrower distally, article I about 0.5x length of next 3 articles together; penultimate article of maxillary palpus quadrate; last article cylindrical, ca. 3x length of penultimate, 0.6x as broad as penultimate. Body convex. Head, elytra and abdomen brunneous with abdominal apex flavescent; pronotum flavobrunneous; articles I and II of antenna flavous, the remainder progressively darker, more infuscate distally and last 4 articles (forming a stout club) very dark; legs and trophi flavous. Head and pronotum with shagreened microsculpture, rather closely punctate; elytra more coarsely and closely punctate. Pronotum without raised basal margin. Anterior coxal cavities partially closed behind by separate post-coxal sclerites; prosternum with median longitudinal carina; mesosternum with median longitudinal carina narrowly separating the mesocoxae; metasternum without carina, metacoxae contiguous. All tarsi with 5 articles; legs without any darkly-pigmented peg setae; femora and tibiae normal except that metafemur of males is expanded ventrally and distally (Fig. 7) and this expansion bears numerous fine setae. Aedeagus (Fig. 2) slender and strongly curved in lateral view; the curvature invariable among all males examined; the structure is well sclerotized and not flexible.

The collection of the type series was made in yeast-baited pitfall traps in turkey oak (*Quercus laevis* Walter) woodland with deep leaf litter on sandy soil. The association of *Proteinus* with fungi may explain the efficacy of the yeast bait. Nine additional specimens had been collected earlier, 5 on 18-20-II-1977 and 4 on 20-24-II-1977, from the same pitfall traps.

After reading a manuscript version of this article, A. F. Newton

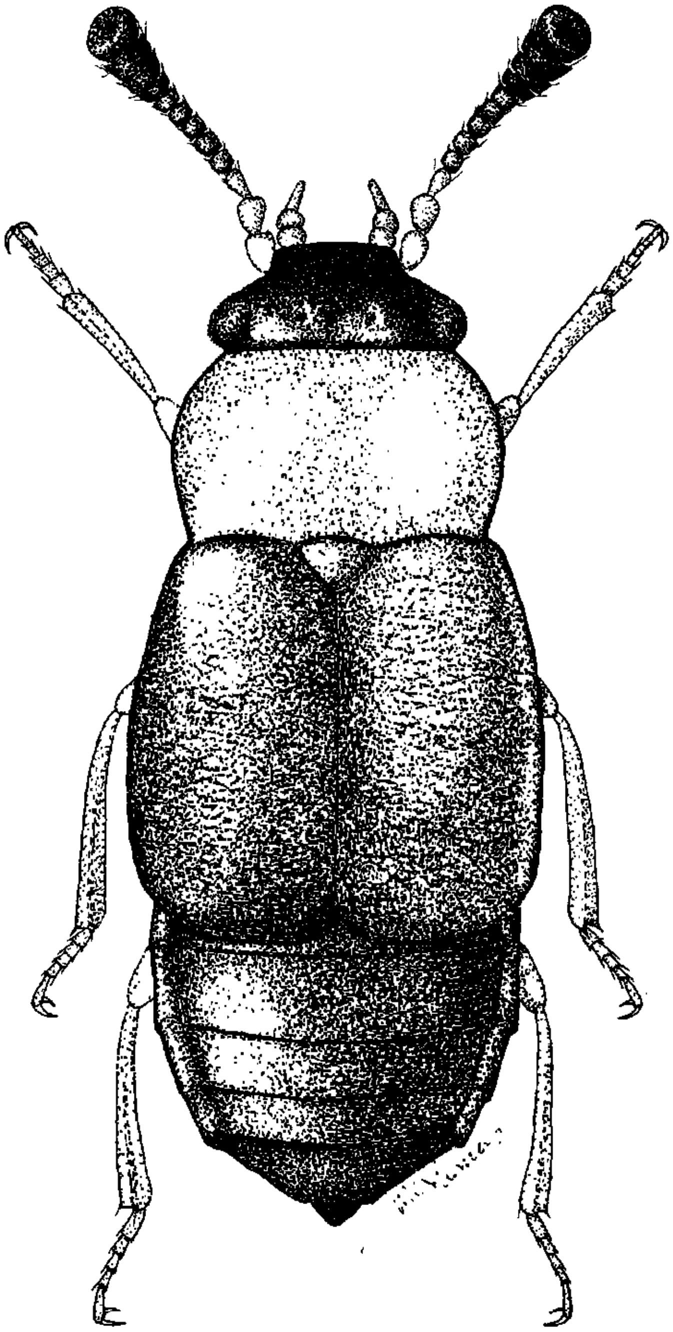
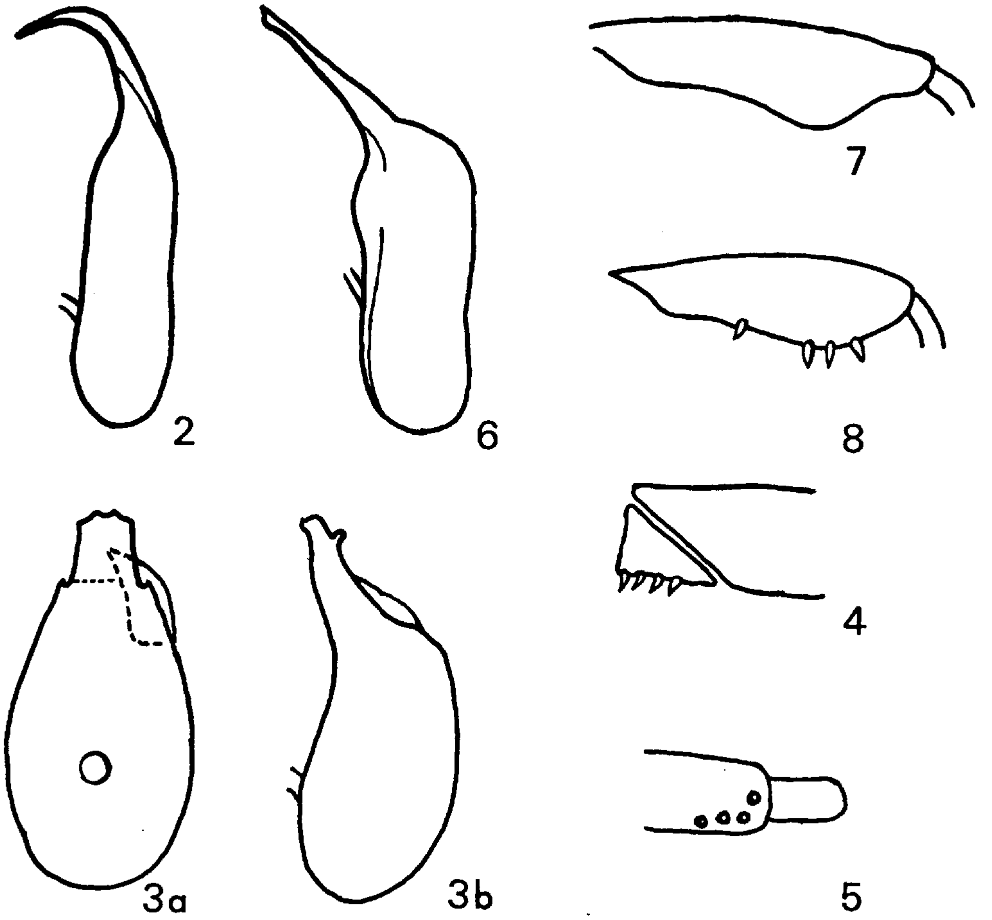


Fig. 1. Habitus of adult *Proteinus thomasi* Frank. Length is 1.5 mm from anterior margin of head to apex of abdomen. The illustration shows the insect a little more elongate than in life, when the abdomen would be more contracted and the elytra would cover an additional abdominal segment.



Figs. 2-8. Structures of adult male *Proteinus.* 2) lateral view of aedeagus of *P. thomasi;* 3) aedeagus of *P. collaris,* (3a) ventral showing basal opening, (3b) lateral; 4) mesotrochanter (showing row of 4 stout setae) and base of mesofemur of *P. collaris;* 5) inner aspect of apex of mesotibia (showing 4 peg setae) and article I of mesotarsus of *P. collaris;* 6) lateral view of aedeagus of *P. parvulus;* 7) metafemur (showing distal, ventral expansion) and base of metatibia of *P. thomasi;* 8) mesofemur (showing ventral expansion with 4 stout setae) of *P. parvulus.*

(Museum of Comparative Zoology) sent me 8 additional specimens of *P. thomasi* with the following collection data: "New Jersey, Burlington Co., Lebanon State Forest, 27-VIII-1976, A. Newton, M. Thayer, on decaying mushrooms, sandy oak-pine forest; *Proteinus thomasi* Frank, A. Newton det. 1978". This represents a considerable northward range extension for *P. thomasi,* but the macrohabitat of both collection sites was oak woodland on sandy soil. The New Jersey specimens do not seem distinguishable from the Florida specimens.

Proteinus parvulus LeConte, REDESCRIPTION

The holotype (in the Museum of Comparative Zoology, Harvard University) bears the following labels: (pale blue disc)/"Type 6602" (on red paper)/"*P. parvulus* LeC.". I am fairly certain that it is a male, although I have not dissected it. The right anterior tarsus and left posterior tarsus are missing, while the right posterior tarsus appears to be connected only by a thread of glue. It is difficult to measure precisely because it is slightly drooped over the card point and cannot be seen in a single plane. However, I believe it measures about 1.7 mm from anterior margin of head to apex of abdomen. I have examined 4 paratypes from the same collection, each of which was on a card point on a single pin bearing a pale blue paper disc. The paratypes appeared similar in habitus to the holotype. One paratype was confirmed to be a male, when the aedeagus was dissected out and mounted in Canada balsam (together with the left mesofemur, tibia and tarsus) on a small celluloid rectangle in much the same way as described by Smetana (1971: 10). This paratype, after examination, was mounted with water-soluble glue on a 3 x 10 mm card rectangle, and placed on a separate pin, above the celluloid rectangle and above the label: "*Proteinus parvulus* LeC. paratype J. H. Frank diss. 1977". A description of this specimen, checked by reference to the holotype and remaining 3 paratypes, follows.

Length 1.7 mm. Pronotum 1.85x broader than long. Elytra 1.35x broader than pronotum. Antenna with penultimate article 1.6x broader than long. Protarsus with articles successively narrower distally, article I about as long as next 3 together. Body convex. Head piceous; pronotum, elytra, and abdomen pale castaneous, the pronotum slightly paler than elytra; legs and trophi pale ferruginous; articles I-VII of antenna pale ferruginous, the remaining articles (forming a less stout club than in *P. thomasi*) slightly infuscate. Head and pronotum with shagreened microsculpture, rather sparsely punctate; elytra more coarsely and closely punctate. Pronotum without raised basal margin. All tarsi with 5 articles; legs without any darkly-pigmented peg setae; femora and tibiae normal except that mesofemur of male expanded ventrally and with 4 stout, pointed setae (Fig. 8). Aedeagus slender, the apex not curved (Fig. 6).

The aedeagus does not resemble that of *P. atomarius* illustrated by Tottenham (1954: 14, Fig. 23) and Lohse (1964: 24, Fig. 5) and in the belief that its structure is highly diagnostic, I remove *P. parvulus* from synonymy with *P. atomarius*. This raises the question of whether *P. atomarius* occurs in the New World.

Adults of *P. thomasi* may be distinguished from those of *P. parvulus* by: (1) smaller size and less ovate form, (2) paler color, (3) stouter and darker antennal club, and (males) by (4) different structure of meso- and meta-femur, (5) different structure of the aedeagus.

Proteinus collaris Hatch, REDESCRIPTION

The holotype and single paratype borrowed from Washington State Museum, Seattle, were examined. The type is labelled: "WASH.:Seattle ex alder litter, Feb. 15, 1955, D. W. Boddy, Type *Proteinus collaris* 1955—M. Hatch" (on red paper); I believe it is a female, but have not dissected it. The paratype is labelled: "WASH.:Seattle Pine litter, April 19, 1955, D. W. Boddy; Paratype *Proteinus collaris* 1955—M. Hatch (on red paper)", and is a male. Both specimens were mounted originally on card points, but I removed the paratype from its point in alcohol, dissected out the aedeagus, examined the specimen before remounting it with water-soluble glue on a 3 x 10 mm specimen card, then mounted the aedeagus in Canada balsam on a celluloid rectangle and pinned the specimen and celluloid rectangle above the original labels. The type and paratype are in good condition, though the type is drooped over its card point so cannot be seen in a single plane and cannot be measured easily. A description of the paratype, checked by examination of the holotype, follows.

Length 1.75 mm. Pronotum 1.85x broader than long. Elytra 1.35x broader than pronotum. Antenna with penultimate article 1.6x broader than long. Protarsus with articles successively narrowed distally, article I longer than next 3 articles together. Body convex. Head piceous, elytra, and abdomen castaneous with apex of latter rufescent, pronotum bright flavo-rufous; articles I and II of antenna pale ferruginous, the remaining articles becoming gradually castaneous distally so that club (the last 4 articles form a less stout club than in *P. thomasi*) is rather darker than base; legs and trophi pale ferruginous. Head and pronotum with shagreened microsculpture, rather sparsely punctate; elytra more closely and coarsely punctate. Pronotum without raised basal margin. All tarsi with 5 articles; male with a row of 4 darkly pigmented peg setae present at apex of mesotibia (Fig. 5), no other peg setae present, femora and tibiae of normal shape; mesotrochanter (but not pro- or metatrochanter) with a row of 4 spinules (Fig. 4). Aedeagus (Fig. 3) stout.

Adults of *P. thomasi* may be differentiated from those of *P. collaris* by: (1) smaller size and less ovate form, (2) paler color, (3) stouter and darker antennal club, and (males) by (4) different structure of metafemur, (5) lack of peg setae, (6) different structure of aedeagus.

Adults of *P. parvulus* may be differentiated from those of *P. collaris* by: lack of brightly differentiated flavo-rufous pronotum; males also by: lack of peg setae at apex of mesotibia, expanded mesofemur, and different structure of the aedeagus.

DIFFERENTIATION OF *Proteinus thomasi* FROM OTHER SPECIES

It is not possible to provide a very useful key to the identification of all the New World species without a thorough revision. Nevertheless, adults of *P. thomasi* may be distinguished from adults of other species described in the literature as follows.

In each of the keys to Palearctic species given by Tottenham (1954) and Lohse (1964) adults of *P. thomasi* key to a couplet containing *P. atomarius* and *P. macropterus* (Gyllenhal). They may be distinguished from those of *P. atomarius* by: larger size (1.5 mm c.f. 1.0-1.3 mm), and aedeagus of different form, strongly curved at apex (Fig. 2, c.f. Fig. 23, p. 14 of Tottenham; Fig. 5, p. 25 of Lohse). They may be distinguished from those of *P. macropterus* by: absence of peg setae at inner face of apex of mesotibia; mesotibia not "thickened and indented in middle of anterior margin"; article I of protarsus not strongly broadened, not about as long as next 3 articles together; aedeagus of different form, more slender (Fig. 2, c.f. Fig. 22, p. 14 of Tottenham; Fig. 6, p. 25 of Lohse). Using the same keys (loc. cit.) they may be distinguished from adults of *P. brachypterus* by: articles I and II of antenna pale (c.f. only article I of antenna pale); mesotibia without peg setae at inner face of apex; aedeagus of different form (Fig. 2, c.f. Fig. 21,

p. 14 of Tottenham; Fig. 4, p. 5 of Lohse); pronotum without raised basal margin.

The original description of *P. densipennis* by Bernhauer (1912) suggests that adults of *P. thomasi* differ from those of the former by: articles I and II of antenna both pale (c.f. only article I pale); pronotum ca. 1.7x as broad as long (c.f. > 2x as broad as long).

The original description of *P. flavocaudatus* by Bierig (1940) suggests that adults of *P. thomasi* differ from those of the former by: head darker than pronotum (c.f. pronotum darker than head); antenna with club very dark (c.f. antenna entirely pale); elytra jointly 1.25x as broad as pronotum (c.f. at least 1.5x as broad as pronotum); pronotum with hind angles not acute (c.f. hind angles acute, acuminate, and directed posteriorly).

The original description of *P. salebrosus* by Casey (1885) suggests that adults of *P. thomasi* differ from those of the former by: legs entirely flavous (c.f. "legs piceous, knees, and tarsi paler, testaceous"); antenna with strong, distinct club (c.f. "antennae very slender"); pronotum 1.7x as broad as long (c.f. 2.3x as broad as long).

The original description of *P. sulcatus* by Fauvel (1878) suggests that adults of *P. thomasi* differ from those of the former by: basal antennal article pale (c.f. dark, nigro-piceous); pronotum without raised basal margin; pronotum ca. 1.7x as broad as long (c.f. 3x as broad as long).

The original description of *P. limbatus* by Mäklin (1852), indicates that the typical adult form of this species is black with thorax in part and legs piceo-testaceous; adults of *P. thomasi* are paler than this. The peg setae of the middle trochanter of the male of *P. limbatus*, as illustrated by Blackwelder (1936: 75), distinguish this species clearly from *P. thomasi* whose males lack peg setae. Adults of "variety b" (or *P. limbatus* var. *maeklini*) were indicated by Mäklin to be yet darker than the typical form thus they could not be confused with adults of *P. thomasi*. Adults of "variety c" were indicated by Mäklin to be paler than the typical form, and may approach the coloration of adults of *P. thomasi;* however, the presence or absence of peg setae in the males should distinguish the 2 taxa.

Mäklin's original description of the adult of *P. basalis* suggests that this is a darkly-colored insect with the base of the elytra pale, a color pattern quite unlike that of adults of *P. thomasi*.

NOTE

During the preparation of this manuscript, the insect collection previously housed at Washington State Museum, Seattle, was transferred to Oregon State University, Corvallis. The type material of *P. collaris* and 2 paratypes of *P. thomasi* are deposited at the latter museum.

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Thomas not only provided the types of *P. thomasi,* but very kindly drew the habitus illustration (Fig. 1).

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A PRELIMINARY STUDY OF NORTH AMERICAN INSECTS ASSOCIATED WITH ELDERBERRY FLOWERS

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Abstract

This is the second part of a study of insects associated with North American species of elderberry (*Sambucus*). Based on original observations by the author, additional records by other entomologists, and recourse to published records, over 150 species of insects are known to visit the flowers of *Sambucus*.

Literature on the relation of insects and plants is enormous; however, according to Kingsolver and Sanderson (1967), no particular studies deal with *Sambucus*. The first portion of this 3 part study involved insects attracted to the extrafloral nectaries of *Sambucus simpsonii* (Frost 1977). The current contribution includes observations made of arthropods associated with blossoms of that species with supplementary records on other species of *Sambucus* as indicated. The third part will deal with insects of more economic importance: feeders of leaves, stems, roots, and berries.

Elderberry grows throughout the world especially in the Northern Hemisphere, and is conspicuous in North America, Europe, northern Africa, Siberia, and Japan. Approximately 40 species of *Sambucus* have been described worldwide (Willis 1966). Only 5 species are common in North America: *Sambucus simpsonii* Rehder, *S. canadensis* L., *S. racemosa* L. (= *S. pubescens* Persoon), *S. caerulea* Rafinesque-Schmaltz, and *S. microbotrys* Rudberg (Fernald 1950).

Sambucus simpsonii differs from the other northern species in that it blooms all winter except during periods of extremely low temperatures but recovers quickly when warm weather returns. The northern species blooms for only a comparatively short period, scarcely 3 weeks, limiting the period for flower visitations and observations. This may account, in part, for the relatively few insects known to be attracted to these flowers.

As early as 1800, large elderberry orchards were planted in Europe, chiefly for making wine. The flowers were distilled with water and alcohol to yield perfumes and lotions. A decoction of the blossoms was reported as part of an herbal remedy for yellow fever (Bates 1864). More recently the planting of elderberry has been expanded in North America, principally for the production of wine and jelly (Still and Buriff 1970). A non-poisonous purple dye is made from the berries and is used by inspectors in marking cuts of meat. Various new and more desirable cultivars have been developed which simplify the picking and processing of the crop and have added better flavor to the fruit. Thus, elderberry has become a more important crop; this change in status has resulted in recognition of insect problems.

Insects visit flowers chiefly for pollen and/or nectar. Bees and wasps seek principally nectar, although some gather considerable pollen. Beetles principally seek pollen. Butterflies and moths apparently are not commonly attracted to elderberry blooms. Records indicate that large insects seeking nectar at elderberry blossoms are relatively few. The openings of the flowers leading to the stamens and nectar glands are small, and large insects are frequently unable to reach these areas. Predaceous forms, seeking their prey, are occasional visitors.

In general, insects that visit the flowers of elderberry have little economic importance except as pollinators. Elderberry blossoms, like those of other flowering plants, attract many insects and provide the entomologist an opportunity to obtain numerous species.

Information concerning insects that visit the flowers of elderberry was obtained by direct observations at various times of the days over a period of many years, from November to May in Florida, and June to July in Pennsylvania. To dislodge small insects, the blooms were cut and immediately placed in 70% alcohol for later removal of specimens that were difficult to obtain otherwise. Other records were obtained also by visual examination of the blooms. The insects were sent to specialists for identification; records from the literature were included also.

Discussion of Species Found on the Flowers of Elderberry

ARACHNIDA, MITES AND SPIDERS

The nymphs and adults of mites and spiders were numerous on the blossoms of *Sambucus simpsonii*. None of the species has been identified.

NEUROPTERA

Chrysopa rufilabris Burmeister (= *C. lineaticornis* Fitch) identified by P. A. Adams, California, was an occasional visitor to the flowers of *S. simpsonii*. Other unidentified neuropterans were observed on the northern species, *S. canadensis*.

ODONATA

A single dragonfly was observed resting on the flower head of *S. simpsonii* in broad daylight. Considerable numbers of damselflies were observed on low bushes at dusk but none was on elderberry.

PSOCOPTERA

A specimen of *Psocus pollutus* Walsh, identified by E. L. Mockford, was taken on *S. canadensis* at State College, PA.

THYSANOPTERA

Frankliniella cephalica Crawford was common on the flowers of *S. simpsonii*. On 1 occasion, 14 males and 15 females were taken.

Leptothrips mali Fitch also was common on the flowers of *S. simpsonii*. L. J. Stannard (1968) stated that this is usually considered a northern form and that the Florida specimens may be a distinct species.

Sericothrips sambuci Hood nymphs and adults were numerous on the flowers of *S. simpsonii*. According to Stannard (1968) this species feeds entirely on the leaves of elderberry. It is common throughout Illinois and also was taken on *S. canadensis* at State College, PA. In the north it hibernates under the bark of its host.

Frankliniella tritici (Fitch), the flower thrips, is a common economic species especially in the eastern United States. Although it never has been reported from elderberry, it might be expected. The same is true of *F. vaccinii* Morgan.

Liothrips sambuci Hood, according to Stannard (1968), was misnamed and occurs only on dogwood.

HOMOPTERA

CICADELLIDAE, leafhoppers. According to D. M. Delong (in a letter 1975) "To the best of my knowledge there are no species of leafhoppers that occur on *Sambucus*."

Graphocephala coccinea (Forster) was taken occasionally on the blooms of *Sambucus simpsonii* and *S. canadensis*. This species occurs in the eastern United States west to Texas and Oklahoma and is reported chiefly on the flowers of *Forsythia* and *Rubus* spp. Specimens have been taken at State College and Black Moshannon, PA, from 5 July to 19 July.

APHIDAE, plant lice. Aphids are associated chiefly with leaves. One small species, *Aphis sambuci* Linnaeus (= *A. sambucifoliae* Fitch), identified by J. O. Pepper, was often common on the blooms of *S. simpsonii* and was taken also on *S. canadensis* at State College, PA.

CERCOPIDAE, spittlebugs or froghoppers. The meadow spittlebug, *Philaeneus spumarius* (Linnaeus), has been reported from elderberry by Still and Buriff (1970). This is a common, widely distributed species that causes injury to a large number of plants. The eggs are laid on stems of grasses and other herbaceous plants and hatch the following spring. The frothy spittle-like masses are common sights.

MEMBRACIDAE, treehoppers. *Ceresa diceros* Say was reported by Funkhouser (1917) as common on *Sambucus canadensis*, but there was no mention that it was taken on the bloom.

HEMIPTERA

ANTHOCORIDAE, flower bugs. *Asthenidea temnostethoides* Reuter, a small species measuring scarcely 2.5 mm, apparently occurs on blossoms of *S. canadensis* in Illinois and New York. Specimens were identified by J. P. Kramer.

Orius insidiosus (Say), a common species taken on *S. simpsonii* and *S. canadensis*, is said to feed on aphids and other soft bodied insects. Blatchley (1926) stated that they sometimes attack small fruits, sucking the juices and giving the berries a nauseous taste. They may cause similar injury to elderberries.

Orius pumilio (Champion), described from Guatemala, apparently is not common in Florida. Specimens were taken 4 March and 20 November on *S. simpsonii*.

Orius tristicolor (White), the minute pirate bug, apparently is a color variety of *O. insidiosus* (Say) which occurs in the Pacific States; it possibly occurs on elderberry.

COREIDAE, leaffooted bugs. *Leptoglossus phyllopus* Linnaeus was taken from December to March on *S. simpsonii* in Florida. It ranges from New York to Virginia southwest to Missouri, Oklahoma, and Arizona and is known from Central America. It causes serious damage to cotton bolls, cucurbits, peaches, oranges, and other fruits.

CORIZIDAE. A single species, *Corizus bohemanni* Signoret, was taken on the bloom of *S. canadensis* at Black Moshannon, PA, by L. E. Adams, 14 July. This is chiefly a northern species known from Quebec west to British Columbia and Colorado south to Texas, Arizona, California, and Florida.

MIRIDAE, plant bugs. *Adelphocoris lineolatus* (Goeze), generally known as the alfalfa plant bug, is a European species 1st recorded from North America in Nova Scotia and subsequently recorded from Manitoba, Iowa, Minnesota, Illinois, Missouri, Dakota, Nebraska, Wisconsin, and Kansas. Lloyd Adams collected this species at State College, PA, on the flowers of *S. canadensis*. The principle crops that the insect normally attacks are alfalfa and sweet clover where it prefers to feed on the flower buds and newly formed seeds.

Neurocolpus jessiae Knight nymphs and adults were taken on the panicles and fruits of elderberry in Illinois. It is known also from Ontario, Kansas, Iowa, Mississippi, New Jersey, and Massachusetts.

Rhinachloa subpallicornia Knight is a Neotropical species common in Florida; it was taken on the flowers of *S. simpsonii*. Specimens were identified by R. C. Froeschner.

Pinaltus approximatus Stål (2 specimens) was taken on the bloom of *Sambucus canadensis* by L. E. Adams at Bear Meadows, PA on 14 July. This species was identified by T. J. Henry, Harrisburg, PA. It is not listed by Knight (1941), and its distribution is not well known.

Peocilocapsus lineatus (Fabricius) was taken by L. E. Adams, Bear Meadows, PA, 19 July.

PENTATOMIDAE, stink bugs. *Euschistus obscurus* (Palisot de Beauvois) was seen frequently on the bloom of *S. simpsonii*, chiefly during March. Specimens were compared with those identified by H. Ruckes.

Euschistus servus (Say), the brown stink bug, was taken on *S. simpsonii*. This pentatonid is said to be common and to pass the winter beneath loose bark. During autumn and spring it frequents flowers, especially those of thistle and goldenrod. It is known from Massachusetts west to Indiana, Illinois, Iowa, and Kansas south to Louisiana, Texas, New Mexico, and Florida.

Euschistus variolarius (Palisot de Beauvois). Blatchley (1926) recorded this species as common in Indiana, ranging from Ontario and New England to British Columbia, Colorado, Indiana, and Kansas. They hide during the winter beneath leaves and other trash. Adults of the last generation seek cover in mid October and emerge in April to oviposit. They apparently occur on the flowers and foliage of numerous plants. Adults were taken on the blooms of elderberry at State College, PA, by Lloyd Adams.

Euthyrhynchus floridanus (Linnaeus) nymphs were found on the flowers of *S. simpsonii*. This species is known also from Pennsylvania, Tennessee, North Corolina, Louisiana, and Georgia. Blatchley (1926) recorded this predator from the flowers of other plants.

LARGIDAE, largid bugs. *Lagaris davisi* (Barber) was somewhat common on the bloom of *S. simpsonii* during January and is known only from Florida. It is closely related to the following species.

Lagaris succinctus (Linnaeus) was taken during November on *S. simpsonii.* According to Blatchley (1926), it is occasionally found on wax-myrtle and oak and is known from New York south to Texas and Florida and west to Colorado and Arizona.

PHYMATIDAE, ambush bugs. *Phymata wolffi Stål* (= *P. pennsylvanicus* Handlirsch) is a predaceous form. It was found on the blossoms of *S. simpsonii* and is known from Quebec and New England west to Illinois and south to Florida.

Phymata fasciata Gray. A single specimen was taken on the bloom of *S. simpsonii* on 12 April. It is common in Indiana and is recorded from New Jersey and Maryland west to California, Texas, Arizona and south to Mexico.

TINGIDAE, lace bugs. Although several lace bugs have been recorded from Caprifoliaceae by Drake and Ruhoff (1965), none is known to be associated with elderberry.

COLEOPTERA

Many species of beetles frequent flowers feeding on nectar and/or pollen. At least 15 families are represented. Relatively few have been recorded previously from elderberry; however, many might be expected.

ANTHICIDAE, ant-like flower beetles. *Anthicus* (=*Lappus*) *obscurus* Laferte, according to Blatchley (1926), was beaten from wild grape and elderberry during June and is known from Indiana, Pennsylvania, and North Carolina.

BUPRESTIDAE, metallic wood-borers. *Acmeaodera pulchella* Herbst has been found on various flowers, especially *Ceanothus,* and might be expected on elderberry.

CANTHARIDAE, soldier beetles. *Cantharis longula* Leconte was collected from the blooms of *S. simpsonii* during April and May. It is known from Georgia and Florida. Specimens were identified by H. Dietrich.

Chauliognathus marginatus (Fabricius) was taken from the flowers of *S. simpsonii* and is known from Indiana, New York, and Florida.

CARABIDAE, ground beetles. *Lebia scapularis* Dejean, a common species, was taken frequently from the flowers of *S. simpsonii.* It is known from Kansas, Oklahoma, and Indiana. Several other *Lebia* are known to visit flowers but have not been reported from elderberry.

CERAMBYCIDAE, longhorned beetles. The following 15 species of Cerambycidae have been collected and identified by J. P. Huether, Penwalt Corporation, Northeastern Research and Development, Fresno, CA. The number of Cerambycidae reported is an excellent example of the importance of intensive observations and collections and may suggest the reason so relatively few insects, especially Cerambycidae, have been reported previously from elderberry.

Analeptura lineola (Say) was taken 28 June, 3, 15, 18 July in Pennsylvania, 23 June in New York, and 21 June in New Jersey, and is known from Ontario to Florida and the midwestern states.

Brachyleptura champlaini Casey was taken 23 June at Lounsberry, NY, and 15 July at Carroll, PA, and is also known from eastern United States south to Florida.

Brachyleptura (=*Anoplodera*) *circumdata* Olivier, was collected 23 June in Pennsylvania and is known from Massachusetts and New York.

Brachyleptura (=*Anoplodera*) *rubrica* (Say) was taken 2, 7, 15 June in Pennsylvania, 23 June in New York, and 22 June in New Jersey.

Desmocerus palliatus Forster is common in the eastern United States and Canada south to Alabama and westward to Indiana and Kansas. It is a large striking beetle ca. 1 in long, chiefly blue in color with a greenish irridescence and the basal portion of the elytra orange yellow. Adults occur on the flowers and leaves of *S. canadensis;* the larvae cause considerable injury by boring into the stems and roots. They are active during June and July. Linsley and Chemsak (1972) stated that this species occurs also on *S. nigra* Linnaeus.

Euderces picipes picipes (Fabricius) was reported 24 June and 3 July at Hall, New York, and is known from Canada and Pennsylvania. It is a small beetle scarcely 1/4 in long; the larvae bore in many hard woods and breed in hickory and chestnut but are not generally abundant enough to cause noticeable injury.

Judolia (=*Anoplodera*) *cordifera* (Olivier) was taken 15 and 22 July in Pennsylvania. It has been found also on the flowers of *Ceanothus* and is known from the eastern United States from New England to Georgia (Linsley and Chemsak, 1976).

Molorchus bimaculatus bimaculatus Say was taken 23 June at Scott, NY, and is known also from Indiana and the Atlantic States where it is common on various flowers. The larvae breed in grape and hard woods.

Pidonia aurata Horn was taken 23 July, Black Forest, PA. Linsley and Chemsak (1976) recorded this species from the Atlantic States to the southern Appalachian region and northwest Georgia.

Pidonia ruficollis (Say) was taken 2 July at Hall, NY. It apparently is common in the eastern United States. Linsley and Chemsak (1976) took it on the flowers of elderberry. L. E. Adams collected several specimens at Barrens, PA, 19 July.

Strangalepta (=*Anoplodera*) *pubera* (Say) was taken 20 and 29 June in Pennsylvania. It has been recorded from various flowers and, according to Linsley and Chemsak (1976), is known from northeastern North America south to North Carolina.

Trigonarthris (=*Anoplodera*) *proxima* (Say) was taken at Pittsfield, ME, 15 July. According to Linsley and Chemsak (1976), this species occurs in eastern North America on *Sambucus* and other flowers.

Xestoleptura (=*Anoplodera*) *octonotata* (Say) was taken 20 and 29 July from Pennsylvania and is known from Connecticut, Indiana, and northeastern New York and has been taken on various flowers.

Additional Species of Cerambycidae Reported by E. G. Linsley and J. A. Chemsak (1976).

Brachyleptura vagans (Olivier), active from April to July, was recorded by Linsley and Chemsak (1976) from the flowers of *Sambucus;* it occurs in eastern North America west to Wisconsin and south to Florida.

Cortodera cubitalis (Leconte), active from April to June, was recorded by Linsley and Chemsak (1972) from *Sambucus* and other flowers; it occurs chiefly on the coastal ranges of California and southern Sierra Nevada.

Evodina monticola monticola (Randall) was recorded by Linsley and Chemsak (1972) from the flowers of *Sambucus* and many other flowers from May to July; it occurs from Newfoundland to North Carolina.

Rhopalophora laevicollis (Leconte), active from June to November, was recorded by Linsley (1964) on *Sambucus;* it occurs from Texas to the lower Rio Grande Valley and Mexico.

Tridactylus lanifer (Leconte) was recorded by Linsley (1964) on *Sambucus* spp. It is known from southern Oregon and California with a flight period from May to April.

Typocerus velutinus (Olivier), active from May to August, was recorded by Linsley and Chemsak (1976) on *Sambucus* and many other flowers, from eastern North America, Nova Scotia to Florida and westward to Kansas.

Typocerus zebra (Olivier) was recorded by Linsley and Chemsak (1976) as a frequent visitor to *Sambucus* and many other flowers; it is known from the eastern United States and southern Canada to Florida and Texas and is active from March to July.

Xestoleptura crassipes (Leconte) was recorded by Linsley and Chemsak (1976) visiting the flowers of *Sambucus* and many others; it is known from British Columbia to Colorado and southern California and is active from May to August.

The flower-visting Cerambycidae usually have a wide choice of blossoms which include even staminate catkins of conifers. Probably additional species might be expected at the blossoms of elderberry.

CHRYSOMELIDAE, leaf beetles[1]. *Bassareus formosus* (Melsheimer) has been collected from the flowers of *S. canadensis* in Pennsylvania. Blatchley (1910) stated that it was beaten from the foliage of wild grape and elderberry in Indiana. It is known from Maine, New York, New Jersey, Illinois, Alabama, Georgia, Ohio, and Connecticut.

Diabrotica undecimpunctata howardi Barber, known as the southern corn rootworm or spotted cucumber beetle, was taken occasionally from the bloom of *S. simpsonii* in Florida. It is widely distributed in the United States from Canada to Florida, and Mexico.

Diachus auratus (Fabricius) is known from Connecticut, southern California, Florida, and South America. Balsbaugh and Hays (1972) stated that this species was swept from *S. canadensis* in Alabama and from false indigo, *Amorpha fructicosa* Linnaeus, June to August.

Disonycha carolineana (Fabricius) is common in Maine, Connecticut, Pennsylvania, Indiana, Florida, Mexico, and Costa Rica. Felt (1906) stated, "Say found this species in considerable numbers on common elder (*Sambucus*) and some other plants but he states he failed to obtain any specimens on elder at Rock Island."

Lexiphanes seminulum Suffrain is known from North Carolina, Alabama, Georgia, Florida, and Mississippi. Balsbaugh and Hays (1972) recorded this species from the flowers of *S. canadensis* and also from evening primrose.

Phyllotreta aerea Allard was collected from the bloom of *S. canadensis* at State College, PA. This is a European species, primarily a pest of Cruciferae, that was 1st noted in America in 1926. It is apparently more common than generally suspected; Frost (1949) took 2079 specimens in 7

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[1] This section has been reviewed by E. U. Balsbaugh who added additional information on distribution.

sweepings 15 July and 2 August on a row of radish 60 ft long. It has been reported also from New York.

Systena hudsonias (Forster) often is known as the smartweed flea beetle. According to Wilcox (1954), this species is found frequently on *Ambrosia* and elder. It is a pest of vegetable crops but occurs on numerous weeds. In Alabama it is active from April to 27 June, but in most northern states it occurs during June and July; it is relatively common throughout Canada and the eastern United States and also from South Dakota, Colorado, and Mexico.

Many flea beetles, especially *Phyllotreta* and *Systena*, might be expected on elderberry.

CLERIDAE, checkered beetles. *Placopterus thoracicus* Olivier was reported and identified by J. P. Huether from the flowers of elderberry at Hall, NY, 2 and 3 July. It is known also from Ontario, Illinois, Indiana, and Florida.

COCCINELLIDAE, lady beetles. *Brachycantha ursina* Fabricius, known from eastern North America, has been collected recently from the flowers of *S. canadensis*. Blatchley (1910) stated that it occurs chiefly on the flowers and leaves of milkweed.

Because of their predaceous habits lady beetles might be expected on the flowers of many plants.

CURCULIONIDAE, snout beetles or weevils. *Derelomus basalis* Leconte, a minute curculionid determined by R. E. Warner, is common on the flowers of *S. simpsonii* and those of paw paw in Florida. It is known also from Georgia and has been reported from the blossoms of cabbage and saw palmetto.

DERMESTIDAE, skin beetles. *Anthrenus castaneae* Melsheimer has been taken on flowers of *S. canadensis* at State College. L. E. Adams found it common at Bear Meadows, PA, 19 July. It is known also from Indiana, North Carolina, and Texas.

Anthrenus scrophulariae Linnaeus has been reported from 27 different species of flowers, especially those that are white or cream colored. It is widely distributed in eastern North America and might be expected on elderberry.

Attagenus piceus Olivier, another common species in Europe and North America, has been taken on many flowers and might be expected on elderberry. Robertson (1928) stated that an *Attagenus* species, perhaps *piceus* Olivier, is a frequent visitor to elderberry.

ELATERIDAE, click beetles. Several small species, especially of the genera *Adelocera, Hypnoidus, Lepturoides, Limonius,* and *Ampedus*, are known to visit flowers and are frequently attracted to liquid baits. Although none has been reported from elderberry, some might be involved.

HYDROPHILIDAE, water scavengers. *Cercyon floridanus* Horn, determined by F. N. Young, was taken occasionally on the flowers of *S. simpsonii* feeding on nectar and apparently is known only from Florida.

Paracymus, a minute species scarcely 1.5 mm, was taken on elderberry bloom by the author at Benner Springs, PA, 2 July.

LAGRIIDAE, lagriid beetles. *Statira gagatina* Melsheimer, identified by H. Dietrich, was taken occasionally on the bloom of *S. simpsonii* in Florida during January and February. It is known also from Indiana and the northern United States.

LYCIDAE, net-winged beetles. *Lycus* (=*Lycostomus*) *lateralis* Melsheimer was collected occasionally on the bloom of *S. simpsonii* in Florida. It is known also from Connecticut, Ohio, Pennsylvania, Georgia, and Texas.

MELYRIDAE (Malachiidae), soft-winged flower beetles. *Anthocomus* sp. was reported by Robertson (1928) on *S. canadensis.*

MORDELLIDAE, tumbling flower beetles. *Anapsis rufa* Say was taken on the flowers of *S. simpsonii* in Florida. L. E. Adams contributed numerous records. On 1 occasion he swept 36 specimens from the bloom of *S. canadensis* at Benner Springs, PA, 12 July.

Mordella marginata Melsheimer, a single specimen, was taken from the bloom of *S. canadensis* at Black Moshannon, PA, 12 July.

Morcellistena sp. was reported on the bloom of *S. canadensis* by Robertson (1928). The Mordellidae have not been studied carefully, and perhaps other records might be discovered. An unidentified small black species was taken frequently by L. E. Adams at Bear Meadows, PA, 12 July.

NITIDULIDAE, sap beetles. *Boreades abdominalis* (Erichson), the sap beetle, was reported by Still and Buriff (1970) feeding on the tips of elderberry, killing and eventually reducing the yield of fruit. It visits various flowers including elderberry (Parsons 1943). It is known from east Canada to Georgia, west to Texas, Missouri, Nebraska, and Kansas.

Carpophilus brachypterus (Say) was taken on *S. canadensis,* 12 July, at State College, PA. It is known also from Indiana, Canada, and California.

Cybocephalus nigritulus Leconte (det. H. Dietrich) was taken on *S. simpsonii* at Lake Placid, FL. It is known also from Michigan and Georgia.

Cateretes (*Cercus*) *pennatus* Murry is known from Canada, New England, and Indiana, occurring from 19 June to 19 July. Blatchley (1910) stated that this species occurs on the flowers of elder and wild hydrangea.

Epuraea labilis Erichson. Blatchly (1910) recorded this species from the flowers of elder and dogwood. It is known from Indiana, Michigan, and Georgia.

Epuraea sp. was taken on the flowers of *S. canadensis,* 2 July, at State College, PA. Extensive collections may reveal that other closely related species of Nitidulidae frequent the flowers of *Sambucus.*

SCARABAEIDAE, scarab beetles. *Euphoria fulgida* (Fabricius) was recorded from the flowers of *S. canadensis* by Robertson (1928). It is known from Michigan, Indiana, and Texas.

Popillia japonica Newman, the Japanese beetle, was taken on the blooms of elderberry at State College, PA; it is widely distributed and recorded from many hosts.

LEPIDOPTERA

Strangely I have never seen moths or butterflies at the blooms of elderberry and know of no records. However, small green geometrid larvae were collected on elderberry blooms, 12 July, at State College, PA. They were not reared or identified. These larvae were 15 to 20 mm in length, green with light brown heads, and the 1st to 5th abdominal segments with small dark colored triangles on the dorsum.

DIPTERA

AGROMYZIDAE, leaf mining flies. A species of *Phytobia*, still unidentified, was taken on the bloom of *S. simpsonii* in Florida.

MUSCIDAE, muscid flies. *Fannia manicata* (Meigen) (=*Phorbia acra* Walker) was reported by Robertson (1928) on the bloom of *S. canadensis*. This is chiefly a northern species although recorded south to Colorado and Georgia.

ANTHOMYIIDAE, anthomyiid flies. *Hylemya* (*Delia*) *platura* (Meigen), commonly known as the seed corn maggot, was recorded from elderberry by Robertson (1928). It is known from Alaska to Greenland and south to California and Florida.

BIBIONIDAE, March flies. *Dilophus* sp. was taken on the bloom of *S. simpsonii* by the author.

BOMBYLIIDAE, bee flies. *Anthrax irroratus* Say was reported by Robertson (1928) on *S. canadensis*. It is known from Alaska to Quebec south to California and Florida.

Villa (*Hemipenthes*) *sinuosa* (Wiedemann) was reported by Robertson (1928) from Illinois on *S. canadensis*.

CECIDOMYIIDAE, gall midges. *Youngomyia umbellicola* (Osten Sacken), the elderberry flower midge, is known from New York, New Jersey, Missouri, Illinois, and Rhode Island. Felt (1940) stated that this species produces swollen florets in the form of spherical galls.

CERATOPOGONIDAE, biting midges (all identified by W. W. Wirth). *Atrichopogon gilvus* (Coquillett), a Florida species, was numerous on the blooms of *S. simpsonii* during March.

Atrichopogon websteri (Coquillett) is found frequently on the bloom of *S. simpsonii*. It is known from Louisiana, California, and Connecticut south to Florida.

Forcipomyia near *calcarata* (Coquillett) was taken on the bloom of *S. simpsonii* during March. This species is known from Mississippi, Virginia, Florida, and Mexico.

CHLOROPIDAE, frit flies. *Olcella cinerea* (Loew). L. E. Adams took 25 specimens at Bear Meadows, PA, on the bloom of *Sambucus canadensis*, 12 July. Its range extends from Michigan to Massachusetts south to New Mexico and Florida.

Hippelates pusio Loew, the eye gnat, was found frequently on the bloom of *S. simpsonii* in Florida. This common species occurs from Washington, North Dakota, and Pennsylvania south to Florida, California, also Mexico and Bermuda.

DROSOPHILIDAE, fruit flies. *Cladochaeta* sp. L. E. Adams took 12 specimens at Black Moshannon, PA, on the bloom of *Sambucus canadensis*, 12 July. Only 1 species, *C. nebulosa* Coquillett, is known from neotropical America.

EMPIDIDAE, dance flies. *Anthalea bulbosa* (Melander). L. E. Adams took 25 specimens on *Sambucus canadensis*, 12 July, at Bear Meadows, PA. This apparently is a common species known from Quebec, British Columbia, South Dakota, and Pennsylvania south to Florida.

Hybos sp. was collected (2 specimens) by L. E. Adams on *Sambucus canadensis*, 14 July, at Bear Meadows, PA.

MILICHIIDAE. *Paramyia nitens* (Loew) is known from British Columbia, Quebec, South Dakota, and Pennsylvania south to Florida. L. E. Adams took

2 specimens on the bloom of *Sambucus canadensis,* 12 July, at Bear Meadows, PA.

Leptometopa latipes (Meigen) was taken on *S. simpsonii* during March in Florida. It is known also from Alaska to Nova Scotia, eastern United States, Cuba, and Germany. Specimens have been identified by the author.

MYCETOPHILIDAE, fungus gnats. An undetermined species was common on the bloom of *S. simpsonii* in Florida during December.

RHAGIONIDAE, snipe flies. *Chrysopilus thoracicus* (Fabricius). L. E. Adams took a single specimen on the bloom of *S. canadensis,* at Waddle, PA, 20 June. This is a common species and has been noted on numerous other flowering plants.

SCIARIDAE, dark-winged fungus gnats. An undetermined species of *Sciara* was taken frequently on the bloom of *S. simpsonii* in Florida during April.

SYRPHIDAE, syrphids or hover flies. The following 20 species of syrphid flies are unpublished records by Frank D. Fee of species he observed visiting the flowers of *S. canadensis* in Centre and Clinton Counties, Pennsylvania. All but *Mallota bautias* (Walker) and *Spilomyia hamifera* Loew are new records. This is another example of the value of extensive observations and collections.

Blera analis (Macquart) is known from South Dakota to Maine south to New Jersey.

Chrysogaster nitida Wiedemann occurs from Wisconsin to Ontario south to Nebraska, Arizona, and Florida.

Chrysogaster pulchella Williston is a common species known from Sasketchewan and Quebec south to New Hampshire, Connecticut, Colorado, and North Carolina. The larvae are aquatic.

Didea fuscipes Loew (=*D. fasciata* of authors, not Macquart) is known from British Columbia to Nova Scotia, Oregon, New Mexico, and Europe.

Eristalis barda (Say) occurs from Alaska and New Brunswick south to Indiana, Colorado, and North Carolina.

Eristalis bastardii Macquart is known from Alberta to Nebraska south to Illinois and Virginia.

Eristalis saxorum Wiedemann occurs from Wyoming to New York south to Colorado, Georgia, and Florida.

Mallota bautias (Walker) is known from Quebec, Wisconsin, Colorado south to Georgia, Florida, and Texas.

Mallota posticata (Fabricius) is known from Minnesota to Quebec south to Florida.

Rhingia nasica Say is a common species known from Manitoba and New Brunswick south to Colorado and Georgia.

Sericomyia chrysotoxoides Macquart is a common species known from Newfoundland, Wisconsin, and south to Tennessee and South Carolina.

Sericomyia lata (Coquillett) is known from British Columbia to New Brunswick south to Nebraska and West Virginia.

Somula decora Macquart occurs from Minnesota to New Brunswick south to Pennsylvania, Texas, California, and Georgia.

Spilomyia hamifera Loew occurs from Wisconsin to Newfoundland south to Pennsylvania, Mississippi, and Florida.

Spilomyia fusca Loew occurs from Minnesota to Nova Scotia south to Georgia.

Milesia (*Temnostoma*) *alternans* Loew occurs from Saskatchewan to Nova Scotia south to Pennsylvania, Ohio, and Georgia.

Temnostoma balyras (Walker) is known from Manitoba to New Brunswick south to New York, Mississippi, and Georgia.

Xylota bicolor Loew is known from Nebraska to Ontario and Quebec south to Illinois, Mississippi, and Florida.

Xylota chalybea Wiedemann is known from Minnesota to Quebec south to Kansas, Mississippi, and Georgia.

Xylota pigra (Fabricius) occurs from British Columbia to Quebec south to California, Florida, and Mexico.

The following 12 species of Syrphidae were reported by Robertson (1928) on the flowers of elderberry from Illinois. The Syrphidae are conspicuous flower visitors, and it is not surprising that many are involved with elderberry.

Allograpta sp. was reported as frequent.

Baccha (*Ocyptamus*) *fuscipennis* Say is known from Manitoba to Quebec south to Texas and Florida.

Chrysogaster nitida Wiedemann is rated abundant and known from Wisconsin to Ontario and from Massachusetts south to Nebraska, Arizona, and Florida.

Eristalis dimidiata Wiedemann is known from Alberta to Nova Scotia and south to Kansas and North Carolina.

Eristalis tenax (Linnaeus) is known from Europe; also from Alaska to Labrador south to California and Florida.

Mallota bautias (Walker) is rated as frequent and is known from Wisconsin to Quebec south to Colorado, Texas, and Florida.

Spilomyia hamifera Loew is known from Wisconsin to Newfoundland south to Pennsylvania, Mississippi, and Florida.

Syritta sp. was reported from elderberry. Only 1 species of this genus is known from North America, *S. pipiens* (Linnaeus) which occurs from British Columbia and Newfoundland south to California and Florida.

Syrphus (*Metasyrphus*) *americanus* (Wiedemann) is known from British Columbia to Quebec south to California, Florida, and Mexico.

Syrphus ribesii (Linnaeus) is a common species known from Alaska to British Columbia south to North Carolina and Central America.

Toxomerus geminatus (Say) is known from Minnesota to Quebec and south to Colorado, Texas, and Florida.

Toxomerus marginata (Say) is known from British Columbia to Quebec and south to California, Florida, and Central America.

The following 2 species were taken by the author:

Allograpta obliqua (Say) was taken on the blossoms of *S. simpsonii* in December. It is known also from Quebec south to Florida and California and from Bermuda and Hawaii.

Helophilus integer Loew was taken from the flowers of *S. canadensis* at State College, PA. It is known also from Ontario and Quebec south to North Carolina.

Weems (1953) listed the hosts of the Syrphidae in considerable detail stating that they were found chiefly on white flowers, but no mention is made of species found on elderberry, a conspicuous flower in Florida. In correspondence he mentioned that he took many species from *Sambucus* spp.

from Florida to Quebec, but relatively few on *Sambucus simpsonii.*

TABANIDAE, horse flies and deer flies. Many species are known to be associated with flowers, but none has been reported from elderberry. L. L. Pechuman agrees with me that this is strange as Tabanidae have been taken rather frequently on the flowers of *Spiraea* and *Ceanothus.*

TIPULIDAE, craneflies. Alexander (1919, 1920) stated that species of *Limonia* sip the nectar of Compositae. *Limonia rostrata* (Say) is widely distributed from Pennsylvania, Maryland, Michigan, Louisiana, Florida, and the Greater Antilles. It might be expected on the flowers of elderberry.

HYMENOPTERA: BEES, WASPS, AND ANTS

ANDRENIDAE. *Andrena imitatrix* Cresson (=*claytoniae* Robertson) reported by Robertson (1928) on elderberry, is known from the northeast United States to Georgia, Texas, and Colorado.

Andrena forbesii Robertson was taken by L. E. Adams on *S. canadensis* at Bear Meadows, PA, 14 July. This species is known from Nova Scotia to Virginia and west to Nebraska and Colorado.

COLLETIDAE. A species of *Colletes* was taken on *S. canadensis* at Bear Meadows by L. E. Adams, 14 July.

XYLOCOPIDAE. *Ceratina dupla* Say was taken on *S. simpsonii* and is known from Quebec to Florida west to Wisconsin and Louisiana.

Ceratina sp. was reported by Robertson (1928) on elderberry.

APIDAE. *Apis mellifera* Linnaeus. Honey bees visited *S. simpsonii* only occasionally and usually on sunny mornings; seldom more than 5 or 6 were seen at a time. Robertson (1928) indicated that they frequently visited *S. canadensis.*

Nomada bilobata Swenk has been recorded by Robertson (1928) and others on the flowers of *Sambucus.* It is known from Nebraska and Wisconsin.

EULOPHIDAE. *Eudermophale flavimedia* (Howard) has been recorded from *Sambucus* (Muesebeck et al. 1951). Some of this family feed on the berries of other hosts; it is known from Maryland, New Mexico, and California.

BRACONIDAE. Numerous specimens, still unidentified, have been collected on the flowers of *S. simpsonii.*

CHALCIDIDAE. Many chalcid wasps, still unidentified, were taken on *S. simpsonii.*

EURYTOMIDAE. *Eudecatoma vacciniicola* (Balduf) was collected on blooms of *S. simpsonii.* It is known from Ontario and Quebec south to Virginia, Illinois, and Louisiana. This species, identified by B. D. Burks, is a gall maker.

FORMICIDAE. The following 8 species of ants were taken by the author from the flowers of *S. simpsonii,* Lake Placid, FL. Identifications have been made by M. R. Smith and Wm. L. Brown.

Crematogaster atkinsoni Wheeler is known from North Carolina, Alabama, and Mississippi.

Conomyrma flavopecta (M. R. Smith) apparently is known only from Florida.

Conomyrma pyramica (Roger) apparently is known only from Florida.

Monomorium pharaonis (Linnaeus) is a common introduced species frequently found in houses.

Camponotus (*Myrmothrix*) *abdominalis* Fabricius is a neotropical species.

Paratrechina longicornis (Latreille), an introduced species, is especially common in Florida and is found frequently in houses.

Pseudomyrmex elongata (Mayr) is known from Florida, South America, and West Indies.

Tapinoma melanocephalum (Fabricius), known from Connecticut and Georgia, is an introduced species widely distributed and an important house species.

HALTICIDAE. The Halticidae are common visitors to flowers. This is a large group containing over 350 species. The following 5 were reported by Robertson (1928) on the flowers of elderberry.

Chloralictus stultum (Cresson). This species is known from Quebec to Georgia and west to Wisconsin, New Mexico, and Texas.

Chloralictus versatus (Robertson) has been reported as abundant on *S. canadensis*. It is known from Maine to North Carolina west to Wisconsin and Kansas.

Chloralictus zepharus (Smith) is widely distributed and known from Maine to North Carolina and Florida west to Wisconsin, Kansas, Colorado, Utah, and Oregon.

Halictus parallelus Say is known from New Jersey to Georgia west to Montana, New Mexico, and Texas.

Lasioglossum (*Evylaeus*) *arcuatum* Robertson is known from Nova Scotia to Georgia west to Wisconsin, Illinois, and Colorado.

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LIFE HISTORY OF A POISON-IVY SAWFLY *ARGE HUMERALIS* (BEAUVOIS) (HYMENOPTERA: ARGIDAE)[1]

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ABSTRACT

Arge humeralis (Beauvois) (Hymenoptera: Argidae) is a North American sawfly that feeds on poison-ivy, *Rhus radicans* L. In northern Florida 3-4 generations occur from March through October, while in south Florida generations are continuous. Egg to adult development takes ca. 55 days in the laboratory. Females have 6 feeding instars while males have only 5. This sawfly is a potential candidate for the biological control of poison-ivy.

Arge humeralis (Beauvois) (Hymenoptera: Argidae), a sawfly, is being considered by the University of Florida and the Commonwealth Institute of Biological Control (CIBC) for importation and release in Bermuda as a biocontrol agent against poison-ivy, *Rhus radicans* L. Although this species occurs over most of the eastern part of North America as far north as Massachusetts (D. R. Smith, USDA Systematic Entomology Laboratory, c/o U.S. National Museum, Washington, DC, personal communication), little is known about the biology. Since field observations (F. D. Bennett, CIBC, Curepe, Trinidad, W.I., personal communication), suggested its feeding may have a deleterious effect on *R. radicans*, biological studies were conducted. Poison-ivy occurs in a variety of habitats as a woody vine or a trailing or erect shrub (Gillis 1975); it is the most common and widespread pest species of the family Anacardiaceae in the United States. The dermatogenic sap is present in roots, stems, leaves, and fruit (Kligman 1958). Nearly 70% of the United States population is susceptible to poison-ivy, with redness, itching and blisters erupting after contact with a bruised leaf or smoke containing particles (Taub 1972).

METHODS AND MATERIALS

The biology of *A. humeralis* was studied under a 15 h photoperiod with mean temperatures of 26°C during photophase and 23°C during scotophase. Relative humidity was not controlled. Clear 28 ml plastic cups were used for individual rearing (Premium Plastics, Inc.). Agar (ca. 0.3 cm) in the bottom of each cup provided moisture. Frass was removed each morning and a fresh poison-ivy leaf was provided. Approximately 120 eggs embedded in poison-ivy leaves were collected from Duval County, Florida during May 1977. Cut stems of plants containing eggs were placed in flasks of water; these, in turn, were placed inside glass aquaria covered with glass. Newly

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[2] Technologist and Professor, respectively. Photography by senior author. Reprint requests should be addressed to D. H. Habeck.

eclosed larvae were transferred to individual cups with a camel hair brush. The life cycle from egg through pupation was observed from these 120 field-collected eggs; egg-stage duration was determined from eggs laid in the laboratory. Daily observations were made to record moulting. Since head capsules split during moulting, head capsules were measured on ca. 100 living larvae to insure accurate data.

Field-collected eggs, larvae and adults were maintained indoors on poison-ivy growing in peat in glass aquaria (37.8, 75.7, or 113.5 liter capacity) covered with a fine, mesh screen. Adult longevity, mating behavior, and oviposition were observed within these aquaria.

Measurements and descriptions of larvae were based on live and/or specimens killed in boiling water and preserved in 70% isopropyl alcohol. Measurements of adults were made on pinned specimens. A dissecting microscope with a calibrated ocular grid was used for all measurements. When given, confidence intervals about means are expressed as standard deviations (sd).

A small hole cut in the end of some cocoons allowed observation of the developing prepupal stage. Secondary sexual structures of prepupae of both sexes were observed by removing them from cocoons and clearing the integument of the ventral abdominal segments with sodium hypochlorite (1:10) for 15-30 min (Fig. 1a, 2).

DESCRIPTIONS OF LIFE STAGES

EGG. Eggs dissected from females are yellowish-white, smooth, crescent-shaped, and moderately pointed on both ends. The mean length and width of 65 eggs removed from 2 female sawflies were 1.5 mm ± 0.09 mm and 0.7 mm ± 0.02 mm ,respectively.

LARVA. All instars: prothorax with 1 pair each of subdorsal, lateral, and sublateral lobes; meso- and metathorax with 1 pair each of subdorsal and lateral lobes; abdominal segments 1-8 with 1 pair each of subdorsal, lateral, and sublateral lobes; abdominal segments 1-9 with 3 annulae; spiracles winged; prolegs on abdominal segments 1-8, 10; thoracic legs and prolegs (especially laterally) dark brown to black; entire body covered with short setae which may be more prominent on the lobes. Head capsule measurements are summarized in Table 1. Any characteristics not mentioned in succeeding instars are the same as for previous instars.

First instar. Length 4-6 mm. Mean head capsule width 0.84 mm. White to pale green with head capsule black except for anterior part which is brown; only prothoracic spiracle visible; prothorax with 4 middorsal spots, a small yellowish-brown inconspicuous pair anteriorly and a large dark brown pair posteriorly; meso- and metathorax each with a pair of dark brown spots middorsally. All lobes grayish-brown to brown.

Second instar. Length 6-8 mm. Mean head capsule width 1.12 and 1.13 mm for males and females, respectively. Deep green with orange head becoming darker toward labrum; with prominent black ocularia and ocellus; all spiracles visible (T1 and A1-8); each thoracic segment with an anterior and posterior pair of middorsal dark spots; abdominal segments usually with a pair of middorsal spots on annulet 3 of segments 1-4 (rarely 1-8); lateral abdominal lobes yellow; sublateral prothoracic and lateral meso- and metathoracic lobes yellow; other lobes black.

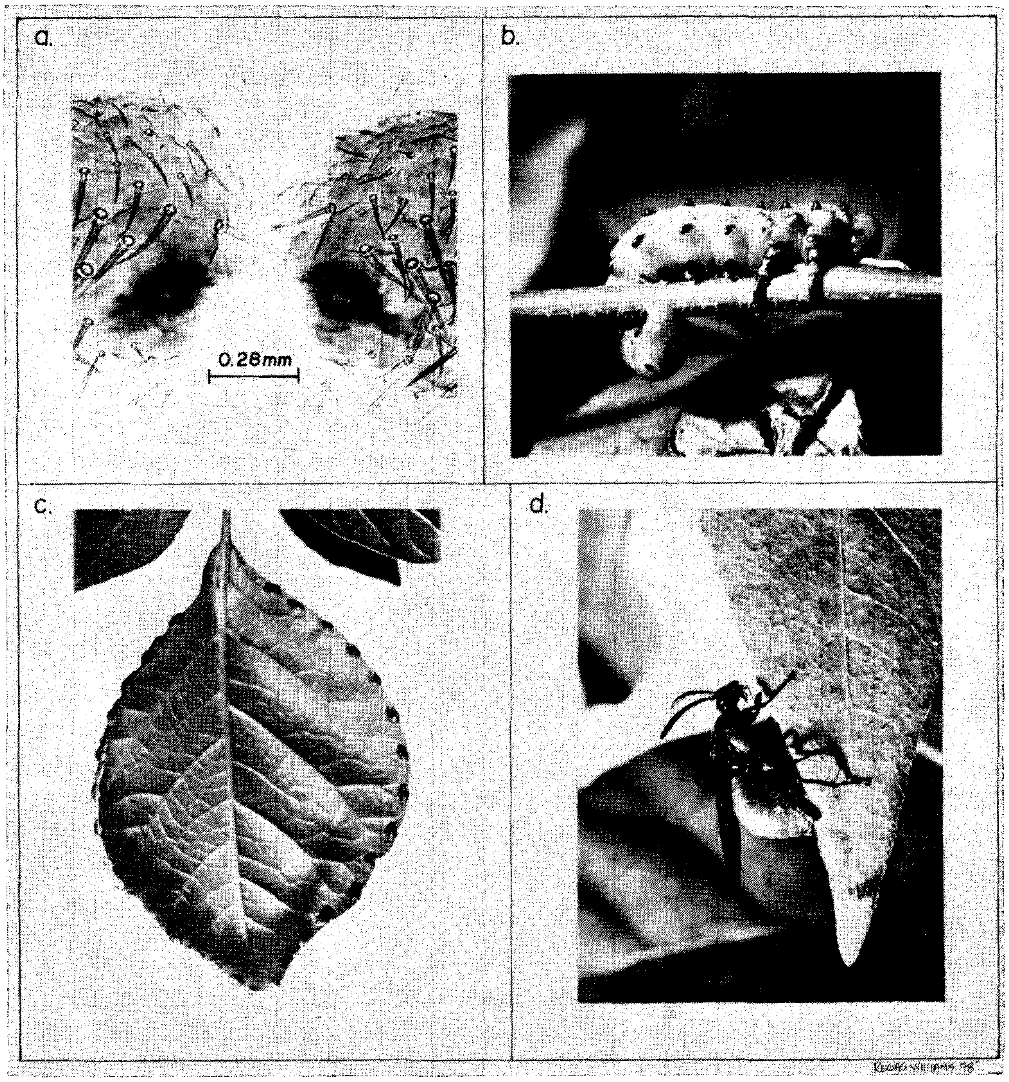

Fig. 1. *Arge humeralis:* a) secondary, sexual structures found on the sternum of male. 400X; b) 6th instar larva. 10X; c) developing eggs along leaf's margin. 10X; d) female ovipositing in poison-ivy leaf. 10X.

Third instar. Length 8-10 mm. Mean head capsule width 1.39 and 1.40 mm for males and females, respectively. Pale greenish-blue with bright orange head; sublateral prothoracic lobes, lateral meso- and metathoracic lobes and lateral abdominal lobes yellow-orange; abdominal segments 1-6 (sometimes 1-8) with a pair of middorsal spots on annulet 3.

Fourth instar. Length 10-12 mm. Mean head capsule width 1.68 and 1.73 mm for males and females, respectively. Similar to 3rd instar but deep blue-green turning to lavender late in instar; sublateral prothoracic, lateral meso- and metathoracic and lateral abdominal lobes bright amber; middorsal spots variable with up to 3 pair of spots per abdominal segment (1 pair per annulet) or 2 spots may be joined to form 1 large middorsal spot.

Fifth instar. Length 13-15 mm. Mean head capsule width 2.05 and 2.08 mm for males and females, respectively. Initially lavender but turning bright

TABLE 1. DURATION OF LIFE STAGES, AND HEAD CAPSULE MEASUREMENTS OF LABORATORY REARED *Arge humeralis* (BEAUVOIS).

	Duration in days						Head capsule measurements (mm)					
	Males			Females			Males			Females		
Stadia	X̄	SD	n	X̄	SD	n	X̄	SD	n	X̄	SD	n
Egg*	13.4	2.4	41	13.4	2.4	41						
Larval stadia 1	3.3	0.5	35	3.6	1.6	50	0.84	0.00	34	0.84	0.00	34
2	2.9	0.5	35	3.1	0.9	49	1.12	0.04	24	1.13	0.90	37
3	2.6	0.6	35	2.5	0.8	49	1.39	0.03	42	1.40	0.50	54
4	3.6	0.6	35	2.8	0.7	49	1.68	0.07	42	1.73	0.09	51
5	5.3	1.2	35	3.4	1.1	49	2.05	0.07	42	2.08	0.05	51
6	—	—	—	6.7	1.1	49	—	—	—	2.37	0.05	51
Prepupae**	14.7	1.1	20	20.9	3.5	20						
Pupae**	10.3	0.77	20	10.6	1.17	20						
Total development†	37.7	2.5	46	44.3	4.1	48						
Adult life span	4.3	0.97	105	3.2	4.0	60						

*Male and female data same since eggs were not held individually.
**Data taken from different sample.
†This is taken from larval stadia 1-6 plus time spent in cocoon.

fuschia pink; sublateral prothoracic lobes, lateral meso- and metathoracic lobes and lateral abdominal lobes bright orange as is 10th tergum; sublateral abdominal lobes may also be bright orange, usually tipped with black; females more robust than males. Male larvae become prepupae at end of this stage.

Six instar. Length 15-18 mm. Mean head capsule width 2.37 mm. Similar to 5th instar in color and morphology. Only females have this additional instar.

PREPUPA. Secondary sexual structures visible through a dissecting microscope were found on the ventral aspect of the abdomen in instars 5 (males) and 6 (females). A single pair of spots occurs on the inner aspect of the paired plates on the 9th sternum of the male (Fig. 1a). The spots are heavily pigmented with paired anterior and posterior invaginations, the latter shallower than the former. These paired structures narrowly separated by the ventral midline, are 0.28 ± 00 mm apart (n = 10). Three pairs of spots occur on sternites 7-9 of the females (Fig. 2). The pairs in 7-8 are located basally on the inner aspect of the prolegs and the pair in 9 is similar to that found on the male. The paired structures on the 7th sternum were 0.70 ± 0.06 mm apart, 0.65 ± 0.09 mm apart on the 8th, and 0.34 ± 0.03 mm apart on the 9th sternum (n = 16). The paired spots on sternites 7 and 8 of the female are trough-like as opposed to the deep invaginations in the 9th sternite of both males and females. The single pair of spots found on the 9th abdominal sternum of the male larva resembles those described in larval bees by Nielson and Bohart (1966). The paired structures of the 7th, 8th, and 9th

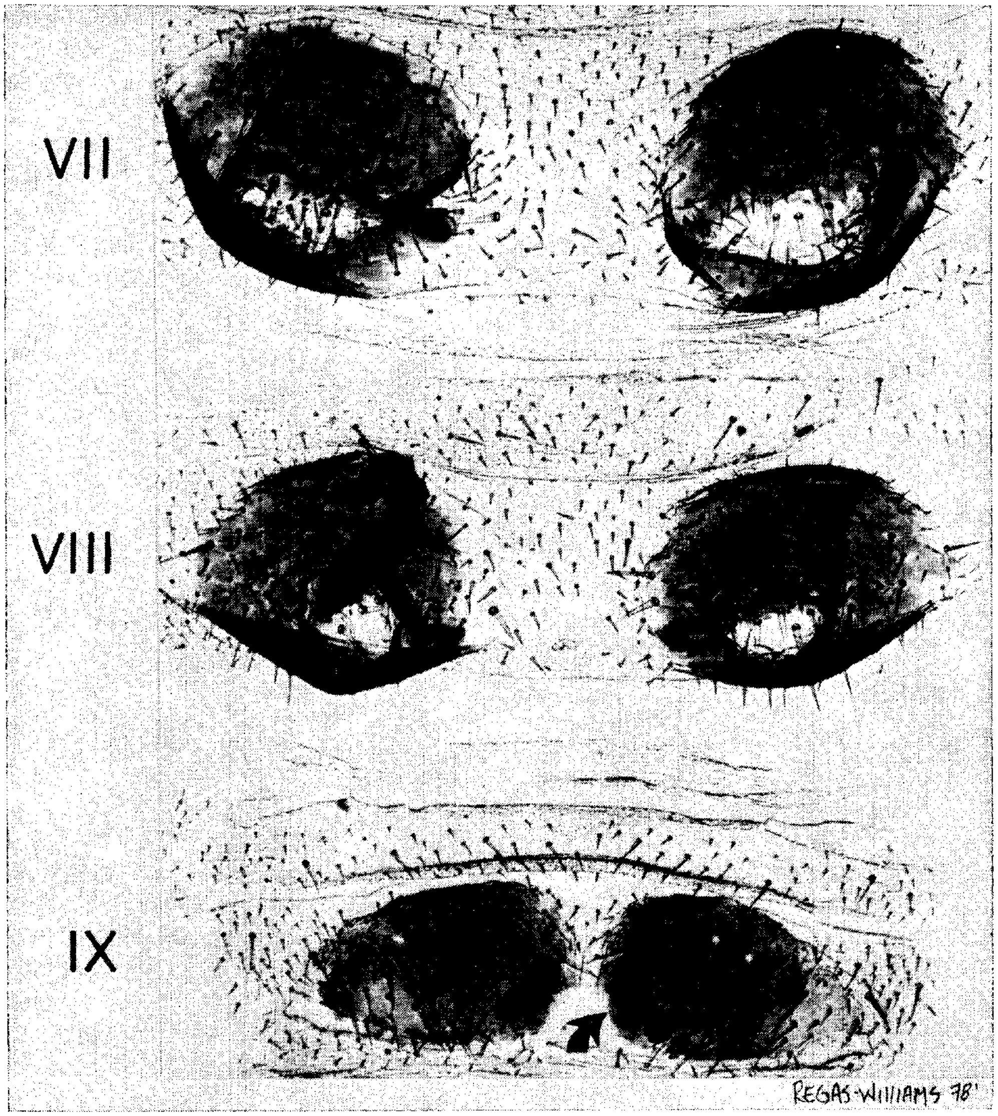

Fig. 2. Paired secondary sexual structures on abdominal sterna VII, VIII, and IX on female *Arge humeralis*. 100X.

sternites of the female larvae resemble those described by Wilkinson (1971) on the slash-pine sawfly *Neodiprion merkeli* (Ross). In the latter species, these structures are present only on sternites 8 and 9 in females and are absent in males.

PUPA. Pupae are exarate and fleshy pink, with the antennae, wing pads, and genitalia yellow. The compound eyes soon become brown to gray.

ADULT. Adult females are 10.6 mm ± 0.3 mm in length (n = 25). The head and thorax are black except for the mesoscutellum and parts of the mesepisternum and mesepimeron which are bright red as is the abdomen. The forewings are smokey-gray and 9.6 mm ± 0.3 mm in length (n = 25). The antennae are black and 3-segmented; the 3rd ca. 9x length of 1st and 2nd segments combined. The legs and thorax are black. Adult males are smaller than females but otherwise both sexes are similar in color and general form. Males average 8.5 ± 0.4 mm in length and have an average wing length of 7.4 ± 0.4 mm (n = 25).

BIONOMICS

Arge humeralis were most commonly found in open, disturbed cypress swamps. Despite the frequent abundance of poison-ivy in other ecosystems, most sawflies were collected in cypress-poison-ivy associations. Three or 4 generations of *A. humeralis* occurred from March through October in northern Florida. Generations were continuous in south Florida.

Adults emerged by chewing a hole in the cocoon. Upon emergence, females either rested, mated, searched for a suitable leaf for oviposition, or began ovipositing immediately, even if mating had not occurred. Unmated females produced only male progeny. Mating lasted from 10-90 minutes and averaged 25 minutes (n = 18). Males searched actively for females and 4-6 males were frequently observed swarming around a mating pair, even to the point of breaking them apart. Observations indicated that females mated only once, whereas some males were observed mating twice. Before ovipositing, the female walked across the leaf with her abdomen curled ventrally in contact with the leaf; this was possibly a display of territorial marking behavior. The ovipositor scratched the surface of the leaf and the emerging plant sap turned black and remained as a faint black trail. Whether the female deposited a chemical substance is not known, but field observations indicated that females did not oviposit on leaves previously used by other females. If the female oviposited without mating, she sometimes returned to the same leaf after mating and resumed ovipositing.

Eggs were deposited individually in pockets sawed by the female into the leaf margin, at points where larger veins were located (Fig. 1C). The female straddled the side of the leaf and inserted her ovipositor between the layers of the leaf tissue (Fig. 1D). The swelling of the eggs was apparent within 24 h and gave the appearance of dark blisters along the leaf margin. Two days before hatching, the blisters were 2.3 mm ± 0.1 mm long, 1.44 mm ± 0.1 mm wide, with an opening 1.3 mm at the slit (n = 20).

Forty-eight laboratory-reared females deposited a mean of 47 eggs/female (min. = 4; max. = 100). Mean life span of adults, provided with water in the laboratory, was 4 days for the males and 3 days for the females (Table 1). One unmated, ovipositing female, lived for 7 days. Adults were uncommonly encountered in the field, but on 1 occasion many (ca. 50) were observed in a localized area for 8 h. Adults were vigorous and aggressive, with both sexes flying actively up to 3 m high. Adults confined to cages in the laboratory were less vigorous and dropped to the floor of the cage when attempting flight.

Eggs hatched after an average of 13.4 days (Table 1). Newly emerged larvae were white with a translucent, white head capsule, but within a few hours the adfrontal area turned amber and the remainder of the head capsule turned black. They fed primarily on the underside of the leaf, grasping its surface with their thoracic legs and raising their abdomens in an S-shaped posture. This posture may be defensive since larvae twisted and twirled their abdomens in response to intruders. Larvae fed gregariously and sometimes migrated en masse to adjacent, intact leaves. First instar larvae skeletonized the leaf, leaving only the main veins and midrib.

As larvae developed, they more commonly fed singly. Later instar larvae stripped the leaf completely, leaving only the midrib. In north central Florida, generations overlapped and the early and late instars frequently were found feeding together on the same plant/leaf area.

Both sexes fed for ca. 3.5 days in the 1st stadium, but the 2nd and 3rd stadia lasted ca. 3 days for both sexes (Table 1). Larval duration in the 4th stadium was ca. 4 days for the males and 3 days for females. The 5th stadium, the final feeding period for the males, lasted ca. 5 days; females fed for a shorter period of 3 days. Sixth instar females fed for ca. 7 days before spinning their cocoons. There were no significant differences between male and female larval head capsule measurements, or body lengths of the different instars during the course of development (Table 1).

In the field, mature larvae dropped to the ground or crawled into cracks in the bark of the tree before spinning cocoons. In the laboratory they spun in the bottom of the cup or in a curled leaf. Construction of the golden cocoon took ca. 1 day. The mean respective length and width of female cocoons were 12.0 mm ± 0.4 mm by 6.6 mm ± 0.7 mm by 5.5 mm ± 0.4 mm ($n = 30$). Male adults emerged from cocoons ca. 20 days after construction and females ca. 21 days ($n = 120$). In a few cases adults emerged the following year.

Another group of 40 cocoons were opened to observe pupation. The males remained as inactive prepupae in the cocoon for ca. 15 days before pupating; females rested for ca. 16 days. In the laboratory, larvae that were unable to complete spinning the cocoon still developed to the adult stage.

PARASITES

Three parasites species were reared from field-collected *A. humeralis*. *Tetrastichus trisulcatus* Provancher (Hymenoptera: Eulophidae) was reared from the prepupa; an average of 53.0 ± 16.03 adults were produced per host cocoon ($n = 18$). Another eulophid, *Cirrospilus argei* (Crawford) was reared from eggs. The third parasite, *Spathimeigenia hylotomae* (Coquillet) (Diptera: Tachnidae), was reared from cocoons spun by sawfly larvae, collected as 1st instars (6 observations) or 2nd instars (4 observations).

A microsporidan, *Nosema* sp. was isolated from 1 field collected larva.

ACKNOWLEDGMENTS

We thank Dr. Eric E. Grissel and Dr. Curtis Sabrosky, USDA Systematic Entomology Lab, Washington, DC, for identification of the eulophid wasps and tachinid fly, respectively, and Dr. John Knell, University of Florida, Gainesville, for the identification of the microsporidan. This research was supported in part by funding provided to the Commonwealth Institute of Biological Control by the Bermuda Department of Agriculture and Fisheries.

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TAXONOMY AND DISTRIBUTION OF CHIGGERS (ACARINA: TROMBICULIDAE) IN NORTHCENTRAL FLORIDA[1]

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ABSTRACT

Chiggers from the northern and north central regions of Florida were collected and identified. Seven species were found: *Eutrombicula alfreddugesi* (Oudemans), *Eutrombicula splendens* (Ewing), *Fonsecia* (*Parasecia*) *gurneyi gurneyi* (Ewing), *Walchia americana* Ewing, *Euschongastia rubra* Farrell, *Miyatrombicula jonesae* Brennan and *Leptotrombidium peromysci* Vercammen-Grandjean. Three species are reported for the first time in Florida. The species, *Leptotrombidium peromysci,* is redescribed as this is the first report in S.E. United States. A key to all the species currently reported in Florida is included.

Chiggers or trombiculid larvae are known to cause trombidiosis in much of the United States, but in the Oriental Region some chiggers transmit scrub typhus, *Rickettsia tsutsugamushi.* Chigger bites produce itching and swelling at the site of chigger attachment. Trombidiosis may also be accompanied by secondary infections and persistent lesions. The major species causing trombidiosis are *Neotrombicula autumnalis* (Shaw) and the 4 species of the genus *Eutrombicula: alfreddugesi* (Oudemans), *splendens* (Ewing), *batatas* (Linneaus) and *belkini* (Gould). In addition the larvae of *Neoschongastia americana* (Hirst) cause losses to the turkey industry particularly in the southern United States (Everett et al. 1972). Recent reports also indicate that chiggers are the cause of lesions on horses in the Pacific Northwest (Easton and Krantz 1973). Several surveys of states other than Florida contributed greatly to the knowledge of species and their distribution throughout the United States. In a preliminary study of the chigger species within the northcentral part of Florida, Dohany (1974) reported 6 species that were new to the State and 2 from new hosts. However, the knowledge of the trombiculid fauna of Florida is still fragmentary. The present research increases the known number of present chigger species and outlines their distribution in North Central Florida.

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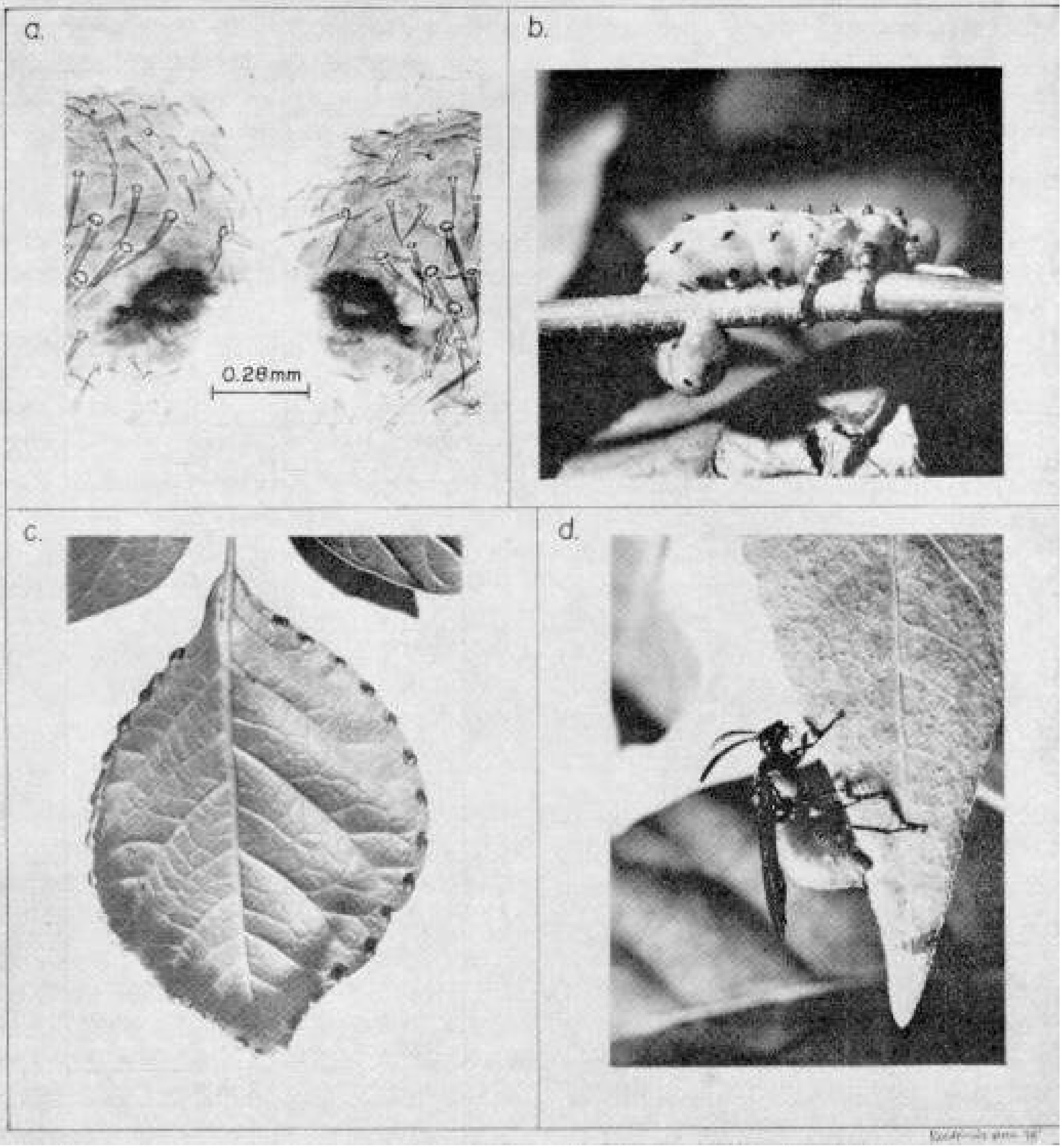
[1] Florida Agricultural Experiment Station Journal Series No. 1127.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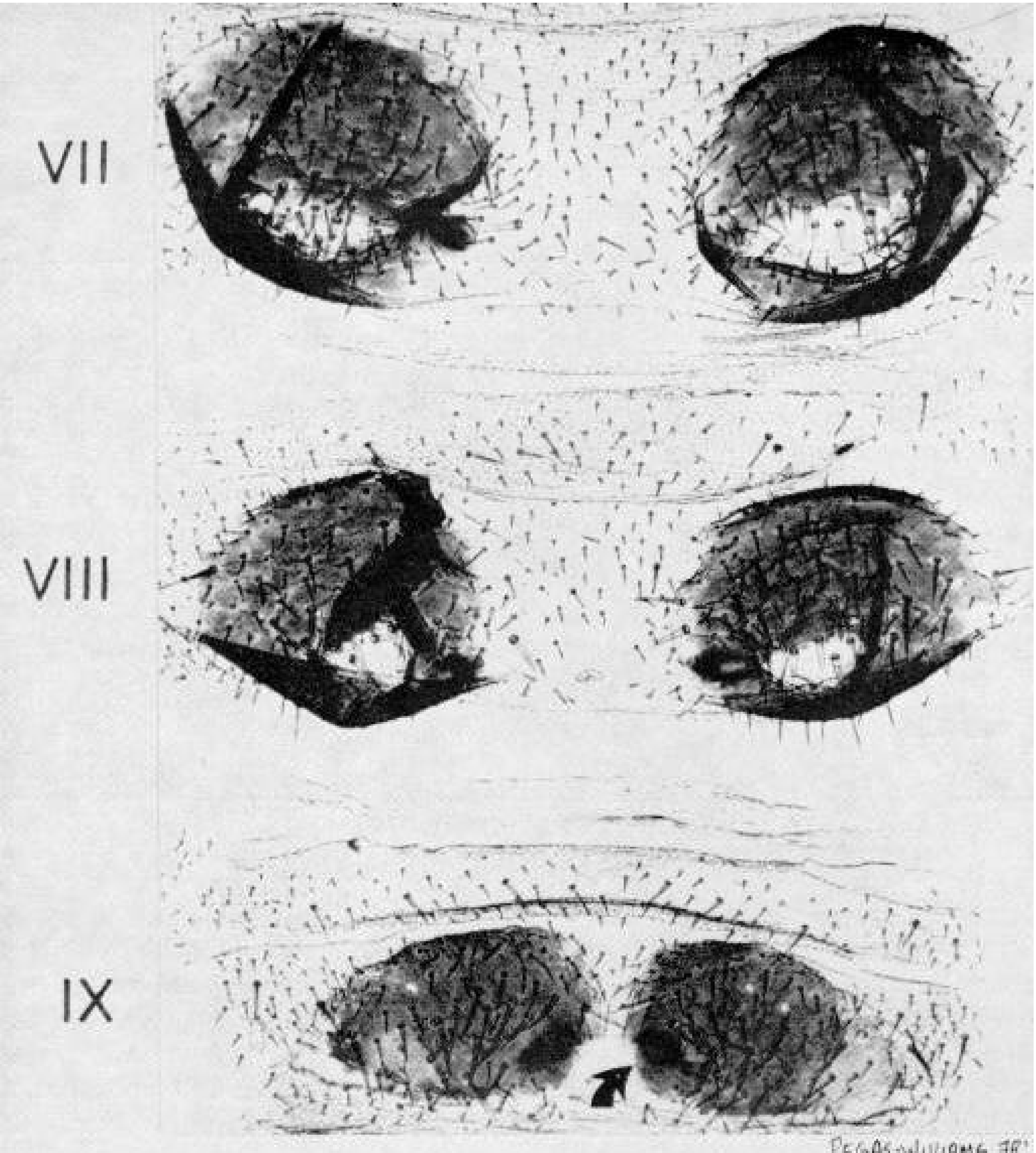
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[1] Florida Agricultural Experiment Station Journal Series No. 1127.

METHODS AND MATERIALS

Chiggers for this study were collected from litter samples, treeholes, black plates, and vertebrate hosts. Samples were taken at various locations in the northcentral parts of Florida, including the Tall Timbers Research Station, Leon County, and the Gainesville area, Alachua County. The majority of the samples (Berlese and black plates), came from the Gainesville area.

Chiggers were collected into 80% ethanol and were mounted directly into Hoyer's modified Berlese media on a microscope slide (Krantz 1970). Coverslips were applied and the slides were heated slightly with an alcohol burner until bubbles began to form. The slides were then dried in the oven and coverslips were ringed with Glyptal. The cleared chiggers were then identified to species.

RESULTS

In the present study, 7 species of chiggers were found, 3 of which are reported for the first time. One species, *Leptotrombidium peromysci* is redescribed. The hosts from which the chiggers have been collected are listed in Table 1.

TABLE 1. THE HOSTS OF COLLECTED SPECIES OF CHIGGERS OF NORTHCENTRAL FLORIDA.

Hosts	Chigger species
Black racer, *Coluber constrictor constrictor* (Linnaeus)	*Eutrombicula alfreddugesi* (Oudemans)
Corn snake, *Elaphe guttata* (Linnaeus)	"
Eastern swift, *Sceloporus undulatus* (Latrielle)	"
Eastern grey squirrel, *Sciurus carolinensis* Gmelin	"
Box tortoise, *Terrepene carolina* (Linnaeus)	*Eutrombicula splendens* (Ewing)
Indigo snake, *Drymarchon corais couperi* (Holbrook)	"
King snake, *Lampropeltis getulus getulus* (Linnaeus)	"
Eastern swift lizard, *Sceloporus undulatus* (Latrielle)	"
Common opossum, *Didelphis marsupialis* Linnaeus	"
Barbour's pigmy rattlesnake, *Sistrurus miliarius barbouri* Gloyd	"
Yellow rat snake, *Elaphe quadrivittata quadrivittata* (Holbrook)	"
Common opossum, *Didelphis marsupialis* Linnaeus	*Walchia americana* Ewing

Checklist of Florida Trombiculidae

Family—Trombiculidae Ewing 1944.

Subfamily—Trombiculinae Ewing 1929.

Genus—*Eutrombicula* Ewing 1938.

Eutrombicula alfreddugesi (Oudemans). *Microtrombidium alfreddugesi* Oudemans 1910. Ent. Ber. 3: 84.

Records: Morningside Park, Alachua Co., 20-VII-1975. R. Ibrahim coll., Welaka, Putnam Co., V-1975, L. Davis and D. Sauerman coll., from fence lizard; Tall Timbers, Leon Co., V-1975, E. Komarek coll., from burnt and unburnt plots; Levy Co., V-1975. D. Sauerman and L. Davis coll., from corn snake; Gainesville, 9-X-1974, R. Kramer coll., from squirrel.

Eutrombicula splendens (Ewing). *Trombicula splendens* Ewing 1913. Bull. Amer. Mus. Nat. Hist. 32: 113.

Records: Alachua Co., 2-IV-1974, F. Romero coll., from lizard; Bronson, Levy Co., V-1975, L. Davis and D. Sauerman, from common opossum, *Didelphis marsupialis* and Barbour's pigmy rattlesnake, *Sistrurus miliarius barbour;* Archer, Alachua Co., V-1975, D. Sauerman and L. Davis coll., from box tortoise, *Terrepene carolina;* Morningside Park, Alachua Co., 20-VII-1975, R. Ibrahim coll., from shrubs and grass; Gainesville, 7-VII-1975, R. Ibrahim coll., from shrubs and grass.

Eutrombicula batatas (Linnaeus). *Acarus batatas* Linnaeus 1758. Syst. Nat., Ed. 10, 1: 617.

Records: (Reported by Jenkins (1949); not recovered in our samples).

Eutrombicula multisetosa (Ewing. *Acariscus multisetosa* Ewing 1943. Proc. Ent. Soc. Wash. 10: 65.

Records: Christmas, 2-I-1936, B. V. Travis coll., from racoon *Procyon* sp.; Bonita Spring, 22-XI-1936, B. V. Travis coll., from cotton rat, *Sigmodon littoris littoris;* Tallahassee, 9-XI-1936 and 10-IX-1936, B. V. Travis coll.; Shellpoint, 30-X-1936, B. V. Travis coll., from *Sturnella magna.*

Genus—*Fonsecia* Radford 1942.

Subgenus—*Parascecia* Loomis 1966.

Fonsecia (*Parasecia*) *gurneyi gurneyi* (Ewing). *Trombicula gurneyi* Ewing 1937. Proc. Biol. Soc. Wash. 50: 169.

Records: Eglin Air Force Base, Okaloosa Co., 22-I-1975, H. L. Cromroy coll., from treeholes; Gainesville, 30-IV-1976, R. L. Wani coll., from treeholes; Tallahassee, no collection date given, A. L. Dohany coll., from treeholes.

Subgenus—*Fonsecia* Radford 1942.

Fonsecia (*Fonsecia*) *palmella* Brennan and Loomis. *Fonsecia palmella* Brennan and Loomis 1959. J. Parasit. 45: 62.

Records: Tallahassee, no collection date given, A. L. Dohany coll., from treeholes.

Genus—*Trombicula* Berlese 1905.

Subgenus—*Miyatrombicula* Sasa, Kawashima, and Egashira 1952.

Miyatrombicula jonesae (Brennan). *Trombicula jonesae* Brennan 1952. Wash. J. Biol. 10: 60.

Records: Archer, Alachua Co., 24-II-1976. L. Davis coll., from treeholes; Levy Co., 26-II-1976, L. Davis coll., from treeholes.

Genus—*Microtrombicula* Ewing 1950.

Microtrombicula crossleyi (Loomis). *Trombicula crossleyi* Loomis 1954. Univ. Kans. Sci. Bull. 36: 920.

Records: Tallahassee, no collection date given, A. L. Dohany coll., from treeholes.

Genus—*Leptotrombidium* Nagayo, Miyagawa, Mitamura, and Imamura 1916.

Leptotrombidium peromysci Vercammen-Grandjean 1975. *Leptotrombidium* complex, Section A, *Leptotrombidium* s. s. Pages 433-4 *in* P. Vercammen-Grandjean and R. Langston, eds. The chigger mites of the world, Vol. 3. George Williams Hooper Foundation. Univ. of Cal., San Francisco.

Records: Tall Timbers, Leon Co., 29-XII-1975, and 4-III-1976. R. Ibrahim coll., from treeholes.

Genus—*Euschongastia* Ewing 1938.

Euschongastia rubra Farrell. *Euschongastia rubra* Farrell 1956. Proc. U.S. Nat. Mus. 106: 163.

Records: Tall Timbers, Leon Co., 29-XII-1975, R. Ibrahim coll., from treeholes.

Euschongastia peromysci (Ewing). *Schongastia peromysci* Ewing 1929. Ent. News 40: 296.

Records: Gainesville, no collection date given, A. L. Dohany coll., from treeholes.

Euschongastia setosa (Ewing). *Trombicula setosa* Ewing 1937. Proc. Biol. Soc. Wash. 50: 171.

Records: Gainesville, XII-1971, A. L. Dohany coll., from treeholes.

Genus—*Blankaartia* Oudemans 1911.

Blankaartia pauli Crossley and Atyeo 1972. J. Med. Ent. 9: 253.

Records: St. Petersburg, 27-30-VI-1966. R. W. Heard, III coll., from nares of *Rallus longirostris;* Vero Beach, VII-1966, R. W. Heard, III coll., from birds; Florida Keys, VII-1966, R. W. Heard, III coll., from birds.

Subfamily—Walchiinae Ewing 1946.

Genus—Walchia Ewing 1931.

Walchia americana Ewing 1942. J. Parasit. 28: 491.

Records: Tallahassee, 8-XI-1936, B. V. Travis coll., from cotton mouse; Gainesville, no collection date given, A. L. Dohany coll., from treeholes; Gainesville, 29-IV-1975, R. Kramer and D. Sauerman coll., from opossum.

Key to Subfamilies, Genera, and Subgenera of the Known Trombiculidae of Florida

1. Scutum without AnteroMedian seta (AM); leg segmentation

7-6-6; 4 scutal setae; sensillae expanded, lanceolate-clavate .... WALCHIINAE, *Walchia* Ewing 1931

1′. Scutum with AM seta; leg segmentation 7-7-7; 5 scutal setae; sensillae flagelliform, filamentous or occasionally thickened .... TROMBICULINAE 2

2. AnteroLateral (AL) setae of scutum stubby, peg-like; parasites of reptiles .... *Fonsecia* Radford 1942

2′. AL setae of scutum normal, usually barbed; wide host range 3

3. Scutum pentagonal, with or without (AL) shoulders; coxae III with 1 or more setae 7

3′. Scutum rectangular, trapezoidal or quadrate, without AL

4. Scutum rectangular with a sinuous posterior margin; anterior setae post-marginal .... *Parasecia* Loomis 1966

4′. Scutum without this combination of characters 5

5. Sensillae expanded distally, capitate to ovoid; palpal tibial claw with 3 or more prongs .... *Euschongastia* Ewing 1938

5′. Sensillae filamentous; palpal tibial claw with 2-3 prongs 6

6. Palpal tibial claw bifurcate with external prong always longer than internal prong; galeal seta nude; leg III with mastitarsala .... *Eutrombicula* Ewing 1938

6′. Palpal tibial claw usually trifurcate; galeal seta always barbed; leg III without mastitarsala .... *Leptotrombidium* Nagayo, Miyagawa, Mitamura, and Imamura 1916

7. Coxa III with 2 or more setae; scutum with an acute posterior angle .... *Miyatrombicula* Sasa, Kawashima, and Egashira 1952

7′. Coxa III with 1 seta; scutum with broadly or deeply 'U' shaped posterior margin 8

8. Coxa of gnathosome and coxae of legs striate punctate; Palpal Tarsus Formula (PTF) = 7BS (BS = strongly Barbed Setae); posterior margin of scutum narrow or broadly 'U' shaped .... *Blankaartia* Oudemans 1911

8′. Coxa of gnathosome and coxae of legs distinctly punctate, never striate punctate; palpal tarsus formula = 6BS posterior margin of scutum slightly or deeply 'U' shaped .... *Microtrombicula* Ewing 1950

Eutrombicula:

The 2 most frequently occurring species of the genus *Eutrombicula* are *E. alfreddugesi* (Oudemans) and *E. splendens* (Ewing). Numerous specimens of the 2 species were collected from black plates and host washing techniques. The specimens were collected throughout the year, during any warm day. *Eutrombicula alfreddugesi* can be taxonomically differentiated from *E. splendens* by the number of dorsal setae, the former having 22, while the latter have 24-28 dorsal setae. Scutal measurements of *E. alfreddugesi* and *E. splendens* and comparison of measurements made by previous chigger taxonomists are presented in Table 2.

Key to Florida Species of *Eutrombicula*

1. Three mastitarsala III; 2 mastitibiala III 2

1′. One mastitarsala; no mastitibiala 3

TABLE 2. SCUTAL MEASUREMENTS* OF *Eutrombicula alfreddugesi* (OUDEMANS) AND *E. splendens* (EWING), AND A COMPARISON OF MEASUREMENTS MADE BY PREVIOUS CHIGGER TAXONOMISTS.

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	S
Eutrombicula alfreddugesi										
Average (n=7)	75	87	42	24	27	26	26	27	38	45
Min.-Max.	73-83	83-96	39-46	22-28	26-28	24-28	24-28	26-28	35-42	39-50
Jenkins (1949)	81	92	44	24	29	26	33	32	46	48
Wolfenbarger (1952)										
Kansas	77	88	43	23	26	27	28	29	40	49
Dohany (1974)	81	92	44	24	29	26	33	32	46	48
Eutrombicula splendens										
Average (n=5)	73	87	38	23	24	21	29	28	46	47
Min.-Max.	73-79	87-92	29-44	18-28	15-33	15-26	18-33	22-33	40-48	44-48
Wolfenbarger (1952)										
Missouri	83	94	43	24	28	27	33	34	47	52
Texas	100	112	50	25	31	29	36	33	47	52
Jenkins (1949)	78	91	44	22	32	27	37	34	48	51
Dohany (1974)	82	94	45	25	30	27	39	35	49	51

*Scutal measurements were taken with an ocular micrometer with all measurements expressed in microns. The standard lengths used are: AW—distance between the bases of anterolateral setae; PW—distance between the bases of posterolateral setae; SB—distance between bases of sensillae; ASB—distance from anterior margin to sensillary bases; PSB—distance from posterior margin to sensillary bases; AP—distance between bases of anterolateral and posterolateral setae; AM—length of anteromedian setae; AL—length of anterolateral setae; PL—length of posterolateral setae; S—length of sensillae.

2. Dorsal setae 50 to 54 .... *multisetosa* (Ewing 1943)
2′. Dorsal setae 32 to 38 .... *batatas* (Linnaeus 1758)
3. Dorsum with 24 to 28 setae .... *splendens* (Ewing 1913)
3′. Dorsum with 22 setae .... *alfreddugesi* (Oudemans 1910)

Fonsecia:

The larvae of this genus are distinguished by having the PosteroLaterals (PL) greater than the AnteroMedian (AM) and the AM greater than AnteroLaterals (AL). The subgenus *Parasecia* differs from the subgenus *Fonsecia* in having normal scutal setae (peg-like in the subgenus *Fonsecia*).

Only 1 species of the genus was collected. This was *gurneyi gurneyi* which belongs to the subgenus *Parasecia.* It was 1 of the most abundant chiggers collected from Berlese tree hole samples at 2 collection sites; in Alachua Co., (Gainesville area) and in Okaloosa Co., (Eglin Air Force Base area). The specimens were collected during January and April 1976. Ewing (1937) reported collecting the specimen from Blue-tailed skink (*Eumeces fasciatus*) in April. Dohany (1974) collected this species abundantly from Berlese treehole samples in Gainesville, Lakeland, and Tallahassee.

Fonsecia (*Parasecia*) *gurneyi gurneyi* is characterized by its small scutum; dorsal formula of 2-6-6-4-2-2-2 = 24; nude palpal genual setae and without mastitarsala of leg III. Scutal measurements of 10 specimens are shown in Table 3.

Key to Subgenera and Species of *Fonsecia*

1. Scutum with peg-like anterolateral setae; a convex posterior scutal margin; palpal tibial claw bifurcate; usually confined to reptiles .... *Fonsecia palmella* Brennan & Loomis 1959
1′. Scutum with normal AL setae; a sinuous posterior scutal margin; palpal tibial claw trifurcate; wide host range .... *Parasecia gurneyi gurneyi* Ewing 1937

Euschongastia:

One species of *Euschongastia* was collected during this study. Dohany (1974) collected 2 species from this area. Farrell (1956) conducted a detailed study of *Euschongastia* of North America.

Euschongastia rubra Farrell was obtained from Berlese treehole samples collected at the Leon Co. site, (Beech-Magnolia Hardwood Hammock, Tall Timbers) in December, 1975. This supports observations made by Farrell (1956) who recorded this species during the months of December through May and who indicated that *E. rubra* was confined strictly to the seasons when the soils were moist and colder.

Euschongastia rubra can be distinguished from other species of this group by the strongly branched lateral setae on the palpal tibia and by the different shape of its scutum, with 3 joined crescentric folds; the middle 1 extending around the anterior median seta. Table 3 presents the scutal measurement of 2 specimens.

Two other species of *Euschongastia* were reported by Dohany and Cromroy (1976). They are *E. peromysci* (Ewing) collected from *Peromyscus*

TABLE 3. Scutal measurements* of *Fonsecia* (*Parasecia*) *gurneyi gurneyi* (Ewing) and *Euschongastia rubra* Farrell.

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	S
Fonsecia (*Parasecia*) *gurneyi gurneyi*										
Average (n=10)	64	74	30	23	17	17	29	25	43	56
Min.-Max.	62-66	70-76	28-32	20-25	15-20	15-18	26-31	22-27	39-45	53-61
Dohany (1974)	65	76	31	23	16	17	30	25	42	56
Loomis (1956)	61	72	28	22	16	15	28	23	41	48
Euschongastia rubra										
Average (n=2)	46	54	16	41	13	14	28	53	52	22
Min.-Max.	44-48	53-55	13-18	33-48	13	13-15	22-33	51-55	52	22
Farrell (1956)	48.5	61.9	15.8	33.8	11.9	20.5	33.9	59.9	59.9	25.8

*Scutal measurements were taken with an ocular micrometer with all measurements expressed in microns. The standard lengths used are: AW—distance between the bases of anterolateral setae; PW—distance between the bases of posterolateral setae; SB—distance between bases of sensillae; ASB—distance from anterior margin to sensillary bases; PSB—distance from posterior margin to sensillary bases; AP—distance between bases of anterolateral and posterolateral setae; AM—length of anteromedian setae; AL—length of anterolateral setae; PL—length of posterolateral setae; S—length of sensillae.

TABLE 4. SCUTAL MEASUREMENTS* OF *Miyatrombicula jonesae* (BRENNAN), *Leptotrombidium peromysci* VERCAMMEN-GRANDJEAN, AND *Walchia americana* EWING.

	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	S
Miyatrombicula jonesae										
Average (n=3)	51	60	20	24	23	22	28	24	20	42
Min.-Max.	44-55	55-64	18-22	22-26	22-24	22	24-31	22-26	26-31	40-44
Brennan (1952)	55	69	20	21	28	23	33	31	45	56
Loomis (1956)	54	70	20	23	30	20	32	31	46	53
Leptotrombidium peromysci										
Average (n=3)	57	66	26	24	15	19	49	34	55	60
Min.-Max.	57-59	64-48	24-26	24-26	15	18-20	48-51	33-35	55-57	53-66
Walchia americana										
(n=1)	37	62	35	24	28	31	—	24	26	—
Gould (1956)	44	73	39	20	50	31	—	25	30	—
Loomis (1956)	45	68	38	20	44	30	—	25	27	51
Dohany (1974)	46	70	41	20	48	29	—	25	27	50X10

*Scutal measurements were taken with an ocular micrometer with all measurements expressed in microns. The standard lengths used are: AW—distance between the bases of anterolateral setae; PW—distance between the bases of posterolateral setae; SB—distance between bases of sensillae; ASB—distance from anterior margin to sensillary bases; PSB—distance from posterior margin to sensillary bases; AP—distance between bases of anterolateral and posterolateral setae; AM—length of anteromedian setae; AL—length of anterolateral setae; PL—length of posterolateral setae; S—length of sensillae.

floridanus from the Gainesville area and *E. setosa* (Ewing) from a treehole in Gainesville collected in December, 1971.

Key to Species of *Euschongastia*

1. Sensillae capitate or subcapitate; palpal tibial claw 3 prongs; tibiala III present 2
1′. Sensillae ovoid; palpal tibial claw more than 3 prongs; tibiala III absent .... *setosa* (Ewing 1937)
2. Scutum with 2 crescentric ridges, 1 anterior to each pseudo stigmata .... *peromysci* (Ewing 1929)
2′. *Scutum with 3 crescentric ridges, 1 anterior to each pseudostig*mata and a 3rd extending from apices of anteriorly around the AM seta .... *rubra* Farrell 1956

Miyatrombicula:

The subgenus *Miyatrombicula* Sasa, Kawashima, and Egashira 1952, was erected within the Genus *Trombicula* Berlese for their new species *kochiensis,* which was collected very commonly from western Japan (Sasa and Ogata 1953). Brennan (1952) discussed a group of 4 species of larval chiggers including *Miyatrombicula cynos* Ewing and 3 related new species which included *M. jonesae.*

Miyatrombicula jonesae Brennan was taken from treehole samples collected from Alachua Co. This species has been previously reported from Kansas (Loomis 1956) and Illinois (Brennan 1952). The collections of *M. jonesae* were made in February, 1976. Brennan (1952) reported collections in October, 1948.

Miyatrombicula jonesae is characterized by having 3 branched setae on coxae III, by its characteristic scutal shape, and 40 or more dorsal setae. The scutal measurements of 3 specimens of *M. jonesae* are presented in Table 4.

Leptotrombidium:

The genus *Leptotrombidium* contains species that are proven vectors of scrub typhus (*Rickettsia tsutsugamushi*). It was erected by Nagayo et al. (1916) with the species, *Trombidium akamushi* Brumpt 1910 as type of the genus. It contains 3 subgenera: *Trombiculindus* Radford 1948; *Leptotrombidium* Nagayo, Miyagawa, Mitamura, and Imamura 1916 and *Ericotrombidium* Vercammen-Grandjean 1966. Most of the species of *Leptotrombidium* currently described are restricted to Asia. Only 5 species were known from North America. *Leptotrombidium peromysci* Vercammen-Grandjean was added to the list of North American "Akamushi" group and to the S.E. United States.

The diagnosis of the genus *Leptotrombidium* Nagayo, Miyagawa, Mitamura, and Imamura as described by Nadchatram and Dohany (1974) is: Palpal tarsal formula (PTF): 7 strongly barbed galeal setae. Palpal claw strongly barbed. Usually 3-pronged. Chelicera simple with a dorsal and sometimes with a ventral tooth. Eyes 2 + 2. Scutum rectangular, sparse to densely punctate. SB either anterior or posterior of line of PL's, but always

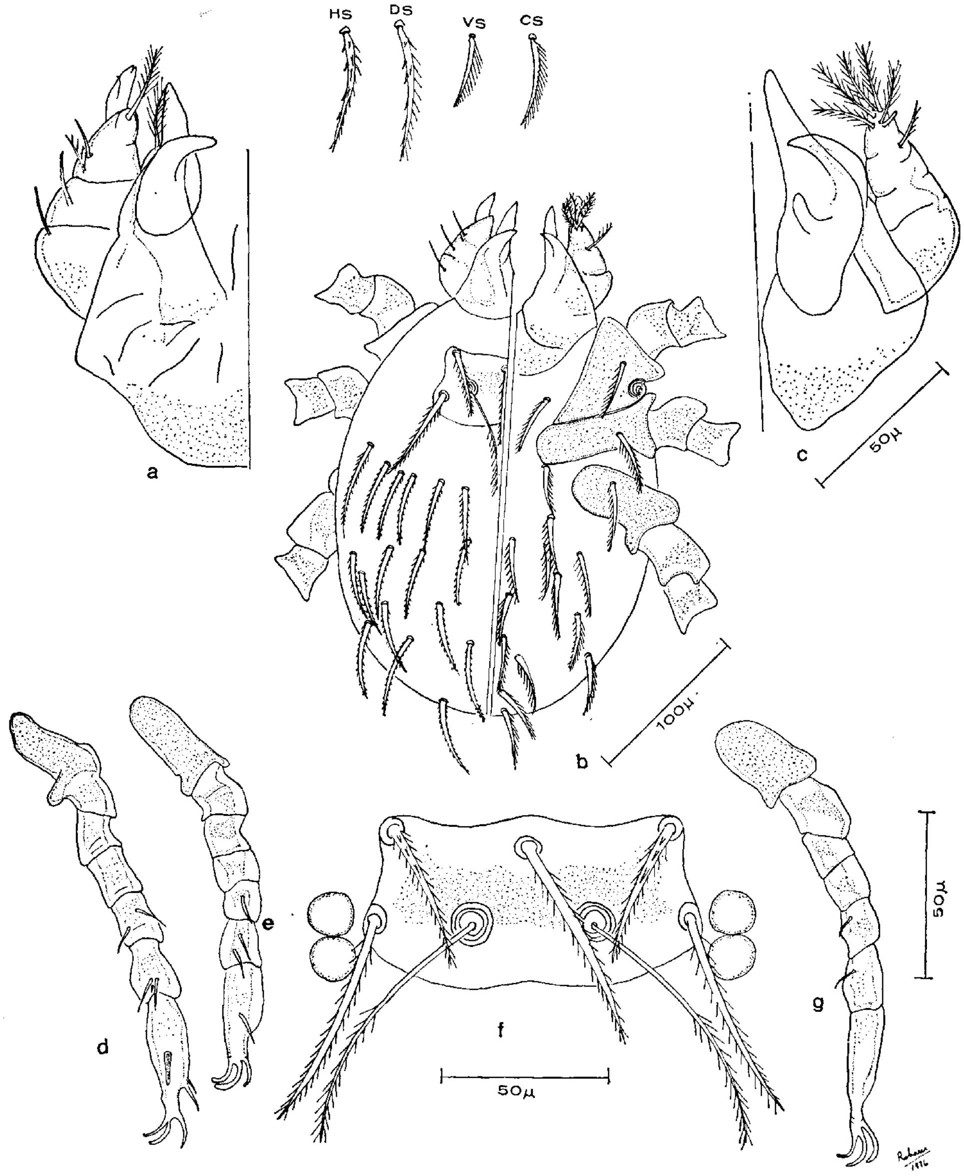

Fig. 1. Larva of *Leptotrombidium peromysci;* (a) dorsal and (c) ventral aspects of gnathosome; (b) dorsal and ventral aspects of idiosome; (d e, & g, respectively) legs I, II, and III; (f) scutum; HS = humeral seta; DS = dorsal seta; VS = ventral seta; CS = coxal seta.

nearer to PL's. AM submarginal, AL's marginal. Sensillae slender with simple barbs, legs 7-7-7 segmented; 2 genualae I. No mastisetae on any of the legs.

Leptotrombidium peromysci Vercammen-Grandjean

(Fig. 1) Larva

Scutum rectangular; punctae small, numerous and evenly distributed; region of anterior and posterior setae bare; sensillae slender, barbed at distal half; eyes 2 + 2, anterior eye equal in size to posterior eye; palpal claw 3-pronged; galeal seta barbed; palpal femoral and genual setae nude; dorsotibial setae barbed, dorsolateral setae nude, ventrotibial seta barbed; palpal formula N/N/BNB + 7B. Dorsal setae arranged 2, 10, 8, 4, 2, 4, 2 (total of 32).

Idiosoma. Idiosoma of the unengorged larva broadly oval, 165 x 163 μ; color in life orange to creamy white. Eyes 2 + 2, anterior eyes subequal to posterior eyes in diameter; when bigger, not more than 2X; easily visible.

Gnathosoma. Well sclerotized and prominently displayed; base of chelicera sparsely punctate, its blade broad at base; cheliceral blade 33 μ long, with small sharp subapical dorsal tooth. Palpal formula N/N/BNB + 7B; nude seta longest on genu; dorsotibial seta always bear more barbs (6-7) than ventrotibial (4-5); claw 3-pronged, with 2 closely appressed unequal accessory prongs. Galeal seta barbed.

Scutum. Rectangular or trapezoidal, anterior margin concave slightly, lateral margins between AL and PL straight; posterior margin shallow and slightly biconvex. Punctae medium-sized, numerous, evenly distributed in the central portion of scutum, absent in region of AM and SB line; sensillae slender with 15-16 barbs on distal half of stem; SB line to line of PL setae AM submarginal, below line of AL setae. The scutal measurements are presented in Table 4.

Body setae:

Dorsal—single pair humeral setae (HS) 55 μ; dorsal setae (DS) 40-48 μ long, arranged 2, 10, 8, 4, 2, 4, 2 = 32. HS and DS strongly ciliated.

Venter—Ventral setae (VS) short and pectinate, arranged 2, 2, 6, 9, 2, 2, 2 (total 25); VS 29-44 μ long, posterior pairs longer, 44 μ long; sternal setae 2 + 2; 42-44 μ long.

Legs—7-7-7 segmented; segments short and strongly sclerotized. Average length 700-717 μ. Coxae I-III unisetosa. Terminal claw stout, empodia slender and longer than claw.

Leg I—251-255 μ long; tarsala blunt, 13 μ long; 2 tibiala 13-14 μ, 2 genuala 15-18 μ, subterminala and parasubterminala present.

Leg II—209-220 μ long; tarsals blunt, 15 μ long; microtarsala proximal to base of tarsala; tibia with 2 tibiala, 13-15 μ long. Genu with 1 genuala 11 μ long.

Leg III—238-242 μ long. Tiba with proximal 11 μ tibiala and 5-6 barbed setae. Genu with 1 genuala 15 μ long.

Larvae collected from tree holes in Beech-Magnolia Hammock, Tall Timbers Research Station, Leon County, FL 29-XII-1975 and on 4-III-1976 by Rohani Ibrahim.

Similar to *L. myotis* Ewing 1929 in having a rectangular or subquadrate scutum. Readily separable in number and arrangement of DS 2, 10, 10, 6, 6, 4 (total 38) in *L. myotis* (Ewing 1929) and 2, 10, 8, 8, 2, 4, 2 (total 36) in *L. myotis* (Wharton 1947), and 2, 10, 8, 4, 2, 4, 2 (total 32) in *Leptotrombidium peromysci.* Further separable from this species by dissimilarity of palpal formula N/N/BNN in *myotis* and N/N/BNB in *peromysci.*

Walchia:

Walchia americana Ewing is the only species of this genus recorded from the New World. This species was originally described by Ewing (1942) from a cotton mouse (*Peromyscus gossypinus*) from Tallahassee, FL. It has been collected from numerous mammalian hosts. Loomis (1956) indicated that the species, like all of the members of the subfamily Walchiinae, seems to occur only on mammals. Two different habitats are associated with the species in this area. A single specimen was removed from an opossum collected in Alachua County on 29-IV-1974; Dohany (1974) collected 2 specimens from tree holes. The larvae have been taken from hosts in Kansas and other states from September to May (Loomis 1956).

Walchia americana can be distinguished easily by its unusual scutum, having only 4 scutal setae, 2 anterolaterals and 2 posterolaterals but always lacking the anteromedian seta; sensillae clavate. Table 4 presents the scutal measurements.

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THE SPECIES OF *DAGBERTUS* (HEMIPTERA: MIRIDAE) ASSOCIATED WITH AVOCADO IN FLORIDA[1]

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ABSTRACT

Two species of *Dagbertus* Distant are frequent on avocado in southern Florida: *D. fasciatus* (Reuter) and *D. olivaceus* (Reuter). The synonymy is elucidated and a key given for their separation *inter se* and from superficially similar mirids sometimes found on the crop.

It has long been known that some Miridae (Hemiptera) may reduce yields of avocado (*Persea americana*) in southern Florida: "Occasionally avocados have suffered serious crop injury from the attack of certain plant bugs known as mirids, closely related to the tarnished plant bug" (Ruehle 1958). The first to identify these members of the subfamily Mirinae was Wolfenbarger (1963), as *Lygus fasciatus* var. *olivaceous* Reuter and *Lygus fasciatus* var. *viridiusculus* Knight. Earlier, Bruner et al. (1945) had noted *Lygus olivaceus* on avocado in Cuba.

Kelton (1955) reviewed the genus *Lygus* Hahn, accepted the splintering of it proposed by Leston (1952) for the British species and went further in

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It has long been known that some Miridae (Hemiptera) may reduce yields of avocado (*Persea americana*) in southern Florida: "Occasionally avocados have suffered serious crop injury from the attack of certain plant bugs known as mirids, closely related to the tarnished plant bug" (Ruehle 1958). The first to identify these members of the subfamily Mirinae was Wolfenbarger (1963), as *Lygus fasciatus* var. *olivaceous* Reuter and *Lygus fasciatus* var. *viridiusculus* Knight. Earlier, Bruner et al. (1945) had noted *Lygus olivaceus* on avocado in Cuba.

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that he covered the global fauna. The 2 forms associated with avocado were transferred to *Dagbertus* Distant, an essentially neotropical genus with *Dagbertus darwini* (Butler), described from the Galapagos Islands, as type. In so doing Kelton was correct, as a comparison of the genitalia of the avocado bugs with those figured for other *Dagbertus* species indicates. However, the figures given by Kelton of the male genitalia of *D. olivaceus* Reuter and *D. fasciatus* Reuter, while agreeing closely with those of the avocado species, do not fit the genitalia of the mirids described under these 2 names; in fact, Kelton had the 2 confused. This had as consequences the later description of a new species by Maldonado Capriles (1969), which now is reduced to synonymy. Another problem (Kelton 1974) was the erroneous equating of *Dagbertus hospitus* Distant with *D. olivaceus*, with the latter a junior synonym; in fact *hospitus* is a junior synonym of *D. fasciatus*. Following is the corrected synonymy of the 2 avocado *Dagbertus* species:

1. *Dagbertus fasciatus* (Reuter), 1876.
    - *Lygus* (*Lygus*) *fasciatus* Reuter 1876: 72 (SC)[2]
    - *Lygus hospitus* Distant 1893: 434 syn. nov. (Mexico)
    - *Lygus fasciatus* Van Duzee 1917: 343
    - *Lygus fasciatus* Knight 1917: 601
    - *Lygus olivaceus* var. *viridiusculus* Knight 1917: 600 (MA)
    - *Lygus fasciatus* Knight 1923: 579
    - *Lygus fasciatus* var. *viridiusculus* Knight 1923: 580
    - *Lygus fasciatus* Blatchley 1926: 761 *partim*
    - *Dagbertus olivaceus* Kelton 1955: 285 *nec* Reuter
    - *Dagbertus fasciatus* Carvalho 1959: 80
    - *Lygus hospitus* Carvalho 1959: 121
    - *Lygus fasciatus* var. *viridiusculus* Wolfenbarger 1963: 29
    - *Dagbertus parafasciatus* Maldonado Capriles 1969: 36 syn. nov. (Puerto Rico)
    - *Dagbertus hospitus* Kelton 1974: 378
2. *Dagbertus olivaceus* (Reuter), 1907.
    - *Lygus olivaceus* Reuter 1907: 6 sp. res. (Jamaica)
    - *Lygus olivaceus* Van Duzee 1909: 127
    - *Lygus olivaceus* Barber 1914: 501
    - *Lygus olivaceus* Van Duzee 1917: 344
    - *Lygus olivaceus* Knight 1917: 599
    - *Lygus fasciatus* Blatchley 1926: 761 *partim*
    - *Lygus olivaceus* Bruner, Scaramuzza and Otero 1945: 129
    - *Lygus olivaceus* Barber 1954: 15
    - *Dagbertus fasciatus* Kelton 1955: 285 *nec* Reuter
    - *Dagbertus olivaceus* Carvalho 1959: 80
    - *Lygus fasciatus* var. *olivaceous* (sic!) Wolfenbarger 1963: 29
    - *Dagbertus olivaceus* Maldonado Capriles 1969: 37

Two systematic problems remain, both outside the scope of the present study: 1) the status and identity of *Lygus hospitus* var. *sonoraensis* Van Duzee 1923, described from Lower California; and 2) the status of the New England bugs currently equated with *D. fasciatus*.

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[2] Abbreviations recognized by the U.S. Post Office are used for names of states in the U.S.

The following key covers members of the subfamily Mirinae found by the writer on avocado in the Homestead area of Dade County and/or associated with the tree by Wolfenbarger (1963).

1\. Larger, over 6.5 mm long; 1st antennal segment densely and coarsely pilose; color yellow to brown with darker markings .... *Neurocolpus nubilus* (Say)

1'. Smaller, less than 5.5 mm long; 1st antennal segment not as above 2

2\. Antennae largely black; pronotum and scutellum with black or dark brown markings; without golden pubescence; bugs 4.8 mm or more long .... *Lygus lineolaris* (Palisot de Beauvois)

2'. Not marked as above; bugs less than 4.8 mm long 3

3\. More or less uniformly pale green, without a conspicuous dark patch at the internal apical angle of the corium; bugs 4.2 mm or more long .... *Taylorilygus apicalis* (Fieber)

3'. Not uniformly pale green; bugs less than 4.2 mm long 4

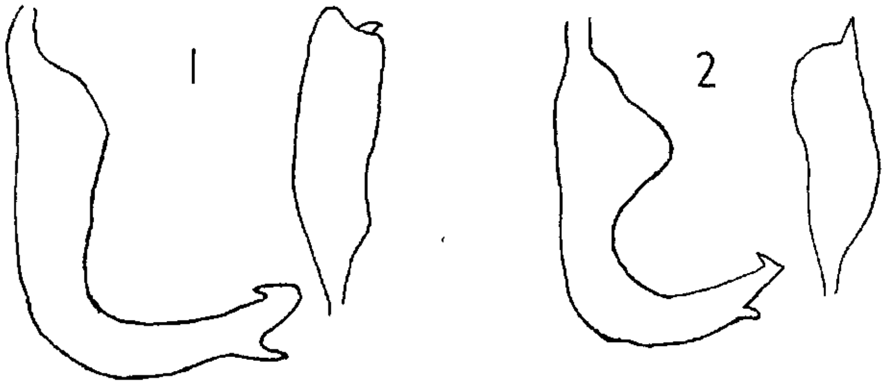
4\. Dark brown to black, covered with coarse, flat, golden pubescence; antennae brown, 2nd segment black at the apex .... *Polymerus cuneatus* (Distant)

4'. Green to brown, with darker (but not black) markings; coarse, flat, golden pubescence lacking 5

5\. Second antennal segment black at the apex; scutellum mostly unicolorous, with some reddening at the margins and apex; pronotum without a transverse dark band; paraclypeus unmarked; male genitalia as Fig. 1. .... *Dagbertus olivaceus* (Reuter)

5'. Second antennal segment unicolorous; scutellum with a conspicuous brown patterning; pronotum with a transverse dark band posteriorly; paraclypeus with a bright red transverse band apically; male genitalia as Fig. 2 .... *Dagbertus fasciatus* (Reuter)

Polymerus cuneatus (Distant). *Taylorilygus apicalis* (Fieber) and the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), are associated with weeds common in and around avocado groves and at dispersal times can be found in ones or twos upon the tree: they neither feed nor breed



Figs. 1-2. Male claspers of 1) *Dagbertus olivaceus* (Reuter); and 2) *Dagbertus fasciatus* (Reuter).

upon avocado, and their presence thereon is purely adventitious. *Neurocolpus nubilus* (Say) sometimes occurs in numbers, but its occurrence is too sporadic for it to be considered a pest at present. Outside of the subfamily Mirinae a dark brown *Rhinocloa* species, subfamily Phylinae, is found frequently on avocado, but its status is so far unelucidated.

ACKNOWLEDGMENTS

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STUDIES OF THE HOST PLANT SUITABILITY OF *ARDISIA SOLANACEA*[1] AND *CITRUS JAMBHIRI*[2] FOR CITRUS BLACKFLY[3] AND CITRUS WHITEFLY[3,4]

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Abstract

Ardisia solanacea Roxb. was comparable to rough lemon, *Citrus jambhiri* Lush., in the number of eggs of citrus blackflies, *Aleurocanthus woglumi* Ashby, per plant. Survival of citrus blackflies was greater ($P < 0.05$) on *A. solanacea* than on *C. jambhiri*. Citrus whiteflies, *Dialeurodes citri* (Ashmead), oviposited on *C. jambhiri* but not on *A. solanacea*. *Ardisia* spp. could serve as a reservoir for citrus blackflies where control measures against this insect are restricted to citrus.

The citrus blackfly, *Aleurocanthus woglumi* Ashby, infests citrus in southeastern Florida and other regions of the world. The insect lays eggs in spiral-shaped clusters on undersides of leaves. If the plant upon which eggs have been laid is a suitable host, the insects complete the development of their immature stages on the leaves, and emerge as adults through T-shaped slits in the exoskeleton of the fourth instar nymphs (Dietz and Zetek 1920, Gowdy 1921). In Florida, citrus blackflies oviposit on at least 115 plant species (David Colbert[5] personal communications; Dowell et al. 1979) and has been observed to complete its development to adulthood on species of 19 genera in 12 families (Howard and Neel 1978, R. V. Dowell[6] unpublished data).

The citrus blackfly has been reported to prefer citrus species as hosts (Angeles et al. 1972, Clausen and Berry 1932, Howard and Neel 1978, Shaw 1959). However, Dietz and Zetek (1920) reported, apparently on the basis of their general observations, that *Ardisia revoluta* HBK (Myrsinaceae) was preferred over citrus species as a host of citrus blackfly in Panama. Marlberry, *Ardisia escallanoides* Schlecht. and Chamb., a native to Florida, is apparently a highly favorable host (Howard and Neel 1978).

Two additional aleyrodids, the citrus whitefly, *Dialeurodes citri* (Ashmead) and the cloudy-winged whitefly, *D. citrifolii* (Morgan) are common on citrus in southeastern Florida and often contaminate research colonies of citrus blackfly. Thus, it is of interest to find a host of citrus blackfly that is not a host of other aleyrodids. This repórt presents results of an experiment

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[1] Myrsinaceae.

[2] Rutaceae.

[3] Aleyrodidae.

[4] Florida Agricultural Experiment Station Journal Series No. 1690. Revised copy received for publication 1 August 1979.

[5] Division of Plant Industry, Florida Department of Agriculture and Consumer Services, P. O. Box 1269, Gainesville, FL 32601.

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in which *Ardisia solanacea* Roxb., an Asian species naturalized in Florida, was tested to determine its suitability as a host of citrus blackfly and citrus whitefly.

MATERIALS AND METHODS

Rough lemon, *Citrus jambhiri* Lush., was chosen as a standard for comparison of host suitability for citrus blackfly, because in a previous study it was found to support greater survivorship of this insect than 5 other citrus species tested (Howard 1979). The rough lemon plants were obtained as bare root seedlings from the Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Winter Haven. They were potted and grown for 8 weeks without application of insecticides.

Ardisia solanacea was grown from seed obtained from Fairchild Tropical Garden, Miami. No insecticides were applied. During the year preceding the experiment, aleyrodids were not observed on these plants. Plants of both species were grown in a shade house in Fort Lauderdale in potting mix consisting of equal parts of muck, sharp sand, and cypress sawdust in plastic pots 15 cm in diameter. Plants were watered and fertilized to promote rapid growth.

Potted seedlings of both species, each about 0.3 m tall and with about 30 leaves were examined on 26 May 1978 and were free of aleyrodids. Seven plants of each species were arranged in a randomized block under a citrus tree with a very heavy infestation of citrus blackflies and were exposed from 26 May to 7 June, after which they were transferred to a screened enclosure. Leaves were examined on 7 June to determine the number of egg clusters of citrus blackflies per plant and the number of eggs per cluster. On 20 July, the number of citrus blackflies that had developed on each plant was determined by counting the number of fourth instar nymph exoskeletons with T-shaped emergence slits.

Ten plants each of *A. solanacea* and *C. jambhiri* which were free of aleyrodids were placed in a randomized block outdoors under a lemon tree with a high infestation of citrus whiteflies. After 2 weeks of exposure, the plants were examined for eggs of citrus whiteflies.

The significance of differences in mean egg clusters of *A. woglumi* per plant, mean eggs per cluster, mean adults developed per plant, and survivorship indices were determined by Student's t-test. The survivorship index per plant was calculated by dividing the number of adults that developed by the number of egg clusters observed previously on the same plant.

RESULTS AND DISCUSSION

Ardisia solanacea was a more favorable host of citrus blackfly than *C. jambhiri* in that the survival index was about 5 times higher on the former than on the latter (Table 1). Of the citrus species studied, lemons and limes were shown to be highly favorable hosts of citrus blackfly (Dowell et al. 1978, Howard, 1979). Thus, *A. solanacea* compares well with citrus as a host of this species.

There was an average of 96.8 citrus whitefly eggs per leaf on *C. jambhiri* and no eggs on *A. solanacea* when they were simultaneously exposed to an infested lemon tree.

TABLE 1. OVIPOSITION, DEVELOPMENT, AND SURVIVAL OF *Aleurocanthus woglumi* ASHBY ON *Ardisia solanacea* ROXB. COMPARED TO *Citrus jambhiri* LUSH.

Host species	Eggs/ spiral cluster	Egg clusters/ plant	Mean no. adults developed/ plant*	Std. error	Mean survival index**	Std. error
Ardisia solanacea	30.7a†	89.9a	131.6a	26.6	1.71a	0.25
Citrus jambhiri	32.0a	85.7a	31.7b	11.2	0.35b	0.10

* Determined by the number of fourth instar exoskeletons with adult emergence slits.

**Calculated by dividing the number of adults developed per plant by the number of egg clusters oviposited previously on the same plant.

†Within a column values not followed by the same letters are significantly different ($P < 0.05$) by Student's t-test.

By using *A. solanacea* as a host plant, high populations of citrus blackflies free of contamination by citrus whiteflies may be maintained. This may be used to advantage in studies in southeastern Florida requiring pure cultures of citrus blackfly and in mass-rearing of citrus blackflies and their parasitoids for biological control. Whether *A. solanacea* is a host of cloudy-winged whitefly has not been investigated.

Ardisia solanacea is planted in southern Florida as an ornamental, and has become naturalized in the Miami area. Along with native marlberry and other non-citrus hosts (Howard and Neel 1978, Dowell et al. 1979), *A. solanacea* could serve as a source of reinfestation where citrus blackflies are controlled by chemical treatments of citrus. Recently, however, citrus blackflies have been under biological control in southeastern Florida (R. H. Cherry[6] personal communications) and the emphasis on chemical control of this insect has been curtailed.

ACKNOWLEDGMENT

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BIOLOGY, HOST SPECIFICITY, AND DESCRIPTIONS OF THE IMMATURE STAGES OF *LIPOSTEMMATA MAJOR* ASHLOCK AND *L. HUMERALIS* BERG (HEMIPTERA: LYGAEIDAE)[1]

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ABSTRACT

Lipostemmata humeralis Berg and *L. major* Ashlock are recorded from Trinidad. Screening tests indicate that both are restricted to the aquatic fern *Salvinia auriculata* Aubl. The immature stages are described and the 5th instar of *L. major* is illustrated.

The genus *Lipostemmata,* without reference to species, was reported as occurring in Trinidad by Bennett (1975). Here we first record the occurrence of *L. humeralis* Berg and *L. major* Ashlock in Trinidad. Since laboratory-grown plants of its host, the aquatic fern *Salvinia auriculata* Aubl., deteriorated within 6-8 weeks when exposed to low numbers of adults of either species, we felt that the low priority assigned to *Lipostemmata humeralis* (as *purpurata* Distant, a junior synonym) as a potential control agent by Bennett (1966) merited reconsideration, particularly in situations where *Salvinia* was already under stress from other agents. Also, as the immature stages were previously unknown, detailed descriptions were prepared.

DISTRIBUTION IN TRINIDAD

Both species were first collected in south Trinidad, Victoria Co. (VIII-1975) near Debe and more recently *L. major* was collected at the edge of the north range St. George Co. (11-IV-1978) in the Guanapo Valley; (22-

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Distribution in Trinidad

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II-1979) south of Churchill-Roosevelt Highway, San Juan; Nariva Co. 16-II-1979, Nariva Swamp. We have also collected *L. major* in a blacklight trap located at the Commonwealth Institute of Biological Control, Curepe (St. George Co.) from VII through X-1978.

BIOLOGY

Unlike most Rhyparochrominae, *Lipostemmata humeralis* and *L. major* are unusual in that they are not seed feeders; rather they feed directly upon leaf tissues.

Both species deposit their eggs on the upper surface of *Salvinia* leaves between the basket hairs (Fig. 1). The early instars are sedentary, usually not moving unless disturbed. The later instars are more active, and certainly unique for lygaeids, later instars as well as the adults will move when disturbed to the underwater portion of these floating plants, where they may remain attached to the lower leaf surface or roots for several minutes. We have not observed them moving freely underwater except when clinging to plants. When separated from the plants or when submerged and released they immediately rise to the surface.

At 25-27°C eggs of *L. humeralis* hatch in 8-10 days; those of *L. major*

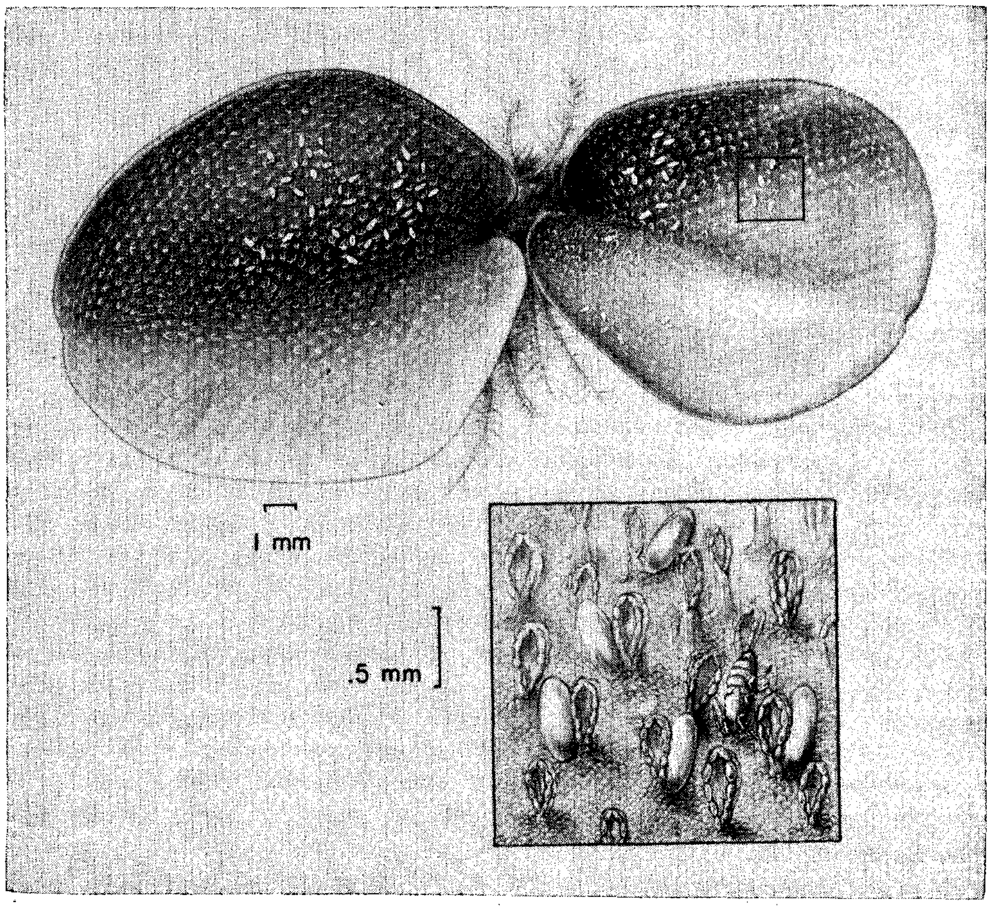

Fig. 1. *Salvinia auriculata* Aubl. with eggs and 1st instar of *Lipostemmata*.

require 10-12 days. The duration of the 1st instar for both species was 2-3 days with the remaining instars each lasting 6-14 days. Of collections made in August, 1975, *L. humeralis* was much more abundant than *L. major.* In collections from the same area (near Debe) in July and August 1978 *L. major* was considerably more abundant; in some collections it was the only species present. This might represent a species displacement responding to ecological change or a temporary population shift. Interestingly, under laboratory conditions, *L. humeralis* was easier to maintain.

HOST RECORDS AND HOST SPECIFICITY TRIALS

Bennett (1966) reported the association of *Lipostemmata humeralis* with *Salvinia auriculata* when searching for natural enemies of *Salvinia* spp. in the Neotropics to control *S. molesta* D. S. Mitchell on Kariba Lake. In his revision of the genus *Lipostemmata,* Ashlock (1970) listed 1 specimen of *L. major* that was labeled as taken on *Agave.* Schnack (1972, 1973) recorded *L. humeralis* from various aquatic weeds. We know of no other references pertaining to host information or biology of *Lipostemmata* spp.

In 1976 we encountered breeding populations of *L. humeralis* and *L. major* on *S. auriculata* in south Trinidad. At 1 location (Mohess Trace near Debe) where *S. auriculata* and *S. sprucei* Kuhn. were growing together we did not find either species of *Lipostemmata* on *S. sprucei.* As attempts to breed both species on *Salvinia minima* Baker [*rotundifolia* Wield. of some authors] were unsuccessful, we undertook a series of experiments to ascertain the host range of these lygaeids. Certain of the trials were conducted in Florida and others in Trinidad as host plant material became available during 1975-77.

MULTIPLE CHOICE TRIALS: After stocking an aquarium with *Salvinia auriculata, S. sprucei, Azolla ficuloides* Lam., *Lemna perpusilla* Torr., *Wolffiella lingulata* (Hegelm.) Hegelm. and *Pistia stratiotes* L. (plants with 4-8 leaves) a mixed population of 300-500 field collected adults and nymphs of *L. humeralis* and *major* was added. Observations were made several times daily for 5 successive days at 3 intervals during a 3 month period. Although adults and nymphs were noted occasionally on plants other than *S. auriculata,* they seldom remained stationary for more than a few minutes and usually moved rapidly onto *S. auriculata.* This was in marked contrast to their behaviour on *S. auriculata* where both adults and nymphs remained stationary or moved only a few millimeters over the course of several hours. when added to the aquarium, clean plants of *S. auriculata,* were infested by the following day even when separated by several centimeters from other plants.

OPEN CAGE TESTS: Nine circular plastic containers (10 cm diameter) were each filled with water to within 1 cm of the brim and stocked with: (1) a mixture of *Lemna perpusilla* and *Wolffiella lingulata* (3 containers), (2) *Azolla ficuloides* (2 containers), (3) *S. sprucei,* (4) *S. auriculata* and (5) *Pistia stratiotes* (2 containers). The containers were positioned randomly in an open aquarium but in such a way that each was in direct contact with at least 2 of the others. Each container was stocked with 10 individuals randomly picked out of a mixed culture of both insect species. The aquarium was filled with water to the same level as the plastic containers. A few plants of *L. perpusilla* and *W. lingulata* were placed between the containers to serve as resting spots for adults or nymphs that moved out of the containers.

On the 4th day all adults and nymphs were counted. Two nymphs were present on *A. ficuloides*, 1 adult on *P. stratiotes*, and 22 nymphs and 29 adults on *S. auriculata*. A few dead specimens were present on *Lemna* and *Azolla;* it is assumed that the remainder escaped from the aquarium.

FORCED FEEDING TRIALS: Ten 1st instar nymphs less than 24 hours old of each species were placed on *Salvinia minima*, *S. sprucei*, *S. molesta*, *S. auriculata* and *A. ficuloides*. Four to 6 pairs of adults of each species were also placed on each plant species. All trials were not conducted simultaneously, but *S. auriculata* was included in each test. Observations were made daily.

Within 48 hours all 1st instar nymphs except those placed on *S. auriculata* were dead or had molted; those that attained the second instar died the next day. Adults did not survive longer than 72 hours on any of the plants except *S. auriculata.*

DESCRIPTION ON IMMATURE STAGES

Lipostemmata major Ashlock

Fifth instar (Fig. 2).—Body elongate, ovoid, head, pronotum and wing pads nearly uniformly dark brown; a pale spot on either side of mid line of pronotal disc and at base of wing pads; eyes red; abdomen pale brown except for margin and area around scent gland openings dark brown; legs and antennae pale brown; head length 0.28[2], width 0.44, interocular space 0.28; pronotum length 0.44, width 0.80, wing pad length 0.76; abdomen length 1.04; labial segments I 0.28, II 0.24, III 0.22, IV 0.26 long, respectively; antennal segments I 0.12, II 0.22, III 0.20, IV 0.30 long, respectively; total length 2.28.

Fourth instar—General form and color as in preceding but somewhat lighter; head length 0.24, width 0.28, interocular space 0.22; pronotum length 0.36, width 0.52; wing pad length 0.36; abdomen length 0.76; labial segments I 0.20, II 0.18, III 0.16, IV 0.20 long, respectively; antennal segments I 0.10, II 0.16, III 0.16, IV 0.22 long, respectively; total length 1.6.

Third instar—General form and color as in preceding; head length 0.22, width 0.28, interocular space 0.16; pronotum length 0.18, width 0.40; wing pad length 0.18; abdomen length 0.66; labial segments I 0.14, II 0.12, III 0.10, IV 0.14 long, respectively; antennal segments I 0.08, II 0.12, III 0.10, IV 0.20 long, respectively; total length 1.24.

Second instar—General form as in preceding; abdomen yellowish, thorax light tan, legs and antennae straw colored; head length 0.16, width 0.24, interocular space 0.16; pronotum length 0.14, width 0.30; abdomen length 0.40; labial segments I 0.12, II 0.10, III 0.10, IV 0.12 long, respectively; antennal segments I 0.06, II 0.10, III 0.10, IV 0.20 long, respectively; total length 0.86.

First instar—General form and color as in preceding; head length 0.14, width 0.20, interocular space 0.14; pronotum length 0.12, width 0.30; abdomen length 0.34; labial segments I 0.08, II 0.06, III 0.08, IV 0.12;

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[2] All measurements are in mm.

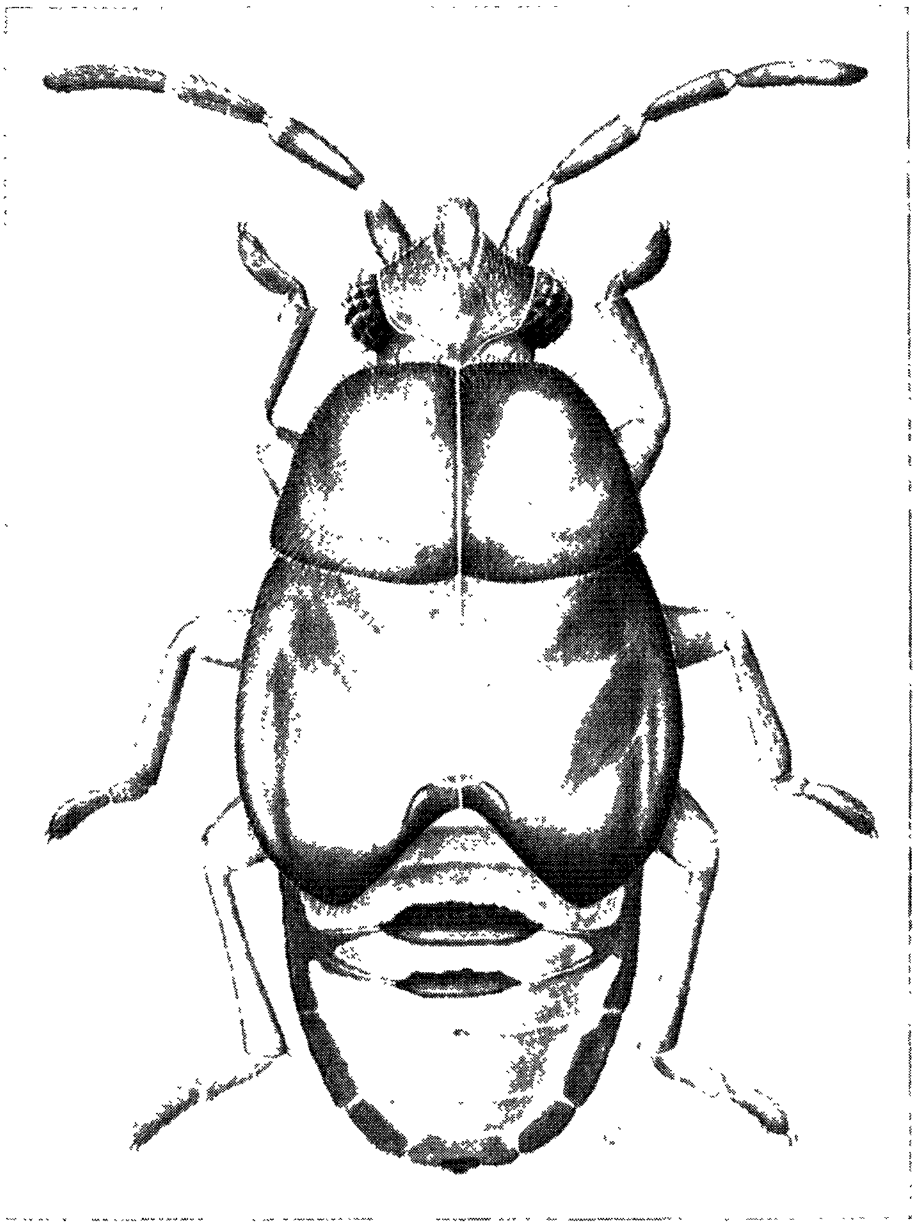

Fig. 2. *Lipostemmata major* Ashlock, 5th instar, dorsal view.

antennal segments I 0.04, II 0.06, III 0.06, IV 0.14 long, respectively; total length 0.76.

Egg—Oval, cream colored, somewhat narrower at the micropylar end; no processes evident, chorion smooth; length 0.52, width 0.32.

Lipostemmata humeralis Berg

Fifth instar—Body elongate oval, head pronotum and wing pads brown, a pale spot on either side of mid line of pronotal disc and at base of wing pads; eyes red; abdomen dull yellow except for margin and area around scent gland openings tan; legs dull yellow, antennae somewhat darker. Generally similar to *major* but lighter and smaller; head length 0.24, width 0.40, interocular space 0.24; pronotum length 0.28, width 0.68; wing pad length 0.64; abdomen length 0.96; labial segments I 0.20, II 0.20, III 0.16, IV 0.20 long, respectively; antennal segments I 0.12, II 0.18, III 0.18, IV 0.26 long, respectively; total length 1.92.

Fourth instar—Form and color as in preceding but somewhat lighter; head length 0.18, width 0.30, interocular space 0.16; pronotum length 0.22, width 0.50; wing pad length 0.26; abdomen length 0.72; labial segments I 0.14, II 0.12, III 0.12, IV 0.14 long, respectively; antennal segments I 0.08, II 0.14, III 0.12, IV 0.20, long, respectively; total length 1.30.

Third instar—Form and color as in preceding; head length 0.20, width 0.24, interocular space 0.16; pronotum length 0.26, width 0.32; wing pad length 0.12; abdomen length 0.52; labial segments I 0.12, II 0.10, III 0.08, IV 0.12 long, respectively; antennal segments I 0.08, II 0.08, III 0.08, IV 0.16 long, respectively; total length 1.10.

Second instar—Similar in shape to preceding, yellow-orange in general color; head length 0.13, width 0.20, interocular space 0.14; pronotum length 0.12, width 0.26; abdomen length 0.40; labial segments I 0.10, II 0.08, III 0.08, IV 0.10 long, respectively; antennal segments I 0.06, II 0.06, III 0.08, IV 0.16 long, respectively; total length 0.76.

First instar—Similar in shape and color to preceding; head length 0.12, width 0.16, interocular space 0.10; pronotum length 0.12, width 0.24; abdomen length 0.32; labial segments I 0.08, II 0.06, III 0.06, IV 0.08 long, respectively; antennal segments I 0.06, II 0.06, III 0.04, IV 0.14 long, respectively; total length 0.68.

Egg—Oval, cream colored, chorion smooth; length 0.50; with 0.28.

Sweet (1964) stated the number of micropylar processes varies from 3 to 12 in the Rhyparochrominae. Cobbin (1968) indicated that the number varies within the Lygaeidae from 3 to 15. The eggs of both species of *Lipostemmata* are apparently unique as no micropylar processes were found. One may speculate that this is another character that supports the primitive position of the genus (Ashlock 1970).

DISCUSSION

Ashlock's (1970) record of an adult of *Lipostemmata major* from *Agave* sp. can be regarded as a casual association. The records from various aquatic plants by Schnack (1972, 1973) resulted from observation that extended over several months and suggest that *L. humeralis* was taken regularly from samples of *Azolla ficuloides* and *Lemna minima* Philippi as well as from *Salvinia rotundifolia*. Our studies did show that adults and large nymphs, when disturbed, seek refuge on other plants; this might provide an explanation that could account for the movement of *L. major* onto non-host plants. While his studies indicate the presence of *L. major* on other plants, Schnack (1972, 1973) did not provide evidence that *L. major* was breeding on these.

One of our goals was to ascertain whether *Lipostemmata* spp. were suitable agents for biological control of *S. molesta*. We consider on the basis of our field observations and screening tests that the Trinidad populations of both species of *Lipostemmata* are highly stenophagous. Our tests indicated that neither species will develop on that species (*molesta*) which is considered to be a serious aquatic weed in many parts of the world. However, we do not discount the possibility that other species or populations of *Lipostemmata* that will attack *S. molesta* may occur in South America.

ACKNOWLEDGMENTS

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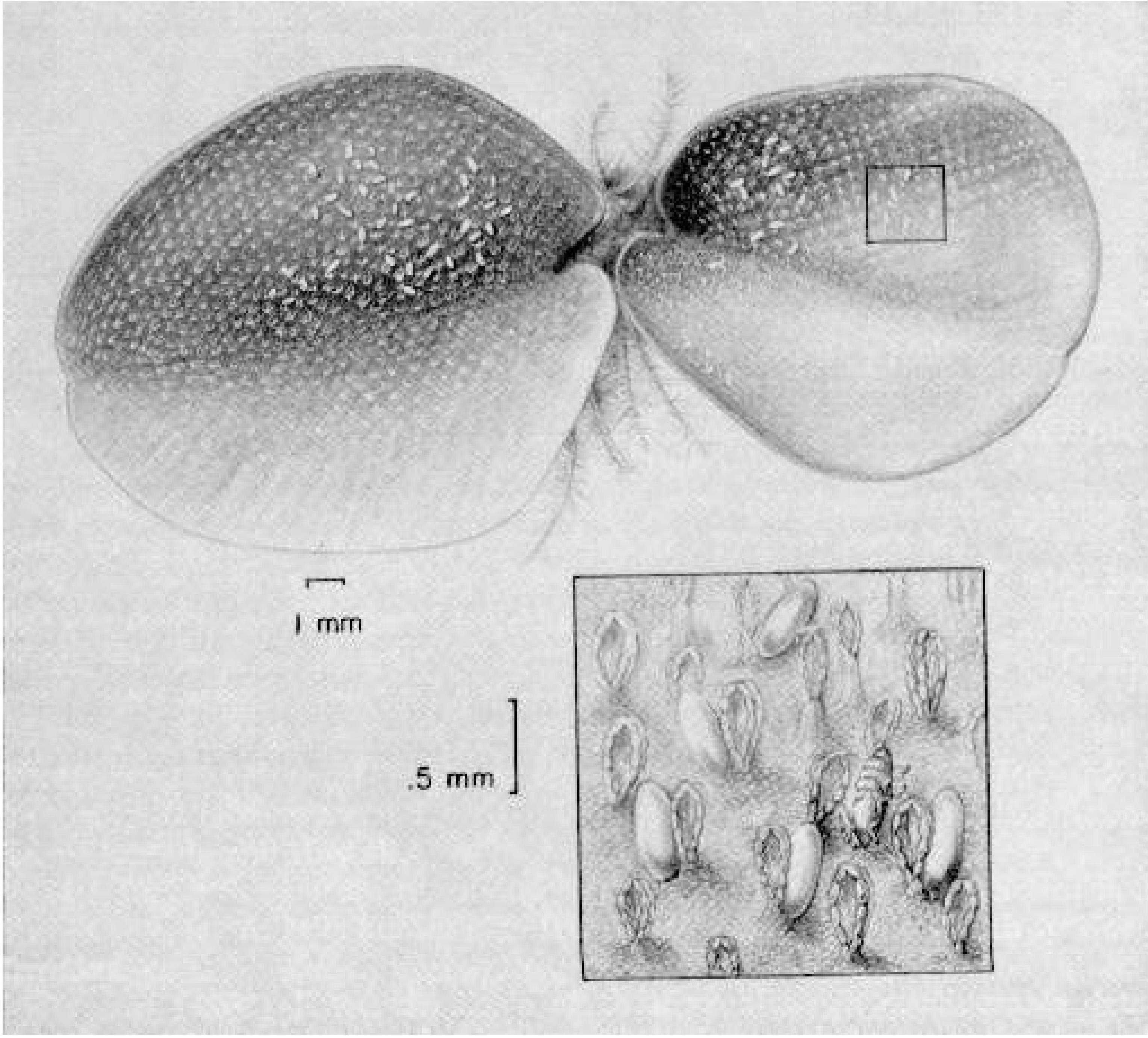
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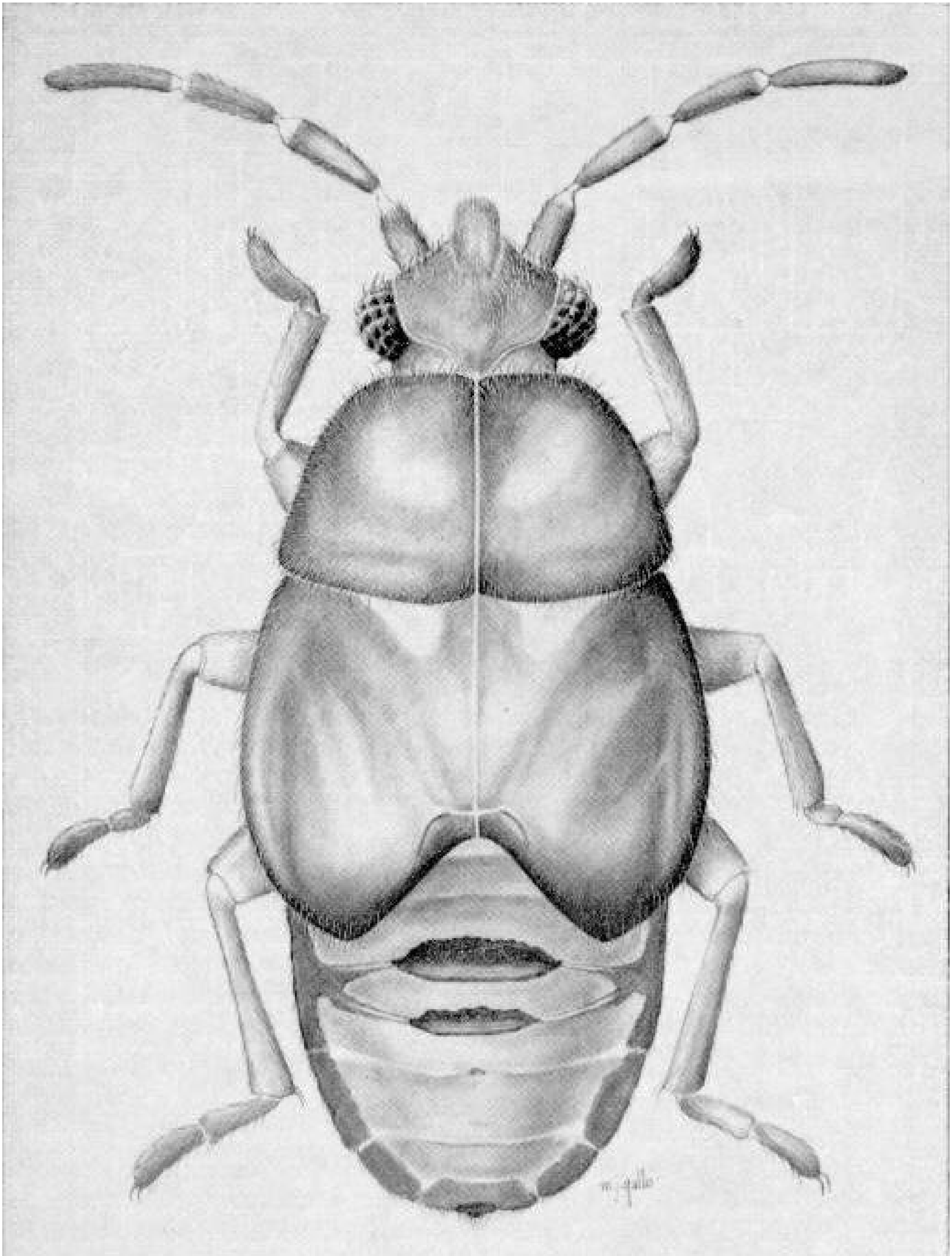
m. gallo

SOIL INJECTION OF INSECTICIDES FOR CONTROL OF CITRUS BLACKFLY IN DOORYARD CITRUS[1, 2]

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ABSTRACT

We studied the effects of 3 soil injected systemic insecticides for control of both high and low density *Aleurocanthus woglumi* Ashby infestations on citrus in an urban environment. Acephate injected at 3 rates provided acceptable levels of control while oxydemetonmethyl and dimethoate did not produce significant control. Presence of acephate and its metabolite methamidophos in citrus leaves was confirmed through the use of temperature programmed gas chromatography. Aggregated field mortality data suggested that the soil injection approach would be more consistent with developing management strategies rather than as a component of more absolute goals such as eradication. The lack of spray drift and the highly localized nature of application can make soil injection a potentially valuable insect management tool in highly urbanized environments.

The citrus blackfly, *Aleurocanthus woglumi* Ashby, has been regarded as an important pest of citrus in many parts of the world. It has been a problem in parts of Mexico for many years (Cooper and Plummer 1950, Enkerlin 1974) and has been found in the United States in Texas (Smith et al. 1964) where it is now established. *Aleurocanthus woglumi* was first found in Key West, FL in 1934 and was eradicated through the use of chemical sprays by 1937 (Newell and Brown 1939). In 1976, it was found infesting nursery stock and dooryard citrus in the Fort Lauderdale area; research is currently underway to develop means of controlling this insect in Florida. One of the goals of this research is to develop application approaches that are both effective and safe for use in highly urbanized settings where citrus is confined to residential areas. Research on certain types of foliar treatments has been published elsewhere (Reinert 1976, Reinert and Fitzpatrick 1977, Vaughan and Fitzpatrick 1978, Rhode and Sanchez 1977). The specific purpose of this research was to evaluate both the performance of 3 systemic insecticides applied by soil injection for *A. woglumi* control as well as the applicability of the technique for use in highly urbanized areas.

METHODS AND MATERIALS

The field experiments were conducted at 2 separate sites. The first took place in Oakland Park, FL, in February-April 1977. The second experiment was conducted in Pompano Beach, FL, in October-November 1977. The citrus

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[1] Florida Agricultural Experiment Station Journal Series Number 695.

[2] This paper reports research involving chemical insecticides. It does not include recommendations for their use nor does it imply that uses discussed here have been registered. All uses of insecticides must be registered by appropriate State or Federal agencies, or both, before they can be recommended.

trees used in both experiments were of mixed species and varieties within species and were all situated in dooryards in highly urbanized areas.

The *A. woglumi* infestation level in the first experiment was high, with a median of 51 nymphs/infested leaf. In the second experiment the levels were lower, with a median of 6 nymphs/infested leaf. The low density in this group was due primarily to parasitization by *Amitus hesperidum* Silvestri, which had been introduced into Florida along with 2 other parasites of *A. woglumi* during 1976 (Hart et al. 1978). In the time span between the first and second experiment, levels of *A. hesperidum* had increased to a level great enough to exert a significant effect on the *A. woglumi* populations.

In the first experiment, acephate was applied at 3 rates (2, 4, and 6 g AI/cm trunk diameter) and oxydemetonmethyl and dimethoate were applied at 1 rate (4 g AI/cm diameter). In the second experiment, acephate only was applied at the above-mentioned 3 rates. In the first experiment, each treatment was applied to 5 randomly selected trees, and in the second, 8 trees received each treatment.

Insecticide suspensions were prepared in such a manner that, for any of the rates used, a volume of 5 liters/cm trunk diameter would be injected. Therefore, trees of the same size would receive the same total volume of toxicant suspension. By following this procedure, it was possible to minimize any effect attributable to disproportionate volumes injected under trees of similar size. Treated trees received an average of 86.2 liters of insecticide mix, with a range of 33.7 to 286.9 liters.

Insecticides were applied by a hydraulic sprayer operating at ca. 18 kg/cm^2 and equipped with a flow meter and a deep root soil injection nozzle which released the suspensions in the root zone ca. 25 cm below the soil surface. Multiple injections were made in 4 liter aliquots in a circular pattern under and within the drip line of each tree until the total volume of insecticide suspension appropriate to each tree's diameter was applied. Spacing between injections varied according to the diameter of the trees, but injections were generally made ca. 1-1.5 m apart.

Populations were estimated by randomly sampling only the newest flush foliage on each tree. Since female *A. woglumi* tend to aggregate and oviposit on the newer foliage, this sampling technique assured collection of viable nymphs.

Leaves were collected, placed in plastic bags, and quickly transported to the laboratory where viability of II, III, and IV instar nymphs was determined by microscopic examination. Each individual nymph was probed and if body fluids were present, it was considered to be alive. This was the same sampling procedure used in other insecticide studies involving *A. woglumi* (Reinert and Fitzpatrick 1977, Fitzpatrick et al. 1979). Data on eggs, I instars, and adults were not taken, since viability is difficult to determine accurately in the former 2 instances, and an efficient sampling scheme for adults has yet to be developed.

Insects were sampled during the 2-week period prior to treatment, 2 weeks after treatment, and 4 weeks after treatment. Female *A. woglumi* oviposit ca. 30 eggs in a spiral pattern on the underside of the host leaves. This ovipositional pattern, combined with the tendency for several females to congregate on the same leaf causes a highly aggregated distribution of nymphs both on and among leaves. Therefore, the normality assumptions appropriate to parametric statistical analyses could not be assured. For this reason, we analyzed numbers of nymphs/infested leaf using the Wilcoxon rank sum test, a distribution-free procedure (Hollander and Wolfe 1973).

Presence of acephate and its metabolite, methamidophos, in citrus leaves was determined in the second experiment by gas chromatographic analysis. As soon as the leaves used in the nymphal viability determinations had been examined (normally the same day they were picked, but occasionally 1 day after) they were placed in a freezer (—20°C) until residues were analyzed. Five grams of leaves were extracted 3 times in 100 ml of ethyl acetate with 15 g Na_2SO_4. The resulting extract was filtered and then evaporated to dryness; the residue was dissolved in methyl isobutyl ketone. Samples were quantified by injection into a gas chromatograph (Tracor Model 222) with 150°C oven temperature. At 0.5 minutes after injection, a program was initiated elevating the column temperature to 200°C at 20°C/min. Inlet and flame photometric detector temperatures were 200°C and 160°C, respectively. The glass column was ca. 1 m in length, 2 mm ID and packed with 1% Reoplex 400 on 80/100 mesh Gas Chrom Q. The extraction and quantification procedures were modifications of earlier published protocols (Leary 1974, Nigg et al. 1979). The limit of detectability was ca. 0.10 ppm for acephate and ca. 0.01 ppm for methamidophos.

RESULTS AND DISCUSSION

At high densities of citrus blackfly, all 3 rates of acephate resulted in significant ($P < 0.05$) reductions of pest densities at 4 weeks after treatment (Table 1). In fact, the median number of nymphs/infested leaf was 0 with all 3 rates at 4 weeks post treatment. The performance of dimethoate and oxydemetonmethyl did not differ significantly from each other nor from the control (Table 1), although both dimethoate and oxydemetonmethyl were effective in controlling citrus blackfly when applied as foliar sprays in earlier studies (Reinert and Fitzpatrick 1977). At low citrus blackfly densities the results were obviously less pronounced, with only 1 rate of acephate, 4 g AI/cm diameter, producing results significantly ($P < 0.05$) different from the untreated control; although the 6 g AI/cm diameter rate differed from the control at $P = 0.059$, the resulting level of control was of debatable practical significance (Table 2).

Residue levels of acephate and methamidophos from the same leaves used in the nymphal viability determinations (experiment 2) are shown in Table 3. The highest residues were found in leaves taken from trees exposed to acephate at the 4 g AI/cm diameter rate, although the differences between residues in leaves exposed to this rate and the 6 g AI/cm diameter rate were small. Efficacy of acephate at the 4 g AI/cm diameter rate was greater than at the 6 g AI/cm diameter rate, as well. Even though the trees used in this test were chosen randomly, and 8 trees received each treatment rate, the possibility exists that differences in uptake rates and efficacy could have been attributable to certain environmental factors, such as soil type, soil moisture levels, or differences in rootstock quality, that were not examined in this study.

In the first experiment, the oxydemetonmethyl treatment resulted in a large nonsignificant ($P > 0.05$) decline in citrus blackfly at 2 weeks post treatment followed by a resurgence at 4 weeks post treatment. This suggests

TABLE 1. PERFORMANCE OF 3 INSECTICIDES APPLIED BY SOIL INJECTION FOR CONTROL OF HIGH DENSITY INFESTATIONS OF *Aleurocanthus woglumi* ON DOORYARD CITRUS. DIFFERENCES BETWEEN EACH TREATMENT AND THE UNTREATED CONTROLS WERE EVALUATED WITH THE WILCOXON RANK-SUM TEST.

Treatment	Rate (g AI/cm diam)	Median* No. of Nymphs/Infested Leaf		
		Pre-count	2 week post	4 week post
Acephate	2	40.0 (37.5-44)	0† (0-0.5)	0** (0-0)
Acephate	4	84.3 (45.5-99.5)	6.0 (0-74.0)	0† (0-21.0)
Acephate	6	36.5 (17.0-72.0)	5.5† (0-12.0)	0** (0-3.5)
Dimethoate	4	56.0 (37.0-71.0)	15.5 (1.0-43.5)	10.5 (0-22.0)
Oxydemetonmethyl	4	45.5 (29.5-68.5)	5.5 (0-40.0)	17.0 (0-29.0)
Untreated	—	60.0 (29.0-78.0)	12.5 (9.0-37.0)	7.0 (1.5-29.5)

*Median of 5 trees with 8 observations per tree; figures in parentheses indicate minima and maxima.
**$P < 0.01$.
†$P < 0.05$.

TABLE 2. PERFORMANCE OF 3 RATES OF ACEPHATE APPLIED BY SOIL INJECTION FOR CONTROL OF LOW DENSITY INFESTATIONS OF *Aleurocanthus woglumi* ON DOORYARD CITRUS. DIFFERENCES BETWEEN EACH TREATMENT AND THE UNTREATED CONTROLS WERE EVALUATED WITH THE WILCOXON RANK-SUM TEST.

Treatment	Rate (g AI/cm diam)	Median* No. of Nymphs/Infested Leaf		
		Pre-count	2 week post	4 week post
Acephate	2	5.5 (2-20)	5.5 (4-14)	2.5 (1-7)
Acephate	4	5.0 (3-7)	4.5 (2-8)	1.5** (0-4)
Acephate	6	6.5 (3-11)	3.5 (2-5)	0.5† (0-8)
Untreated	—	6.0 (1-15)	6.0 (1-13)	4.0 (0-22)

*Median of 8 trees with 3 observations per tree; figures in parentheses indicate minima and maxima.
**$P < 0.05$.
† $P < 0.10$ ($P = 0.059$).

TABLE 3. ACEPHATE AND METHAMIDOPHOS RESIDUES IN CITRUS LEAVES AFTER TREATMENT BY SOIL INJECTION.

Treatment	Rate (g AI/cm diam)	Residue (ppm wet weight)*					
		Pre-Tmt		2 weeks		4 weeks	
		A**	M**	A	M	A	M
Acephate	2	ND†	ND	TR†	0.01	TR	TR
Acephate	4	ND	ND	0.59	0.12	0.20	TR
Acephate	6	ND	ND	0.52	0.06	TR	TR
Untreated	—	ND	ND	ND	ND	ND	ND

*Residues are means of 3 determinations.
**A = acephate; M = methamidophos.
†ND = not detected; TR = trace.

that oxydemetonmethyl, when applied by soil injection, has a very short active life. None of the 3 toxicants studied in this experiment exerts a known ovicidal effect on citrus blackfly. Any unhatched eggs present upon the foliage or oviposited up to 1 week after treatment would have accumulated enough thermal units to be in the II or III instar by the 4 week post treatment sample (Dowell and Fitzpatrick 1978). The acephate treatments, in contrast, provided control for a longer period of time, especially at the 2 higher rates, and even at the lowest rate when applied to high density citrus blackfly populations (Table 1).

While acephate has been shown to provide satisfactory control of *A. woglumi* when applied as a foliar spray (Reinert 1976, Reinert and Fitzpatrick 1977, Vaughan and Fitzpatrick 1978), the safety and overall suitability of this method of application needs further evaluation. One objection to the use of foliar treatments in highly urbanized areas is drift of the spray to non-target areas. The soil injection approach can allow circumvention of this potentially serious problem. Our data establish the efficacy of acephate applied by soil injection while the performance of dimethoate and oxydemetonmethyl was shown to be considerably less effective (Tables 1 and 2).

The aggregated distribution of the viability data could have been a result of differences in levels of toxicant uptake through the roots. Multiple injections of toxicants were made around and within the drip line, but the possibility existed that certain portions of the root systems in the treated trees did not come into close contact with the suspensions injected. If this were the case, then certain portions of the foliage in the treated trees would not be expected to contain enough toxicant to produce measurable mortality of *A. woglumi*. The aggregated distribution of the viability data seemed to support this.

An important tactical difference between foliar treatments and soil injection concerns the volume of tank mix applied. Each tree in this test received an average of 86 liters of toxicant suspension, while in studies involving foliar applications of acephate a much lower volume, ca. 20 liters/tree, was applied (Reinert 1976, Reinert and Fitzpatrick 1977). The trees involved in these tests were in the same size range. The difference in spray volume as well as the difference in the method of application resulted in soil injection being a more time consuming technique. The longer time involved in application coupled with the greater required volume of carrier make the soil injection technique potentially more expensive than foliar treatments. Still another drawback of the soil injection technique is the possibility that certain toxicants might become bound in the soil or contaminate ground water supplies. Also, soil injection could result in excessive insecticide residues in fruit. On the other hand, the soil injection method eliminates the potential of phytotoxic damage on many ornamental plants caused by exposure to foliar sprays. Spray treatments of dooryard citrus can result in adjacent ornamentals receiving drift or direct spray, and increasing the potential of phytotoxic damage on ornamentals caused by many insecticide formulations (Reinert and Neel 1976).

Soil injection of systemic toxicants as an approach to *A. woglumi* control is a potentially useful and effective control measure. While it can be more time consuming and is likely to be more expensive than other application approaches, it allows circumvention of drift problems. This is an important asset, especially in highly urbanized areas, and this factor is consistent with acceptability to the public and environmental safety to humans and animals in urban and semi-urban environments.

ACKNOWLEDGMENTS

We gratefully acknowledge the technical assistance of Sandy Cabrera-Lotorto, Lynda Economu, James Lawrence, Judy McCormick, Dennis Steele, Karen Vaughan, and Robert Zumstein. We also thank R. H. Cherry, F. W. Howard, and W. B. Ennis for reviewing this manuscript.

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OBSERVATIONS ON THE SPITTLEBUG, *TOMASPIS INSIGNITA* FOWLER (HOMOPTERA: CERCOPIDAE)

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ABSTRACT

Nymphs of *Tomaspis insignita* Fowler, thought to be aquatic, were reared to adults and their biology and behavior were studied. Adults, nymphs and eggs were described. Available collection records for this species indicate that they inhabit southern Costa Rica and western Panama. All field observations and laboratory experiences indicated that nymphs move away from the water-filled *Heliconia* flower bracts at their first chance, and should not be considered aquatic insects.

Fish (1977) reported what he thought was an aquatic cercopid nymph in the rain water accumulated in a *Heliconia* (Musaceae) flower bract in Costa Rica. Because he was not able to rear the specimen to maturity and had no chance to return to the location for further work, identification of this unusual insect was impossible. I have followed up on his interesting finding primarily because this was the first report of an aquatic homopteran. My goal was to obtain adults for determination of the species and to observe and describe the behavior of the nymphs.

With Dr. Fish's advice (personal communication), I returned to Costa Rica during 1978 to the same *Heliconia* plants at the Las Cruces Tropical Botanical Garden near San Vito de Java from which his nymph was collected. Most of the *Heliconia bihai* L. (syn. *H. bourgaeana* Peters) flower bracts were fully developed in mid-March (Fig. 1) and contained enough water to support at least 6 different aquatic organisms. By using a converted insect aspirator, 6 liters of rain water were transferred from the flower bracts into pans, and checked for insects. No cercopid nymphs were found in 516 flower bracts, and 11 other species and varieties of *Heliconia* in bloom at that time in the botanical garden failed to yield any. With the help of

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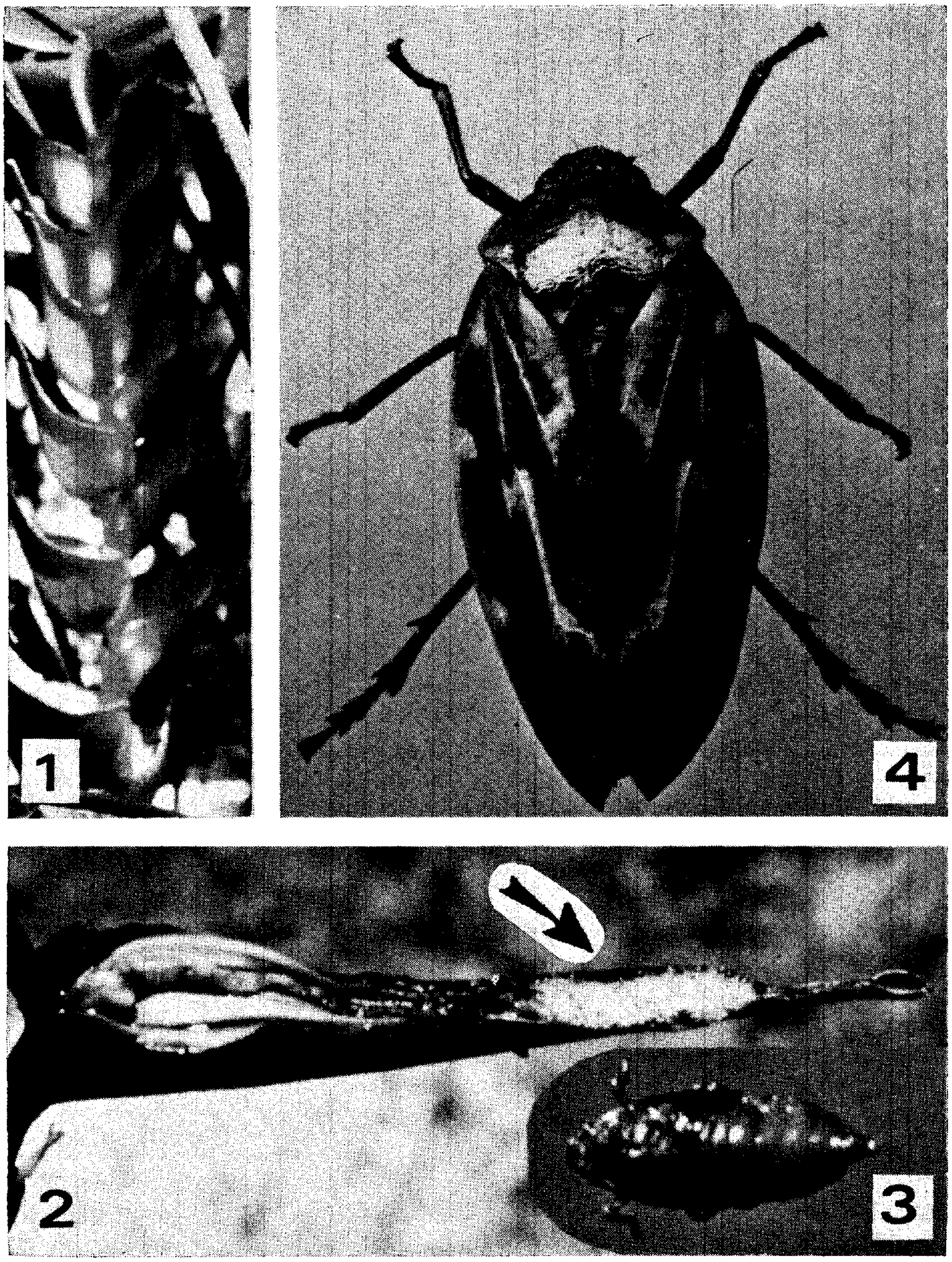
Apparently the common host plant of *T. insignita* is *H. villosa* Klotzsch (syn. *H. tortuosa* Griggs) (Fig. 2). This plant is 1.5-3.0 m tall, and is com-



Figs. 1-4. 1) *Heliconia bihai* L. flower bracts that collect rain water; 2) Spittle mass produced by *Tomaspis insignita* Fowler nymph on flower bract of *Heliconia villosa* Klotzsch; 3) Last stage nymph of *Tomaspis insignita;* 4) Adult female of *Tomaspis insignita.*

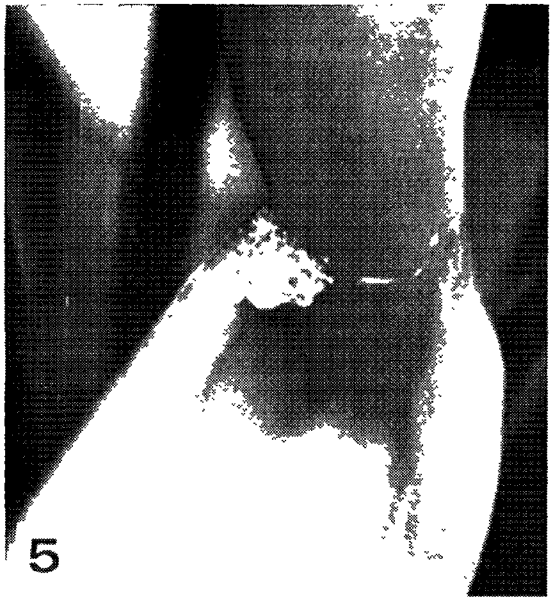
mon in tropical America in highland forests at elevations of 800 to 1500 m from Honduras to Brazil (Woodson and Schery 1945). I found the plant where sunlight penetrates along trails, forest openings and at the edge of the tropical rain forest. All my collections were from the Las Cruces Tropical Botanical Garden, close to the border of Panama. I also found 3 nymphs on a 45 cm long banana shoot, *Musa sapientum* L., at the base of the stem and 2 leaves. Since banana and *Heliconia* belong to the same plant family (Musaceae), it suggests the possibility of an oligophagous insect with host-specificity restricted to members of 1 plant family.

The nymphs were usually present on the lowest fresh *Heliconia* bracts in varying amounts of spittle (Fig. 2). When stems of infested *Heliconia* were removed and placed in a jar of water, nymphs on new sites developed a large spittle mass in about 2 h. Such flower bracts with nymphs, either with or without a protective plastic bag, were observed in a room. Under field conditions, the nymphs extended the terminal abdominal segments containing the spiracles through the spittle mass to obtain air, every 3-7 sec. Last stage nymphs were almost motionless before transformation to adults. In my laboratory rearings, 2 fully developed nymphs (Fig. 3) transformed into adults over night (Fig. 4). The shed exuviae of the last nymphal stage were found attached to stems under flower bracts.

To test if the nymphs were adapted to aquatic conditions, I transferred them from nearly dry *H. villosa* flower bracts to *H. bihai* bracts containing ca. 50 ml of rain water. The nymphs never approached the water on their own. When I transferred nymphs directly into the water of a flower bract, they stayed at the waterline (Fig. 5) on the margin, with their abdominal tips at the surface of the water producing bubbles. When placed in the middle of the water, they "swam" to the flower bract wall. When nymphs were forcefully submerged into water ca. 30 mm deep in the bracts, they soon came up to the surface, often walking under water up to the surface at the main stem area of the flower bract. They started producing bubbles through their abdominal tips while their bodies were under water, staying there for hours. When the same flower stem with the nymphs was removed and placed in a jar of water over night, the nymphs moved during the night from the water filled bract to another almost dry flower bract on the top of the stem. During another night, 1 nymph moved down the flower stem of *H. bihai* and stayed on the stem base of the native *H. villosa*, just above the water level in the container. Other nymphs that were isolated on the host plant in a plastic bag crawled as far as 2-3 m on the floor while searching for suitable feeding sites when given the opportunity. Apparently most of their movement to new flower bracts takes place during the night, thereby avoiding dessication from sunlight, and predation by birds and other day-feeding animals. When they are placed on a glass surface to crawl, an almost transparent trail of liquid is ejected from the anus (Fig. 6).

Apparently the black and red adults with such warning colorations receive some protection from predators by mimicking the red coloration of the host *Heliconia* flower bracts and the black flower styles. Their nymphs are well hidden and protected from parasites and predators by the large spittle mass (Fig. 2) which covers their bodies.

Copulation was observed twice along the edge of a sunny trail between 10 and 11 AM. The pair in each case was head up in an almost vertical posi-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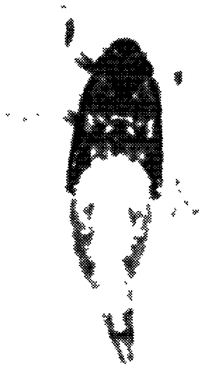
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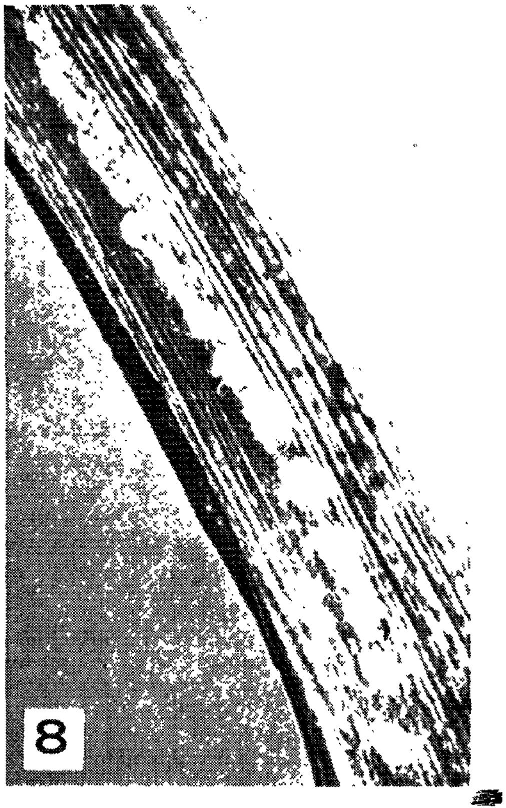
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Figs. 5-8. 5) *Tomaspis insignita* nymph producing bubbles when placed in water filled *Heliconia bihai* flower bract; 6) Penultimate stage nymph of *Tomaspis insignita* crawling on glass surface, with a trail of liquid ejected from anus; 7) Copulating *Tomaspis insignita* pair on stem of *Heliconia villosa;* 8) Oviposition sites of *Tomaspis insignita* covered with white cottony secretion at base of a *Heliconia villosa* flower bract.

tion on the stem close to the flower bracts, side by side, with only the abdominal tips touching (Fig. 7). Every 2 or 3 seconds they squirted drops of a honeydew-like liquid. The copulating pairs in each case quickly escaped when I tried to catch them with a net or with my bare hand. The adults became active by late morning, and on approach they escaped with a swift flight that produced an obvious clicking noise at take-off and a buzzing noise during flight.

Two adults were placed in a cheese cloth cage, 70 cm high with a circular top and bottom (diameter 40 cm), made of 6 mm thick plywood. The cage was hung from the ceiling of a room for observation. The insects moved upward on the cheese cloth wall and oriented toward the sun or electric light, thus exhibiting positive phototaxis. During the night they remained almost motionless in the cage.

Available distribution records of this species indicate that they inhabit southern Costa Rica and western Panama. A total of 4 adult males and 10 females were found in 4 collections as follows: 1) at British Museum: 4 adult ♂♂ (1 labelled as type) from "Volcan de Chiriqui, Panama, at 750 to 1200 m, coll. Champion" (no date, but prior to 1897; data sent by Mr. R. G. Fennah. Collection site near southern border of Costa Rica); 2) at Florida Department of Agriculture: 2 ♀♀, 1 from "Cañas Gordas, southern Costa Rica, Sept. 25, 1957, C. F. Dowling, Jr.", 1 with same records as USNM specimens (det. R. C. Froeschner, 1964); 3) at U.S. National Museum, 1 adult ♀, from "Las Cruces, near San Vito de Java, southern Costa Rica, May 20, 1960, coll. C. F. Dowling, Jr." (records from Dr. J. Kramer); 4) at Virginia Polytechnic Institute and State University: 6 adult ♀♀, also several nymphs of different sizes and eggs, from *H. villosa* flower bracts, at "Las Cruces near San Vito de Java, Costa Rica, March 14-16, 1978, coll. M. Kosztarab, Nancy Moran, Steve Rissing and Gary Stiles", 1 ♀, same location, "March 16, 1979, coll. D. E. Mullins".

Because adults were collected from March through September, and nymphs of different sizes were found during February and March, I am assuming that more than 1 yearly generation develops.

DESCRIPTION OF STAGES STUDIED

ADULTS: Apparently, the 2 sexes are not dimorphic. No morphological differences were seen between specimens in copula from 50 cm distance (Fig. 7). Body of female (Fig. 4) ovate, ca. 17-20 mm long and 8-10 mm wide; tegmina dark, cupreous, finely sculptured, outer margins with 3 bright red spots and a narrow red band continuing around wing tip, also with irregular red oblique marking towards base; metopidium compressed and produced; pronotum black, pentagonal, as long as wide; venter black; antennae setaceous with 3rd segment elongate, base conical and prominent; clypeus medially without a carina or keel, and broadly inflated; apical segment of rostrum ca. 3 times as long as wide; apex of tibia red. No adult males were available for study.

EGGS: White, elongate, almost parallel-sided, pointed at lower end, slightly rounded at upper end (head region), ca. 1 mm long, 0.25 mm wide; inserted at the base of flower bracts at a 45° angle in rows of 12-16 into plant tissue under epidermal layer; oviposition slits covered with a white cottony secretion that hardens on plant surface (Fig. 8).

PENULTIMATE STAGE NYMPHS (Fig. 6): Body spindle-shaped, widest at 3rd abdominal segment, pointed and narrowed at caudal end, 12 mm long and 4 mm wide; eyes many faceted, red; antennae, legs and abdomen light yellow; wing buds black; middle of thorax smoky gray with yellowish markings; pinkish red line on each side of 3rd and 4th abdominal segments; at least 6 abdominal segments distinct, body terminating in a tubelike abdominal tip wth a black ring and 2 spiracles.

LAST STAGE NYMPHS (Fig. 3): Body brownish-red with dark almost black wing bud base, 16 mm long and 5 mm wide; top of head yellow with pink central line and with pink at base of antennae; eyes large, black, many faceted; antennae apparently 6-segmented, yellow; legs with sections alternating yellow and pink; abdomen amber with some pink, ventral plates grayish-white.

ACKNOWLEDGMENTS

Appreciation is expressed to Durland Fish, University of Notre Dame, for advice on the collection site and host for this species; to Robert Wilson, Director of the Organization for Tropical Studies, Las Cruces Tropical Botanical Garden, San Vito de Java, Costa Rica, for his permission to collect and study specimens in their *Heliconia* collection; to graduate students, Lynn Garling, Nancy Moran, Steve Rissing, Gary Stiles and others, for assistance in locating the first specimens in the field; to Homoptera specialists, R. G. Fennah, Commonwealth Institute of Entomology; J. Kramer, USDA-ARS; and F. W. Mead, Florida Department of Agriculture, for providing records on specimens in their institutional collections; to Ronald G. Baer, USDA Southern Weed Science Laboratory, Stoneville, MS, for preparation of Figs. 4 and 8 used in this article; and to John L. Eaton, VPI&SU for making useful comments while reading this manuscript.

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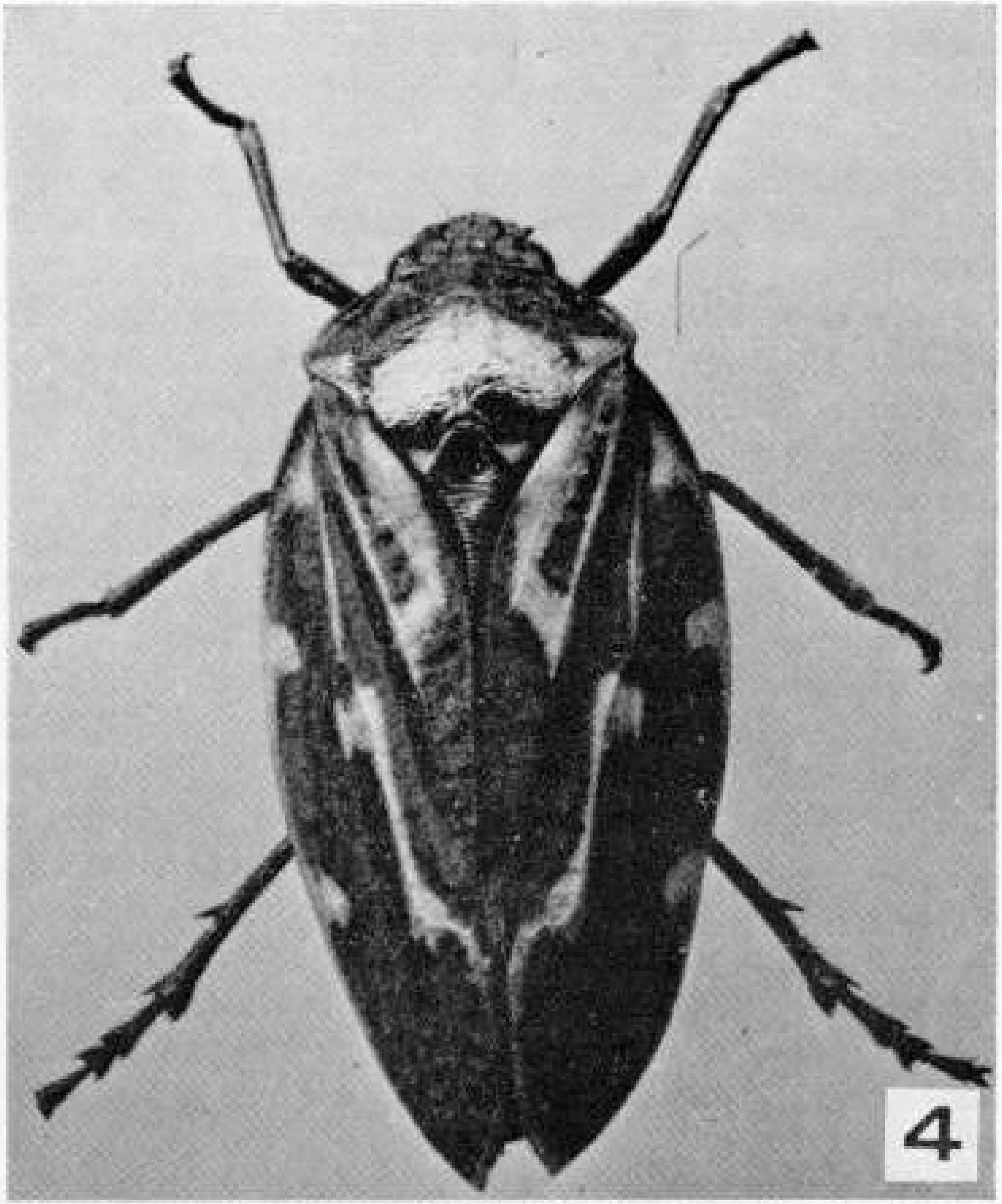

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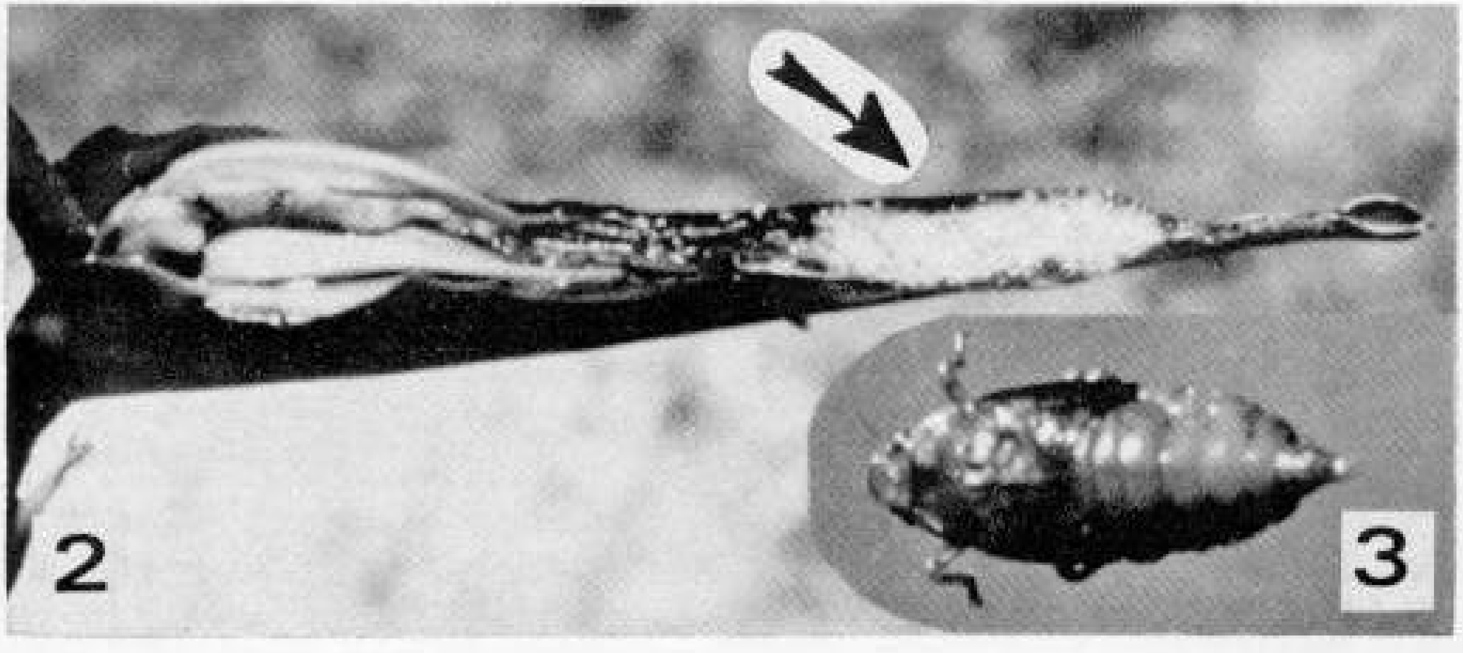

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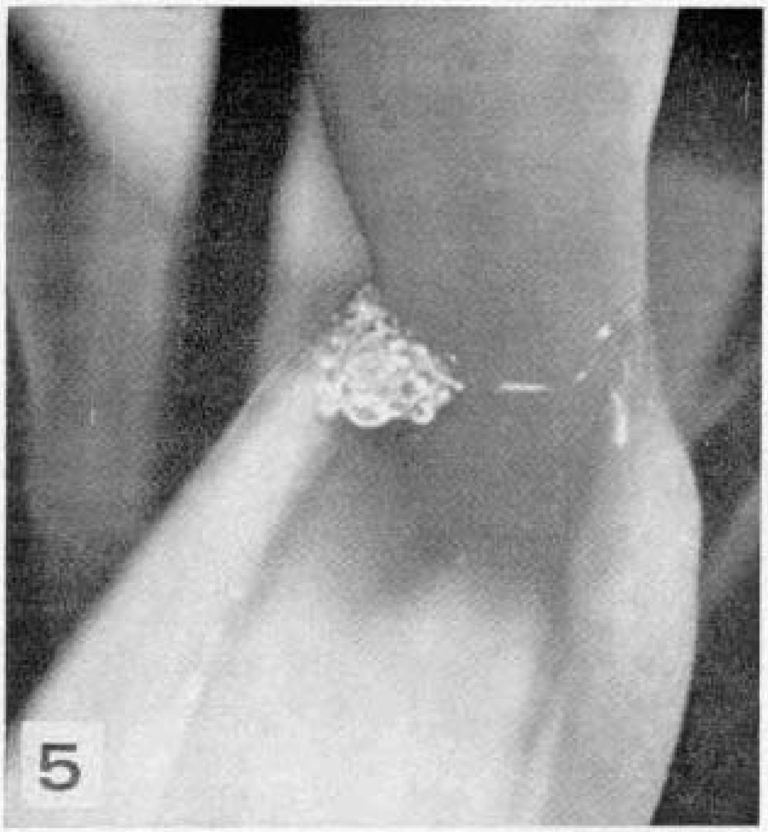
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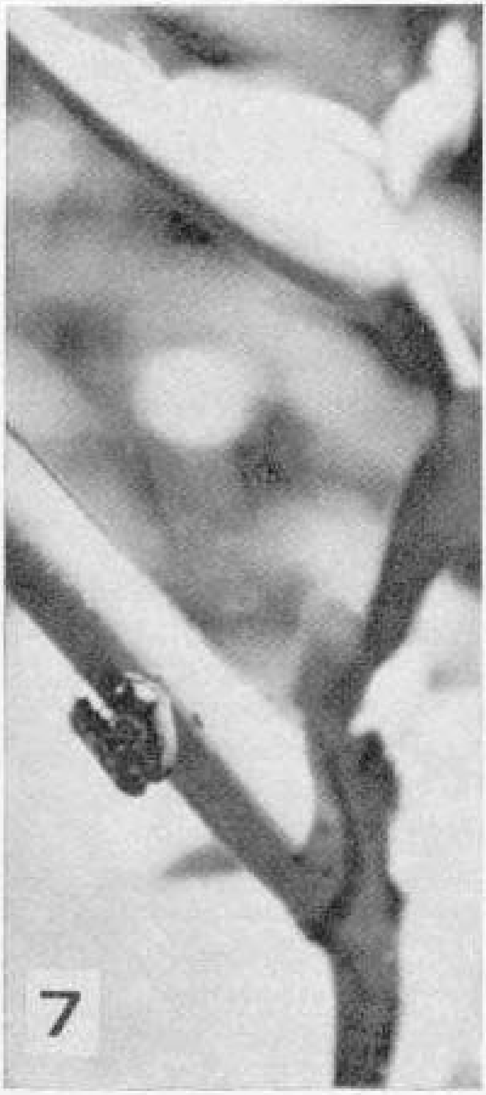
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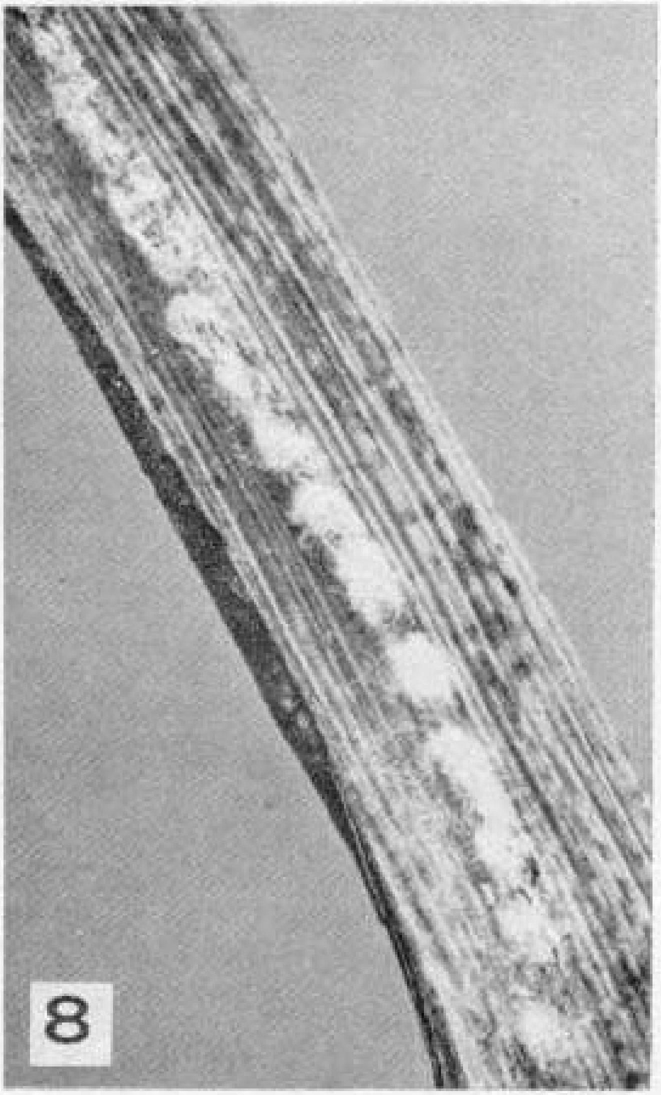
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DESCRIPTIONS AND KEYS TO LARVAE AND PUPAE OF THE GRASS LOOPERS, *MOCIS* SPP., IN FLORIDA (LEPIDOPTERA: NOCTUIDAE)[1]

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ABSTRACT

Comparative descriptions and keys are given for larvae and pupae of 4 species of *Mocis* Hübner, all of which are pests of pasture and turf grasses in Florida. Length and shape of anal setae separate *M. latipes* Guenée and *M. disseverans* Walker from *M. marcida* Guenée and *M. texana* Morrison. No characters of larvae or pupae were found to separate *M. latipes* from *M. disseverans*; and *M. marcida* from *M. texana*.

Mocis larvae are major pests of cultivated and wild grasses (Ogunwolu and Habeck 1975). Four species, *Mocis latipes* Guenée, *M. disseverans* Walker, *M. marcida* Guenée, and *M. texana* Morrison occur in Florida (Kimball 1965).

The larval stages of *M. latipes* were described by Dyar (1902) and Dinther (1954). Crumb (1956) described the larva of *M. disseverans* and Forbes (1960) briefly described larvae of *M. latipes* and *M. texana.* The descriptions were scattered in the literature, many were abbreviated, and none was diagnostic for any species.

The reliability of records of host plants and natural enemies are doubtful since there are no species keys for larvae and pupae. The objective of this paper was to provide keys to immature stages of *Mocis* spp. in Florida.

MATERIALS AND METHODS

Laboratory cultures of the *Mocis* spp. were started from females collected at light traps in Gainesville and Belle Glade. Larvae were individually reared in 9 cm wide, labelled, glass petri-dishes. The larvae of all species were reared on guineagrass, *Panicum maximum* Jacq., at 75 ± 5°F and a 16L:8D photoperiod. Mature larvae (6th or 7th instar) and pupae were killed in boiling water and preserved in 70% isopropyl alcohol. Reared adult progeny were used to verify determinations made of light trap collected females. We also collected larvae and pupae from pastures; a few were preserved as described above, the rest were reared to adult stage. Larval specimens were borrowed from Florida State Collection of Arthropods in Gainesville for examination. External morphology of reared larvae and pupae of *Mocis* spp. was studied under a dissecting microscope. Mouth parts of larvae were dissected and examined for diagnostic characteristics. The chaetotaxy of larvae and pupae was compared using Hinton's (1946) nomenclature for lepidopterous larvae. Larvae were measured, in mm, from

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the anterior part of the mandible to the end of the anal proleg; the length of individual pupa excluded anal setae. Width of pupae was measured across widest part of mesothorax.

Color descriptions were made from living larvae; abdominal segments are referred to by numbers A1-10. Setal length in drawings was not figured to scale.

RESULTS AND DISCUSSION

GENERAL CHARACTERS OF *Mocis latipes* LARVA: Head subspherical, yellowish-white with many brown to brownish-black stripes; each stripe geminate, curved, and parallel with the next; stripes on genae form a loop proximad of ocellar area. Front and adfrontal sclerites extend ca. 1/3 and 1/2 distance, respectively, to vertical angle; frons with an inscribed brown oval or circle (Fig. 1); anteclypeus white with brownish tinge laterally; labrum brownish-yellow and acutely notched; labral notch bordered with dark brown or reddish-brown. Distal and lateral edges of mandible, black; body and base, yellow to yellowish-brown; mandible with 2 small teeth submedially on cutting margin with long distinct, marginal molar area both dorsal and ventral of these teeth. Premental arm of hypopharynx with 5-8 spines proximally; hypopharynx densely spined disto-medially; spinneret more than 2X wider than labial palpus; spinneret with lateral lobes apically; labial palpus brownish-yellow. Second antennal segment pale brownish-yellow; 6 brownish-black ocelli, 1st and 2nd ocelli proximate; postgenae brown to brownish-black.

Larval body smooth, whitish-yellow, yellow or gray. Two brown or orange

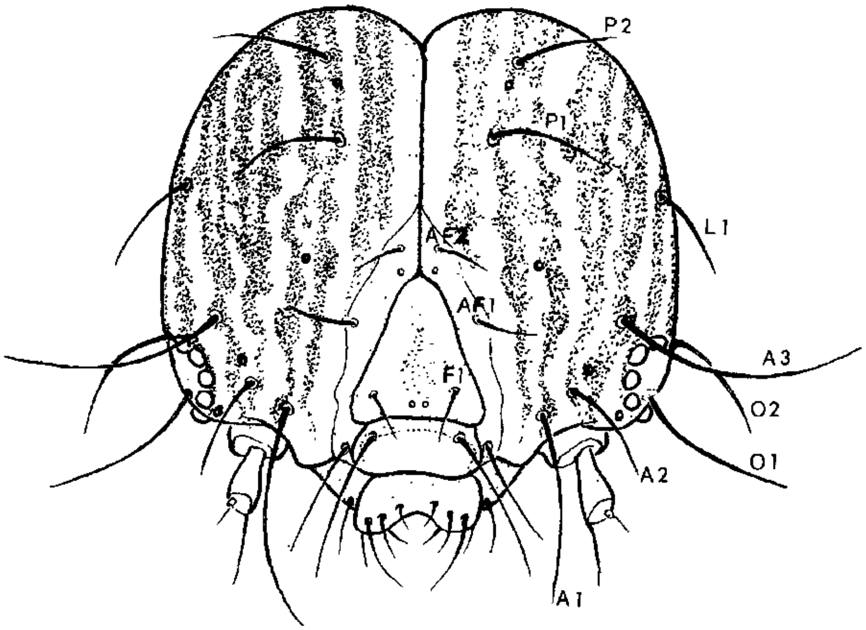


Fig. 1. Head of mature *Mocis latipes* larva.

brown stripes middorsally; each stripe bifurcated on A1-6; addorsal with 6 brownish-black or black frequently indistinct stripes; 2 brownish-black maculae on addorsal surface intersegmentally at A1-2, A2-3, maculae exposed when larva loops. Four brown or reddish-brown stripes subdorsally; 2 dark brown supraspiracular stripes; 2 brown to reddish-brown spiracular stripes; interspace of spiracular and subventral areas yellow, frequently obliterated by dark brown stripe. Eight grayish-brown or dark brown subventral stripes; stripes frequently indistinct above coxal bases of thoracic legs and abdominal prolegs; 4 light brown or grayish brown adventral stripes; midventrally, a dark brown stripe, broadened on A3-4. Spiracles oval and dark rimmed, prothoracic and 8th abdominal spiracles of ca. equal height and width. Spiracles yellowish or grayish-brown. Prothoracic and anal shields poorly defined; anal shield indented posteriorly. Thoracic legs light yellow or yellowish-white with brown stripes; coxae of thoracic legs sclerotized on cephalic margin. Three pairs of prolegs on A5, 6, and 10; anal proleg obliquely striped.

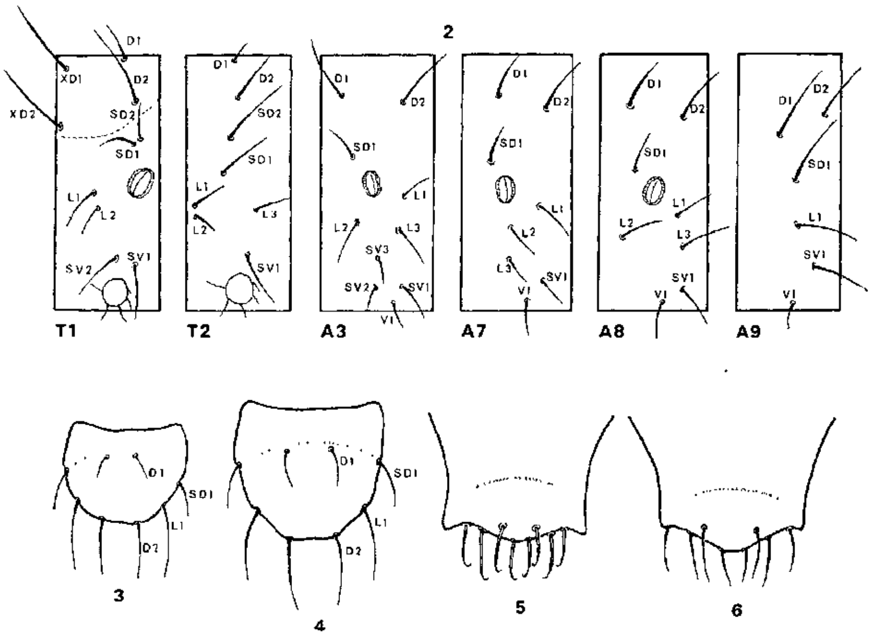
Head setae P2 farther apart than P1 setae (Fig. 1); seta AF2 slightly closer to seta AF1 than to P1; puncture AFa closer to seta AF2 than to AF1 seta; Fa puncture below F1 setal line, punctures contiguous or slightly separated; C2 setae about 1.25X farther apart than F1 setae; seta A2 closer to A1 than to A3; puncture Aa closer to seta A2 than to A3 seta; Ab puncture close to 4th ocellus; seta A3 more than 2X length of A2 seta. Seta SO2 ventral to a line drawn from 5th to 6th ocellus, and less than the ocellar width from the 5th ocellus; O1 seta ventrad or slightly postero-ventrad of 4th ocellus; seta O2 distinctly postero-ventrad of 1st ocellus; O2 seta closer to and postero-ventrad of O1 seta than to O3. Prothorax with seta XD1 antero-ventrad of D1 seta (Fig. 2); XD2 seta about equidistant between XD1 and D2 setae on prothorax; on meso and metathorax seta D1 dorsad to postero-dorsal of D2; L1 seta closer to L2 than to L3 (Fig. 2). Seta D1 on anterior half of abdominal segments except on A1 where it is in or just posterior of the middle; setae D1 and D2 about 2X farther apart on A2-4 than on A9; SD1 seta antero-dorsal or dorsal to spiracles. SD2 seta microscopic (Fig. 2); D1 setae on anal shield closer together than to corresponding SD1 setae; D1 setae farther apart than D2 setae.

GENERAL CHARACTERS OF *Mocis* PUPAE: *Mocis* pupae share at least 5 characters with other members of the subfamily Catocalinae. These include a whitish bloom covering; both pro- and mesothoracic legs extending cephalad to eye-pieces; femora of prothoracic legs seldom visible; labial palpi present; antennae, mesothoracic legs, and maxillae reaching or approaching caudal margin of wings (Mosher 1916). Pupae reddish-brown to brownish-black; anterior 0.75-.80 of dorsum punctate on A1-8; extremities of cremaster indented; no spiracle on A1, spiracles elongate oval on A2-8; spiracle on A8 closed. Head with 2 pairs of postero-dorsal and a pair of clypeal setae; A8 with same setal map as *Mocis* larva.

DIAGNOSTIC DESCRIPTIONS OF MATURE (INSTAR 6 OR 7) *Mocis* LARVAE

Mocis latipes Guenée

Head width 2.9-3.3 mm, (avg. 3.0 mm). Body length 40.0-52.0 mm, (avg. 45 mm); width 4.0-5.0 mm, (avg. 4.5 mm). Few stripes on coronal region



Figs. 2-6. 2) Setal map of mature *Mocis latipes* larva; 3) Anal shield of *M. latipes* larva; 4) Anal shield of *M. marcida* larva; 5) Anal segment of *M. latipes* pupa (dorsal view); 6) Anal segment of *M. marcida* pupa (dorsal view).

abut on adfrontal sutures. Labial stipes usually same color as mentum. Ventral prolegs on A5-6 and A10 with 22-29, (avg. 26); 24-30, (avg. 28); and 23-31, (avg. 25) crochets, respectively. Seta P1 longer than P2, ratio P1:P2 variable, but usually 1-1.5X; seta P1 about equidistant between AF2 and P2. L1 and L2 setae farther apart than SD1 and SD2 setae on prothorax; SV1-SV2-SV3 setae obtusely angled with SV2 on A1; distance between V1 setae on A9 less than 1.5X the distance between V1 setae on A8; L1 seta longer than D2 seta on anal shield (Fig. 3). Setal pinacula inconspicuous, particularly those of MD1 and SD2.

Mocis disseverans Walker

Head width 3.0-3.4 mm, (avg. 3.1 mm). Body length 40.0-52.0 mm, (avg. 45 mm); width 4.0-5.5 mm, (avg. 5.0 mm). Head stripes yellowish-brown, often lighter than those of *M. latipes*. Labial stipes usually lighter than color of mentum. Ventral prolegs on A5-6 and 10 with 26-30 (avg. 27); 27-31 (avg. 29); and 25-31 (avg. 27) crochets, respectively. Ratio of length of P1 and P2 variable, P1 usually 1.5-1.8X length of P2; SV1-SV2-SV3 setae frequently acute to right angled with SV2 on A1.

Mocis marcida Guenée; and *M. texana* Morrison

Head width 3.1-3.5 mm, (avg. 3.2 mm). Body length 46.0-56.0 mm, (avg. 51 mm); width 4.0-6.0 mm, (avg. 5.6 mm). Ventral prolegs on A5-6 and 10 with 28-32 (avg. 30); 27-34 (avg. 30); and 24-30 (avg. 26) crochets, respectively. P1 seta 2-3X length P2 seta; seta A2 sometimes equidistant between A1 and A3 setae; L1 and L2 setae about the same distance apart as SD1 and SD2 setae on prothorax; V1 setae on A9 1.5X farther apart than V1 setae on A8; L1 seta as long as D2 seta on anal shield (Fig. 4); setal pinacula white, MD1 and SD2 pinacula conspicuous on abdominal segments.

DIAGNOSTIC DESCRIPTIONS OF *Mocis* PUPAE

M. latipes Guenée; *M. disseverans* Walker

Length 17.0-20.0 mm, (avg. 18.4) mm); width 3.0-5.0 mm, (avg. 4.5 mm). Head rounded anteriorly; thoracic integument rugulose to rugose; cremastral tubercles prominent, cremastral setae with hooked tips (Fig. 5).

Mocis marcida Guenée; and *M. texana* Morrison

Length 18.0-24.0 mm, (avg. 21.8 mm); width 5.0-6.0 mm, (avg. 5.5 mm). Head pointed anteriorly; labrum sometimes notched; thoracic integument smooth to rugulose; cremastral tubercle prominent; cremastral setae slender, may be slightly curved but without hooked tips (Fig. 6).

KEY TO THE MATURE LARVAE OF *Mocis* SPP. IN FLORIDA

1. L1 seta on anal shield longer than D2 seta (Fig. 3); MD1 and SV2 setal pinacula on abdominal segments yellow or yellowish-white; distance between setae V1 on A9 less than 1.5X the distance between setae V1 on A8; L1 and L2 setae on prothorax usually farther apart than SD1 and SD2 setae .... *Mocis latipes* Guenée; *M. disseverans* Walker

1′. L1 seta on anal shield as long as D2 seta (Fig. 4); MD1 and SD2 setal pinacula on abdominal segments white; setae V1 on A9 1.5X farther apart than setae V1 on A8; L1 and L2 setae on prothorax about the same distance apart as SD1 and SD2 setae .... *Mocis marcida* Guenée; *M. texana* Morrison

KEY TO THE PUPAE OF *Mocis* SPP. IN FLORIDA

1. Cremastral setae with hooked tips (Fig. 5); head broadly rounded anteriorly .... *Mocis latipes* Guenée; *M. disseverans* Walker

1′. Cremastral setae without hooked tips (Fig. 6); head pointed anteriorly .... *Mocis marcida* Guenée; *M. texana* Morrison

These keys are of limited value if the anal setae on the unidentified specimens are broken. The length and shape of anal setae are the most consistent key characters on *Mocis* larvae and pupae examined.

Field collected and laboratory reared *Mocis* larvae were highly variable in color and only the most common color types were described. Larvae and pupae of *Mocis* spp. were morphologically similar. We found no character to separate *M. latipes* from *M. disseverens;* and *M. marcida* from *M. texana.* Crumb (1956) also reported that he found no difference between *M. latipes* and *M. disseverans* larvae. Structural homogeneity among *Mocis* larvae and pupae strongly indicates close relationship among species.

The inability to provide species keys for *Mocis* larvae and pupae would compel individual rearing of these stages collected from the field.

ACKNOWLEDGMENT

The authors thank Phyllis P. Habeck for preparing the figures.

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SCIENTIFIC NOTES

OBSERVATIONS ON THE SEA ANEMONE *AIPTASIA PALLIDA*, A POTENTIAL BIOLOGICAL CONTROL AGENT OF SALT MARSH MOSQUITOES—(*Note*). Potential utilization and effectiveness of Coelenterata (i.e. hydra) as predators of immature mosquitoes in natural habitats have been reviewed by E. F. Legner (Mosq. News, 1979, in press). Only fresh-water species of hydra have been thus far evaluated. For this reason, laboratory studies were conducted to determine if another coelenterate, the sea anemone *Aiptasia pallida* (Verrill) (Cnidaria: Anthozoa), could be used as a potential biological control agent of mosquitoes breeding in highly saline environments near mangroves along the southwest Florida coast. Although *Aiptasia pallida* is similar to hydra in life history, no one has reported its potential for mosquito control.

Cultures of *Aiptasia pallida* (Fig. 1) were obtained from the Carolina Biological Supply Company, Gladstone, OR. General information concerning culturing, feeding, regeneration, and physiology of this species was obtained with the cultures (Carolina Biological Supply Company, Sea Anemone Culture Kit, 16-2825, 1976).

Sea anemones were cultured in sea water (ca. 18,000 ppm Cl^-) obtained from Sanibel Island, FL in 20.9 liter glass aquaria that were aerated and filtered. Sea anemones were maintained at 26-28°C (ambient) and 12-h photophase. Length of individuals ranged from a few mm for immatures to 2-4 cm for adults.

A few hundred larvae and pupae of *Aedes taeniorhynchus* (Wiedemann) and *Ae. sollicitans* (Walker) collected from salt marsh habitats were fed to anemones in each aquarium daily. Observations showed that sea anemones

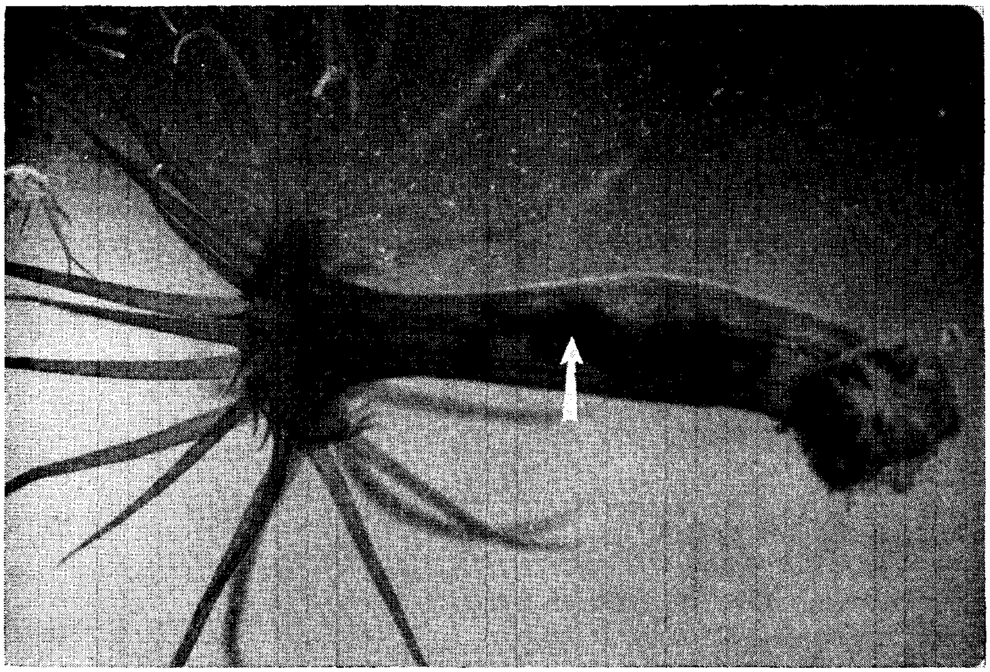

Fig. 1. Mature *Aiptasia pallida* showing (arrow) ingested larvae of *Aedes taeniorhynchus* in gastrovascular cavity.

would engulf larvae and pupae of these species after contacting them with their tentacles and nematocysts; the paralyzed mosquitoes were transferred through the pharynx into the gastrovascular cavity within seconds. This entire process was easily observed due to the transparency of the cuticle around the gastrovascular cavity.

In 1 series of observations 5 medium to large sea anemones were transferred directly from 1 rearing aquaria to 400 ml glass beakers containing 100 (control), 75, 50, 25, and 0% sea water (distilled water) (3 replications/salinity level). Results indicated that sea anemones transferred to 100 and 75% sea water actively preyed upon all *Ae. taeniorhynchus* larvae introduced into the beakers over a 48 h period. Anemones contracted in 50% sea water and did not feed over the 48 h period; no apparent mortality was noted. All sea anemones died within 48 h when tested in 25% or less sea water.

Sea anemones moved via their pedal discs toward the surface where high concentrations of dead (frozen) mosquito larvae were floating. Numerous anemones were attached to the submerged portion of a plastic hygrometer free-floating in 1 aquarium. This could suggest possible mechanisms for transferring these organisms to a new environment. Anemones were easily removed with a spatula from aquaria or buckets lined with polyethylene bags but they could not be removed undamaged if they adhered to the glass of an aquarium.

Populations in each aquaria greatly increased over a 1 month period when anemones were fed high concentrations of immature mosquitoes. Little or no mortality resulted when the sea anemones in 1 aquaria were not fed for 3 weeks; however, these individuals decreased in size.

The apparent ease in culturing *Aiptasia pallida* plus its tolerance and possible adaptation to fluctuations in habitat salinity indicate a potential for biological control of mosquitoes in some salt marsh habitats of southwest Florida.—R. LEVY AND T. W. MILLER, JR., Lee County Mosquito Control District, P.O. Box 2237, Ft. Myers, FL 33902.

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THE EVERSIBLE RECTAL ORGAN OF CERTAIN MIRIDAE (HEMIPTERA) AND ITS FUNCTION[1]—(*Note*). Rectal structures dissociated from the normal functions of excretion are known in Hemiptera; an example is provided by the paired rectal diverticula of some Belostomatidae. This structure stores a noxious inky black fluid that is squirted when the bug is attacked. The organ described below has hitherto passed unnoticed, as far as I am aware.

The mirid *Dagbertus olivaceus* (Reuter) (Mirinae) is found on several species of trees in south Florida, most importantly on avocado (Leston 1979. Fla. Ent. 62(4): 376-9). Last instar larvae were collected at Homestead on 5 January 1979. (I have followed the practice universal outside USA of using the term "larva" for the immature stages of hemimetabolous insects). When the vial of live larvae was tapped, the bugs clung to the vial wall by their perianal organs; the bugs hung free, heads down. After transfer to 80% alcohol some individuals still had the perianal structures extruded.

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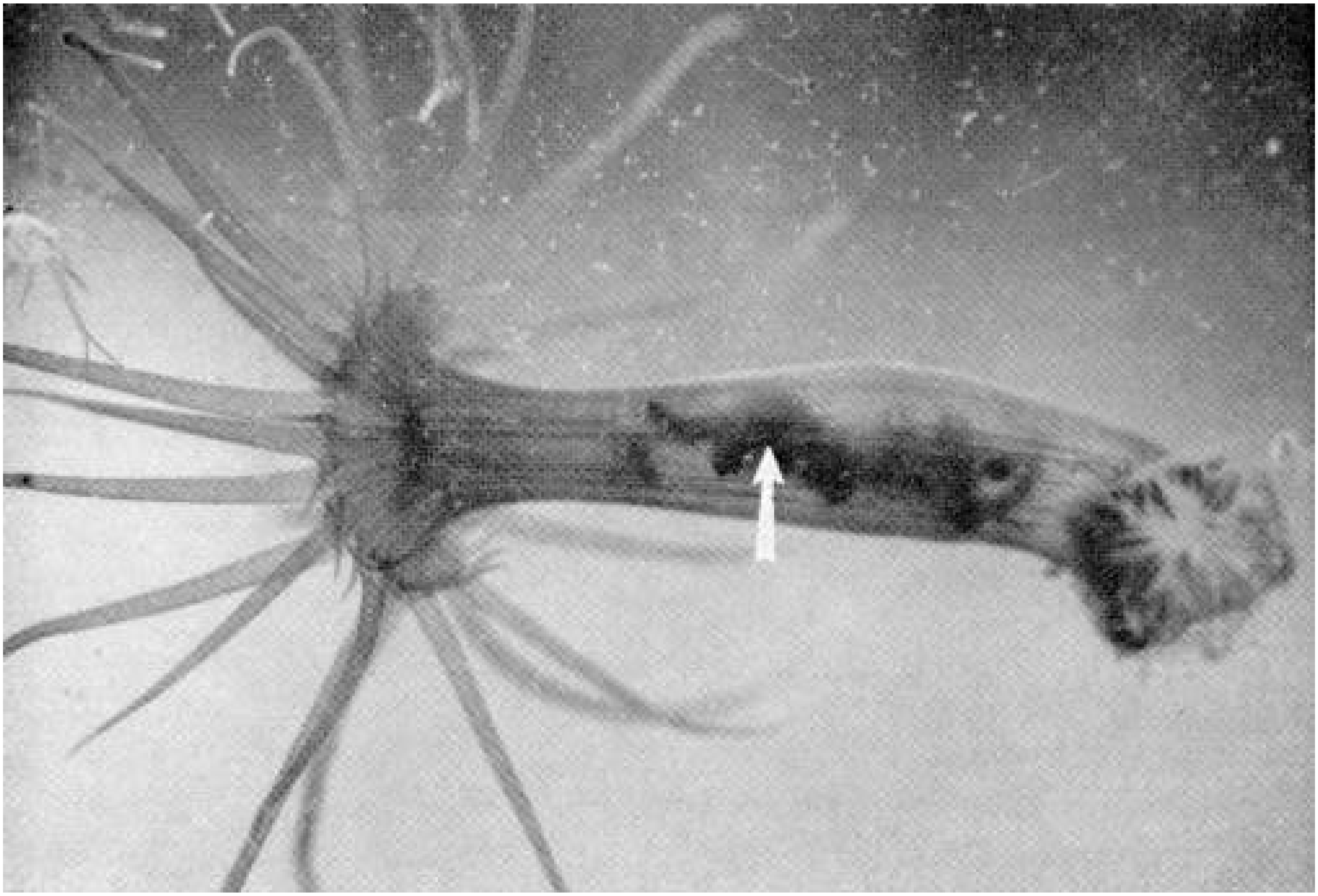
[1] Florida Agricultural Experiment Station Journal Series No. 1733.



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The organ (Fig. 1) was comprised of the exerted rectal cuticle, inflated by green hemolymph. When expanded it was a single trilobed structure with glassy and colorless walls; the surface was sticky. The dorsal lobe was more than twice as long as wide; the paired latero-ventral lobes were interconnected by a ventral bridge. After some minutes in alcohol the hemolymph coagulated and shrank. When fully extruded and expanded the entire organ was about 0.6 mm long and 0.7 mm wide. It was present too in the 3rd and 4th instars.

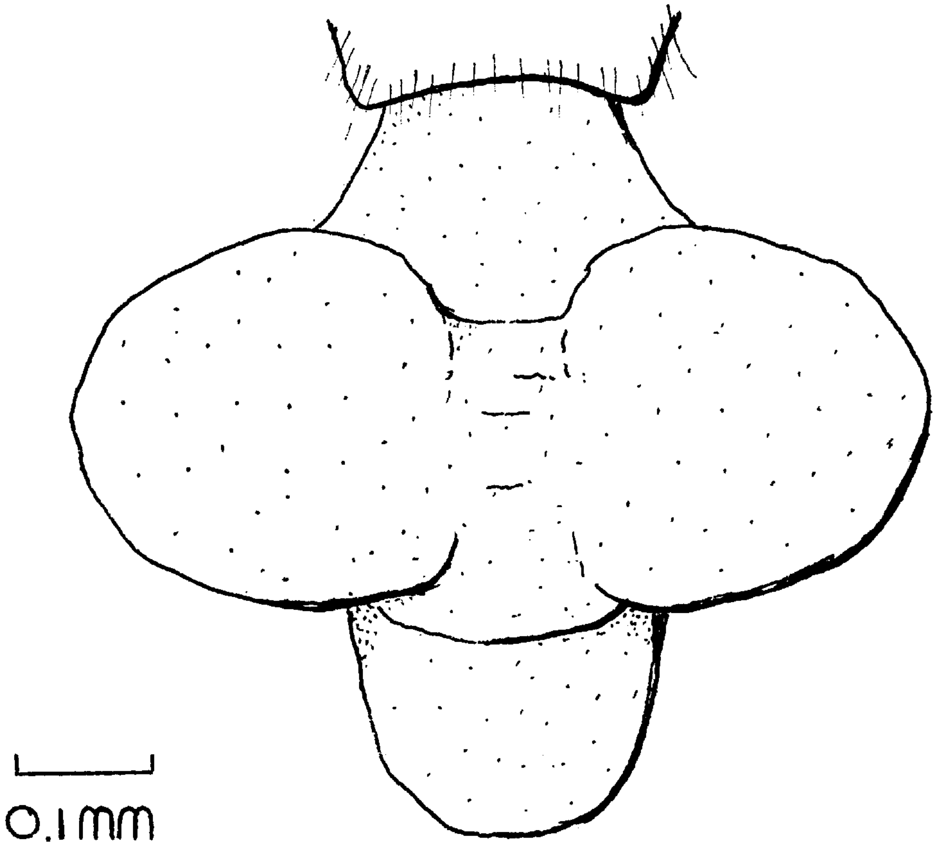

Fig. 1. Eleventh abdominal segment and the extruded eversible rectal organ of 5th instar *Dagbertus olivaceus* (Reuter) (Hem., Miridae), viewed ventrally.

A similar organ occurs in 5th instars of *Pantilius tunicatus* (Fabricius) (Mirinae), collected by the writer from hazel at Bricket Wood, Herts, England, 17 September 1960, and from birch and alder at Flitwick Moor, Beds, England, 18 September 1962.

Dagbertus olivaceus and *P. tunicatus* (for its biology see T. R. E. Southwood and D. Leston 1959. Land and Water Bugs of the British Isles, London, Warne and Co.) are both arboreal. I suggest the eversible rectal organ forms a sticky suction cup, enabling the insect to remain attached to its food plant during storms or windy periods. I have seen a similar structure in the larvae of several other unidentified mirids in Britain, West Africa, and the USA. Occurrence of what is certainly a homologous organ in the Palearctic

Pantilius and the Neotropical *Dagbertus* suggests it is a survival from at least the earliest Cenozoic times. The present distribution of another mirid subfamily, Bryocorinae (Leston 1970. Ann. Rev. Ent. 15: 273-94) can also be interpreted to indicate the primary radiation of Miridae took place in the Upper Cretaceous or lower Cenozoic. It is likely, too, that the main trend in phytophagous mirids has been from arboreal to herbaceous food plants, thus paralleling the history of angiosperms.—DENNIS LESTON, Agricultural Research and Education Center, IFAS, University of Florida, Homestead, FL 33031.

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CENTRAL AMERICAN RECORDS FOR *CYBOTUS ESTRIATUS* (LECONTE) (COLEOPTERA: TENEBRIONIDAE)—(*Note*). The genus *Cybotus* was erected by Casey (1890. Ann. N. Y. Acad. Sci. 5: 307-504) to include the single species *estriatus* LeConte (1878. Pages 373-434 *in* E. A. Schwarz, ed. The Coleoptera of Florida. Proc. Amer. Phil. Soc. 17: 373-434), originally described in the genus *Blapstinus*. LeConte suggested that the lack of sexual dimorphism in the (front) tarsi, the convex form of the body and the absence of elytral striae might require the placement of *estriatus* in a separate genus. As Casey (1890: 482) noted, *Cybotus* is "rather isolated (from other genera of Pedinini), having no decided bond of affinity with any other."

In his original description, LeConte (1878) recorded this species from Haulover and Capron, FL. In describing the genus *Cybotus*, Casey (1890) mentioned only Florida, and all subsequent lists and catalogs record *Cybotus estriatus* only from Florida. We have seen specimens from Miami Beach, Biscayne, Pompano Beach, and Virginia Key, but in our experience it is not a common beetle. Dr. Robert E. Woodruff (in litt.) reported the following Florida localities based on 7 specimens in the Florida State Collection of Arthropods: Key Biscayne and Sunny Isles (Dade Co.), Golden Beach and Hollywood Beach (Broward Co.), and Merritt Island (Brevard Co.).

Among miscellaneous Tenebrionidae sent to the senior author for identification by the Florida Department of Agriculture, Division of Plant Industry, were the following records:

MEXICO: Quintana Roo, Cozumel Island, 26-27-VI-1970, B. K. Dozier (13 specimens).

HONDURAS: Trujillo, 24-VII-1968, B. K. Dozier. (Another specimen in the Canadian National Collection bears the following data: "HONDURAS: La Ceiba, XI-1949, E. C. Becker".)

These are considerable extensions of the known range of this species, which probably occurs in other places within the Circum-Caribbean area.

Both LeConte (1878) and Casey (1890) overlooked an unusual and conspicuous sexual character. Males have a dense patch of golden setae located at each side of the midline of the metasternum. These patches are elliptical and posteriorly divergent and are readily visible at very low magnification. The metasternum of the female lacks these patches.

Both male and female genitalia appear to be identical in specimens from Florida and Cozumel Island. Florida specimens and the 2 from Honduras tend to be much duller in luster than those from Cozumel Island, but we are

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convinced that there is only 1 species involved.—C. A. TRIPLEHORN, Dept. Ent., 1735 Neil Ave., Columbus, OH 43210; and B. K. DOZIER, 1987 Gotham, Chula Vista, CA 92010 (Research Associate, Florida State Collection of Arthropods, Dept. Agr. and Consumer Serv., Gainesville, FL).

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DESIGNATION OF TYPE SPECIES FOR 2 GENERA OF SIPHLONURINAE (EPHEMEROPTERA: SIPHLONURIDAE)[1]—(*Note*). Two genera of Ephemeroptera established by Bengtsson (1909. Lunds Univ. Arsskr., N.F., Åfd. 2, 5(4): 1-19), *Potameis* and *Siphlurella*, have had no type species designated for them. These are the only known genera of mayflies established before 1931 which lack type species; the International Code of Zoological Nomenclature does not recognize the validity of genera established after 1930 without a designated type species. In this note I designate type species for both genera.

Siphlurella Bengtsson, 1909: 11 (type species by present designation: *Siphlurella thomsoni* Bengtsson [=*Siphlonurus* (*Siphlurella*) *linnaeanus* (Eaton)]). *Siphlurella* has most recently been treated as a subgenus of *Siphlonurus* by Jacob (1974. Ent. Nachr. 18: 1-7).

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PERCENT UNSUCCESSFUL ECLOSION IN DRAGONFLIES—(*Note*). Percentage mortality from incomplete eclosion of emerging dragonflies (Odonata) was determined from studies at 3 habitats in South Carolina and in Connecticut. On 27 September 1978, odonate cuticles of the last larval instar were counted along the 392 m perimeter of the man-made pond adjoining Clemson University's R. M. Cooper Library. One hundred eighty-five empty "nymph cases" were recorded, and 8 (ca. 4.19%) contained remains of partially eclosed imagoes. In counts made in May 1979 along the perimeter of Pendleton Swamp, Pendleton, SC, 83 cuticles were noted with 4.82% containing decomposing adults. In June 1979, a similar investigation, conducted along the shore of Trading Cove Pond, Montville, CT, yielded 41 cases. One imago (2.44%) was unsuccessfully eclosed. Most dead insects appeared to have successfully increased thoracic volume, splitting enclosing cuticles, but failed to pull themselves out. Dead yellow jacket wasps (*Véspula maculifrons* Buysson) were twice observed, with stingers embedded in empty cuticles, perhaps indicating diurnal emergence of those dragonfly individuals. However, unsuccessful eclosions appeared related to physiological failures rather than predation. I thank the Deshefy-Sekora clan.—G. SCOTT DESHEFY, Dept. Zoology, Clemson University, Clemson, SC 29631.

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convinced that there is only 1 species involved.—C. A. TRIPLEHORN, Dept. Ent., 1735 Neil Ave., Columbus, OH 43210; and B. K. DOZIER, 1987 Gotham, Chula Vista, CA 92010 (Research Associate, Florida State Collection of Arthropods, Dept. Agr. and Consumer Serv., Gainesville, FL).

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DESIGNATION OF TYPE SPECIES FOR 2 GENERA OF SIPHLONURINAE (EPHEMEROPTERA: SIPHLONURIDAE)[1]—(*Note*). Two genera of Ephemeroptera established by Bengtsson (1909. Lunds Univ. Arsskr., N.F., Åfd. 2, 5(4): 1-19), *Potameis* and *Siphlurella*, have had no type species designated for them. These are the only known genera of mayflies established before 1931 which lack type species; the International Code of Zoological Nomenclature does not recognize the validity of genera established after 1930 without a designated type species. In this note I designate type species for both genera.

Siphlurella Bengtsson, 1909: 11 (type species by present designation: *Siphlurella thomsoni* Bengtsson [=*Siphlonurus* (*Siphlurella*) *linnaeanus* (Eaton)]). *Siphlurella* has most recently been treated as a subgenus of *Siphlonurus* by Jacob (1974. Ent. Nachr. 18: 1-7).

Potameis Bengtsson, 1909: 13 (type species by present designation: *Potameis elegans* Bengtsson [=*Parameletus chelifer* Bengtsson]). *Potameis* is a synonym of *Parameletus* Bengtsson (Hubbard 1977. Proc. Ent. Soc. Wash. 79: 409-10).—MICHAEL D. HUBBARD, Laboratory of Aquatic Entomology, Florida A&M University, Tallahassee, FL 32307.

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PERCENT UNSUCCESSFUL ECLOSION IN DRAGONFLIES—(*Note*). Percentage mortality from incomplete eclosion of emerging dragonflies (Odonata) was determined from studies at 3 habitats in South Carolina and in Connecticut. On 27 September 1978, odonate cuticles of the last larval instar were counted along the 392 m perimeter of the man-made pond adjoining Clemson University's R. M. Cooper Library. One hundred eighty-five empty "nymph cases" were recorded, and 8 (ca. 4.19%) contained remains of partially eclosed imagoes. In counts made in May 1979 along the perimeter of Pendleton Swamp, Pendleton, SC, 83 cuticles were noted with 4.82% containing decomposing adults. In June 1979, a similar investigation, conducted along the shore of Trading Cove Pond, Montville, CT, yielded 41 cases. One imago (2.44%) was unsuccessfully eclosed. Most dead insects appeared to have successfully increased thoracic volume, splitting enclosing cuticles, but failed to pull themselves out. Dead yellow jacket wasps (*Vèspula maculifrons* Buysson) were twice observed, with stingers embedded in empty cuticles, perhaps indicating diurnal emergence of those dragonfly individuals. However, unsuccessful eclosions appeared related to physiological failures rather than predation. I thank the Deshefy-Sekora clan.—G. SCOTT DESHEFY, Dept. Zoology, Clemson University, Clemson, SC 29631.

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[1] Supported by a research program (FLAX 79009) of SEA/CR, U.S.D.A., at Florida A&M University, William L. Peters, Research Leader.

A RARE FLY AND ITS PARASITIC BEHAVIOR TOWARD AN ANT (DIPTERA: PHORIDAE, HYMENOPTERA: FORMICIDAE)[1]—(*Note*). The second known specimen of *Apocephalus tenuipes* Borgmeier, 1963: 184; a female, was collected during the mid-morning of 26 September 1978. The first behavioral observations also were recorded for this species. The only other known specimen, the holotype female, was collected on 11 September 1938 at Polk City, Polk County, FL, by Paul W. Oman. The new specimen was collected in Lake Harbor, Palm Beach County, FL. The holotype at the U.S. National Museum of Natural History is damaged so this new specimen in the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Gainesville, FL, is the only 1 in good condition.

The new specimen was captured on U.S. Sugar Corporation property, 7 mi (11 km) S of Lake Okeechobee, approximately in the middle of a sugarcane field planted on muck soil. The sugarcane was quite dense and over 8 ft (2.5 m) tall as it also was in the surrounding miles of fields.

The serendipitous second capture of this species occurred while the author collected baits made of hamburger meat and honey-agar which were used to survey ant populations in the field. Two or 3 small phorids of the same gross morphology were seen flying and hovering above the ants, *Pheidole dentata* Mayr, which were attracted to a pair of baits. These phorids, 1 of which was the collected specimen, had no apparent interest in the actual bait. Their flight usually remained within 1-3 in (2.5-7.6 cm) of the ground and consisted of short darting flights, followed by brief periods of almost motionless hovering. When the flies approached closely, the ants moved quickly and raised their heads, with a few of them pivoting rapidly. This caused the phorids to rapidly resume their flight-hover pattern temporarily at a greater height. At least 1 fly was definitely seen landing on an ant's dorsal abdominal or posterior thoracic region. This ant quickly turned its head toward the fly. The phorid took wing immediately, but the ant continued to either examine or groom the area where the fly had landed. I believe that the fly that was collected was this same individual. The ant, unfortunately, was not captured although only *P. dentata* minor workers were collected on the baits.

Parasitism of *P. dentata* Mayr by another member of the same phorid genus, *Apocephalus aridus* Malloch, was reported by W. E. LeBerge (1953. J. Kansas Ent. Soc. 26(2): 69). Most members of the genus *Apocephalus* and many members of related genera seem to be myrmecophilous according to Borgmeier (1963. Studia Ent. 6: 1-256), even though the biology of relatively few species have been studied in detail.

I would like to thank the following individuals: Mrs. Maryanne H. Cage for her always cheerful assistance; Dr. W. W. Wirth (Systematic Entomology Laboratory, USDA) for the identification of the phorid; Dr. H. V. Weems, Jr. (Florida State Collection of Arthropods) for assistance in the preparation and publication of the manuscript; and Dr. Daniel P. Wojcik (Insects Affecting Man and Animals Laboratory, USDA) for the identifica-

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[1] Contribution No. 450. Bureau of Entomology, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32602.

tion of the ants and for creating an atmosphere wherein all subordinates are encouraged to think and act creatively and independently under any circumstances that they fined or create.—RICHARD J. BURGES, Dept. of Entomology and Nematology (USDA), Univ. of Florida, Gainesville, FL 32611.

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REPORT OF *ARRHENOPHAGUS CHIONASPIDIS* ON *PSEUDAULACASPIS PENTAGONA* IN FLORIDA[1]—(*Note*). Inspection of peach twigs with a heavy infestation of white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti), disclosed that many of the males were parasitized by *Arrhenophagus chionaspidis* Aurivillius (Hymenoptera:Encyrtidae). The infestation came from a commercial orchard in Madison Co., FL on 8 November 1978. This is the only record of *A. chionaspidis* from *P. pentagona* in the United States, although fairly extensive surveys have been made (Hughes, I. W. 1960. Fla. Ent. 43: 89-92; Bobb, M. L., et al. 1973. J. Econ. Ent. 66: 1290-2; Collins, F. A., and W. H. Whitcomb. 1975. Fla. Ent. 58: 15-21.). This species was first reported parasitizing *P. pentagona* in Japan (Tachikawa, T. 1958. Insecta Matsumurana 21: 118-9.).

As its name indicates, *A. chionaspidis* is primarily a parasite of the male scale. Escapees from the field sample contaminated our insectary culture of *P. pentagona* contributing to its near collapse over a 7 month period, possibly through reduced mating within the population. At the end of this period, 86% of the males were parasitized and 92% of the parasites survived. Although 48% of the female scale were also parasitized, only 11% of those parasites survived to emerge. Parasite mortality was fairly equally divided between late instar larvae (51%) and adults (41%) which were unable to escape from the host mummy. Parasites were observed to oviposit in the settled 1st instar host; emergence was from the 2nd instar.

Arrhenophagus chionaspidis was found recently in another peach orchard in Madison Co. and at present may be fairly common. Why this species was not found in previous surveys remains a mystery; it has been reported in the United States since 1895 (Howard, L. O. 1895. Proc. Ent. Soc. Wash. 3: 239-40.). Certainly competition is not a factor, since this is the only parasite to attack the male scale. Perhaps to maximize parasite emergence, survey collections concentrated on samples with mature females which would have been past the emergence period of *A. chionaspidis*.—J. C. BALL, University of Florida, Agricultural Research Center, Monticello, 32344, and L. A. STANGE, Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, 32602.

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[1] University of Florida Agricultural Experiment Station Journal Series No. 2009.

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BELTSVILLE AGRICULTURAL RESEARCH CENTER SYMPOSIUM V

The Beltsville Agricultural Research Center sponsors an annual research symposium with a specific theme. The subject of the fifth "BARC Symposium" will be "Biological Control in Crop Production." It is scheduled for 19 May to 21 May 1980. Subject matter will be presented as invited lectures and contributed posters with the lectures published in the BARC symposium series (5th volume). Previous symposia in this series were: 1) Virology in Agriculture, 2) Biosystematics in Agriculture, 3) Animal Reproduction, and 4) Human Nutrition Research: Questions and Answers.

Registration and a reception will be held Sunday evening followed by 5 technical sessions held Monday morning through Wednesday noon. The sessions are as follows:

Session 1—Relevance of ecological theories to practical biological control.
Session 2—Concepts, principles, and mechanisms of biological control of pests.
Session 3—Recent advances in mass production of biological control agents.
Session 4—Strategies of biological control.
Session 5—General considerations: Environmental, regulatory, safety, economic, and biocontrol in intergrated pest management systems.

Voluntary poster presentations will be held Monday from 5:30 to 7:30 pm. Registration fee $60.00.

Anyone wishing to receive a registration packet for this symposium should contact

Publicity Chairman
Symposium V
Room 214, Bioscience Bldg 011A
BARC-West
Beltsville, MD 20705

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