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Frank Henry Parker
1910-1984[1]

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Frank Parker was born June 16, 1910 at Little Silver, New Jersey. Entomologists have known him as a long-term resident of 6-Shooter Canyon, near Globe, Ar-

Figure 1. Frank Henry Parker, undated. Courtesy of Persis Parker.

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[1] The University of Arizona Agricultural Experiment Station, Journal Series No. 4069.

izona. His family moved to Globe in 1914, and purchased the ranch from the original homesteader. Frank graduated from Globe High School at the age of 14, but was denied entrance to the University of Arizona because of his age, and spent several years working in the Globe area, constructing some of the first barbed wire fencing in that region, before continuing his education.

He entered the University of Arizona in the Fall of 1927, for a major in Entomology and Economic Zoology. His interest in insects, beetles in particular, had started when another well-known coleopterist, Douglas K. Duncan, came to the canyon on collecting trips. Mr. Duncan was employed in the Globe post office and was acquainted with Frank, Sr. through the latter's employment as a postman on the Globe area rural route.

Even with a grazing allotment on adjacent National Forest land, the Parker ranch did not support the Parker family. The Parkers put in an orchard and a market garden, watered by a quite elaborate system of ditches from 6-Shooter Creek. This creek, starting high in the Pinals, runs most of the time during the winter, and well into the summer during a wet year. Summer rains can cause it to roar.

Frank's labels for the ranch are "Globe, Ariz."; Duncan chose "base of Pinal Mts." The localities are the same. Much of what was collected probably came from the lower part of the canyon, because that is where the ranch houses are. Collecting trips onto the upper part of the ranch would have been called "Pinal Mts." by both collectors. The "Pioneer Pass" of Wickham is in the upper part of the ranch, where dense stands of chaparral oak dominate the scene. The creek bottom has a good mix of mesophytic vegetation, but the sides of the canyon are definitely desertic, with a thin stand of grass and some small shrubs.

At the University, Frank found kindred spirits in E. D. Ball and A. A. Nichol. The department hired him as a laboratory assistant, for the many things that entomologists are used to doing, including pinning an infinity of points for the leafhopper collections of Ball and Nichol's mirids. Ball was Dean of the College of Agriculture for part of this time, but continued his work on Homoptera even while a dean, favoring work in the early morning, which he considered the best time to get things done. The Ball collection went to the U.S. National Museum. I have not seen it, but the selection of Arizona species of leafhoppers that came back to the University of Arizona, in recognition of the state's claim to part of the material, was itself quite impressive. For at least part of the time in his undergraduate years, Frank worked at the Tucson "bug station" of the Office of the State Entomologist. This was an entomological quarantine station, which could cover part of the entrance roads into the state, on a stretch of highway with the unoriginal name of "Miracle Mile." Frank's transportation was a bicycle, and the roads were mostly dirt or gravel. He told of the joys of the trip to Sabino Canyon and how easy it was to stop and look at vegetation from a bicycle. The Santa Rita Range Reserve, which appears on his labels as "Santa Rita RR," was also within his travel circle. A label vagary of this period is his "Tuczon" labels. For these there is a simple explanation. The department had a printing press and a few fonts of type. What with labels left set up and type lost, the lower case "s" was at a premium. Frank used a long list of locality labels, and fitted them to field locations quite precisely.

Frank graduated from the university in 1932, and married Persis Stewart the same year. The Parkers had three children, Caroline, Frank and Stan. In the early 1930's, Frank took to the road collecting and tried to make a living selling specimens. During this period he was employed to an extent by Owen Bryant, who lived in Tucson. The commercial collecting venture was pretty well concentrated into the years 1934 and 1935, with Persis a partner on most of the trips.

He started into a graduate program at the University of California in 1937, and there became acquainted with E. C. Van Dyke and F. E. Blaisdell. He would certainly have gone through the program if financial problems and a bout with pneumonia had not interfered. He had found employment and housing as caretaker of a large church in Berkeley, but apparently had little time to collect, because I haven't found any specimens in his collection from that period. He was in Berkeley less than a year.

For some years Frank then worked as a professional entomologist in the Office of the Arizona State Entomologist. Phoenix was his home base most of the time. We can put dates on his other duty stations from the labels in his collection. During one period the Parkers moved to Blythe, California and Frank worked at the station at Ehrenberg, across the Colorado River in Arizona. In the days before air conditioning, being stationed in Ehrenberg during the summer was hard time.

I first became acquainted with Frank when I started working on the genus *Epicauta* in 1942. My undergraduate employment was for 18 hours a week at the Museum of Comparative Zoology, in the beetle room, with easy access to the LeConte collection. In the course of sorting and arranging the general collection, I discovered that the genus *Epicauta* had a good many undescribed species hidden by misidentifications. Comparison with the critical types was easy, so I selected this genus to revise for an honors thesis in biology. It didn't seem as if there was anyone working on it at the start, but correspondence with H. S. Barber, I think, finally put me into contact with Frank. He also had been working on the genus, and must have been farther along than I. But he had nothing but encouragement for my efforts, and I submitted the thesis, which became the basis for a published revision. World War II and a year in the Philippines for the Field Museum intervened for me. I wrote Frank from the Philippines and arranged to visit him in Phoenix on the way back, in July 1947. He and Louis Lauderdale, then the State Entomologist, took me along on a week's field trip through southeastern Arizona. I had gotten used to a certain level of insect populations in the Philippines, and provided myself with pill boxes and other storage supplies at this scale. The abundance and diversity of the insects that I collected on this trip filled all the boxes in the first couple of days.

I started graduate school that Fall, but Bill Nutting and I were back in Arizona in the summers of 1948 and 1949, running circuits around the state following Frank's advice and using the ranch as base. Frank and his family had moved to the ranch in the winter of 1947, and were busily engaged in making a living ranching, selling fruit, mostly peaches as I remember, and eggs.

Frank lived at the ranch from then on, but in 1952 was employed by the Inspiration Consolidated Copper Company at its Miami mine. He and D. K. Duncan were clerks for the electrical department. Sharing the job made getting off for a collecting or fishing trip easier. They worked together on beetles at night over many years, identifying specimens and interpreting keys. During his employment by Inspiration Consolidated, Frank moved from the electrical department to the mechanical engineering department, to the Christmas mine, and finally to the computer division of the Miami mine. He retired in 1970 as chief systems analyst.

Over the years there has always been a string of visitors to the ranch, to see Frank and his collection and to collect in the canyon. Frank had built a small adobe building to house the collection in 1933, and kept it there until he and Persis moved to the main ranch house in 1972. Frank, and the whole family, were ever alert to rare beetles in the canyon. Frank continued collecting trips, but over the years found his familiar haunts and camping areas increasingly crowded. One other car in a campground made a crowd. He and "Dunc," D. K. Duncan, made forays into the Sierra Anchas and to the White Mountains trout fishing, and the Parker family to Cholla Bay and Rocky Point in Sonora for ocean fishing. The early day trips to the Mexican localities were over long stretches of roads of dirt, sand or worse, with the problem of an overheated engine one to be reckoned with. On one such trip tomato juice substituted for water in a Model T Ford. No matter what the objective, every trip was a collecting trip.

The high price of Schmitt boxes early drove both Parker and Duncan to make their own housing. The design they settled on was a large double Schmitt, Parker's larger than Duncan's. The pinning bottom changed over the years. An early choice was composition cork, which they discovered, as many entomologists did, was quite corrosive to pins. The softer grades of wall board were substituted, but these were too hard for easy pinning, especially for the smaller sizes of insect pins. For his best boxes Frank finally used dried flower stalks of century plants, cut lengthwise. These are very soft near the center, much harder near the rinds.

Mr. Duncan notified us in 1963 that he wanted to donate his collection to the University of Arizona. He had sold some of the choicest specimens to Edith Mank, who had offered him a dollar a species for anything that she did not have in her collection. But the collection was a major addition, in both species and localities of collection.

Frank had become acquainted with another beetle collector in Phoenix, Peter C. Grassman, at first when Mr. Grassman was in high school. Mr. Grassman made boxes like Frank's and was well started on a beetle collection when World War II intervened. He left his collection with Frank when he entered the military, and was killed in action in the Battle of the Bulge. Frank donated the Grassman collection, a large part of his own, and the tiger beetles from the Duncan collection, with the intention of using the extra space in boxes to expand the parts of his collection that he still retained.

Ill health forced him to early retirement. Despite problems, he remained cheerful and calm, and ever ready to discuss the issues of the day or the populations of beetles with family and visitors. We asked him to run a light trap for us at the house, and he kept this going until his final day at the ranch, when he entered the hospital in Phoenix and died four days later, on August 18, 1984.

Mrs. Parker has donated the balance of the Parker collection to the University of Arizona, along with the journals and reprints. The Meloidae and Buprestidae, which were his favorites, are particularly impressive. Parker and Duncan kept good track of publications on the beetle fauna of Arizona. Frank had copies of essentially all of the pertinent literature on Meloidae, part of which were typed from the originals when he was at Tucson or Berkeley. There is a start on a catalog of the beetles of Arizona, with many records entered. Frank's interleaved copy of the Leng catalog has been annotated from the supplements, and has many other entries.

The combined Parker-Duncan-Grassman collections are the product of over a century of diligent collecting of beetles and some other groups of insects. Some of the localities represented have changed vastly over the past 50 years, and many that were easy to get to in the past have now been blocked off for the insect collector. It isn't easy to come up with a conspicuous beetle that these collectors did not find. Much of my collecting has been in the small to minute size range, where additions are easier. But one of Frank's recommendations, which I have passed on to others, is a good one. Never abandon a good collecting site for another that you think will be better. It almost always isn't, and you never seem to get back to the good place in time to capitalize on it. Perhaps this is more true in an arid area than elsewhere, but it certainly holds here.

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Asian Biting Fly Studies V: Tabanidae. Records from Thailand

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Following the work of Burton (1978) it would seem inappropriate to add another study to the tabanid fauna of Thailand. However, the material under consideration in the present study was collected by this author almost 20 years earlier; at that time it was recognized to include a number of new forms, all of which have since been described by Burton (1978) or Philip (1960a). The collections reported in this study strongly supplement that of Burton and provide much new data on the distribution of southern Thailand species.

1. *Tabanus agnoscibilis* Austen, 1922

1922. Austen, Bull. Ent. Res. 12:453, f.
1978. Burton, Tabanini of Thailand:100, synonymy.

A single male taken at a light in my living quarters. This is the first record of this species from Chiengmai Province.

Record.—Chiengmai Province, Chiengmai, 10 July 1959.

2. *Tabanus aurilineatus* Schuurmans Stekhoven, 1926

1926. Schuurmans Stekhoven, Treubia 6-Suppl.:231, f, m.
1978. Burton, Tabanini of Thailand:68.

Two specimens were captured at a light at about 2200 hours in jungle villages. Both specimens agree well with the form ascribed to this species by Burton. The frontal callus of the two is like that figured by Schuurmans Stekhoven (fig. 94b). This is the first record of this species in Trang Province.

Records.—Trang Province, Lamor, Vill. #4, 9 May 1960, f; Vill. #3, 8 June 1960, f.

3. *Tabanus brunnicolor* Philip, 1960

1960b. Philip, Studies Inst. Med. Res. Malaya No. 29:43, new name for *T. brunneus* Macquart, 1834, f, m, synonymy.

The tomentum of the subcallus and clypeus is whiter in a specimen taken in May. Also, its median dorsal abdominal triangular markings are narrower and somewhat shorter and whiter and the ventral abdominal markings do not show median darker areas as clearly as specimens taken in June.

I am not sure why Burton did not include this species in his review of the Thai fauna.

All specimens were taken along the edge of a jungle stream.

Records.—Trang Province, Chong, 13 May, 15, 24 June 1960, 3f.

4. *Tabanus brunnipennis* Ricardo, 1911

1911. Ricardo, Rec. Indian Mus. 4:160, f.
1978. Burton, Tabanini of Thailand:70.

Of three specimens representing this form, the one from Sarapee is darkest with a strongly contrasting mid-dorsal abdominal stripe and lateral spots on TII; there are faint small lateral spots on TIII.

Records.—Chiengmai Province, Sarapee, Vill. #5, 23 July 1959, f; Trang Province, Bang Mark, 29 April 1960, f, Trang, 10 May 1960, f.

5. *Tabanus ceylonicus* Schiner, 1868

1868. Schiner, Reise Novara, Diptera, Band 2:93, f.
1978. Burton, Tabanini of Thailand:38, synonymy.

Record.—Chiengmai Province, Chiengmai, 1 Nov. 1959, f.

6. *Tabanus dissimilis* Ricardo, 1911

1911. Ricardo, Rec. Indian Mus. 4(6):180, f.
1960b. Philip, Stud. Inst. Med. Res. Malaya No. 29:45.

The frontal callus of a single specimen agrees well with that figured by Ricardo (fig. 15) and by Schuurmans Stekhoven (1926:369). The center of distribution of this species seems to be to the south of Thailand. Burton (1978) did not include this species in his review although Schuurmans Stekhoven (1928:443) reported it from Trang Province.

Record.—Trang Province, Trang, 3 March 1959, f.

7. *Tabanus hybridus* Wiedemann, 1828

1828. Wiedemann, Aussereuropäische zweiflügelige Insekten 1:57, f.
1926. Schuurmans Stekhoven, Treubia 6-Suppl.:235.

These Thai specimens agree well with the form recorded by Philip (1960b:48) from Malaya; the frons corresponds closely to that figured by Schuurmans Stekhoven (Text fig. 97a). The series shows very little variation and I suggest that the variable Schuurmans Stekhoven material should be examined to determine whether more than a single species is involved. Secondly, the Wiedemann type, or topotypic material from Macao, needs to be studied to determine if it, the Philip material and specimens included here as *hybridus* are conspecific.

This is the first record of this species from Thailand and for the time, it represents the northernmost population of *hybridus.* Capture was along a jungle stream.

Records.—Trang Province, Chong, 19 May 1960, f; 15 June 1960, 8f; 29 June 1960, 5f.

8. *Tabanus subhybridus* Philip, 1960

1960a. Philip, Studies Inst. Med. Res. Malaya No. 29:22, f.

This species was taken flying with *hybridus* and can be distinguished from it by its deeper orange appearance. Although Philip indicates that his specimens are rather small (13 mm), the forms from Thailand are equivalent in size to *hybridus.*

Despite other minor differences, these southern Thai forms correspond quite closely to the description of *subhybridus.*

This is the first record of this species from Thailand and it represents the northernmost population of *subhybridus.* All were taken in a Shannon trap along a jungle stream.

Records.—Trang Province, Chong, 15 June 1960, 2f; 29 June 1960, f.

9. *Tabanus konis* Philip, 1960

1960a. Philip, Studies Inst. Med. Res. Malaya No. 29:17, f.
1978. Burton, Tabanini of Thailand:99, synonymy.

Four specimens were taken at a light. The series represented by these collections is highly variable in respect to size (10–13 mm) and markings; abdominal tergites vary from entirely concolorous to with up to the first four tergites lighter than the posteromost ones. Totally unrubbed specimens have scattered light-colored mesonotal and scutellar setae and a distinct median dorsal abdominal line of these on TI–TVI, the line being slightly expanded laterally on TI.

Records.—Chiengmai Province, Chiengmai, 6, 10, 19 July 1959, 3f; Tawan Tan, 14 July 1959, 2f; Chompu, 27 July 1959, f; Sarapee Distr., July 1959, f.

10. *Tabanus leucocnematus* (Bigot) 1892

1892. Bigot, Mem. Soc. Zool. France 5:656, *Atylotus leucocnematus,* f.
1926. Schuurmans Stekhoven, Treubia 6-Suppl.:321, redescription.

This, the earliest-named species of a large group of radiating Asian tabanids of distinctive appearance, includes the *biannularis* group of Philip (1962) and Burton (1978:17). This large complex would be better called the *leucocnematus* group. Considerable speciation has occurred and I attribute 28 species to it, some of which, including the name species, are poorly known. The characteristics defining this group are a combination of the following: subcallus bare; callus subrectangular and either wider than high or higher than wide, connected or not to an oval-shaped median callus which may be as large as the callus; scutellum with white or yellow pollinosity and setae, in most species contrasting sharply with a darker scutum which may have a band of light pollinosity and setae along the anterior margin; white or yellow tibiae with apical dark rings; abdomen generally with distinctive bands or wide spots along the posterior margin of some of the tergites. Preliminary evidence seems to indicate that the polymorphic form of the spermathecae in each species I have studied as well as the highly membranous characteristic of the spermathecal ducts serve to indicate the close relationships within this group. Much more study needs to be done before incorporating these characteristics into the diagnosis of this group. If these characteristics should prove to be valid after widespread study of species considered to be in the group, it would be valid to resurrect the subgenus *Callotabanus* Szilady, 1926. Burton (1978:14) has discussed the validity of *Callotabanus* based on other criteria; I am not in accord with either his treatment of the subject nor with that of Philip. Within this complex, color and pattern generally fall into three major and one unique (*T. equicinctus* S.S.) category.

I have seen a single rather denuded female from Boun Tay, nr. Phong Saly, Indochina, 6 January 1929 (R. Wheeler) and I have a single female from Trang

Province, Chong, Vill. #1, 19 May 1960 (Surin et al.) which are provisionally referred to this species. Neither specimen is in perfect condition and they may not be conspecific with *leucocnematus* nor with each other. Differences are found in their size and in the color of their frontal areas; the antennae of the Thai specimen are missing. A study of the internal characteristics of the type and any specimens which have been referred to this species is necessary to resolve the identity and distribution of *leucocnematus.*

11. *Tabanus caduceus* Burton, 1978

1978. Burton, Tabanini of Thailand:27, f.

A single female flying at the same time as *macdonaldi* and *griseipalpis* was taken in a Shannon trap along a jungle stream just above a waterfall. In the field, its larger size and the anterior infuscation of its wing quickly separated it from those species. This is the southernmost collection of *caduceus* in Thailand, others being from the northern province of Chiengmai.

Record.—Trang Province, Chong, 15 June 1960, f.

12. *Tabanus griseipalpis* Schuurmans Stekhoven, 1926

1926. Schuurmans Stekhoven, Treubia 6-Suppl.:312, f.
1978. Burton, Tabanini of Thailand:28.

At the time of original description, Schurrmans Stekhoven described a single female of this species from Nakon Sri Tamarat in southern Thailand along with specimens from Sumatra and Java. There is some reason to wonder if these are conspecific considering the differences he noted in the frontal area of the head and in the subcallus. Burton indicates that of two specimens from Trang which Schuurmans Stekhoven later determined as *griseipalpis* (1928:443), one is certainly not.

Examination of my series of nine specimens shows the basal callus and median callus of eight of them to be separated and much like that in the 1926, Textfig. 142b (Java). The ninth has a partial lateral connection between the calli. Thus, a worn specimen could conceivably appear as Textfig. 142c (Thailand). Additionally, the subcallus of all my specimens is as figured in 142c which shows a median projection on the lower margin. Burton describes "a considerable amount of yellow hair on both the anterior portion and the hind margin of the scutum, ..." Such setation is sparse anteriorly and either absent or virtually so on the posterior scutum of all of my specimens.

Until the types can be studied, it appears that the best course is to refer my series to that of the Schuurmans Stekhoven species.

All specimens were taken in a Shannon trap; that in May from jungle surrounding a small village, those in June from jungle along a stream above a waterfall.

Records.—Trang Province, Chong, 15 June 1960, 8f; Vill. #1, 19 May 1960, f.

13. *Tabanus macdonaldi* Philip, 1960

1960a. Philip, Stud. Inst. Med. Res. Malaya, No. 29:18, f.

Although my specimens show some differences from the original description, they agree in many characteristics with *macdonaldi.* The differences are as follows:

median callus shaped like a broad arrowhead; calli red-brown rather than black; TI–II with yellowish pollinose markings; no banding whatsoever on the sternites. Field notes mention a single green eye band. I hesitate to erect a new taxon for this form in the present state of knowledge of the *leucocnematus* group.

This is a jungle species and was taken in a Shannon trap along a jungle stream above a waterfall.

Records.—Trang Province, Chong, 19 May 1960, f; 15 June 1960, 2f.

14. *Tabanus monilifer* (Bigot) 1892

1892. Bigot, Mem. Soc. Zool. France 5:654, f, *Atylotus monilifer.*
1978. Burton, Tabanini of Thailand:104.

The most southern population of this species is represented by this collection. The spur vein which is rather short in this series does not occur at all on the wing of one specimen. Taken along a jungle stream.

Records.—Trang Province, Chong, 13 May 1960, 2f; 19 May 1960, 2f; 24 May 1960, f.

15. *Tabanus pristinus* Burton, 1978

1978. Burton, Tabanini of Thailand:84, f.

My specimens agree well with the original description except that those taken in October and December exhibit dark abdominal sternites. One of the specimens is almost twice the bulk of the other two although the difference in length is only about 4mm.

Records.—Chiengmai Province, Chiengmai, 29 October 1959, f; 23, 26 December 1959, 2f.

16. *Tabanus striatus* Fabricius, 1787

1787. Fabricius, Mantissa Insectorum 2:356, f.
1981. Burger and Thompson, Proc. Entomol. Soc. Washington 83:340, review of the *striatus* complex, figures.

Records.—Chiengmai Province, Chiengmai, 10 July 1959, f; 4 August 1959, f.

17. *Tabanus unicus* Burton, 1978

1978. Burton, Tabanini of Thailand:116, f.

There are some differences between my specimens and the holotype. My southern forms have a darker and differently shaped subcallus and less developed markings on the abdominal tergites. Data on the collection of these specimens are not available and they can only be recorded as having been taken in Trang Province between early March and the middle of July 1959.

18. *Chrysops dispar* (F.), 1798

1798. Ent. Syst. Suppl.:567, *Tabanus,* m.
1960b. Philip, St. Inst. Med. Res. Fed. Malaya No. 29:38.

My personal experience with this species involves its distribution in both Thailand and Nepal. Except for darker pigment in high altitude Nepalese specimens, I find no differences in the populations from these two areas. This fly was on the wing in large numbers during early and middle June in north central Nepal; a single specimen was collected in the south central terai during early July and the coloration of this specimen is very much like those from Thailand.

Records.—Chiengmai Province, Chiengmai, 1959; 28 June, 2f; 10 July, f; 13 July, f; Sarapee District, July, 6f; Vill. #4, 23 July, 2f; 6 July, f; Trang Province, Bang Mark, 26 April 1960.

19. *Chrysops fixissimus* Walker, 1857

1857. Walker, J. Linn. Soc. London 1:112, *fixissima,* f.

A single female taken in a Shannon trap within the edge of the jungle during the early afternoon. This represents the first record for this species in Thailand; its principal distribution lies to the south of this area.

Record.—Trang Province, Chong, 15 June 1960.

Discussion

Three species of *Tabanus* and one of *Chrysops* are reported for the first time from Thailand; these are *T. hybridus, T. subhybridus* and *T. macdonaldi* from Malaya and *C. fixissimus.* Two other species, *T. brunnicolor* and *T. dissimilis* are confirmed as part of the Thai fauna. Others of the nineteen (19) tabanid species reported represent extensions of the range of these forms in Thailand or in respect to their total known range.

Problems with speciation and variation occur in respect to the *leucocnematus* group. Further studies are needed to ascertain the identity of a number of forms described by several authors and the relationship of those to forms such as those included in this review.

A review of some major assemblages of species flying on the same date and often at the same hours is of some interest.

19 May 1960. Chong: *griseipalpis, hybridus, macdonaldi* and *monilifer.*
15 June 1960. Chong: *brunnicolor, caduceus, griseipalpis, hybridus, macdonaldi, subhybridus* and *C. fixissimus.*
29 June 1960. Chong: *hybridus* and *subhybridus.*
10 July 1959. Chiengmai: *agnoscibilis, konis, striatus* and *C. dispar.*
23 July 1959. Sarapee: *brunipennis* and *C. dispar.*

All collections at Chong were taken at the same site.

Specimens will be deposited at the California Academy of Sciences, Cornell University and the National Museum of Natural History.

Acknowledgments

I would like to thank Dr. Peter F. Beales, WHO, OMS, Geneva, Switzerland for his cooperation and aid in the capture of a number of these forms. Dr. L. L. Pechuman of Cornell University has made material of a number of Thai species available, resulting in more critical comparison of my material with Burton's than descriptions alone would allow.

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Geographic Variation in Flight Wing Development and Body Size of the Tule Beetle, *Tanystoma maculicolle* (Coleoptera: Carabidae)

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Abstract.—The tule beetle, *Tanystoma maculicolle* (Coleoptera: Carabidae), a common ground beetle in California, shows considerable geographic variability in flight wing development and body size. Flight wings may be fully developed or reduced to flap-like stubs. Ecologically marginal populations on the mainland exhibit high percentages of fully winged individuals, whereas populations from more mesic habitats and from the California Channel Islands are predominantly brachypterous. Populations with high percentages of macropterous individuals are restricted to ecologically marginal habitats, suggesting frequent extinction and recolonization in these areas.

On the mainland, body size increases clinally from south to north. Stepping-stone gene flow between mainland populations would facilitate this clinal variation. Body size of Channel Island populations varies erratically from south to north but is positively correlated with the floristic diversity of the islands.

The tule beetle, *Tanystoma maculicolle* (Dejean), is a common carabid beetle of mesic, open and woodland habitats in California, northern Baja California, and southern Oregon (Liebherr, 1985). In California, it occupies lowland habitats in the Central Valley which are hot and dry during the summer, along with more mesic, mid-elevational habitats in the foothills of the Coast Range and Sierra Nevada. Coast Range habitats receive more winter rain than Central Valley habitats, and the climate is moderated by a maritime influence. Sierra Nevada foothill habitats regularly receive winter rains and snow, as well as spring and summer runoff from snowfall at higher elevations. Tule beetle larvae develop during the winter, and most adults eclose from March to June (Liebherr, 1984). Thus, the occurrence of the larvae and pupae, the stages most susceptible to desiccation, is synchronized with the period of winter rains.

The tule beetle exhibits flight wing dimorphism across its distributional range (Liebherr, 1985). The macropterous morph possesses a well-developed flight apparatus; the metepisternum is elongate, and internal apodemes of the metanotum are evident. The flight wings range from 1.3 to 1.5× the length of the elytra. The brachypterous morph has a much shorter metepisternum, the internal apodemes of the metanotum are much reduced, and the flight wings are short scale-like flaps that extend only to the base of the abdomen.

This paper first describes the geographic variation in flight wing configuration in this species, and investigates the relationship between habitat stability and flight wing development. Secondly, the patterns of body size variation on the mainland are compared with those on the California Channel Islands. Comparison of the isolated populations on islands with ecologically marginal populations on the mainland suggests fundamental differences in selective regimes acting on the two types of populations.

MATERIALS AND METHODS

Our evaluation of the geographic distribution of macroptery and brachyptery in *T. maculicolle* is based on museum material used in a taxonomic revision of the genus *Tanystoma* (Liebherr, 1985). Presence or absence of fully developed flight wings can be observed through the semi-hyaline areas of the maculate elytra, or by lifting the apex of an elytron. To determine the geographic distribution of fully flighted forms, we excluded specimens possibly collected at light. Although this results in fewer samples, it eliminates any bias toward flighted forms. Data for males and females were recorded separately for flight wing dimorphic populations. Because no difference in flight wing configuration was attributable to sex, the sexes were pooled in all samples. Specimens collected on different dates at particular localities were also pooled because no temporal variation was observed in the material at hand.

We used elytral length as a measure of body size. Elytral length is highly correlated with overall body size (Liebherr, 1986), and measurement of the elytra rather than overall body length eliminates error due to the posture of pinned specimens. Elytra were measured from the tip of the mesoscutellum to the elytral apex. Specimens were held horizontally in a rotatable specimen holder, and measured using a calibrated ocular grid. On average, females are larger than males, so the sexes were analyzed separately. Seven mainland localities were compared to 7 samples from the Channel Islands. Twenty individuals of each sex were measured for most localities; the smaller sample sizes from some localities are due to a shortage of material. Results are portrayed using Dice-Leraas diagrams with the modifications suggested by Simpson et al. (1960).

As body size of the beetles varies among the California Channel Islands, biological attributes of the islands were investigated to determine whether they are correlated with the pattern of body size variation. Floristic diversity, measured by the number of plant associations present on each island (Philbrick and Haller, 1977), was used as an independent variable upon which elytral length was regressed. Floristic associations that occur in habitats unsuitable for *T. maculicolle* were excluded from the analysis; this limited the associations tallied to island chaparral, valley and foothill grassland, southern coastal oak woodland, island woodland, southern riparian woodland, Bishop pine forest, Torrey pine forest, and coastal marsh (Philbrick and Haller, 1977).

RESULTS

The proportion of macropterous individuals ranges from 1.0 (Warner Springs, Brentwood) to 0 (San Jacinto Mtns., several Channel Islands, Three Rivers, Tiburon, and Oroville) (Appendix 1). The pattern of flight wing variation is a mosaic, with abrupt frequency changes occurring over short distances within the species' range (Fig. 1). For example, the macropterous Warner Springs sample ($n = 17$) was taken at most 70 km away from the totally brachypterous San Jacinto Mountains sample ($n = 13$) (different at $P < 0.001$, chi-squared = 30.3, d.f. = 1). The

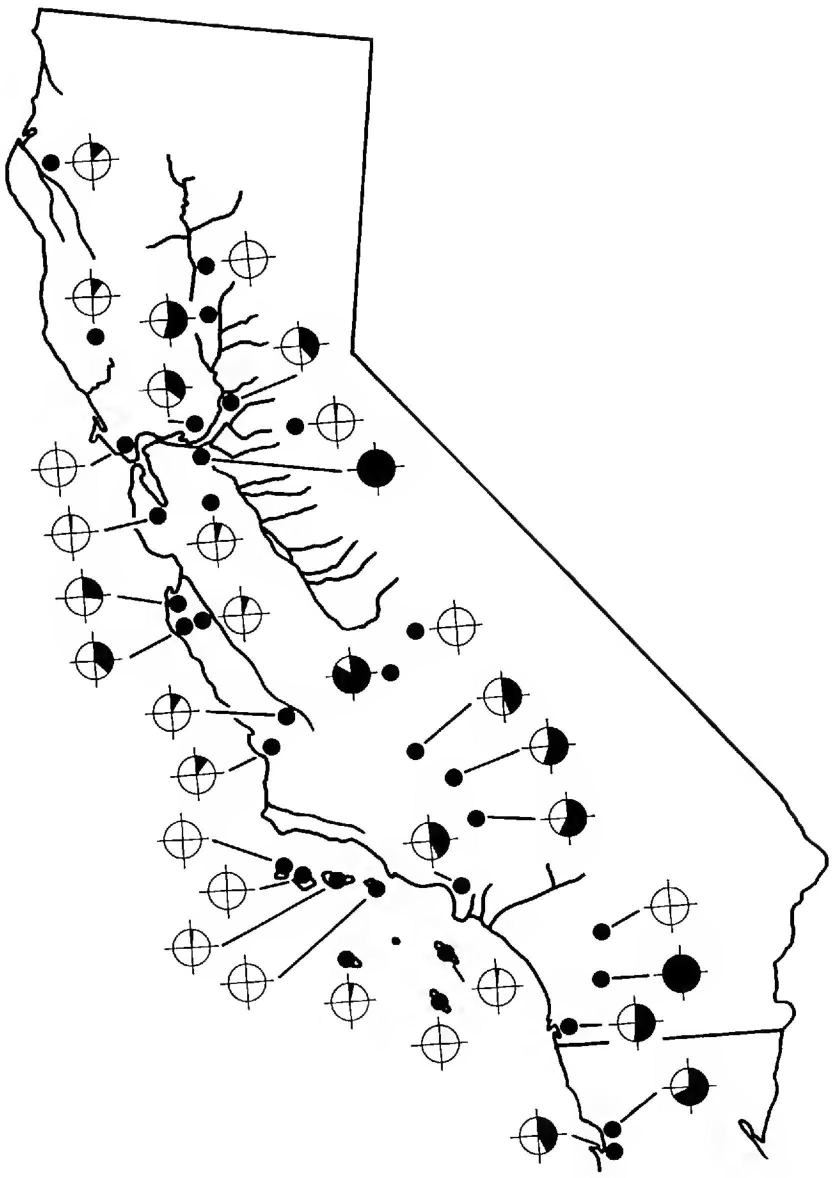

Figure 1. Percentage of macropterous (solid) and brachypterous (open) *Tanystoma maculicolle* from 34 localities in California and northern Baja California (see Appendix 1 for numbers of specimens in each sample).

Tipton sample ($n = 8$) has 7 individuals winged, whereas the Three Rivers sample ($n = 11$) from 55 km away is 100% brachypterous (different at $P < 0.001$, chi-squared = 15.3, d.f. = 1).

In general, populations from the floor of the Central Valley, Los Angeles, and the southernmost portion of the range exhibit the highest fraction of fully winged individuals. Populations along the coast are more variable. The Carmel and Big Sur samples contain 27% and 37% macropterous beetles, whereas other coastal samples (San Luis Obispo, Paso Robles, Paraiso Springs, Stanford, Tiburon, Hopland, Humboldt Co.) range from 0 to 13% macropterous. The few samples available from higher elevations (e.g., Three Rivers [250 m], West Point [650 m], and San Jacinto Mtns.) exhibit a high proportion of brachypterous beetles.

Almost all beetles on the Channel Islands are brachypterous. Sample sizes are quite large for most of the islands, and only the Sta. Catalina, San Nicolas, and Sta. Cruz island samples contain any macropterous individuals. The only fully winged beetle from Sta. Catalina Isl. is teneral, indicating this specimen actually eclosed on the island. San Nicolas Isl., the most isolated of the islands and farthest from the mainland, has 5% macropterous individuals. The closest mainland samples to compare with the Channel Island populations are San Diego and Los Angeles. These samples contain 52 and 43% macropterous individuals, respectively.

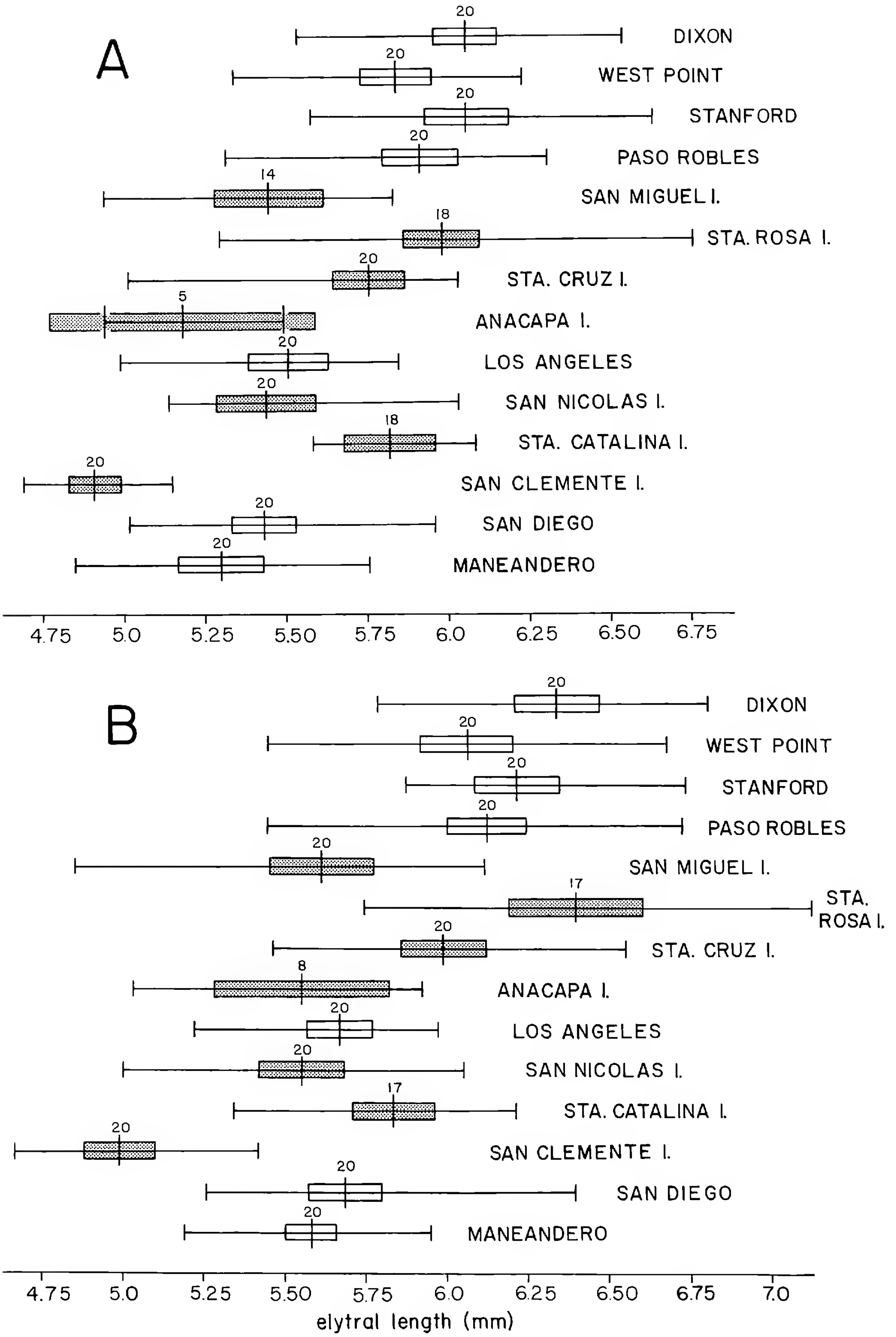

Figure 2. Dice-Leraas diagram showing elytral length for 7 California mainland (open) and 7 Channel Island (shaded) populations. Range shown as long line; box represents 95% confidence interval about mean ($\bar{x} \pm t_{0.5,n-1} \times s/n^{1/2}$); number above mean is sample size. Samples are ordered by latitude, from south to north. A) Males. B) Females.

Table 1. Mean elytral length for males and females of *Tanystoma maculicolle* from the Channel Islands, and the number of plant associations on each island suitable for habitation by the species.

Island	$\bar{x}$ (♂♂)	$\bar{x}$ (♀♀)	# plant associations
San Clemente	4.91	4.99	3
Sta. Catalina	5.82	5.83	6
San Nicolas	5.44	5.55	2
Anacapa	5.18	5.55	1
Sta. Cruz	5.76	5.98	7
Sta. Rosa	5.98	6.39	8
San Miguel	5.45	5.61	1

Average elytral length varies from 4.92 mm (San Clemente Isl.) to 6.06 mm (Dixon and Stanford) for male beetles, and 4.98 mm (San Clemente Isl.) to 6.38 mm (Sta. Rosa Isl.) for females (Fig. 2). Mainland populations of both males and females exhibit a relatively smooth increase in body size from south to north. Maneandero, Baja California averages the smallest of the mainland samples, San Diego and Los Angeles average somewhat larger, and the 4 northernmost samples are the largest of the mainland samples. Within sample variability is similar in all 7 mainland samples.

The Channel Island samples exhibit a very erratic pattern of body size variation from south to north (Fig. 2). San Clemente Isl. beetles are significantly smaller than those of any other island or mainland population, except the small sample of beetles from Anacapa Isl. The Sta. Catalina, Sta. Cruz, and Sta. Rosa samples have the largest beetles among the island populations. Several beetles from Sta. Rosa Isl. are actually larger than any of the other mainland or island specimens.

The variation in body size is much greater among the island populations than among populations from the larger mainland area. When differences between the geographically adjacent localities in Figure 2 are averaged, for males the change in elytral length per km map distance is 0.039 mm/km in the island populations versus 0.00087 mm/km for the mainland populations ($t = 85.7$, d.f. = 12, $P \ll 0.01$). For female beetles, adjacent island populations differ in elytral length by an average of 0.046 mm/km, whereas mainland populations change by 0.00095 mm/km ($t = 58.2$, d.f. = 12, $P \ll 0.01$).

For our 7 Channel Island samples, average elytral length is positively correlated with the number of plant associations available to *T. maculicolle* on each island (Table 1, Fig. 3). For males, the regression of elytral length on number of plant associations produces the equation $y = 0.099x + 5.11$, with a slope significantly different from zero ($t = 2.73$, d.f. = 6, $P < 0.05$). The regression accounts for nearly 60% of the variation in the data set. Female beetles are also larger on floristically more diverse islands ($y = 0.108x + 5.27$; $t = 2.39$, d.f. = 6, $P < 0.05$). Over 53% of sample variation can be accounted for by this regression. In both sexes, beetles from San Clemente Island are much smaller than expected based on the regression ($P < 0.001$ for both sexes).

A very limited sample of male beetles from Guadelupe Isl., Baja California Norte, has an average elytral length of 5.33 mm ($n = 5$, range 5.11–5.73 mm). The body size on Guadelupe Isl. does not differ significantly from that at Maneandero, the nearest mainland locality.

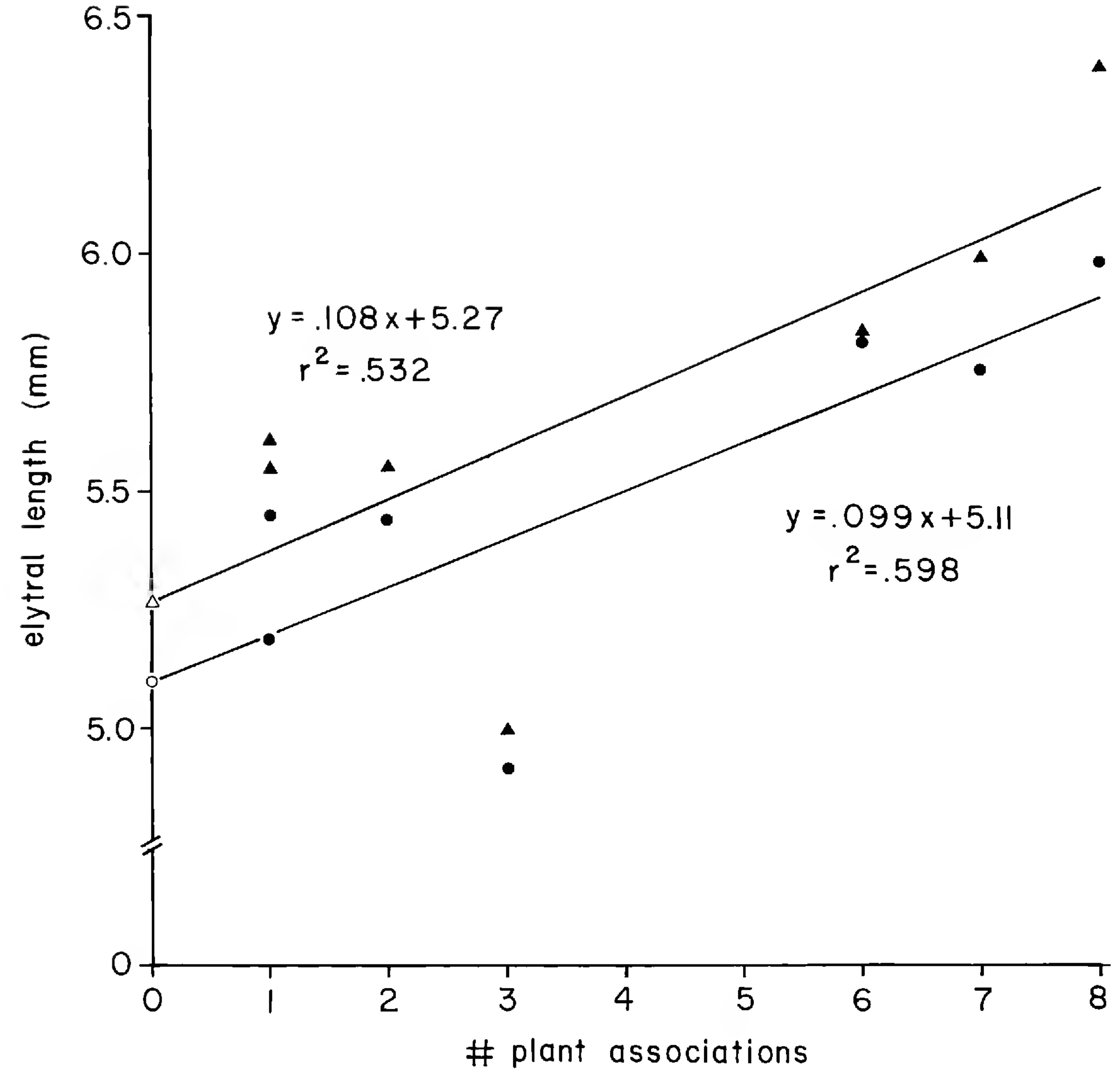

Figure 3. Regression of average elytral length (mm) on number of plant associations suitable for *Tanystoma maculicolle* males (●) and females (▲) on the California Channel Islands (see Table 1).

DISCUSSION

Wing polymorphism. — A dispersal polymorphism can be interpreted as an evolutionary response that permits a species to utilize a mosaic of stable and temporary habitats. Darlington (1943) reported that brachypterous carabids are concentrated in mountains and mountainous islands, apparently because flight is not required in these limited habitats. Brachyptery is not limited to mountain inhabiting populations of *Notiophilus biguttatus* (F.) in Bohemia. Lowland populations may also contain up to 30% brachypterous individuals (Honěk, 1981), demonstrating that higher altitudes are not the only habitats in which brachyptery can occur.

Based on data from carabid species that had colonized areas glaciated during the last glaciation, Lindroth (1969, 1979) hypothesized that regions with high percentages of brachypterous individuals had served as glacial refugia. He argued that these more stable areas maintained wingless stocks, whereas colonization of newly available habitats proceeded by macropterous propagules. Such a relationship between habitat age and brachyptery has also been reported for 3 species of capniid Plecoptera in Alberta (Donald and Patriquin, 1983). Vepsäläinen (1978) adds that isolation is frequently characteristic of brachypterous populations in genetically determined polymorphic species. Among Gerridae (Hemiptera), isolated populations receive few macropterous colonists, enhancing the trend toward brachyptery.

Southwood (1962) extended Lindroth's historically based hypothesis, generalizing that dispersal from habitats of origin is the means by which species colonize changing or temporary habitats. This hypothesis has been corroborated by numerous studies of insects (Greenslade and Southwood, 1962; Den Boer, 1970, 1971, 1979; Denno, 1976, 1979; Vepsäläinen, 1978). Maintaining a fraction of vagile colonizing individuals in a population assures the ability to colonize nearby habitats where extinction has occurred.

For *Tanystoma maculicolle,* an hypothesis of relatively frequent extinction and refounding of populations due to environmental fluctuations in marginal habitats is consistent with our findings. Localities in the Central Valley, and lower elevational sites in the southern part of the range have the highest percentage of winged individuals. These localities are the most unpredictable in terms of habitat suitability for these winter and spring breeding beetles; i.e., winter rainfall is the least and its occurrence sporadic. By comparison, the more mesic mainland habitats which receive more winter rain, and the geographically isolated Channel Island populations have higher percentages of brachypterous individuals.

That the Channel Islands were never connected to the mainland during Pleistocene sea-level fluctuations is now well established (Junger and Johnson, 1980). We conclude therefore that the islands were colonized by *T. maculicolle* from the adjacent mainland. The relatively high percentage of macropterous individuals in Los Angeles and San Diego suggests that the islands were colonized by winged propagules, and that selection pressure is acting against macroptery on the islands. Although colonization of the islands by macropterous individuals is most likely, brachypterous beetles may also have colonized as suggested by Ås (1984) for carabids colonizing islands in the Baltic Sea.

Several bases for selective advantage of winglessness on islands have been proposed. The notion that winged individuals may be blown away from suitable habitats or face more environmental hazards on islands has been attributed to Darwin (1859), and recently supported by Den Boer et al. (1980) and Bengtson and Eriksted (1984). Several of the Channel Islands (San Clemente, Sta. Catalina, Sta. Cruz, Sta. Rosa) are large enough to support a number of localized populations of *T. maculicolle.* These local populations occur in a variety of woodland and grassland habitats. In this case it is apparent that flight activity would not necessarily result in movement to unsuitable habitats, or off-island dispersal. We feel an hypothesis in which the frequency of macropters is reduced solely due to dispersal cannot completely explain the near total brachyptery on the Channel Islands.

Other hypotheses for the evolution of brachyptery stem from Darlington's (1943) suggestion that brachypterous individuals are favored when dispersal is not required for maintenance of the population. Among gerrids (Vepsäläinen, 1978; Zera, 1984) and aphids (Wratten, 1977), flightless morphs are more fecund and frequently develop faster than flighted morphs. Such an occurrence would give a selective advantage to brachypterous individuals of *T. maculicolle* if density-dependent mortality acted on the populations. One such mortality factor operating within populations could be cannibalism. The larval stages of *T. maculicolle* are voracious predators, and often cannibalistic when reared together (Liebherr, 1984, unpubl. data). *T. maculicolle* is a very common species, often occurring in dense populations. If the larvae of wingless individuals develop faster, cannibalism would exert strong selective pressure to reduce the frequency of slower developing macropters in dense populations. A combination of intrasite advantage for brachypters, and lack of winged immigrants due to isolation would be sufficient to explain the absence of macropters on the Channel Islands.

Body size.—Body size in mainland populations of *T. maculicolle* increases clinally from the southern to northern limits of the distributional range (Fig. 2). The gradual change in body size is consistent with an isolation by distance model of differentiation (Wright, 1943) influenced by uniformly changing selection pressure.

In *Eusattus muricatus* LeConte, a sand dune inhabiting tenebrionid beetle, specimens from southern California are larger than specimens from northern California (Doyen and Rogers, 1984). A longer period for larval development in the southern portion of the range is believed to be the determinant for larger body size. Southern populations of this univoltine species can develop year round, whereas northern populations must cease activity during winter.

The tule beetle breeds during the rainy California winter and teneral adults are present from March to June (Liebherr, 1984). Large body size in northern populations is associated with the longer rainy season there. Southern populations have a much shorter period for larval development because of the shorter rainy season. The converse clines in body size variation observed in *E. muricatus* and *T. maculicolle* can both be related to the length of the larval developmental period. Differences in habitat preference and phenology appear to govern the difference in body size clines between these species.

The pattern of body size variation among all of the Channel Islands is a mosaic (Fig. 2), but is positively correlated with floristic diversity (Table 1, Fig. 3). The variety of plant associations on an island can be considered an indication of the general suitability of an island for larval development. It is not known whether floral diversity is indicative of general moisture conditions, the quality or quantity of prey, or other factors influencing the size of adult *T. maculicolle.*

The 4 northern Channel Islands (San Miguel, Anacapa, Sta. Rosa, and Sta. Cruz) were united in a superisland, Santarosae, during periods of maximum sea-level lowering in the Pleistocene (Wenner and Johnson, 1980). Yet, distinct differences in body size exist among tule beetle populations on these islands today. The San Miguel and Anacapa populations have significantly smaller beetles than those on Sta. Cruz or Sta. Rosa. The intense stripping of vegetation on San Miguel Isl. (Johnson, 1980) has left only valley and foothill grassland (Philbrick and Haller, 1977) as habitats suitable for *T. maculicolle.* Due to its small size, Anacapa Isl. also has only grassland for *T. maculicolle* to inhabit. The Sta. Rosa and Sta. Cruz islands have a variety of chaparral, and oak and pine woodlands that are suitable for tule beetle populations. Among these 4 islands, the divergence in body size has occurred since the fragmentation of Santarosae. Whether differential selection pressures have resulted in genetic change among the island populations remains to be studied.

CONCLUSIONS

Tanystoma maculicolle populations that are isolated on islands or in ecologically marginal areas on the mainland possess fundamentally different characteristics. Island populations are predominantly brachypterous, with this reduced vagility suggesting very limited among-island dispersal. Island populations are long-lived enough for substantial among-island divergence in body size to have arisen. In contrast, marginal mainland populations possess mostly winged individuals, and appear to be in genetic contact with adjacent populations based on clinal variation in body size. Population extinction is judged to be a relatively common occurrence on the mainland, based on the low frequency of brachypterous individuals in many of these populations.

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APPENDIX 1

Sample localities and numbers of brachypterous (B) and macropterous (M) individuals used in analysis of flight wing variation.

MEX: B.C. Norte, Guadelupe Isl. (4B, 1M); MEX: B.C. Norte, Maneandero (14B, 10M); MEX: B.C. Norte, Ensenada (5B, 11M); CA: San Diego Co., San Diego (14B, 15M); CA: S.D. Co., Warner Sprs. (0B, 17M); CA: Riverside Co., San Jacinto Mtns. (13B, 0M); CA: L.A. Co., Los Angeles (50B, 38M); CA: L.A. Co., Antelope (3B, 5M); CA: L.A. Co., San Clemente Isl. (168B, 0M); CA: L.A. Co., Sta. Catalina Isl. (35B, 1M); CA: Ventura Co., San Nicolas Isl. (113B, 6M); CA: Sta. Barbara Co., Anacapa Isl. (13B, 0M); CA: Sta. Barb. Co., Sta. Cruz Isl. (93B, 1M); CA: Sta. Barb. Co., Sta. Rosa Isl. (35B, 0M); CA: Sta. Barb. Co., San Miguel Isl. (46B, 0M); CA: Kern Co., Tehachapi Mtns. (4B, 5M); CA: Kern Co., Bakersfield (10B, 7M); CA: S.L.O. Co., San Luis Obispo (15B, 2M); CA: S.L.O. Co., Paso Robles (26B, 3M); CA: Tulare Co., Tipton (1B, 7M); CA: Tulare Co., Three Rivers (11B, 0M); CA: Monterey Co., Big Sur (5B, 3M); CA: Mont. Co., Paraiso Spgs. (27B, 2M); CA: Mont. Co., Carmel (8B, 3M); CA: Sta. Clara Co., Stanford (62B, 1M); CA: Alameda Co., Arroyo Mocho (37B, 3M); CA: Marin Co., Tiburon (19B, 0M); CA: Contra Costa Co., Brentwood (0B, 13M); CA: Solano Co., Dixon (33B, 19M); CA: Calaveras Co., West Point (52B, 1M); CA: Sac'to. Co., Sacramento (11B, 7M); CA: Yuba Co., Yuba City (4B, 5M); CA: Butte Co., Oroville (8B, 0M); CA: Mendocino Co., Hopland (9B, 1M); CA: Humboldt Co. (pooled localities) (7B, 1M); OR: (pooled localities) (9B, 2M).

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Scientific Note

A Collection of Four Species of Tabanid Flies Taken from an Anaconda Snake in Peru in May 1984

This note is to report identification of 4 species of Tabanidae (Diptera) among 17 flies taken by Dr. W. Pulawski of California Academy of Sciences while the flies were biting a large Anaconda snake. The snake was a lethargic, recently-fed specimen on the bank of a tributary of the Rio Tambopata, Peru, on 6 May 1984. The specimens are deposited in the entomology collections of the California Academy of Sciences (CAS), Smithsonian Institution (SI), and Universidad Nacional de San Marcos, Lima, Peru (UNSM).

The specimens, all females, comprised 4 species in 3 genera of the subfamily Tabaninae as follows: *Phaeotabanus innotescens* (Walk.), 5 (CAS, SI, UNSM); *Tabanus dorsiger* ssp. *stenocephalus* Hine, 1 (CAS); *T. d.* ssp. *modestus* Wied., 10 (CAS, SI, UNSM); and *Stenotabanus incipiens* (Walk.), 1 (CAS). The last 2 were reported to me by Dr. F. Medem of Colombia, South America (Philip, 1976, Pan-Pac. Entomol., 52:83–88) as feeding exclusively on tethered caimans, even in the presence of nearby persons, while the first 2 species were taken occasionally on those reptiles.

Only *P. innotescens* has not been reported to invade Central America; the others have been recorded as far north as Honduras or Guatemala.

It is an interesting corollary that I have since discovered in our collection another female of *P. innotescens* identified in 1981 by Dr. G. B. Fairchild of University of Florida (ret.) labelled "biting caiman" in Colombia (upper Amazon tributary) in 1971.

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Dominance Hierarchies in *Myrmecophila manni* (Orthoptera: Gryllidae)[1]

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Myrmecophila manni Schimmer are small, apterous crickets found only in association with ants. Their primary host in southeastern Washington is the western thatching ant, *Formica obscuripes* Forel (Henderson, 1985). A study of these crickets was initiated in 1983 to investigate their biology and relationship with the host ants. Observations of the behavior of the crickets soon revealed that they establish linear dominance hierarchies in the laboratory. Field crickets also establish hierarchies in laboratory populations (Kato and Hyasaka, 1958), but these hierarchies are usually associated with territoriality (Alexander, 1961). The purpose of this paper is to report the hierarchy, how it is established and maintained, and its possible roles.

MATERIALS AND METHODS

Crickets were collected from colonies of *F. obscuripes* in the vicinity of Pullman, Whitman Co., WA. They were transported to the laboratory in small containers with a layer of plaster of Paris/charcoal in the bottom. This layer was moistened with distilled water to maintain a high humidity since the crickets were very susceptible to desiccation.

Initially, crickets were maintained without ants in 6.5 × 15 cm plastic containers to determine if ants were necessary for their survival (Henderson, 1985). The containers also had a thin layer of plaster of Paris/charcoal that was moistened with distilled water to maintain humidity. Honey on paper toweling was supplied as food, and it was replaced at least once a week.

Observations of aggression between crickets soon developed into the present study on dominance hierarchies. Crickets in three containers were used. One contained 5 adult male and 3 adult female *M. manni.* The males were identified by a letter designation for observations, A–E. Most of the crickets were recognizable by size or general appearance. Males A and B were the largest of the five, and about the same size. However, A was missing one hind leg. Male C was the smallest, with males D and E being slightly larger. The latter were marked with White-out® for rapid identification purposes since they were similar in size. Females were identified, and their behavior was recorded. A second container housed two immature crickets and a single *F. obscuripes* worker. One of these crickets was obviously larger, and was probably a later instar. The third container housed 3 1st instars (1.4 mm), one 2nd instar (1.8 mm), and 2 *F. obscuripes* workers.

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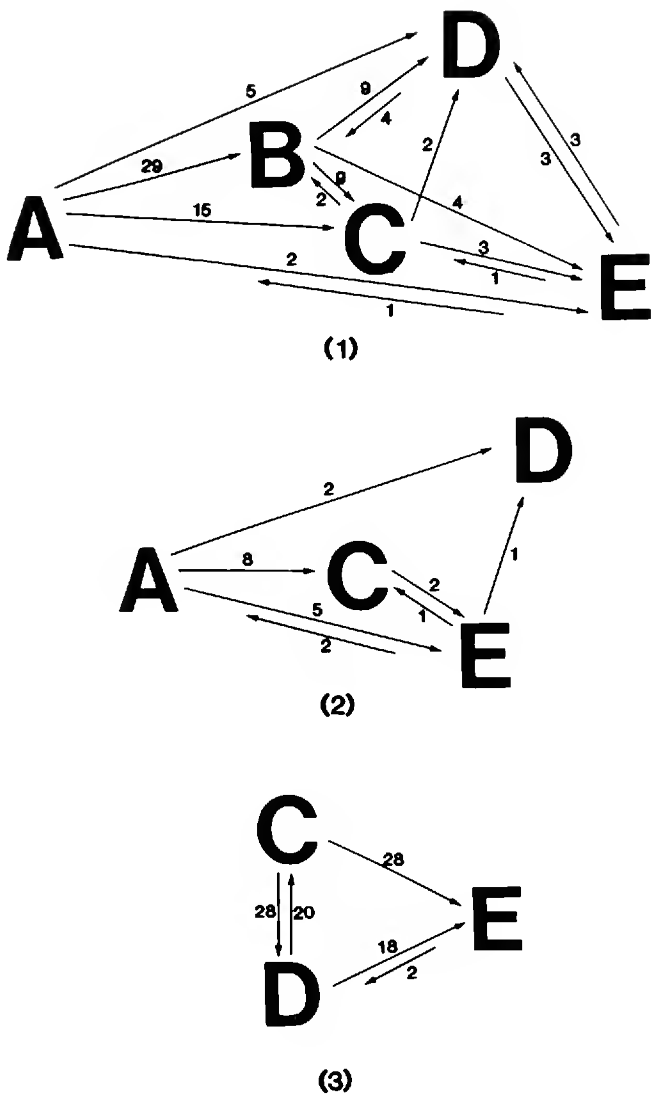

Figures 1–3. Diagrammatic representation of dominance hierarchies among male *M. manni.* Letters represent individual males. Numbers indicate the number of aggressive interactions between adversaries. Arrows point from the winner to the loser of the fights.

Most observational periods of the crickets were one hour in duration, and they were made at random times during the 24 hour cycle. A total of 31 recordings were made from 1 July to 22 August 1984.

RESULTS

A linear dominance hierarchy existed among male *M. manni.* Two hundred twenty male–male and 101 female–male aggressive interactions were recorded. Interactions were categorized into four distinct types. Type 1 consisted of a head thrashing duel. Crickets, upon contacting each other, faced off and moved their heads in an up and down swinging motion in an attempt to bring their head over that of their opponent's and to strike downward. This sometimes caused physical damage when the mandibles of one cricket struck the unsclerotized cervical region of the other. Bouts usually lasted about 2 sec and were terminated when one cricket broke off the attack and moved away. Just prior to fully retreating, the loser turned away from the winner, and one or both crickets then shook their cerci in quick, lateral motions of short duration (ca. one sec). Type 2 interactions were characterized by less aggressive behavior than in Type 1. Interactions involved cercal shaking by one or both crickets (as in Type 1 interactions), stilt-walking, (one cricket lifted its body high off the substrate and walked in a slow, stiff gait toward its adversary), or head bobbing, (one cricket moved its head up and down in a manner similar to that in Type 1 interactions but slower and with

Table 1. Frequency of Type 1–4 interactions between crickets.

	Type of interactions				
	1	2	3	4	Total
Male–male interactions	77	109	30	4	220
Male–female interactions	2	14	68	17	101

reduced intensity). Type 3 interactions involved one cricket butting another and chasing the latter from its position. Type 4 interactions were characterized by one cricket lowering its head and body so that it laid flush with the substratum and did not move despite persistent head butts by its opponent, a position, apparently, of complete subordination.

The dominance order in a five male hierarchy, observed from 1 to 20 July is shown in Figure 1. Male A was dominant over the other four crickets, and fought its closest rival, male B, more often than any other opponent ($n = 29$). Similarly, male B fought often with its close rivals, male C ($n = 11$) and male E ($n = 13$). Males D and E did not establish a clear dominant-subordinate relationship since both fought and won equal numbers of fights with each other ($n = 3$ and $n = 3$). In fact, encounters between the more subordinate males were limited. Possibly, their rank in the hierarchy caused them to avoid interactions.

Type 1 interactions were most often observed between close rivals with the exception of male E. Male E interacted with male A in Type 1 displays and was the only cricket other than male B to challenge the dominant male. Interactions between crickets did not appear to become less aggressive over time. Type 1 interactions continued to occur despite the apparent dominance of one cricket over another. However, Type 2 interactions were the most common behavior when crickets came into contact with each other (Table 1).

Upon the death of male B, a new linear dominance was established, but the same dominant-subordinate relationship among the remaining crickets was maintained (Fig. 2). Observations of this hierarchy were made from 20 July to 6 August, at which time male A died. Male E was the only cricket to challenge male A, and on two occasions it inflicted telling blows with its head to the dominant male. Both fights occurred while the crickets were positioned on the wall of the container. Immediately after the mandibles of male E contacted the neck region of male A, the dominant male dropped to the ground and then moved in an uncoordinated fashion as it rubbed its head against the side of the container. This did not, however, seem to give male E an advantage in later battles with male A.

The study was continued 6–22 August with the remaining 3 males (Fig. 3). However, the dominance order of this latter group remained unstable. Males C and D remained dominant over male E, but a single male did not dominate.

Male–female encounters.—Generally, females were much less active than males so that interactions with other crickets were minimal and were usually initiated by males. Interactions between males and females involved mostly Type 3 and 4 interactions. Even the most subordinate male dominated a female. However, just prior to egg laying (ca. three days) a noticeable change in female aggressiveness was evident, and Type 1 and 2 interactions, where females won over males occurred ($n = 15$). In 40, Type 3 interactions males followed females and then went into a mating posture for 1–5 sec (Henderson, 1985). This behavior suggests

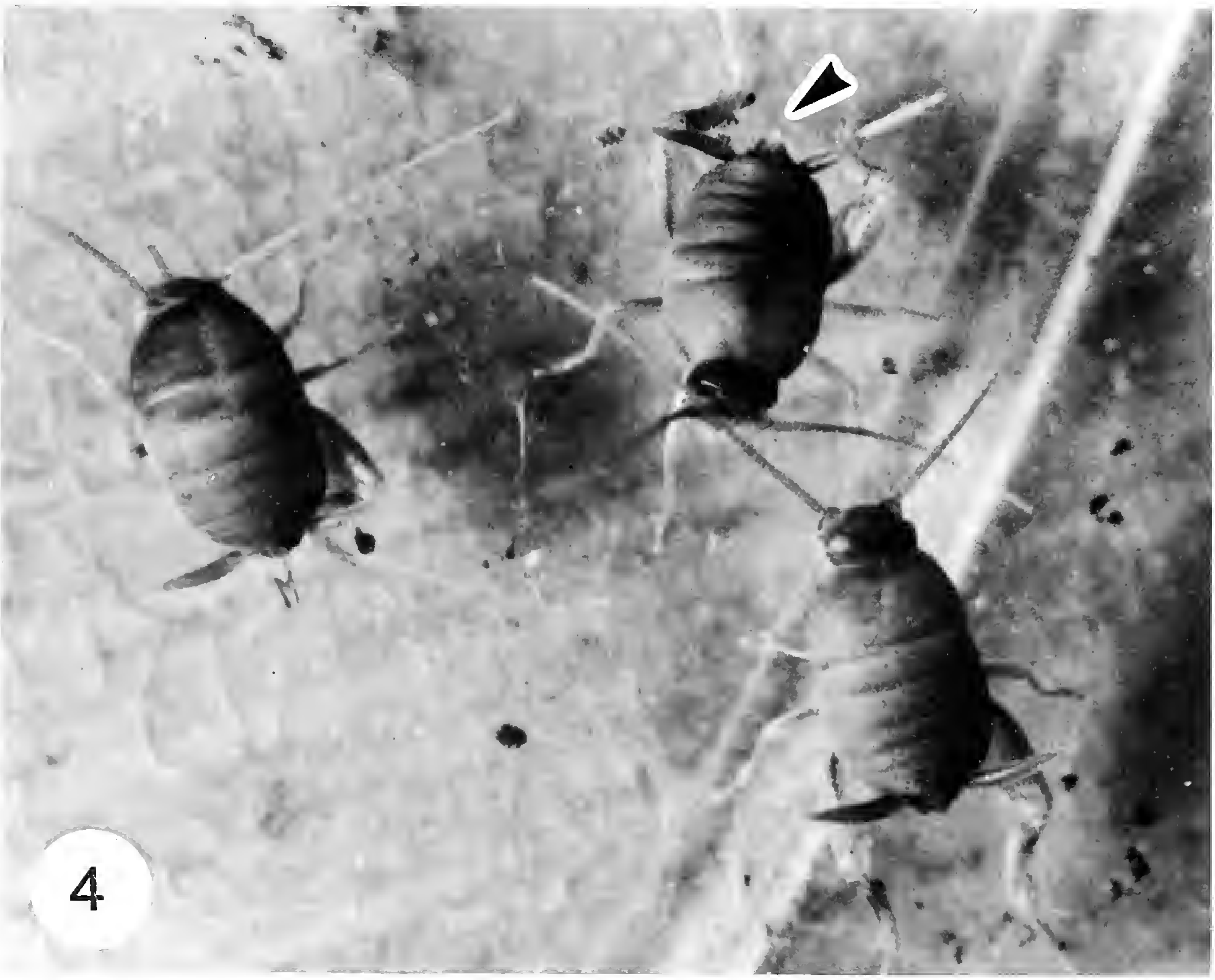

Figure 4. Dominant male interfering in subordinate male's courtship of female. Note spermatophore on the subgenital plate of the subordinate male (arrow).

that males interact with females in an attempt to mate and these interactions probably have little to do with dominance.

Immatures.—Competition among immature crickets was observed as they strigilated and engaged host ants in trophallaxis ($n = 22$). Crickets usually maintained at least a 40° angle, 1–2 mm from other crickets when simultaneously strigilating on an ant. Displacement resulted when crickets were closer than these minimum spacing requirements. Displacement of first instars by second instars indicated that size was a key factor influencing dominance among the immatures. The same dominance relationship was observed in the container with the two larger immatures of undetermined age; the larger dominated the smaller immature. Competition among first instars was also evident but a dominance relationship was not determined because of the difficulty of distinguishing individuals.

DISCUSSION

Size and age seem to play a role in the dominance hierarchies of *M. manni.* Conversely, Alexander (1961) found that age, but not size was a factor in the establishment of dominance hierarchies among field crickets. The large males A and B were always the dominants during this study, and second instars displaced the smaller, first instars to feed on the ants. In addition, the stilt-walking displays in Type 2 interactions also suggest that size is important in maintaining dominance. A similar behavior observed by Holldobler (1976) in competing *Myrmecocystus mimicus* Wheeler ants led him to suggest that stilt-walking is done so that the ant will appear larger and that this had a potential effect on the outcome of the encounter. However, size is obviously not the only factor influencing dominance since male C was much smaller than its subordinates D and E. It is perhaps somewhat ironic that size plays a role in dominance hierarchies in *M. manni* since its myrmecophilous life style, undoubtedly, caused this cricket to be the smallest of all crickets.

All reasons ascribed for the establishment of dominance hierarchies suggest that the dominant individual attains an advantage towards some limiting resource. Nutritional advantages along with an increase in reproduction are associated with dominance in *Polistes* wasps (Pardi, 1948). Nutritional advantages may also be a factor in *M. manni* dominance relationships since immatures fought for trophallaxis or strigulation on a host ant. However, for adult males, mating seems to be the major reason for the establishment of dominance. Successful mating was linked to the establishment of territories in field crickets (Alexander, 1961), but no advantage in fighting by *M. manni* was ever detected due to position in the container. Although males mark areas where they lead females for mating, these areas are not defended and cannot be considered territories (Henderson, 1985). However, subordinate males were sometimes displaced by a dominant when they attempted to mate with a female (Fig. 4) (Henderson, 1985). Although the evidence collected during this study is minimal, it suggests that mating may be one of the primary reasons for dominance hierarchies in *M. manni.*

ACKNOWLEDGMENTS

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Geographic Distribution of *Synanthedon sequoiae* and Host Plant Susceptibility on Monterey Pine in Adventive and Native Stands in California (Lepidoptera: Sesiidae)

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Abstract.—A systematic survey of larval *Synanthedon sequoiae* in adventive and native California stands of Monterey pine, *Pinus radiata,* indicated that the insect is mostly restricted to urban northern California. High densities of *S. sequoiae* were found north of San Francisco to Ft. Bragg in mostly inland valleys; around the southern portion of the San Francisco Bay; and around Monterey Bay. *Pinus radiata, P. patula* and *P. thunbergiana* were preferred hosts in urban areas; whereas *P. canariensis, P. halepensis* and *P. pinea* appeared largely resistant. *Synanthedon sequoiae* was significantly more abundant on host trees that had been pruned. The current practice of planting fast-growing pines, especially Monterey pine, in urban landscapes makes it likely that *S. sequoiae* will spread more widely through the state, eventually establishing in the Central Valley and in southern coastal cities. An isolated infestation in southern California and another in the Sierra-Nevada foothills support this possibility.

The sequoia pitch moth, *Synanthedon sequoiae* (Hy. Edwards),[1] occurs throughout western North America (Essig, 1926; Keen, 1952; Ohmart, 1981). Larvae feed and develop locally on phloem, cambium and, to a limited extent, on xylem tissues in branches and trunks of numerous native and exotic pine species (Weidman and Robbins, 1947) and on Douglas fir, *Pseudotsuga menziesii* (Mirb.) (Furniss and Carolin, 1977). Their feeding results in a colorful, red-brown mass of pitch and frass that protrudes noticeably from the wood substrate. Occasionally, this localized feeding causes weakened branches, but rarely branch dieback. Two reports (Brunner, 1914; Powers and Sundahl, 1973) suggest that under certain conditions *S. sequoiae* may become a forest pest. However, greatest concern for the insect stems from the unsightliness of pitch masses on ornamental trees (Payne, 1973; Ohmart, 1981; Koehler et al., 1983).

Although some general biological and behavioral information has been generated on *S. sequoiae,* much remains to be learned about its habits. Interest in the insect increases yearly due to a general awareness of its potential as a pest in ornamental landscapes. Information gaps include the lack of data on its current distribution in specific geographic areas, especially where pines are being used extensively in landscape plantings. Further, although *S. sequoiae* is known to use numerous pine species as hosts (Weidman and Robbins, 1947), preferred and non-preferred (resistant) species have yet to be appropriately designated. Finally,

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[1] Formerly in the genus *Vespamima.*

several factors that render a host attractive have been suggested (see above references), but more work is needed on this aspect. In particular, previous host damage appears to be the most important factor predisposing a tree to infestation (Weidman and Robbins, 1947; Powers and Sundahl, 1973; Koehler et al., 1983).

In this paper we report results of a survey that systematically examined the distribution of *S. sequoiae* on Monterey pine in adventive (mostly urban) and native stands in California. Tabulated infestation sites on surveyed trees (esp. pruned versus unpruned) provided new insights on the attraction of *S. sequoiae* to its host trees. Finally, an assessment of preferred ornamental pine species in urban areas and an evaluation of potential for spread to new areas are offered.

Methods and Materials

Monterey pine was used in 1981 as the primary host for surveying *S. sequoiae* infestations in numerous adventive and in three native endemic stands. Suitability as an index host derives from its known wide-spread distribution in California and general attractiveness to the insect (Engelhardt, 1946; Payne, 1974; Koehler et al., 1983). Five different geographic zones were recognized and used in the survey (Fig. 1). The first of these was the north coastal zone. The second was the San Francisco Bay Area, which included the northern, southern and eastern sections of the Bay Area. The third zone was the central coastal region that extended from just south of San Jose along the coast to just beyond Santa Barbara in southern California. The fourth was the Central Valley, which extended from Redding to Bakersfield. Finally, the south coastal zone included the greater southern California coastal region. Specific adventive sites within each zone were preselected on a map at intervals of approximately 30 km. Native sites, all of which were in the central coastal zone, were selected in different representative sublocations that were easily accessible (steep hillside forests were avoided).

Forty Monterey pines were selected for survey in adventive and native sites in zones I–III from northern California (Fig. 1). In some Central Valley and southern coastal sites (zones IV and V) it was not always possible to locate 40 planted Monterey pines. Where this was a problem, other pine species known to host *S. sequoiae* were surveyed to supplement the available Monterey pines, the combination of which amounted to 40 sampled trees.

In adventive stands (usually urban plantings in cities), about half the trees were unpruned and half were pruned. Pruning ranged from one or two branches sawed close to the trunk to a complete pruning of all branches up to three meters on the trunk. Adventive stands consisted of variously aged hedgerow and specimen trees in industrial and recreational parks, around schools, or in wind breaks along coastal roads. Estimated tree age ranged from 6–30 years; however, surveyed trees at a given adventive location were usually of one age class. On rare occasions, two or three smaller groups of trees (each variously aged) had to be sampled within a few hundred meters to achieve a sample size of 40.

In each of the three native Monterey pine stands on mainland California (Ano Nuevo, Monterey and Cambria) three subsites were selected for survey (Fig. 1). Forty unpruned trees of mixed ages were chosen at each of these nine subsites. Natural branch pruning, which was common on older trees in native stands, was not considered equivalent to artificial pruning in urban areas.

Trees in both types of stands were individually inspected on trunks, branches

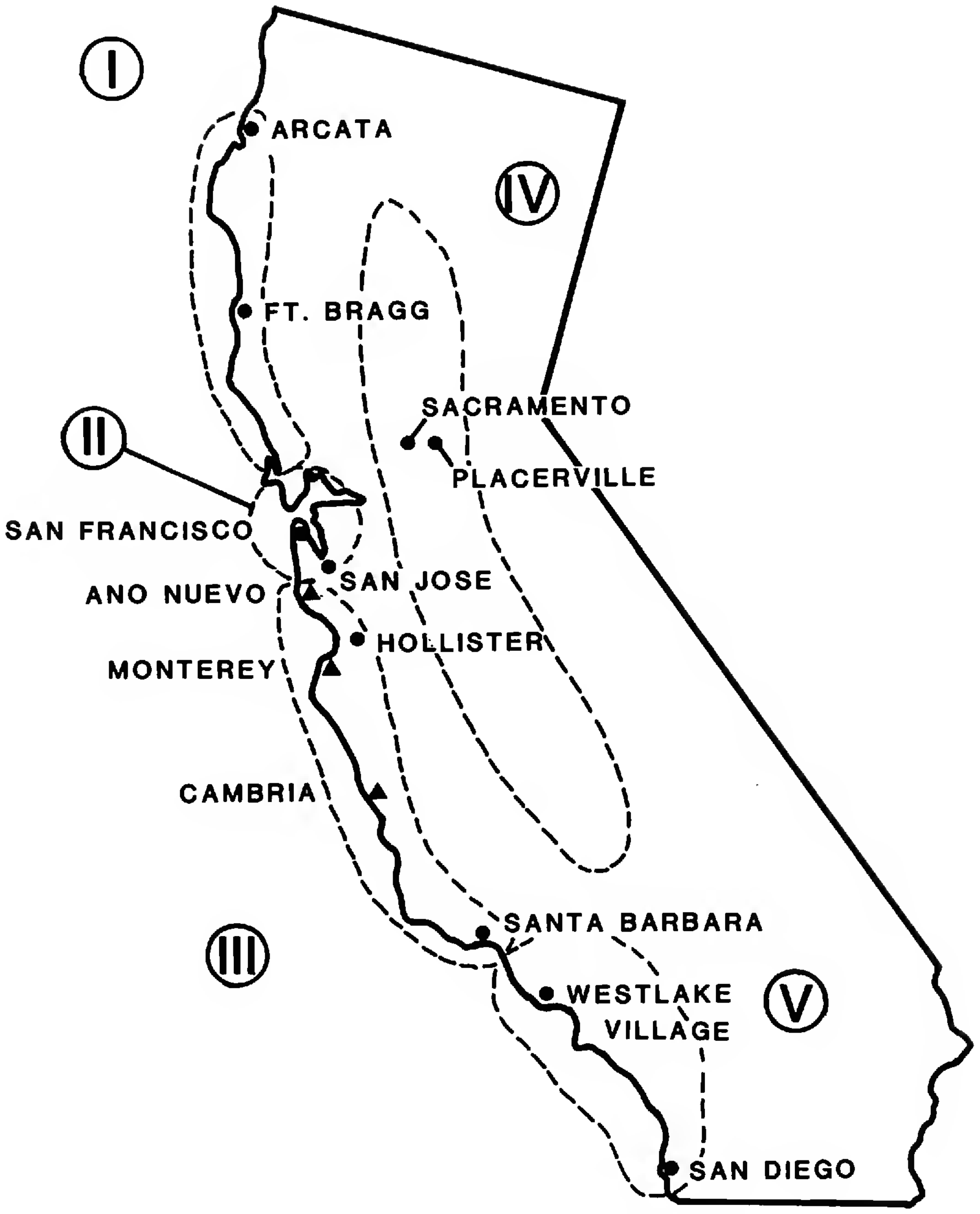

Figure 1. Geographic zones surveyed for *S. sequoiae* pitch masses. Zone I: north coastal; zone II: San Francisco Bay Area; zone III: central coastal; zone IV: Central Valley; zone V: south coastal. ▲—endemic stands of Monterey pine; ●—cities having general geographic significance or unique *S. sequoiae* infestations.

and nodal/internodal areas, as well as the unions where pine cones attached to branches. To assist in this process binoculars were used for many of the taller trees. On rare occasions where infestations were suspected high in the crown, trees were climbed to make a closer inspection. Very large, old trees, although rarely encountered, were bypassed because of the difficulty of assessing infestations at the highest crown levels.

Three distinct infestation types, new, old and reinfestations, on trunks and branches were recognized. New infestations were reddish-brown in color, had a glistening, pitchy appearance and protruded noticeably from the wood substrate. Old infestations were grey in color, hardened, protruding or flat and were often large and cracked in appearance. They remain recognizable on trees for several years. Finally, reinfestations were characterized by new flows of red-brown resin and frass that exuded from the margins and/or center of old pitch masses.

An arbitrary system of infestation categories was established to generally assess low, moderate and high levels of pitch masses (all types) in the surveyed stands. A low level had 1–40 infestations; 41–80 constituted the moderate level; and a high level consisted of more than 80 infestations.

Collection records of *S. sequoiae* were examined and compiled from the following California collections and museums: State Department of Food and Agriculture, Sacramento; California Academy of Sciences, San Francisco; Natural History Museum of Los Angeles County, Los Angeles; University of California, Riverside.

RESULTS

California Survey Results

New, old and reinfestations of *S. sequoiae* were noted and compiled for each of 97 adventive sites and 9 native subsites in the California survey. Sampling revealed that the insect was established in the north coastal region of California which includes geographic zones I–III (Fig. 1, Tables 1 and 2). The survey did not detect *S. sequoiae* in the Central Valley or the south coastal region (zones IV and V in Fig. 1 and additional distribution information below). Overall, much higher levels of *S. sequoiae* were recorded on trees in adventive as compared to native stands (Tables 1 and 2).

Using the arbitrary system of infestation categories, each site was placed into a low, moderate or high infestation level. All sites were then grouped to determine where the insect was least and most abundant in the state. Most sampled areas had no infestations or low levels, including 8 of 9 natural areas (Tables 1 and 2). Only the adventive stands at Willits and Fremont I and the Monterey B natural site were found to contain moderate levels. Twelve sites, all adventive, had high levels and these were distributed primarily in three regions: two in the north coast (Ukiah and Napa), seven around the south end of San Francisco Bay, and three in the north section of the central coastal zone. Sites at Mountain View, Sunnyvale, San Jose I and II and Carmel had exceptionally high infestation levels with total infestations exceeding 300 per site (Table 1). Although high densities were recorded from these three regions, a few of the included stands in each region had relatively few or no pitch masses (e.g., Cloversdale, Healdsberg and Rohnert Pk. in zone I; San Carlos and Menlo Pk. in zone II; Davenport and Salinas in zone III; see Table 1).

The percentage of trees infested was almost always greater in pruned versus unpruned adventive stands (Table 1). San Jose II was an obvious exception to this generality. It was common for some trees at a site to be highly infested while other surrounding or nearby trees had only a few pitch masses. This uneven distribution is reflected in part by high variances of the means reported in Table 1. There was no obvious reason for differences in the uneven distribution of pitch masses on comparable nearby trees. Other workers (cf. Powers and Sundahl, 1973) have also observed clear differences in infestation levels among trees in affected stands.

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[1] New, old and reinfestations.

[2] Pruned and unpruned *P. radiata, halepensis* and *thunbergiana,* and to a limited extent *canariensis, muricata* and *sabiniana.*

[3] Pruned and unpruned *P. halepensis* only.

[4] Pruned and unpruned *P. halepensis, thunbergiana,* and to a lesser extent *canariensis.*

Table 1. Numbers of infestations,[1] percent trees infested and mean numbers (±SD) of *Synanthedon* on unpruned and pruned trees in adventive sites in five geographic zones (see Fig. 1). Unless otherwise indicated, surveyed trees were Monterey pine.

	Nos. infestations		% trees infest.		$\bar{x}$ nos. infest. per infest. tree	
Location	Unpruned	Pruned	Unpruned	Pruned	Unpruned	Pruned
I. North Coastal						
Willits	0	46	0%	21%	0	11.5 ± 14.7
Ukiah	4	85	14	63	1.3 ± 0.6	7.1 ± 6.0
Healdsburg	0	2	0	8	0	1.0 ± 0
Rohnert Pk.	3	0	21	0	1.0 ± 0	0
Napa	9	212	33	64	1.5 ± 0.6	15.1 ± 22.0
Albion, Arcata, Cloverdale, Eureka, Ft. Bragg, Jenner, and Pt. Arena: none with infestations.						
II. San Francisco Bay Area						
Novato	0	3	16	0	1.0 ± 0	0
San Rafael	2	0	5	0	2.0 ± 0	0
Mill Valley	0	5	0	15	0	1.7 ± 0.6
San Bruno	0	35	0	47	0	3.9 ± 3.1
Burlingame	0	245	0	53	0	11.3 ± 21.7
Menlo Pk.	16	17	31	17	4.0 ± 4.8	3.4 ± 3.4
Mt. View	70	240	21	90	17.3 ± 17.6	12.6 ± 16.1
Sunnyvale	14	336	45	95	1.6 ± 0.9	17.7 ± 16.2
Santa Clara	29	60	30	70	4.8 ± 3.4	4.3 ± 1.9
San Jose I	100	314	80	95	6.3 ± 3.8	17.3 ± 16.9
San Jose II	429	168	95	80	22.6 ± 11.5	10.5 ± 11.5
Livermore	73	216	54	89	10.4 ± 9.5	9.0 ± 8.4
Fremont I	0	41	0	41	0	2.7 ± 2.1
Fremont II	0	4	0	20	0	1.0 ± 0
Hayward	0	2	0	10	0	1.0 ± 0
Castro Valley	0	1	0	5	0	1.0 ± 0
Oakland	1	0	5	0	1.0 ± 0	0
Piedmont	0	1	0	5	0	1.0 ± 0
Albany	0	9	0	8	0	3.0 ± 2.6
Vallejo II	0	4	0	5	0	4.0 ± 0
Alamo, Berkeley, Concord, Crockett, Daly City, El Cerrito, El Sobrante, Richmond, San Carlos, San Francisco, San Gregorio, San Leandro, Sausalito, Stinson Beach, Union City and Vallejo I: none with infestations.						
III. Central Coastal						
Davenport	0	1	0	20	0	1.0 ± 0
Santa Cruz	27	157	50	69	3.9 ± 6.7	8.7 ± 11.1
Watsonville	24	100	38	75	2.7 ± 1.4	8.3 ± 8.9
Salinas	0	23	0	14	0	7.7 ± 7.6
Carmel	28	459	38	96	4.7 ± 5.2	20.9 ± 17.9
Atascadero, Gaviota, Lompoc, Los Padres, Lucia, Morro Bay, Pismo Beach, San Miguel and Santa Maria: none with infestations.						
IV. Central Valley						
Bakersfield,[2] Chico, Davis, Delano,[2] Fairfield,[2] Madera,[2] Merced,[2] Modesto, Orland,[3] Oroville, Red Bluff, Redding, Sacramento,[2] Selma,[2] Stockton, Tracy,[2] Tulare,[2] Turlock,[2] Yuba City/Marysville: none with infestations.						
V. South Coastal						
Beverly Hills,[2] Buena Park,[2] Chula Vista, Compton,[2] Laguna Hills,[2] Long Beach,[2] National City,[2] North Hollywood,[2] Oceanside, Pasadena,[2] Pomona,[2] San Clemente,[2] San Diego,[4] Simi Valley, Ventura[2] and Woodland Hills[2]: none with infestations.						

Table 2. Numbers of infestations,[1] percent trees infested and mean numbers (±SD) of *Synanthedon* infestations on 40 Monterey pines at each native subsite.

Location	Nos. infestations	% trees infest.	$\bar{x}$ no. infest. per infest. tree
Ano Nuevo[2]			
Site C	4	5	2.0 ± 1.4
Monterey			
Site A	17	25	1.7 ± 0.9
Site B	64	48	3.4 ± 2.4
Site C	9	15	1.5 ± 0.8
Cambria			
Site A	29	25	2.9 ± 1.8
Site B	11	1	2.8 ± 1.0
Site C	17	23	1.9 ± 1.5

[1] New, old and reinfestations.

[2] No. infestations at subsites A and B.

The type of infestation (i.e., new, old or reinfestation) was tabulated for each site to assess the relative infestation age of a particular stand. In the following account, only those sites having greater than 20 infestations were examined (Tables 1 and 2). In virtually all adventive and native stands there were considerably more old or new infestations than reinfestations. Further, most sites (71%) had more old as compared to new infestations; the opposite relationship was noted at Santa Clara, Santa Jose I, Livermore, Santa Cruz, Watsonville and Salinas. In these cases, it appeared that the trees supported incipient or growing populations of *S. sequoiae*.

Examination of tabulated data provided information on preferred infestation sites on individual trees (Tables 3 and 4). Comparing overall infestations on trunks and branches of adventive trees, approximately twice as many were found on the trunks (Table 3). Pruned sites on both trunks and branches had about three times as many infestations as did the respective unpruned sites, and the differences in both cases were significant (*t*-test, $P = 0.005$). On the lower halves of trees about four times as many infestations were recorded as compared to the upper halves (each half included trunks and branches) (Table 3). Further, pruned areas had significantly more infestations than unpruned areas, regardless of tree half. The same general infestation patterns were also observed on native trees where substantially more infestations were recorded on trunks versus branches and on lower versus upper halves of trees (Table 4).

Pitch masses were found on adventive or native trees at the following specific locations: nodes (bases of branches), internodes, injured or pruned areas, previous infestations, and pine cone attachment points on branches. To gain insight on which locations were preferred, new infestations only were tabulated from all survey trees (Table 5). In the case of unpruned trees, nodes and internodes were the preferred sites. To a slightly lesser extent, previous infestations were also preferred. New pitch masses were relatively uncommon on injured sites and pine cone bases in this group of trees. In the case of pruned trees, nodes and internodes had considerably more pitch masses than the other sites, including those injured or pruned. Previous infestations and pine cone bases were the least preferred in this group.

Table 3. Total numbers of infestations[1] on trunks versus branches and on lower versus upper halves of unpruned and pruned Monterey pines in adventive stands.

	Total nos. of infestations per zone			
	Trunk		Branches	
Location	Unpruned	Pruned	Unpruned	Pruned
N. Coastal	12	254	4	91
S.F. Bay Area	491	1078	243	616
Central Coastal	53	448	21	292
Totals:	556	1780	268	999
$P = 0.005$	$t = 5.19$		$t = 4.17$	
	Lower half		Upper half	
N. Coastal	13	279	3	65
S.F. Bay Area	647	1352	87	342
Central Coastal	59	548	15	190
Totals:	719	2179	105	597
$P = 0.005$	$t = 4.45$		$t = 5.1$	

[1] New, old and reinfestations.

In 1943 and 1944, Weidman and Robbins (1947) recorded the distribution and numbers of *S. sequoiae* pitch masses on 3690 pine trees at the Eddy Arboretum in Placerville, California (Fig. 1). They found evidence of the insect on 33 pine species and four hybrids. Based on total numbers of pitch masses per 100 trees, they constructed a list of the most frequently infested pine species. According to their tabulation, Monterey pine was one of the least infested pines. However, it seems that variously-treated trees at the arboretum may have influenced this tabulation. For example, some pine species were pruned; others were not. A few pine species were extensively drilled by sapsucking woodpeckers; others were scarcely affected or lacked drillings entirely. Further, infestations were often localized within the arboretum. Thus, the Weidman and Robbins (1947) listing serves best as guide only for those species that are likely to host *S. sequoiae.* To develop a more accurate scale of relative suitability or susceptibility by host pine species would involve a considerable testing effort, exposing reared adult moths to trees standardized for such characteristics as age, size and pruning activity.

Although this type of testing was beyond the scope of the current investigation, a group of similarly-treated ornamental pines was surveyed in the city of San Jose to develop information on the question of relative host susceptibility. San Jose

Table 4. Total numbers of infestations[1] on trunks versus branches and on lower versus upper halves of Monterey pines in native stands.

	Total nos. of infestations per site			
Location	Trunk	Branches	Lower ½	Upper ½
Ano Nuevo	4	0	4	0
Monterey	65	25	65	25
Cambria	54	3	45	12
Totals:	123	28	114	37

[1] New, old and reinfestations.

Table 5. Total numbers of new infestations only on five specific sites on adventive and native Monterey pines.

Infestation site	Nos. of new infestations	
	Unpruned	Pruned
Nodal (intact)	198	274
Internodal (intact)	157	299
Injury and/or pruning	19	121
Previous years' infest.	141	55
Pine cone base	8	43

was chosen since the insect was found to be very active there (Table 1). Representatives of five common pine species were selected throughout the city (Table 6). They ranged in age from 10–25 years, and each tree had some evidence of past flush pruning on the trunk. Comparing the San Jose results with those of Weidman and Robbins (1947), there was agreement in relative susceptibility for three species, *P. canariensis, P. pinea* and *P. thunbergiana.* However, for three species (*radiata, patula* and *halepensis*) there were considerable differences in survey results. With regard to *P. halepensis,* our supplemental observations in other California cities (unpub.) indicated that this species is only an occasional host, especially if unpruned (see also results of Westlake Village survey below).

Additional sites throughout California were examined, and these locations provide supplemental information on the current geographic distribution of and relative susceptibility of host pine species to *S. sequoiae.*

Ft. Bragg.—Surveyed Monterey pine in this city showed no evidence of *S. sequoiae* (Table 1), which is consistent with its general distribution in this geographic zone (Fig. 1). However, a later examination of another group of Monterey pines in Ft. Bragg revealed that the insect occurred there in low numbers. Rather than resurvey the second group, two other common pines, *P. muricata* and *P. contorta* were examined for the insect. Twenty pruned and 20 unpruned ornamental trees, mostly 5–20 years old, of each species showed the insect in low densities in *P. muricata* (total of 39 masses) and in high densities in *P. contorta* (total 126 masses). These results indicated that *S. sequoiae* can effectively use other pine species as hosts, even in the presence of Monterey pine. It is noteworthy that both pines occur natively in and around Ft. Bragg, and thus the infestation was considered long-standing in the area.

Hollister.—At a nursery just north of the city, about 60,000 Monterey pines are grown in pots for use as Christmas trees (Fig. 1). Trees were first planted at this site in 1980, and *S. sequoiae* first appeared on a few trees in late 1983. A survey in early 1985 of several hundred trees in three age classes revealed the following distribution. One year old trees were almost entirely free of the insect; two year olds had a frequency of about 1%; three year olds had a 10% infestation rate. Most infested trees had a single pitch mass.

Although *S. sequoiae* is considered new to this locality, its potential as a major pest in such a pine plantation is recognized on the basis of several factors. It does not usually infest such small sized trees; larger diameter wood is generally required to support developing larvae. Further, the vigorous handling trees receive during repotting and shearing, and the rapid growth they experience through generous applications of drip-irrigated water and fertilizer may be predisposing them to

Table 6. Numbers of infestations and percent trees infested with *Synanthedon* on pruned *Pinus* species in San Jose.

Pinus species	*n*	Nos. infestations	% trees infested	Est. relative attract.	Relat. attract. cf. Weidman & Robbins ('47)
P. radiata I[1]	20	314	80	hi	low
P. radiata II[2]	20	168	95	hi	low
P. patula	16	117	69	hi	low
P. thunbergiana	20	37	55	mod	mod
P. halepensis	20	23	40	low?	mod–hi
P. canariensis	20	0	0	NR[3]	none
P. pinea	20	0	0	NR[3]	low

[1] San Jose I from Table 1.

[2] San Jose II from Table 1.

[3] NR—none recorded. Occasionally, pruned or injured trees have been observed with a few pitch masses, however.

the insect. Finally, the nursery is in close proximity to Monterey Bay (zone III–Fig. 1), one of the regions where *S. sequoiae* was found in high densities (Table 1).

Westlake Village.—The Westlake Village Golf Course, located in the south coastal zone (Fig. 1), was the only site in southern California where *S. sequoiae* was found. The golf course was not part of the systematic survey, but rather it resulted from an information inquiry about the moth during the time of the statewide survey in 1981. The site contained more than 300 Monterey pine, with some *P. halepensis* and *P. pinea*; the majority of these trees were planted in 1967. Most Monterey pines were infested with the insect, and many were highly infested. Two trees were exemplary: one had 225–250 pitch masses; the second had 350–400 (new, old and reinfestations). Only a few infestations were found on some individuals of *P. halepensis,* and one infestation was located on *P. pinea.*

Infestations of *S. sequoiae* at Westlake differed from others in the state in two respects. First, the pitch masses were about twice as large as masses in any other location. The weight of some caused them to fall from trees and litter the edges of fairways. Secondly, masses were commonly found on the upper trunk region and associated branches. This unique distribution appeared to be related to bark lesions that commonly occurred in the upper crown. Lesions were small and irregularly shaped and may have resulted from localized feeding by squirrels or other rodents. Although none of these mammals were actually sighted at Westlake, in Pacific Grove (Central Coastal zone, Fig. 1) squirrels have been observed chewing lesions of this type in Monterey pine branches.

The first pitch masses at Westlake were noticed by grounds keepers in 1980. By 1981, the numbers of new masses far outnumbered old ones, indicating that the population was still developing. Despite the observed high densities in 1981, it appeared that the golf course infestation was highly localized since various ornamental pines examined in 1982 in a residential neighborhood around the golf course showed no evidence of the insect. Further, at a nearby golf course in Camarillo, 10-year-old Monterey pines (and *P. halepensis*) showed similar lesions on branches and trunks but no evidence of *S. sequoiae.*

Placerville.—Pines at the Eddy Arboretum in Placerville were examined in 1981 and 1982 for pitch masses of *S. sequoiae.* A few masses were found on some representatives of several pine species; however, none of the affected species appeared to be as susceptible as reported by Weidman and Robbin (1947) in their 1943–1944 assessment of the *S. sequoiae* infestation. Because of these low densities it was impossible to sort out the most and least susceptible pine species. Overall, the infestation was assessed as persisting at low densities, which may be characteristic of older trees that have not been damaged for several years.

Collection records from major California collections and museums were of limited use in supplementing the state distribution pattern of *S. sequoiae.* Most collections were taken from Monterey pine in northern California, especially around the south end of the San Francisco Bay and from the Carmel/Monterey area. In southern California, only a very few collections were available, and these were from pines in natural forests at higher elevations (~1500 m). One of these was taken from *P. coulteri* at the Arrowhead area of the San Bernardino Mountains. Two collections each were from *P. coulteri* and *P. jeffreyi* at Idyllwild (vicinity of Mt. Baldy) in the San Jacinto Wilderness Area.

DISCUSSION

Overall results of the systematic survey, supplemental observations in specific locations and museum records indicated that *S. sequoiae* is mostly a coastal to somewhat inland insect in urban northern California. More specifically, the moth is found in relatively high densities in three general areas. The first extends from Ft. Bragg to San Francisco, just east of the coastal mountains (Fig. 1 and Table 1). The second area occurs around south San Francisco Bay (mostly San Mateo and Santa Clara Counties). Payne (1974) also noted a high frequency of *S. sequoiae* in Santa Clara Co. The third area is located around Monterey Bay, immediately coastal and slightly inland, and includes the cities of Santa Cruz, Watsonville, Hollister and Carmel.

Additional collecting from native pines (*P. coulteri, P. jeffreyi, P. ponderosa* and *P. sabiniana*) in the inland mountains of northern and southern California would probably reveal a more widespread distribution of the insect in the state. The observations at Placerville and collections from the San Bernardino and San Jacinto mountains provide evidence for this possibility. The long-standing infestations of *S. sequoiae* in Placerville and the new infestations at Hollister and Westlake Village also suggest that the insect has the capacity to establish high populations in new areas. The popular trend of using fast-growing pines in many urban California landscapes, especially in southern California and in the cities of the Central Valley, may increase the chances of new localized infestations.

Based on our observations statewide and the observations of other workers (Brunner, 1914; Engelhardt, 1946; Weidman and Robbins, 1947; Powers and Sundahl, 1973; Payne, 1974), it was possible to sort the urban ornamental pines into two major groups; preferred and non-preferred species. In the preferred category were *P. radiata, P. patula, P. thunbergiana, P. muricata, P. contorta* and *P. ponderosa* (the latter three species are only occasionally used in urban California landscapes). Pines showing resistance to *S. sequoiae* were *P. canariensis, P. halepensis* and *P. pinea. Pinus halepensis* can best be described as generally resistant, but susceptible under some circumstances. *Pinus canariensis, P. pinea* and *P. halepensis* become slightly more susceptible as hosts only if they have experienced substantial pruning or other mechanical damage.

Because of its rapid growth and desirable form, it is likely that Monterey pine will continue to be widely planted in urban California, despite its susceptibility to the moth. However, in areas where *S. sequoiae* is common, *P. halepensis* may be substituted for *P. radiata* owing to its general resistance to the insect and similarity in size, form, texture and needle color with *P. radiata.* It is likely that this option will only be considered by land owners and managers when *S. sequoiae* or other insect pests such as bark beetles severely damage Monterey pine. This was the case at Westlake Village Golf Course where *S. sequoiae* and *Ips* bark beetles threatened to seriously damage about one-third of the standing trees.

It seems clear that certain human activities, especially pruning or similar mechanical injury, predispose host trees to *S. sequoiae.* This was experimentally demonstrated by Koehler et al. (1983) and by our comparative survey on unpruned and pruned trees in adventive and native stands of Monterey pine. Other factors that render host trees more susceptible include the activities of rodents, woodpeckers (Weidman and Robbins, 1947), increment borers (Powers and Sundahl, 1973), and damage by moving vehicles and support wires/metal stakes left in place too long (Payne, 1974). Powers and Sundahl (1973) also suggest that rapidly growing trees have a higher risk of infestation by *S. sequoiae.* Our experience with fast-growing Monterey pines in Hollister and elsewhere support their observation. Overall, the evidence indicates that tree stress leading to bark rupture or reduced outer bark thickness will encourage entry of the insect.

Several other studies have demonstrated the relationship between increased borer infestations and human-induced tree stress. Potter and Timmons (1981) showed that trunk wounding and exposure to sun were the most important factors predisposing flowering dogwoods in Kentucky to the dogwood borer, *Synanthedon scitula* (Harris). Frankie and Koehler (1971) and Frankie and Ehler (1978) described how larval infestations of the cypress bark moth, *Laspeyresia cupressana* (Kearf.), increased on Monterey cypress that had been stressed through rapid growth and mechanical bark ruptures in urban California environments. Byers et al. (1980) reported that the smaller European elm bark beetle, *Scolytus multistriatus* (Marsh.) was more attracted to pruned limbs of European and Siberian elms compared to healthy, non-pruned limbs in California. Landwehr et al. (1981) found that native elm bark beetles, *Hylurgopinus rufipes* (Eichhoff), were more attracted to pruned versus unpruned American elms in Minnesota. Their work also showed that treating pruned sites with wound dressing compound would reduce the number of incoming bark beetles. Finally, collection notes by Engelhardt (1946) on U.S. sesiids suggest that larvae of several species are commonly associated with fast growing trees, especially in urban or suburban settings. The implication is obvious; that trees in well cared for human environments are apparently more attractive than conspecific hosts in natural environments. Engelhardt mentions that one sesiid, *Vitacea scepsiformis* (Hy. Edwards), is exceptional in this regard; it thrives on host plants in cultivation and is very rare or absent in natural habitats.

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Time of Nuptial Flight in Two Ant Species (Hymenoptera: Formicidae)

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Abstract.—A flight of *Myrmecocystus ewarti* was seen near Palm Desert, California, at 1500 on 30 December. It is reported because neither hour nor date has been published for this species; and more important, because this genus varies more than most in flight and worker timing among species. This is the first winter flight record for the genus. Secondly, a flight of *Pogonomyrmex californicus* was seen near Riverside, California, at 1015 on 4 October, surprising because the flights usually occur in June and July.

A single flight of each of two species is reported here: *Myrmecocystus ewarti* Snelling because we are aware of no published record for this species; and *Pogonomyrmex californicus* (Buckley) because it was seen at an unusually late date. *M. ewarti* was observed by JSN and *P. californicus* by ESM.

Myrmecocystus ewarti

The nest was about 8 km north of Palm Desert, California, in a *Larrea-Encelia* desert community. The entrance was a 2 cm hole straight down, in a wash area. The ground had been moist several days before, indicating a previous rain.

The nest was observed several times on 30 December 1983, as noted below. The day was sunny and warm, becoming partly shaded by cloud by 1500 (PST); the temperature at the surface then was 23°C in the sun and 15° in the shade; at 7 cm deep it was 19°.

1415: Passed by nest and noticed nothing.

1500: About 300 workers moving in unusual zigzag pattern within 1-m radius of entrance. About 15 males motionless on pebbles, some taking flight. Four females emerged gradually from nest and were collected.

1600: 20 workers only were left.

Several days later, 3 January 1984, this nest was observed again. The afternoon was clear and sunny, with surface temperature in the sun 24–27°. The ground was now quite dry. No ants were seen at 1445, 1500, or 1550; 2 workers were inside the entrance at 1520. (At a nearby nest of *M. mimicus* 100 workers and 2 males [in the entrance] were seen at 1500.)

The two dates listed by Snelling (1976) when alates of *M. ewarti* have been found in the nest, 26 January and 1 March, are both in the winter like the flight reported here.

Published records of flight time for other species in the genus include *M. men-*

dax, 18 July at 1610 (Wheeler, 1908); *M. mexicanus,* 24–28 July, 1922–1936 (Conway, 1980); *M. mimicus,* July, 1730–1900 and 0600–0700 (Bartz and Hölldobler, 1982); *M. pyramicus,* 7 April, near sundown (Smith, 1951 with Snelling, 1976); *M. testaceus,* early spring and midautumn, late afternoon (Snelling, 1976). A second morning-flying species is *M. depilis,* July, 0600 (G. Alpert, personal communication). Thus there is more spread of both date and hour of flight than for most genera (cf. McCluskey, 1974); and our new record (*M. ewarti*) adds yet another season, winter.

Pogonomyrmex californicus

Published records of date of flight include 27 June–15 July (Michener, 1942) and June–July (Mintzer, 1982). Through the years locally the flights have often been observed (such as collecting the alates for laboratory study, McCluskey and Carter, 1969) from the first of June into August. So imagine my surprise to encounter a flight in the fall. A couple times in preceding days a female had been noticed at a nest, but thought to be merely a straggler left over for some reason.

The nest openings were in a crack of the pavement of a parking lot in Loma Linda (near Riverside, CA), where I passed one or more times a day; the colony had been there for many years. At 1005 on 4 October 1983 I noticed many alate females out. So observations were made as follows:

1010: About 150 females out at three exits, massed in usual way (somewhat in rows around exits); also many workers. No males seen now or later.

1005–1035: Large number continued out, sometimes spreading to a meter beyond exits, both females and workers running excitedly. Several females flew, perhaps one per minute for a while (but could never verify by sighting against sky). A student who stopped by (1015–1020) also said he saw them fly. Sunny and warm (hot sitting in sun) most of time, but dimmed by clouds part of time. Often a breeze. By 1035 number out had dropped to a half or third.

1055: Only 7 females out.

1100: Sun much dimmed by clouds; shade air temperature 24°C.

Between 1035 and 1055: Checked six other nests, mostly in more typical habitat, as along railroad siding. Workers but no alates out. More cloudy by now. Ground wet from heavy rain 30 September.

In conclusion, this report adds another species flight hour and date for a genus that deserves further analysis because of unusual diversity in timing. Secondly, it provides a reminder that variability in biological phenomena within a species should not be overlooked.

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Seasonal Distribution, Trophic Structure and Origin of Sand Obligate Insect Communities in the Great Basin

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Recent surveys of insects in western North American sand dunes (Hardy and Andrews, 1979, 1981; Andrews et al., 1979; Cobb, 1981; Bechtel et al., 1981, 1983; Rust et al., 1983) have established the presence of unique, often endemic groups of Coleoptera, Hemiptera and Orthoptera. These species are referred to as sand obligate species and are defined as species whose life history activities are restricted to sand dune environments (Koch, 1961; Hardy and Andrews, 1976). I will show that sand obligate (SO) species from one sand dune, Sand Mountain, Nevada, are principally detritivores and carnivores that occur either throughout the year or in cold, winter months. The distribution of sand obligate faunas in several dunes in the Great Basin Desert of the United States may possibly be explained by examination of past climatic conditions during the Pleistocene in the Great Basin. The hypothesis being examined is that the present distributions and restriction of the sand obligate fauna is a result of contraction of Pleistocene sand areas with decreasing aridity in recent times.

STUDY AREA

Sand Mountain dune is approximately 46 km ESE of Fallon, Churchill County, Nevada (39°20'N–118°20'W) and is 1250 m in elevation. It is an active star dune of approximately 3.2 km^2 and results from eolian sand deposited during the Turupah and Fallon formations of about 4000 years before present (B.P.) (Morrison and Frye, 1965). Sparse dune vegetation consists of the shrubs *Atriplex confertifolia, Tetradymia tetrameres, Chrysothamnus viscidiflorus, Eriogonum kearneyi, Psorothamnus polyadenius* and the grass *Oryzopsis hymenoides.* The dune was sampled 18 times from June 1979 through June 1980.

Monthly average temperature and precipitation from Fallon, Nevada (39°27'–118°47'W and 1208 m elevation) for a thirty year period are given in Table 1 (USDC 1970). Sand Mountain is in the cold desert of North America with cold, wet winters (−0.4 to 5.8°C and 1 to 1.6 mm) and hot, dry summers (10 to 22°C and 0.5 to 1.8 mm). Thirty year mean monthly temperatures were analyzed by Fisher's L.S.D. test to determine which months have equal mean temperatures. L.S.D. valve was 0.73°C or all monthly means are significantly different from each other.

METHODS AND MATERIALS

Several collecting techniques were used. Permanent pitfall traps were 0.95 L (11.5 cm diameter) plastic cartons buried level with the sand surface and one-third to one-half filled with ethylene glycol. Traps were covered with a 13 × 13 cm Masonite lid held 2 cm above the surface. Six traps were placed 10 meters apart in a transect and six transects were used. Traps were operative for 30 days between collecting periods. Temporary pitfall traps were 15 cm diameter ceramic bowls placed level with the sand surface. Twelve traps placed 10 meters apart represented a transect and six transects were used. Temporary pitfall traps were used for 12 to 18 hr during a survey period and trapping duration was determined by the length of the night. Hand held lamps were used in searching the dune for nocturnal species. Sand was sifted through two screens of 12 × 12 mm and 1.5 × 1.5 mm mesh to recover subsurface arthropods. Surface sand to a depth of 0.4 to 0.5 m both from beneath vegetation and open sand (non-vegetated areas) was sifted. During surveys, four or five different sites on the dune were visited and sampled and the sites were varied each survey.

All specimens were sent to taxonomists for identification (see Bechtel et al., 1981, 1983; Rust et al., 1983 for listings). Four of the species were determined as new to science. These species will be described by taxonomists and are here treated as species unique to Sand Mountain, NV.

Trophic level placement of species was based on field observations, dissection of digestive tracts and literature citations. When few specimens were available or species specific literature was not available, then trophic level assignment was based on generic patterns.

Spearman's rank correlation test was used to compare a species monthly abundance to both mean monthly temperature and precipitation. The hypothesis being tested is that a species monthly abundance ranking is independent of either monthly temperature or precipitation ranking.

RESULTS

Sixteen species are recognized as sand obligate, 3 herbivores, 4 carnivores and 9 detritivores (Table 1). *Serica* species (Scarabaeidae) adults were found from May to June and were observed feeding of *Psoralea lanceolata* (Fabaceae) and *Ambrosia acanthicarpa* (Asteraceae). Larvae were recovered in October and March–April from sand beneath the roots of *Oryzopsis hymenoides* (Poaceae). Their guts contained masticated plant material. *Cardiophorus* species (Elateridae) adults were found from November to March and were recovered from sand beneath several dune shrubs. A single larva was taken in May. *Cardiophorus* have unknown feeding habits. The larval mouth opening is small suggesting that they probably take only liquid food. *Edrotes ventricosus* (Tenebrionidae) was present in all months but November to January. La Rivers (1947) observed *E. ventricosus* feeding on saltgrass, *Destichlis spicata,* brome grass, *Bromus tectorum,* Russian Thistle, *Salsola kali,* and wild onion, *Allium* sp. and considered it a strict herbivore. SO carnivores, *Rhadine myrmecodes* (Carabidae), and *Mecynotarsus delicatulus* (Anthicidae) were present in all months, *Philothris* species (Histeridae) was found during the winter months, and *Tetragonoderus pallidus* (Carabidae) was present from May to September. Of the detritivores, *Niptus ventriculus* (Ptinidae) (Hinton, 1941; Brown, 1959), *Eusattus muricatus* (Doyen, 1984 for recent review), *Lariversius tibialis* (gut analysis, unpublished data), and *Trogloderus costatus* (La Rivers, 1946; Tanner and Packham, 1965; Thomas, 1979) (Tenebrionidae) were present in all months. *Chilometopon brachystomum* (Doyen, 1982) (Tenebrionidae) was present during the summer months. *Aegialia hardyi* (Rust and Hanks, 1982), *Aphodius nevadensis* (gut analysis, unpublished data), and *Coenonycha* species (Scarabaeidae) were

Table 1. Seasonal distribution of sand obligate insects from Sand Mountain, Nevada from June 1979 through June 1980, larval numbers are given in parentheses. Species dry weight is given in milligrams (E means estimated dry weight because of few specimens). Mean monthly temperature and precipitation based on a thirty year average are given for Fallon, Nevada.

Species	Weight	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
					Herbivores								
Cardiophorus species	6.0E	2		1		(1)						1	2
Serica species	14.8			(17)	(37)	36	63	37			(10)		
Edrotes ventricosus	13.7		4	3	19	5	19	46	5	4	1		
					Carnivores								
Mecynotarsus delicatulus	5.0	3	2	5	2	2	7	12	296	26	9	3	1
Rhadine myrmecodes	94.0	2	21	29	7	13	12	7	25	12	1	13	22
Tetragonoderus pallidus	18.5					1	10	13	14	4			
Philothrus species	2.0E	1		2	2	4				2	2	1	
					Detritivores								
Ammobaenetes lariversi	40.1	3	7	4	2	10	42	48	30	40	45	3	1
Niptus ventriculus	6.6	4	1	3	1	3	33	5	12	9	2	11	7
Aegialia hardyi	2.2	158	55	54 (79)	68 (144)	30 (38)					54	86	60
Aphodius nevadensis	5.4	15	28	23 (26)	 (21)							5	16
Coenonycha species	10.0E	6	4										
Chilometopon brachystomum	20.0E						12						
Eusattus muricatus	133.0	2	10	29	14	7	6	98	372	85	22	6	3
Lariversius tibialis	19.1	16	39	32	23	15	50	70	482	241	76	7	12
Trogloderus costatus	18.9	3	3	3	9	13	35	52	25	210	2	2	1
					Average temperature °C								
		−0.4	3.0	5.8	9.7	14.2	18.5	22.7	21.2	16.9	11.0	4.6	0.7
					Average precipitation mm								
		12.4	16.0	13.9	9.6	18.5	11.4	4.8	4.3	5.5	10.6	9.1	11.6

Table 2. Spearman's rank correlation and probabilities of species monthly abundance to monthly temperature and monthly precipitation 30 year averages and probability levels. Rankings are from high to low for monthly species abundance, temperature and precipitation.

	Temperature			Precipitation	
Species*	n	r_s	P	r_s	P
Mecynotarsus delicatulus	12	0.805	$0.002 < P < 0.005$	−0.631	$0.02 < P < 0.05$
Neptus ventriculus	12	0.335	$0.20 < P < 0.50$	−0.482	$0.10 < P < 0.20$
Rhadine myrmecodes	12	−0.108	$P > 0.50$	0.136	$P > 0.50$
Tetragonoderus pallidus	5	0.80	$P = 0.20$	−0.90	$P > 0.10$
Ammobaenetes lariversi	12	0.797	$0.002 < P < 0.005$	−0.203	$P > 0.50$
Aegialia hardyi	8	−0.660	$0.05 < P < 0.10$	−0.482	$0.20 < P < 0.50$
Aphodius nevadensis	5	0.375	$P > 0.50$	0.825	$0.10 < P < 0.20$
Edrotes ventricosus	9	0.595	$0.10 < P < 0.20$	−0.412	$0.20 < P < 0.50$
Eusattus muricatus	12	0.715	$0.01 < P < 0.02$	−0.548	$0.05 < P < 0.10$
Lariversius tibialis	12	0.692	$0.01 < P < 0.02$	−0.475	$0.10 < P < 0.20$
Trogloderus costatus	12	0.795	$0.002 < P < 0.005$	−0.319	$0.20 < P < 0.50$

* *Cardiophorus* species, *Philothris* species, *Coenonycha* species and *Chilometopon brachystomum* were not analyzed because of limited number of specimens and *Serica* species and also *Coenonycha* species and *Chilometopon brachystomum* were not analyzed because of insufficient sample size for Spearman's rank correlation test.

found during the winter months. Larvae of *Aegialia hardyi* and *Aphodius nevadensis* were found from March to May in sand beneath dune vegetation. *Ammobaenetes lariversi* (La Rivers, 1948) (Rhaphidophoridae) adults and nymphs were found in all months with most individuals obtained from July to October.

Spearman's rank correlation of species monthly abundance to either monthly temperature or precipitation 30 year averages (Table 2) indicate that *Mecynotarsus delicatulus, Ammobaenetes lariversi, Eusattus muricatus, Lariversius tibialis,* and *Trogloderus costatus* were significantly, positively correlated with monthly temperatures and only *Mecynotarsus delicatulus* was significantly, negatively correlated with monthly precipitation. *Eusattus muricatus* shows a possible negative relationship with monthly precipitation.

DISCUSSION

Three seasonal activity patterns exist in the sand obligate species: 1) continuous year-round, 2) summer-warm months, and 3) winter-cold months. Carnivores *Rhadine myrmecodes,* and *Mecynotarsus delicatulus,* and detritivores *Ammobaenetes lariversi, Niptus ventriculus, Eusattus muricatus, Lariversius tibialis,* and *Trogloderus costatus* are active year-round. Herbivores *Serica* species, and *Edrotes ventricosus,* carnivore *Tetragonoderus pallidus,* and detritivore *Chilometopon brachystomum,* are summer-warm month species, with *E. ventricosus* extending into the cooler winter months. Winter-cold month species are herbivore *Cardiophorus* species, carnivore *Philothrus* species, and detritivores *Aegialia hardyi, Aphodius nevadensis,* and *Coenonycha* species. Winter activity of *Cardiophorus* species may represent non-feeding adults that mate and deposit eggs during this period. Other populations of *Cardiophorus* species from Great Basin sand dunes show similar adult winter activity periods (Hardy and Andrews, 1976; E. C. Becker, pers. comm.).

Comparisons of seasonal activity patterns of other populations of SO species

(Table 3) are in general the same as Sand Mountain. Notable exceptions are *Tetragonoderus pallidus* showing gradually year-round activity in populations at decreasing latitude or reduced cold-winter months, *Niptus ventriculus* with reduced hot-summer month activity with decreasing latitude, and *Trogloderus costatus* showing a reduction in the winter–spring activity with decreasing latitude.

Year-round and winter-cold active SO species are responding to both the physical and biotic factors during the cold period. During the cold-month period, warming of surface and subsurface (10 to 15 cm) above ambient produced an environment allowing both adult and larval activity (Rust and Hanks, 1982). Maximum precipitation during the cold period, with monthly averages above average monthly precipitation for Oct., Dec., Jan., Feb., and Mar. and fall only slightly below in Nov. (Table 1), produces a humid environment for adults and especially immatures developing during this period. Combination of lower temperatures and more precipitation reduces evaporative losses from subsurface sand which prolongs humid conditions, reducing desiccation problems for the winter active species. Hot, dry summers may represent conditions that are physically unsuitable for many of the smaller SO species and only larger (10 mg or more) species can escape by active temporal movements (Holm and Edney, 1973).

The addition of leaves and flowers from deciduous shrubs on the dune (*Eriogonum kearneyi, Chrysothamnus viscidiflorus, Tetradymia tetrameres, Atriplex confertifolia, Psorothamnus polyadenius* and *Psoralea lanceolata*) will be at a maximum during the start of the cold-month period adding to the organic base for the detritivores. Plant materials are trapped in the sand that collects around the stems of the perennial shrubs, the site where most of the winter active species were collected (Rust and Hanks, 1982). The combination of detritus availability, temperature and moisture conditions favorable to both adults and immatures may explain the winter activity period observed in many SO species.

Long distance dispersal characters, wings, of the SO species divide them into two groups: 1) winged and 2) wingless or brachypterous. *Serica* species, *Tetragonoderus pallidus,* and *Philothris* species are winged and capable of flight. *Rhadine myrmecodes, Niptus ventriculus, Edrotes ventricosus, Eusattus muricatus, Lariversius tibialis,* and *Ammobaenetes lariversi* have no wings and *Cardiophorus* species, *Mecynotarsus delicatulus, Aegialia hardyi, Aphodius nevadensis, Coenonycha* species, and *Chilometopon brachystomum* have brachypterous wings and flight is most likely impossible.

The wingless condition of most of the SO species may represent a derived state of recent origin resulting in reduced chances of being blown away from the dune. However, except for *Chilometopon brachystomum,* the wingless tenebrionids belong to genera or tribes that are primatively flightless (Doyen, 1968, 1972; Arnett, 1960). Active sand dunes are limited in their distribution and size in Great Basin and the chances of being blown to a new dune are considered extremely rare. Sand dunes may be viewed in the same manner as remote oceanic islands with respect to the evolution of flightlessness (Darlington, 1943). An individual of *Aegialia crescenta* from Cresent Dune, NV was observed being blown across the dune in a wind storm. The individual was unable to stop itself (unpublished observation). In *Chilometopon brachystomum,* Doyen (1982) found that the brachypterous condition produced wings that still showed distinct anterior venation indicating recent origin. The wings of *Aegialia hardyi, Aphodius nevadensis, Me-*

Table 3. Seasonal distribution of sand obligate Coleoptera species from eight sand dunes in southwestern United States: Sand Mountain Dune (present study): Blow Sand Mountains Dunes, Nevada (Bechtel et al., 1983): Eureka Valley Dune, California; Owens Lake Dune, California; Cadiz Dune, California; Rice Dune, California; Palen Dune, California; and Algodones Dune, California (Andrews et al., 1979). Dunes are arranged latitudinally from north, Sand Mountain, to south, Algodones Dune. Winter (W) November to February, spring (S) March to May, summer (S) June to August and fall (F) September to October (after Andrews et al., 1979).

	Sand				Blow				Eureka				Owens				Cadiz				Rice				Palen				Algodones			
Species	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F
Mecynotarsus delicatulus	X	X	X	X			X	X			—			X	X			—				—			X	X		X		X		
Tetragonoderus pallidus		X	X				X	X		X	X	X		X		X	X			X		X	X	X	X			X	X	X	X	X
Neptus ventriculus	X	X	X	X	X	X	X	X			—				—		X	X		X	—		X			X		X		X		X
Edrotes ventricosus	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Eusattus muricatus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		—		
Lariversius tibialis	X	X	X	X	X	X	X	X	X	X	X			—				—				—				—				—		
Trodloderus costatus	X	X	X	X		X	X		X	X	X	X		X	X	X			X	X			X	X		—				—		

cynotarsus delicatulus, Coenonycha species, and *Cardiophorus* species are reduced to very short paddle-like structure without any trace of venation. This being interpreted as an older condition than that of *C. brachystomum.*

The hypothesis being presented is that the present distributions and restriction of the sand obligate fauna in the southwestern United States is a result of past climatic conditions and contraction of sand areas with decreasing aridity in recent times. This hypothesis is not new; Howden (1963) suggested that distribution patterns observed in eight genera of flightless Scarabaeid beetles found in North America can best be explained by past climatic conditions during the Pre-Pleistocene and Pleistocene periods in non-glaciated areas. La Rivers (1946) also suggested that the subspeciation observed in *Trogloderus costatus* may have been associated with the desiccation of Pleistocene lakes in western Nevada and that *T. costatus nevadus* is confined to the distribution of Lake Lahontan.

The Pleistocene is geologically noted for its glacial record (Flint, 1971) and approximately 15 periods of cooling and warming have been associated with glacial and interglacial periods (Kvasov, 1978). The past 40,000 years in the Great Basin began with an interpluvial period lasting to near 25,000 B.P. Two pluvial periods lasted from 25,000 to 21,500 and 13,600 to 11,100 B.P. with high stands of greater than 1300 m (Benson, 1978; Morrison, 1965). Numerous pluvial lakes, the largest in the western Great Basin being Lake Lahontan (13,580 km^2) (Mifflin and Wheat, 1979), existed throughout the Great Basin. Extensive sand shores and sand deposits were present in the western lakes receiving discharge from the Sierra Nevada Mountains (Morrison, 1964). Warm, arid conditions prevailed from 9000 to 5000 B.P. and during this time all lakes except Pyramid Lake (northwestern Nevada) desiccated and during the last 5000 years Pyramid and Walker lakes (west-central Nevada) have increased in size (Benson, 1978). Pluvial paleoclimates have been estimated as approximately 5°F (2.77°C) cooler than present with a corresponding increase in precipitation averaging 68% above present basin averages (Mifflin and Wheat, 1979).

Present species distributions potentially follow the eolian dispersal patterns of the sands from points of deposition or distribution on pluvial lake shores to its present position. Sand at Sand Mountain is from the Walker River drainage of the Sierra Nevada Mountains (D. Trexler, USGS, Univ. Nevada, Reno, pers. comm.) and has moved from 50 to 55 km to its present position at Sand Mountain. One other active dune, Blow Sand Mountains, lies 25 km SSW of Sand Mountain and is formed from the same sand deposit. All SO species except *Cardiophorus* species, *Aphodius nevadensis* and *Coenonycha* species were present at Blow Sand Mountains (Bechtel et al., 1981, 1983). Presently, we see widespread and/or newly evolved populations of these past faunas trapped in the active sand dunes of the intermountain basins. The widespread species are *M. delicatulus, T. pallidus, N. ventriculus, E. ventricosus, E. muricatus,* and *T. costatus,* with *Ammobaenetes lariversi* and *A. hardyi* and other possible Sand Mountain endemics represent the newly speciated forms. Doyen and Slobodchikoff (1984) have shown the development of microgeographic races of the costal dune beetle *Coelus ciliatus* (Tenebrionidae) from different types of dunes without isolation. Populations inhabiting the eolian and stabilized dunes were among the longest and smallest observed for the species. Doyen and Rogers (1984) found that body size (elytral length and width) in *Eusattus muricatus* was inversely associated with altitude and latitude over a large geographic area and speculate that temperature (annual accumulated day degrees) is involved with body size determination. Whether or not the widespread SO species are genetically different at different dunes within their geographic ranges, it appears that the ephemeral nature of sand dunes may allow for extremely rapid selection and isolation of SO species and populations.

ACKNOWLEDGMENTS

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Description of a New Species of *Hexatoma* (*Hexatoma*) from California (Tipulidae, Diptera)

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Recently I received, and later found and reared, specimens of a crane-fly which is recognized as a new species of the subgenus *Hexatoma,* genus *Hexatoma.* The subgenus *Hexatoma* has two species recorded from the North American continent, none from the western United States. All other species of the genus within the United States are of the subgenus *Eriocera.* The types are preserved in the collection at California Polytechnic State University at San Luis Obispo, CA.

Hexatoma* (*Hexatoma*) *hartmani, NEW SPECIES

Male.—Length 6.1–7 mm; wing 6.3–6.9 mm; antenna 0.71–1.7 mm.

Female.—Length 7.4 mm; wing 7.7 mm; antenna 1.5 mm.

Rostrum dark gray, short, palpi black. Antennae black, short, 7 segments; the scape twice the length of the pedicel. The first flagellar segment twice the length of the scape and pedicel combined. The last flagellar segment small, about one-fourth the length of the penultimate segment. Head with the anterior vertex black. Mesonotal praescutum with two yellowish stripes on either side of a dark brown median line. Halteres at bases dark gray, remainder of stem and knob yellow. Legs with the coxae, trochanter and femur black, the remainder of the leg gray. Wing (Fig. 1) with ground color light yellow, radial and medial veins bordered by darker coloration. Darkened areas also at base of cells R, M, origin of Rs, and in the Cell IA toward the margin of the wing; dark brown bordering the vein Cu. Venation with Sc_1 ending beyond the fork of Rs, Sc_2 at fork of Rs, Sc_1 alone equal to the length of r-m. R_2 about its own length before the fork of R_{3+4}; Rs angulated at origin; m-cu just beyond the fork of M. Vein M_{1+2} present and reaching the wing margin; other veins of M absent. Cell 1st M_2 preserved. Abdominal segments uniformly dark gray, with white setae at edges of terga. Hypopygium dark gray except on distal portion of the basistyle, which is yellow. Outer dististyle slender, gently curved medially. Inner dististyle relatively large, fleshy, and cylindrical with abundant erect setae. Aedeagus elongated, reaching back to about the level of the dististyles, curved downward and inward at posterior third of its length. Ovipositor of allotype is fleshy.

Holotype.—(male) Atascadero, CA, Atascadero Creek, March 19, 1984 (Hynes).

Allotype.—With the same data as given above for the holotype.

Paratypes.—Three males and 3 females, with same data as given for holotype; one male (Tracey Estes) slide 1590 (wing and genitalia), April 2, 1983 Atascadero, CA. All specimens, with the exception of the one collected by Miss Estes, were reared from larvae and pupae.

I am pleased to name this fly after Dr. Margaret Hartman, whose work with

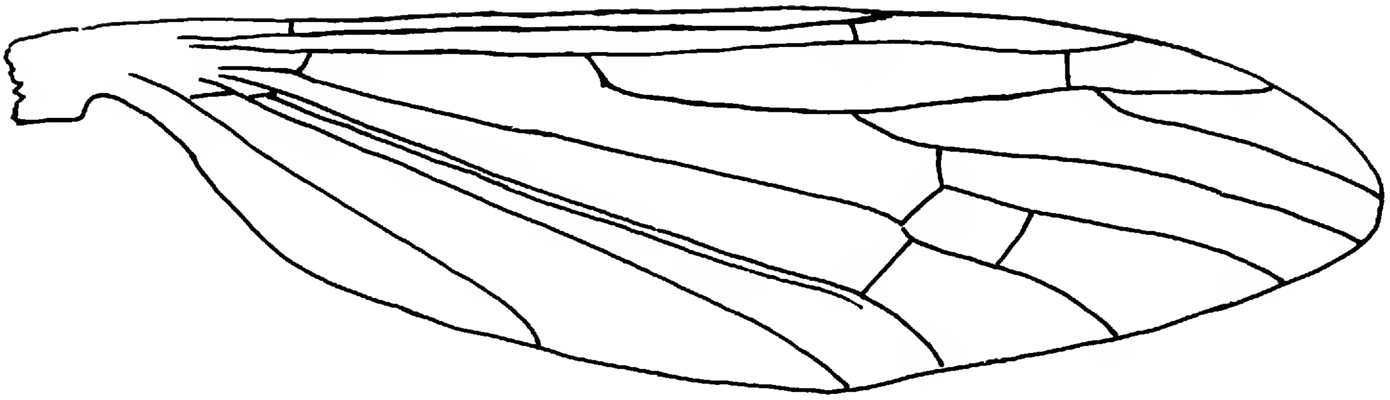

Figure 1. Wing of *Hexatoma* (*Hexatoma*) *hartmani,* new species.

the Rangeland Crane-fly, *Tipula simplex,* has been of great value to the knowledge of crane-fly biology.

Hexatoma hartmani is very much like *Hexatoma microcera* Alexander, but readily told from this species by the coloration and the larger terminal segment of the antennae. The retention of the Cell 1st M_2 by the adult is not reflected by differences in the larval stages. Consequently, the erection of a new subgenus on this basis is not warranted. The preservation of the Cell 1st M_2 is much as in *Hexatoma* (*Hexatoma*) *schmidiana* of Kashmir, Pakistan (Alexander, 1957a). However, by its description, *Hexatoma schmidiana* has longer antennae and the coloration very different. Another species with the Cell M_2 preserved was described by Alexander in 1957 as *Hexatoma coheri* (Alexander, 1957b), placing it in the subgenus *Eriocera.* He later explained that he did so on the basis of the elongate antennae in the male (Alexander, 1958). Since the preservation of Cell M_2 is accompanied by short antennae and the presence of a fleshy ovipositor in the female, I am placing *Hexatoma hartmani* in the subgenus *Hexatoma.*

Numerous larvae and pupae were found in the sandy areas between mounds of *Carex senta* which abounds along the edges of the stream.

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Floral Predation of *Yucca whipplei* (Agavaceae) by the Sap Beetle, *Anthonaeus agavensis* (Coleoptera: Nitidulidae)

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Abstract.—Female sap beetles, *Anthonaeus agavensis,* oviposit in the flower buds of *Yucca whipplei.* The larvae destroy both pollen and ovaries, causing premature abortion of buds and flowers.

Adult sap beetles, *Anthonaeus agavensis* (Crotch) (Nitidulidae), are often found on the flower stalks of *Yucca whipplei* Torrey (Agavaceae) in southern California. They occur in large numbers at many of the sites where I have been studying the pollination biology of *Y. whipplei* (Udovic, 1981, MS), particularly in coastal sage scrub (Munz, 1973) south of the Los Angeles basin. Parsons (1943) reported that the adults of this species occur in the flowers of *Agave.* However, of the 18 samples of specimens with host-plant information in the collections of the University of California, Berkeley, and the University of California, Riverside, 11 were found on *Y. whipplei,* 2 others were probably on *Y. whipplei,* and 4 were on undetermined species of *Yucca*; none were reported from *Agave* (Powell, pers. comm.; Frommer, pers. comm.). Since the larvae of many of the other members of its subfamily (Cateretinae) live in seed capsules of various plants, Parsons (1943) conjectured that the larvae of *A. agavensis* are associated with seed capsules of *Agave.* Here I report observations showing that the beetle larvae are floral predators of *Y. whipplei* that may significantly affect the plant's floral display.

I observed adult and larval behavior during the spring of 1981 on the Ryan Oak Glen Reserve northeast of Escondido, CA, in a coastal sage scrub community. This site corresponds to CSS4 in Udovic (1981). Adults congregate in the open flowers of *Y. whipplei* and are often found mating inside the flowers. The developing branches of yucca inflorescences, together with their primordial flower buds, are covered by protective bracts. Female *A. agavensis* are able to crawl beneath the bracts, where they oviposit on the developing flower buds. Although I was unable to determine how many eggs are placed in each bud, I never observed more than one larva in a bud or flower. Inside the bud the larva feeds on the anther sacs and burrows into and excavates the floral ovary, causing significant damage. Completion of larval development takes approximately one week. If the flower has not opened before the larva completes development the larva drills an exit hole through the petals and drops to the soil. Since the duration of the flowering season for *Y. whipplei* is usually two months or less, *A. agavensis* is probably univoltine.

Many of the attacked buds are aborted by the plant before they open. Open flowers that have been attacked by beetles typically wilt and abscise more rapidly

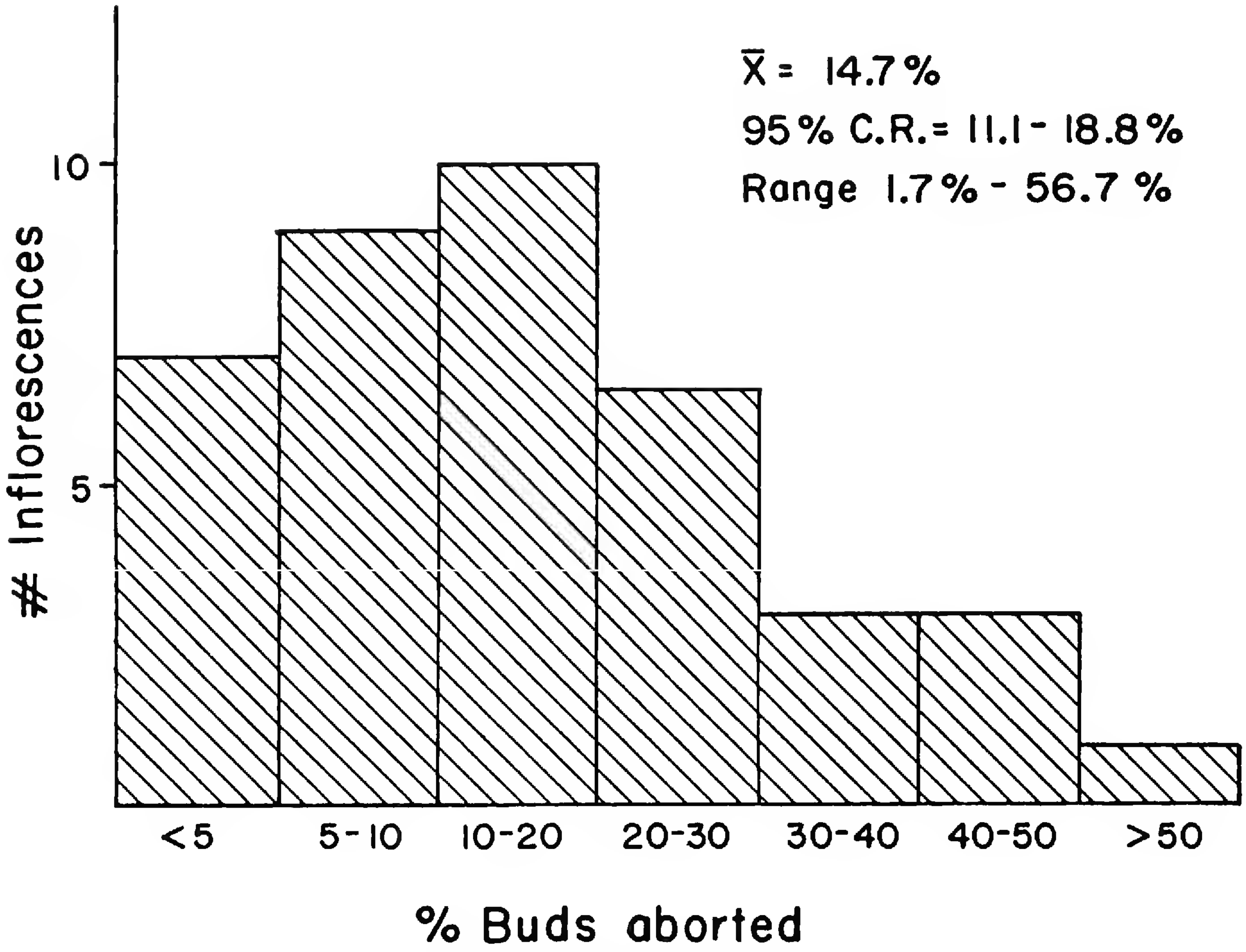

Figure 1. Frequency distribution for the percentages of flowers which aborted as buds among plants flowering at Ryan Oak Glen in 1981. Aborted buds are a measure of the extent of floral predation by *Anthonaeus agavensis.*

than neighboring uninfested flowers. The flowers are invariably too severely damaged to serve as pollen donors or to produce mature fruits. Furthermore, the specialized pollinators of *Yucca whipplei,* the yucca moths, *Tegeticula maculata* (Riley) (Lepidoptera: Incurvuriidae; Powell and Mackie, 1966; Aker and Udovic, 1981), apparently avoid damaged flowers. I have never observed female moths, which also oviposit in floral ovaries, pollinating, ovipositing, or resting in damaged flowers.

Damage to yucca inflorescences resulting from floral predation is quite variable both within and between populations. I determined the total number of flowers produced, the height of the flower stalk, and the number of buds aborted for each of 40 plants at Ryan Oak Glen in 1981. Floral predation was the major cause of abortion, although occasionally buds aborted for other reasons. The percentage of aborted buds ranged from 2% to 57% (Fig. 1) with a mean value of 14.7% and a 95% confidence range of 11.8%–18.8% (obtained using the arcsine transformation and then backtransforming). Regressions of the percentage of aborted buds on either the total number of flowers or on stalk height yield no significant relation. At Pinyon Flat, CA, in the evergreen chaparral (corresponding to CH4 in Udovic, 1981), infestation rates in 1981 were much lower than at Ryan Oak Glen. Only a few plants showed any signs of beetle attack with damage never exceeding 5%. Although plants at this study site often abort buds, particularly near the end of the flowering season (Aker, 1982), only a few of the aborted buds which I examined showed any signs of beetle infestation. Perhaps the heaviest infestation I've encountered was on the Elliot Reserve, east of San Diego, in 1979 (corresponding to CSS3 in Udovic, 1981). Although at that time no attempts were made to quantify the extent of damage, most plants probably lost over 25% of their flowers to beetle predation.

The extent of coevolution between *A. agavensis* and *Y. whipplei* deserves further investigation. The beetle may be highly specialized, and may be an important agent of selection on the plant's floral display. Its interaction with yucca's specialized pollinator, the yucca moth, which competes with it for suitable oviposition sites, also deserves further study.

ACKNOWLEDGMENTS

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Movement and Distribution of *Pleocoma* Larvae in Western Oregon Coniferous Forest Soils (Coleoptera: Scarabaeidae)[1]

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Abstract.—The movement and spatial and vertical distribution of *Pleocoma* larvae were studied in coniferous forests of western Oregon, incidental to a study of larval feeding habits. Larvae are able to burrow, using their mandibles, through hard and compact forest soil at rates up to 11 cm per day. With the exception of first stage larvae and larvae preparing to moult or pupate in early fall, most larvae actively burrow throughout the year. Larvae do not appear to travel for any length of time in any particular direction. Larval populations in forested areas in western Oregon are usually localized. More than 60 sample holes (1 m^2 and no less than 75 cm in depth) were dug searching for larvae. More than one-third produced no larvae, and populations in the others ranged from 1 to 56. Larvae were found at depths from 10 to 110 cm. Vertical distribution and, to a lesser extent, spatial distribution of larvae appear to be influenced by a combination of factors, principally soil moisture, soil temperature, and the presence or absence of a silicate clay layer. This silicate clay hardpan directly affects the distribution of smaller coniferous roots—the principal source of food for *Pleocoma* larvae.

I studied the feeding habits of *Pleocoma* larvae in some old-growth coniferous forests in western Oregon in the early 1960's (Fellin, 1975). The study began shortly after Stein (1963) confirmed that *Pleocoma* larvae feed on the roots of forest trees. Five species of *Pleocoma* were studied: *P. dubitabilis dubitabilis* Davis[2], *P. carinata* Linsley, and *P. simi* Davis primarily, and to a lesser extent *P. minor* Linsley and *P. crinita* Linsley.

Incidental to that study, other studies and observations were made on the biology, ecology, behavior, and distribution of *Pleocoma* spp. Many new localities were recorded and described. Based on these and other locality descriptions, the geographic distribution of all species of *Pleocoma* in Oregon was summarized and the habitats for *P. simi* and *P. carinata* were described (Fellin and Ritcher, 1967). Observations also were made on trapping male *Pleocoma* with female-baited traps

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[1] This investigation was supported chiefly by the Oregon Agricultural Experiment Station and National Science Foundation Grants Numbers 14296 and 17935 and partially by the Intermountain Research Station, USDA Forest Service.

[2] According to Hovore (pers. comm.) the variety *dubitabilis* Davis was described in 1934 as a new variety of *Pleocoma staff* Schaufuss. Later, it was considered by Linsley to be a distinct species but inadvertently misspelled as *P. dubitalis.* This error of misspelling has persisted since that time.

Figure 1. Technique used to mark *Pleocoma* larvae. (Left) Thoracic area of seventh instar *P. dubitabilis* showing minuten nadeln thrust through fleshy lobes at base of meso thoracic leg (15×). (Right) Thoracic area of seventh instar *P. dubitabilis* showing two black spots (arrow) caused by darkening of haemolymph where lobes were punctured by minuten nadeln (25×).

(Fellin, 1968). Observations on egg and larval biology and the flight characteristics of adults were presented elsewhere (Fellin, 1981). This paper presents results from studies of movement and spatial and vertical distribution of larvae.

Movement of Larvae

The movement of *P. dubitabilis* larvae in the soil was studied at a site in McDonald Forest, 8 km north of Corvallis from 1 May to 31 October 1961. I collected larvae at the study area and brought them to the laboratory for measurement and marking for later identification.

Each larva was pierced in one of its many fleshy areas, particularly along the meso-ventral line of the thorax or abdomen, with a minuten nadeln (Fig. 1A). Darkening of the haemolymph upon exposure to air left an obvious mark (Fig. 1B), and by piercing larvae on different segments or in different areas of the same segment, numerous marking combinations were achieved. I noticed no ill effects on the larvae as long as the puncture was made as far as possible out on the lobes.

Marked larvae were returned to the study area and placed in small niches in the side of a sample hole that had not been refilled with soil. The niches were then covered with a salve tin lid (Fig. 2A). After a week, lids were removed and the soil dug away until the larvae were recovered and identified (Fig. 2B).

Because it was impossible to follow larval burrows through the soil, I used an arbitrary method to determine how far larvae traveled. Vertical and lateral measurements were taken between the point at which a larva was released and the point of recovery. From these measurements I computed two distances: (1) the distance a larva would have traveled had it gone straight into the soil and then

Figure 2. Technique used in studying movement of larvae in the soil (Left) A larva is placed in a small niche provided for it in the side of an old sample hole, and the niche is covered with a salve tin lid. (Right) Searching for *Pleocoma* larvae that had been marked and placed on the side of the sample hole 1 week prior.

at a right angle downward, upward, or to the right or left (the two perpendicular sides of a right triangle), and (2) the distance traveled had it gone a direct route from the point of release to the point of recovery (the hypotenuse of a right triangle). The average of these two distances was used to estimate the distance traveled during the week, then an average rate of movement per day was calculated. Because *Pleocoma* larvae often follow winding paths through the soil, the calculated average rate of movement is probably conservative.

Burrow Construction and Method of Movement

Larvae move through the ground by biting away soil in front of them with their mandibles and depositing it to their rear as they move. Each bite of soil is momentarily held beneath the thorax by the thoracic legs. After a few bites, the larva—holding the soil by its legs, mandibles, and maxillae—turns and deposits this soil in the rear of the burrow. Here, presumably with the aid of secretions from the mouth, it is cemented against the back wall, filling the burrow behind.

Cells removed intact from the soil reveal on their edges an interesting pattern of marks made by the larval mandibles. The photographs in Figure 3 illustrate this and establish that larvae move through the soil by use of the mandibles and not by burrowing with the thoracic legs.

Larval movement through the soil depends mainly on three-point body contact. By manipulating the dorsum of the abdomen, the anal area and the thoracic legs, larvae are able to move through an open burrow fairly rapidly by pressing these three points against the walls of the burrow. *Pleocoma* larvae are well adapted for this type of movement; they possess many spine-like setae dorsally on most abdominal segments and on the caudal segments where contact is made with the soil. Necessity of three-point contact is shown by the helplessness of larvae trying to move on a flat surface.

Figure 3. Cell showing pattern made by mandibles as larvae moved through the soil. (Top) Portion of a *P. simi* cell halved lengthwise to show the mandible pattern on cell wall (2.5×). (Bottom) Closeup of individual mandible marks in the cell. Arrow points to a narrow ridge of soil formed at the point where each mandible of a pair come together (10×).

While moving through the soil, larvae maintain some distance of open burrow behind them, the length of which often varies with depth, direction, size of larva, or time of year. Fifth instar *Pleocoma* have been found with as much as 10 cm of open burrow behind them.

Table 1. Average rate of movement of *P. dubitabilis* larvae through hard and compact forest soil between early May and late October 1961.[1]

Approximate instar	No. of larvae	Average rate of movement (cm per day)
2	9	0.8
3	6	3.8
4	2	0.7
5	2	8.7
6	3	1.7
7	3	4.9
8	4	4.6
8-older	8	2.9

[1] Data are not included for larvae preparing for or recovering from a moult.

Rate of Movement

Larvae are able to move through the hard and compact forest soil at speeds varying from a little less than 1 cm per day to nearly 9 cm per day (Table 1).

Of the individual larvae observed, a fifth instar traveled the fastest, covering about 11 cm per day between 27 April and 18 May. Also, a seventh and an eighth instar burrowed 8.5 and 7.5 cm per day, respectively, during June.

Time of Year of Movement

First instars and young second instars were often collected in groups at or near the site of oviposition, indicating these small larvae do not move far. First stage larvae do not leave the egg niche moulting therein to second instars in early October. Second stage larvae have been found in egg niches in mid-November; evidently they do not begin to travel from the oviposition site until after that.

Most larvae actively burrow from early May to late October when larval movement was most intensively studied. Periodic observations from early November to late April indicate that most larvae are active during this period as well. However, between early August and late October, especially during September, there is a general period of inactivity when larvae are moulting or pupating.

The number of days that larvae ceased burrowing during the moulting period varied considerably between individuals. Some larvae slowed little in their movements prior to moulting, while others ceased movements entirely for as many as 21 days prior to the moult. Following the moult, some larvae began burrowing almost immediately and others remained motionless for as many as 24 days before they traveled again.

Direction of Movement

The inability to follow larval burrows through the soil made it difficult to determine exactly which direction the larvae moved. Of the 46 larvae studied, 31 traveled predominantly downward, two traveled down and then up, and one larva went up first and then down. Six larvae traveled horizontally, and the direction that another six traveled is not known.

It appears that *Pleocoma* larvae generally do not travel for any length of time in any particular direction. Open burrows behind larvae indicate that in the relatively short distance of 5 to 10 cm, they may have traveled in several directions.

Figure 4. A typical larval sample collecting hole, 1 m^2 and about 120 cm deep.

For example, one medium-sized *P. simi* larva was found with 10 cm of open burrow behind it, and in this distance had traveled upward, turned a bit, leveled off, and turned twice more on a generally flat plane. Other Scarabaeidae larvae also change direction of movement, often doubling back in the direction from which they had burrowed (Hallock, 1935; Hawley, 1934).

There is no evidence that *Pleocoma* larvae migrate, in the sense of a continued or prolonged movement in a direction and at a rate over which they have control and resulting in a temporary or permanent change of habitat (Schneider, 1962; Williams, 1957). Movement of *Pleocoma* larvae beneath the ground can probably be characterized in terms of dispersal, defined by Schneider (1962) as a lengthening of the average distance between neighboring individuals. The abundance and distribution of the smaller coniferous roots, their principal diet in the forest environment (Fellin, 1975), no doubt also influences the movement of *Pleocoma* larvae.

DENSITY OF LARVAE IN THE SOIL

Because the primary objective of this study was to determine the feeding habits of *Pleocoma* larvae in the coniferous forest environment, the goal in collecting was to gather as many larvae as possible. Consequently, the number and location of sampling holes was purposely, and not randomly, selected.

Table 2. Spatial distribution of *P. dubitabilis* larvae in coniferous forest soil at McDonald Forest during 1961.

Date	Depth of hole (cm)	Larvae/m^2
28 January	120	21
25 February	94	[1]22
31 March	94	[2]35
28 April	75	0
29 April	90	21
29 May	130	21
28 June	120	11
28 July	120	18
15 August	100	2
13 September	124	11
21 October	110	14
21 November	105	14
22 December	105	20

[1] Unavoidable circumstances prevented the sampler from completing this hole. Had further digging been possible more larvae may have been collected.

[2] Fifteen of these 35 larvae were young second instars congregated in the same general area and probably all from the egg complement of a single female.

Sites at which sample holes were dug and larvae collected were restricted to known larval habitats or where adult males had been taken in flight. The sample hole was 1 m^2 and dug at least 75 cm deep (Fig. 4). Any hole dug 75 cm deep without larvae being found was abandoned. When larvae were found, the sample hole was dug as least 15 cm deeper than where the deepest larva was found. The depth at which larvae were collected was measured to the nearest 2 cm and depths later grouped into 10 cm classes. Other investigators have also used some of these procedures for collecting Scarab larvae—particularly determining depth of sample holes (Ellertson, 1958; Hartzell and McKenna, 1939; Shorey and Gyrisco, 1960; Travis, 1939).

Spatial Distribution of Larvae

I made 13 collections of *P. dubitabilis* larvae at the McDonald Forest study site in 1961. Larval population densities averaged 16 larvae per m^2 and ranged from 0 to 35 in sample holes varying from 75 to 130 cm in depth (Table 2).

Between May 1960 and October 1961, I made 17 collections of *P. carinata* larvae at three sites in southwestern Oregon. Larval abundance varied from 0 to 15 per m^2 in sample holes ranging from 75 to 105 cm deep (Table 3). Six of the 17 sample holes, or about 35%, produced no larvae.

Thirty-one sample holes were dug searching for *P. simi* larvae at eight sites in southwestern Oregon between May 1960 and December 1961. Fifteen of the 31 holes produced no larvae and five yielded only one larva. The two most dense populations of 34 and 56 larvae per m^2 were collected at the same site (#19) in May and March 1961, respectively (Table 4).

Four collections each of *P. crinita* and *P. minor* were made in forested areas adjacent to Hood River Valley orchards, averaging, respectively, 2 and 5 larvae per m^2.

Table 3. Spatial distribution of *P. carinata* larvae in coniferous forest soil at three forested sites in southwestern Oregon in 1960 and 1961.

Date	Site[1]	Depth of hole (cm)	Larvae/m^2
2 January 1961	3	90	0
3 January 1961	3	90	0
3 January 1961	3	105	5
28 March 1961	8	90	6
10 May 1961	3	75	0
10 May 1961	3	90	2
11 May 1961	3	60	0
11 May 1961	3	105	1
12 May 1961	2	80	2
21 May 1960	2	60	0
21 May 1960	2	75	15
18 July 1961	2	90	3
19 July 1961	2	75	3
2 September 1960	2	75	3
2 September 1960	2	75	8
27 October 1961	8	75	1
27 October 1961	8	60	0

[1] The location of each site is as follows:

	Elevation
Site #2—32 km east of Medford, Jackson Co.	762–822 m
Site #3—21 km east of Butte Falls, Jackson Co.	—
Site #8—23 km northeast of Idleyld Park, Douglas Co.	700–762 m

Tables 3 and 4 show that larval populations of *P. carinata* and *P. simi* in forested areas in southwestern Oregon are very localized. Had I dug sample holes at random rather than in areas where larvae were known to occur or where adults had been collected, the densities shown in the two tables would undoubtedly have been even less.

The relative larval densities for the five species in coniferous forest soil are compared to the larval densities for three species in some orchard soils (Table 5). Larval populations in the Hood River apple orchards are quite high. Though larval populations vary widely between and within orchards, with islands of high *Pleocoma* density surrounded by areas where no larvae can be found, Zwick et al. (1970) collected 4312 *P. crinita* larvae in the soil under one mature "Newton" apple tree. One can easily see why larvae of *P. minor* and *P. crinita* are a serious economic problem in these orchards.

Vertical Distribution of Larvae

Pleocoma dubitabilis larvae were collected at the McDonald Forest study site in August and November 1960 and once each month during 1961. The vertical distribution of these larvae (Fig. 5) indicate several points of biological significance: (1) From May to September larvae were generally absent from the upper 40 cm of soil, and only five larvae, all of a size large enough to pupate, were found at depths shallower than 40 cm. (2) Larvae were generally deeper in the soil in July than in any other summer month; with the exception of two larvae, none were found shallower than 60 cm in July. (3) Between October and April, excluding

Table 4. Spatial distribution of *P. simi* larvae in coniferous forest soil at eight forested sites[1] in southwestern Oregon in 1960 and 1961.

Date	Site[2]	Depth of hole (cm)	Larvae/m²
7 January 1961	14	75	12
22 March 1961	19	130	[2]56
22 March 1961	19	90	0
19 May 1960	10	60	0
19 May 1960	10	60	1
20 May 1960	55	75	0
20 May 1960	55	75	0
22 May 1961	27	75	0
22 May 1961	27	90	0
22 May 1961	27	75	0
26 May 1961	19	120	34
9 June 1960	14	60	1
9 June 1960	14	60	0
9 June 1960	14	60	0
9 June 1960	14	60	0
16 June 1960	21	60	3
16 June 1960	21	60	3
16 June 1960	21	75	13
16 June 1960	21	75	9
16 June 1960	21	60	1
19 July 1960	14	75	0
19 July 1960	14	75	0
19 July 1960	14	75	4
19 July 1960	14	75	2
26 August 1960	11	60	2
26 August 1960	11	75	0
26 August 1960	11	60	0
26 August 1960	16	75	16
1 September 1960	10	60	0
1 September 1960	10	75	7
7 December 1961	19	120	21

[1] The location of each site is as follows:

	Elevation
Site #10—11 km north of Trail, Jackson Co.	850 m
Site #11—8 km west of Elkton, Douglas Co.	30 m
Site #14—8 km south of Eugene, Lane Co.	400 m
Site #16—3 km northwest of Drain, Douglas Co.	90 m
Site #19—10 km north of Oakland, Douglas Co.	200 m
Site #21—27 km northwest of Union Creek, Douglas Co.	850 m
Site #27—16 km northeast of Tiller, Douglas Co.	—
Site #55—1 km south of Selma, Josephine Co.	400 m

[2] Thirteen of these 56 larvae were small second instars congregated in the same general area and probably all from the egg complement of a single female.

December, most larvae were fairly well distributed vertically through the soil. (4) Of the 176 larvae represented in Figure 5, I collected 134, or 76% in a 50-cm stratum between 41 and 90 cm in depth.

The vertical distribution of *P. simi* larvae from eight collections at five sites (Fig. 6) reveals some interesting characteristics: (1) Frequency distributions A and B in March and May, respectively, show a large congregation of larvae in a 20-

Table 5. Larval densities of the six western Oregon species of *Pleocoma* in some coniferous forest and orchard soils.

Species	No. larvae/m^2		Site
	Minimum	Maximum	
P. dubitabilis	0	35	Douglas-fir forest
P. simi	0	56	Douglas-fir forest
P. carinata	0	15	Mixed conifer forest
P. oregonensis[1]	0	18	Beneath western yellow pine
P. oregonensis[1]	1	4	Beneath cherry tree
P. crinita[1]	5	84	Apple orchard
P. crinita	0	5	Mixed conifer forest
P. minor[1]	—	227	Apple orchard
P. minor	1	11	Mixed conifer forest

[1] Data from Ellertson and Ritcher (1959), recomputed from ft^2 to m^2.

cm stratum between 61 and 80 cm; in no other *P. simi* collection was there such a striking example of larval accumulation by depth. (2) Larvae presented in distribution C were taken in December at the same site as those in distributions A and B; there was, however, no accumulation of larvae at the lower depths in December when larvae were generally evenly distributed between 21 and 110 cm in the soil. (3) Though collected in 5 months and from four sites, larvae represented by distributions D–H were generally in the upper layers of soil, mostly above 60 cm in depth.

P. carinata larvae were collected at relatively shallow depths in the soil. Fifteen larvae collected on 21 May 1960 were generally less than 50 cm deep in the soil, and six collected on 28 March were shallower than 70 cm.

Most *P. dubitabilis* larvae collected during the 4 summer months (June to September) were generally fairly deep in the soil, usually below 40 cm (Fig. 5F–I). *P. simi* larvae collected at other sites during those 4 months were generally shallow in the soil, usually above 50 cm in depth, however (Fig. 6E–H).

Throughout this study, no *Pleocoma* larvae of any of the three species were found below 110 cm in depth. This is considerably more shallow than the maximum depth that larvae of other *Pleocoma* species and other genera of white grub have been observed. *P. minor* larvae have been found as deep as 149 cm (Ellertson and Ritcher, 1959) and *P. puncticollis* Rivers as deep as 240 cm (Linsley, 1938). Larvae of *P. linsleyi* Hovore have been taken at depths of between 60 and 240 cm (Hovore, 1971). Larvae, pupae, and adults of *P. conjungens lucia* Linsley have been collected from cells in rocky, clay soil at depths ranging from about 36 cm to several meters below the soil surface (Hovore, 1977). White grubs of the genus *Phyllophaga* have been found as deep as 190 cm in some Canadian soils (Hayes, 1929).

Environmental Factors Influencing Larval Distributions

On the basis of other Scarabaeid research, soil temperature, moisture, pH, and profile were considered most likely to directly or indirectly influence larval density in the soil, particularly vertical distribution, and to a lesser extent spatial distribution.

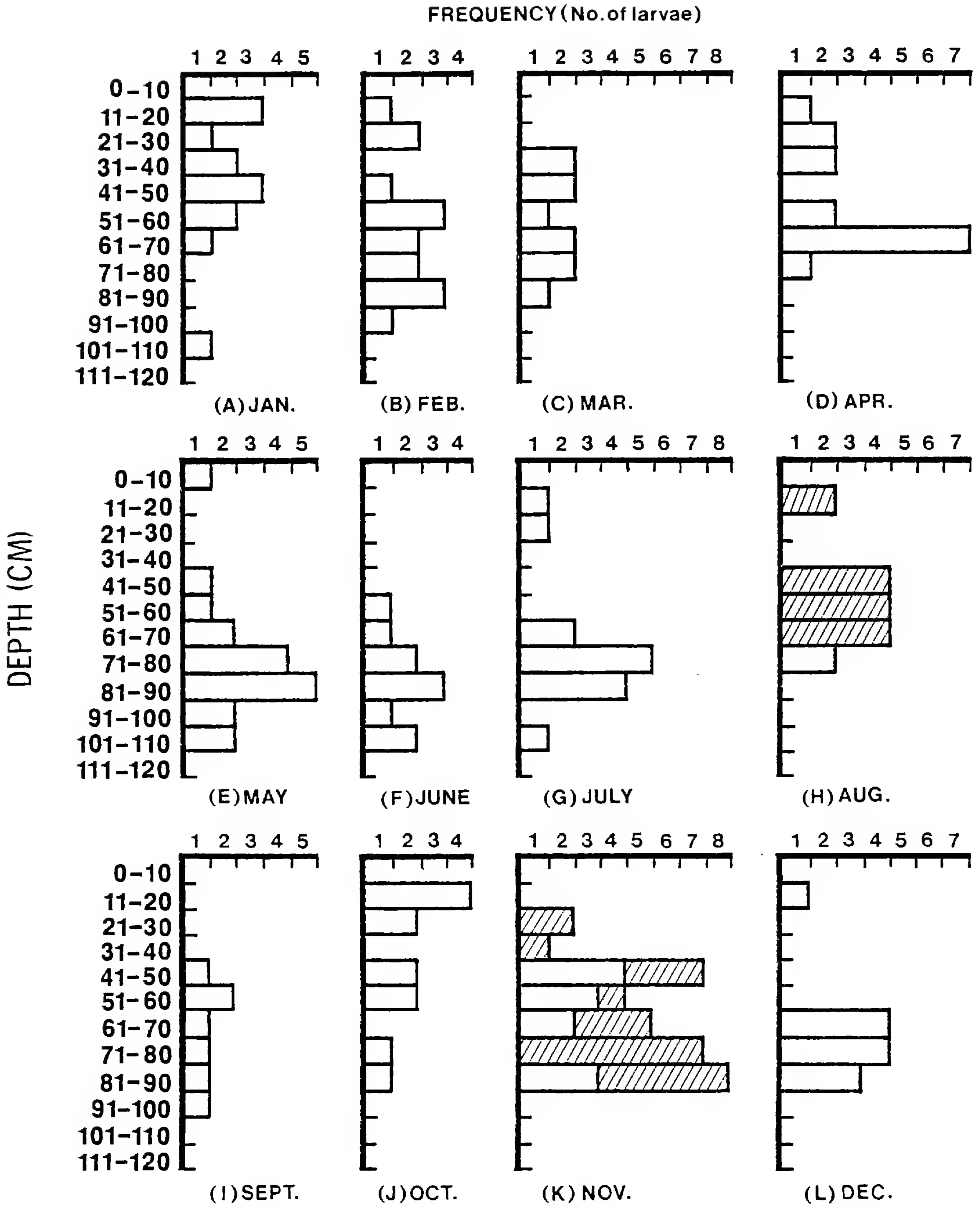

Figure 5. Vertical distribution of *Pleocoma dubitabilis* larvae in the soil at McDonald Forest in 1960 and 1961. Hatched blocks indicate larvae collected in 1960.

I collected soil samples at four depths—15, 45, 75, and 105 cm—in each sample hole to determine soil moisture content and soil pH.

Soil moisture was expressed in percentage of dry weight as outlined by Lyon and Buckman (1948). By their procedure, 100 grams of soil was mixed, weighed, air dried, and heated in an oven for 7 to 8 hours at 38 to 43°C, then cooled in a desiccator and weighed again.

Soil samples for pH determination were collected in 1-pint waxed cardboard containers. A 2-gram soil sample was suspended in 2 ml of distilled water in a 5-ml beaker. Micro-electrodes were immersed in the suspension and the pH read

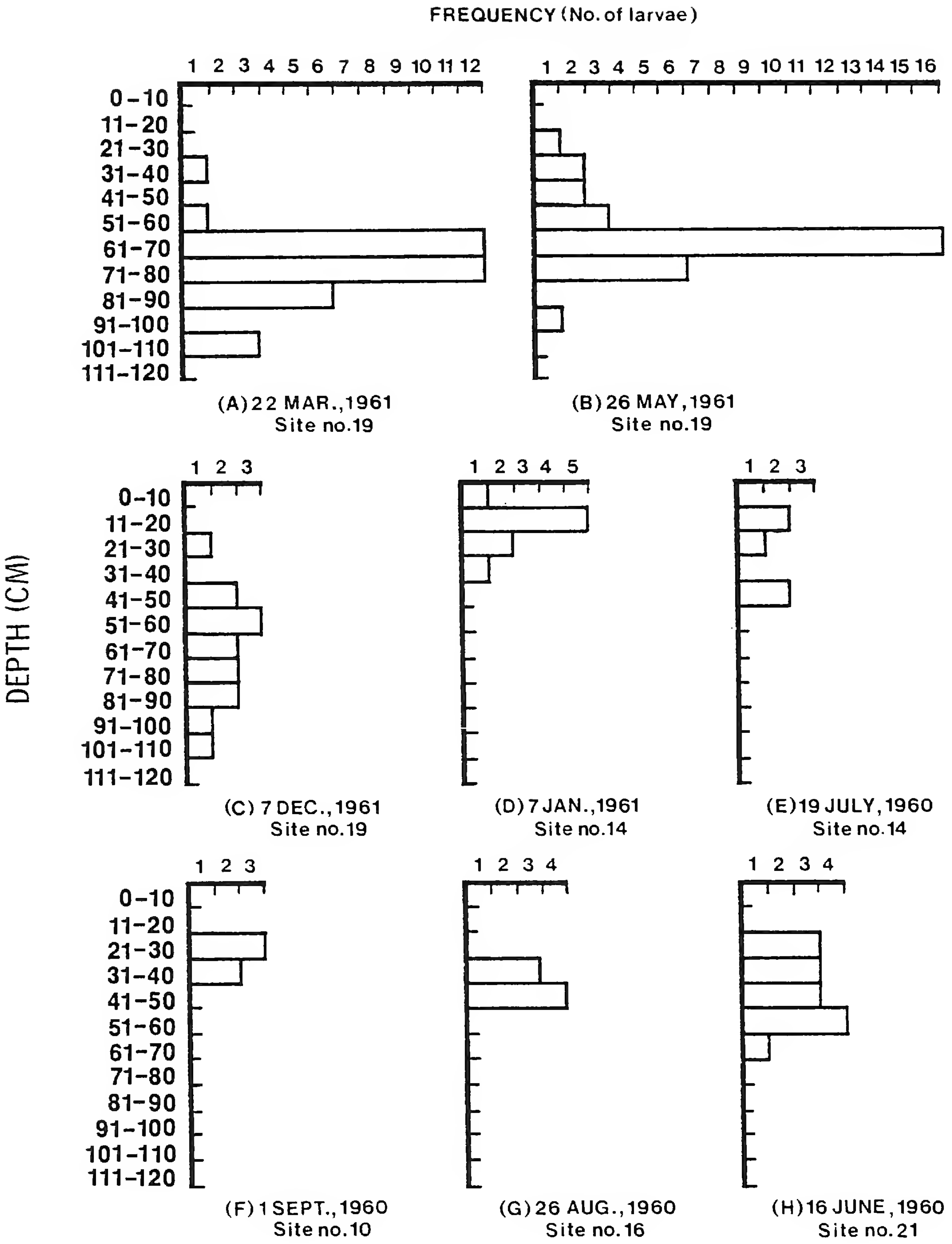

Figure 6. Vertical distribution of *Pleocoma simi* larvae in the soil at several forested sites in southwestern Oregon in 1960 and 1961. Locations of sites are described in footnote 1, Table 4.

on a Beckman Model N portable pH meter[3]. All measurements were first made using a buffer of pH 7; samples measuring 5.5 or below were rerun using a buffer of pH 4 for a more accurate reading.

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[3] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

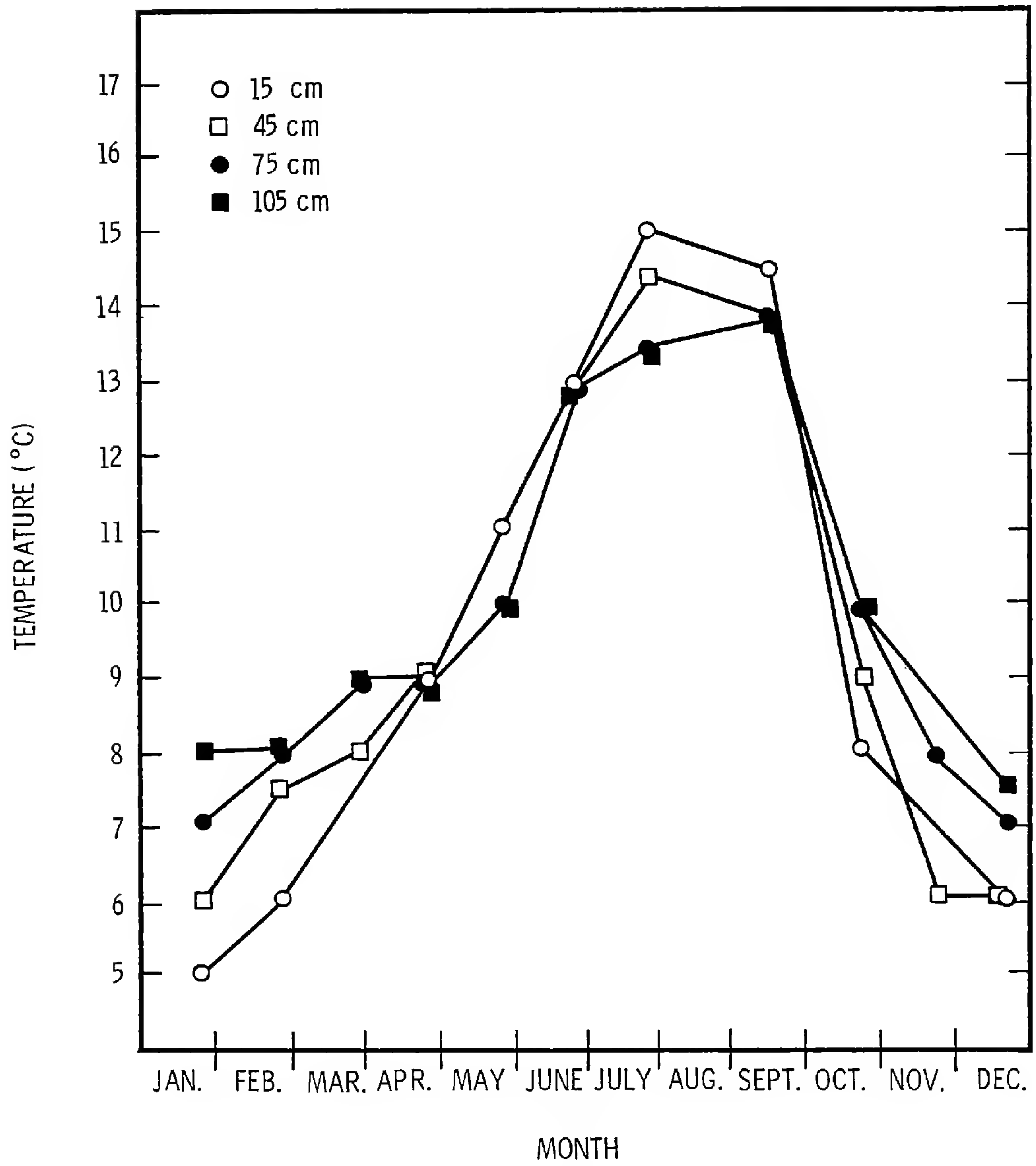

Figure 7. Soil temperatures at four depths during 1961 at McDonald Forest study area, 8 km north of Corvallis.

At each of the four depths, I took soil temperatures by thrusting an ordinary immersion-type 110°C etched-stem thermometer at least 4 cm laterally into the soil and leaving it for at least 5 minutes before reading it.

The soil profile also was described for each sample hole.

Soil Temperature

At the McDonald Forest study area, where *P. dubitabilis* is found, soil temperatures at all depths were generally highest during the summer months and lowest during the late fall, winter, and early spring months. During the summer months, temperatures at the shallower depths were higher than those at lower depths, but during the winter months the reverse was true (Fig. 7). This transition in soil temperature was responsible for two temperature overturns during the year, when temperatures at all four depths were equal or nearly so. During the spring overturn in April, soil temperature at all four depths was 9°C while during the fall overturn in late September to early October 1961 temperatures at all four depths were 12 to 13°C.

The general absence of *P. dubitabilis* larvae above 40 cm during the 5 summer

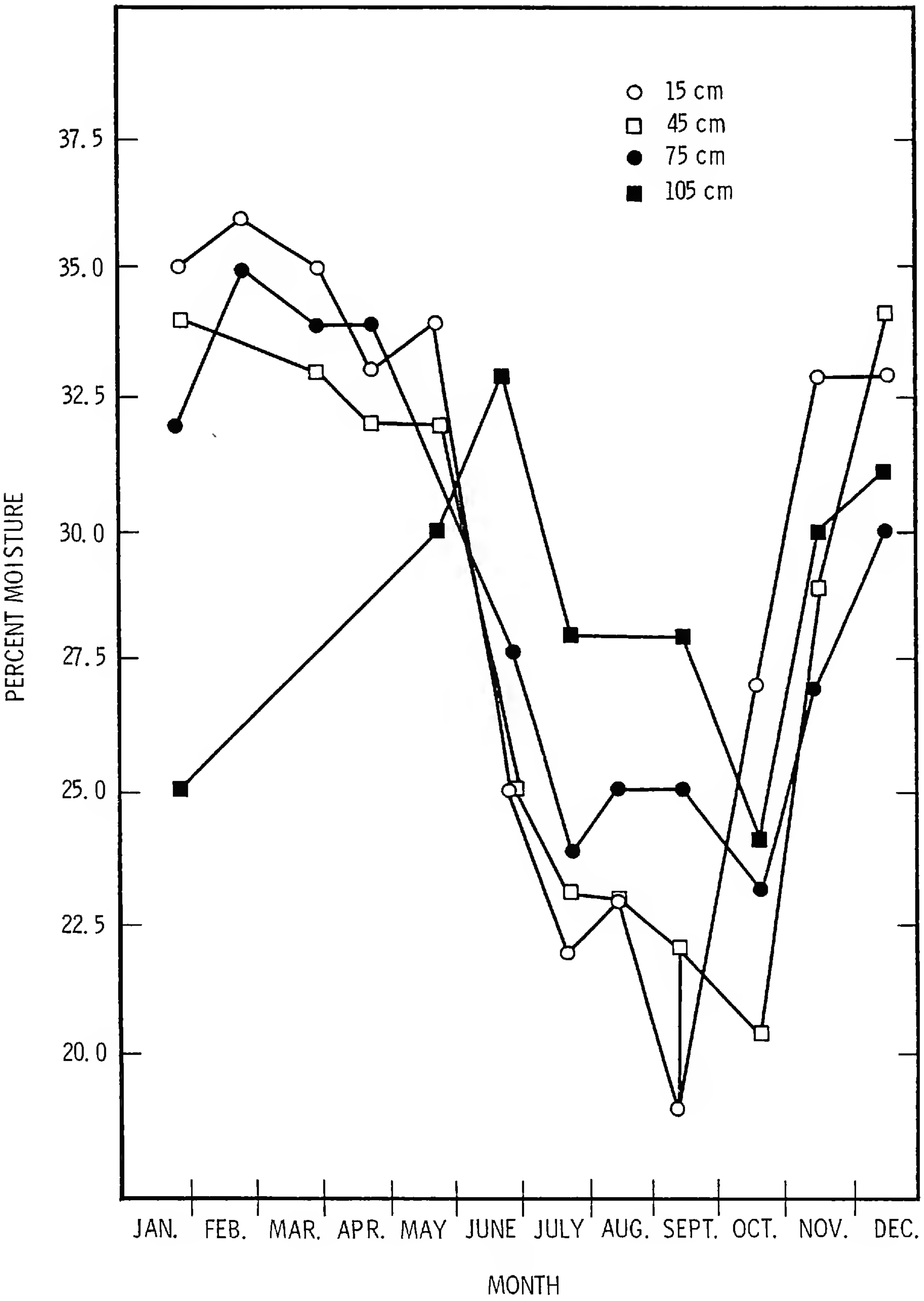

Figure 8. Soil moistures at four depths during 1961 at the McDonald Forest study area, 8 km north of Corvallis.

months from May to September seems to be correlated with higher soil temperature at the 15-cm depth during this period. This is not a strong relationship, however, because temperatures at 45 and 75 cm during these 5 months were within 1 to 1.5°C of temperatures at 15 cm. Moreover, in May, July, and September, the difference in soil temperature between the 15- and 45-cm depths was only 0.5°C or less.

Pleocoma dubitabilis larvae did not appear to seek the soil stratum with the least temperature fluctuation. Had they done so, they should have been congregated at a depth of 105 cm or deeper, where soil temperatures throughout the year fluctuated the least (Fig. 7).

Soil temperatures taken with collections of *P. simi* and *P. carinata* larvae generally followed the same seasonal pattern as shown for the *P. dubitabilis* collections at the McDonald Forest study area (Fig. 7). Larvae of both *P. simi* and *P. carinata,* however, were generally shallower than 60 cm during summer months when temperatures were highest at the more shallow depths.

At least one site shows that no relationship appears to exist between soil temperature and vertical distribution of *P. simi* larvae (Fig. 6A–C). In May, when soil temperatures at 15 cm were higher than temperatures deeper in the soil, most larvae were congregated between 61 and 80 cm. In March, soil temperatures at 15 cm were cooler than those deeper in the soil, yet larvae were also congregated between 61 and 90 cm—even a more striking congregation than in May. During December, larvae were rather evenly distributed over a wide range in depths between 21 and 110 cm, and soil temperatures varied from 5.5°C at 15 cm to 8.0°C at 110 cm.

Soil Moisture

At the *P. dubitabilis* sites in McDonald Forest, percentage soil moisture was generally lower at all depths from June through October and higher from November through May. As with soil temperature, there was an overturn in soil moisture percentage twice a year, although the transposition in May to June and October to November is a bit indistinct (Fig. 8).

The generally drier soil at the 15- and 45-cm levels seems to be related to the absence of larvae at these levels from June through September (Fig. 5). In October, percentage soil moisture, though remaining low at 45 cm, increased at the 15-cm depth with the onset of fall rains, accompanied by the movement of some larvae to the more shallow depths (Fig. 5J). However, this apparent response to increased soil moisture is not supported by larval distributions in May and December (Fig. 5E, L). In those months, percentage soil moisture was highest at the 15- and 45-cm stratum, yet larvae were generally concentrated below 40 and 60 cm, respectively. October, November, and January to April moisture percentages at 15 and 45 cm were relatively high, yet larvae were reasonably well distributed in these strata. Other Scarabaeid larvae are known to move deeper into the soil as the upper layers dry out during the summer months (Shorey and Gyrisco, 1960; Rudolph, 1950).

Soil moisture percentages fluctuated least at the 105-cm level at the McDonald Forest study area in 1961 (Fig. 8). *Pleocoma dubitabilis* larvae, however, did not appear to search out the depth at which soil moisture was most stable or they would have congregated at 105 cm or deeper in the soil.

The relationship of *P. simi* and *P. carinata* larvae to percentage soil moisture is about the same as their respective relationship to soil temperatures. Soil moisture percentages taken with collections of larvae of these species are similar to the seasonal pattern shown for *P. dubitabilis* (Fig. 8). As was found with soil temperatures, larvae of *P. simi* and *P. carinata* generally burrowed at relatively shallow depths during that period of the year when the soil there was driest.

Although apparently only weakly related to vertical distribution of *Pleocoma* larvae, variations in percentage soil moisture could influence their spatial density. Infestations of other root-feeding Scarabaeid larvae are often light in poorly drained locations (Shorey et al., 1960; Nitto and Tachibana, 1955; Forbes, 1907; Smith and Hadley, 1926). Excessively dry soil, however, can at times be detrimental to Scarab larvae (Smith and Hadley, 1926; Travis, 1939).

Soil pH

Soil pH did not appear to be a factor affecting the vertical distribution of *P. dubitabilis* larvae at McDonald Forest or *P. simi* or *P. carinata* at the various sites where they were collected. There was a slight increase in acidity with depth, averaging a pH of about 0.3 between 15 and 105 cm.

Though not apparently tied to vertical distribution of *Pleocoma* larvae, soil pH could influence their spatial density. A generally low pH seems to be correlated with higher larval population of the Japanese beetle (Polivka, 1960; Wessel and Polivka, 1952), *Phyllophaga* sp. (Hammond, 1949), and the European chafer (Shorey et al., 1960).

Soil Profile

Spatial distribution of *Pleocoma* larvae probably is not influenced by soil profile, but the vertical distribution of larvae apparently is influenced by the presence of a silicate clay horizon (hardpan or fragipan) at some sites. When a clay horizon was present, larvae were often congregated just above it, and when the horizon was absent there was usually no significant congregation of larvae by depth.

At the *P. dubitabilis* site at the McDonald Forest study area, no silicate clay horizon exists as attested by the vertical distribution of larvae collected there. Throughout the year there was no congregation of larvae at either shallow depths or deeper in the soil (Fig. 5); even in those months when I collected only a few larvae (i.e., September), they were rather well distributed vertically.

All collections of *P. simi* and *P. carinata* were made in coniferous forests in Lane, Douglas, and Jackson Counties, each lying in a major soil type characterized by horizons of silicate clay accumulation (Knox, 1962). The depth of the clay hardpan varied considerably between sites. At some sites it was relatively deep, 80 to 85 cm, and fairly regular, while at others it was as shallow as 15 cm and generally irregular and undulating.

The presence of a silicate clay hardpan at most sites where *P. simi* larvae were collected is reflected in the vertical distribution of larvae. At site #19, for example, a definite silicate clay hardpan existed at about 95 cm, and the horizon boundary was fairly regular. In all three collections at that site (Fig. 6A–C) the majority of the larvae were above 90 cm. The concentration of larvae immediately above that hardpan is particularly evident in the March and May collections (Fig. 6A, B). At other *P. simi* sites the hardpan was encountered at relatively shallow depths. Without exception, larvae collected at these sites were above the hardpan (Fig. 6D–H).

Clay hardpans and other soil characteristics are also known to affect the vertical movements of other Scarab larvae, especially *Phyllophaga* (Granovsky, 1958; Travis, 1939).

A silicate clay horizon may also affect maximum depth of oviposition, thus indirectly influencing vertical distribution of *Pleocoma* larvae, at least soon after hatching. On 8 July 1960, I collected a female *P. dubitabilis* and her 64 eggs at a forested site 3 miles north of Brownsville in Linn County. She was taken at 47 cm and her first eggs had been deposited at 58 cm. At about 60 cm there was a horizon of silicate clay accumulation.

DISCUSSION

The vertical distribution of *Pleocoma* larvae and, to a lesser extent, the spatial distribution probably are influenced by an interaction of factors. During the summer months most larvae probably avoid the upper layers of soil as temperatures there increase and the soil dries out. If no silicate clay layer is encountered, or if the hardpan is relatively deep, larvae are able to burrow as deep as necessary to find moisture and temperature conditions more suitable than near the surface. If a fairly shallow silicate clay layer is present, it obstructs the larvae in their movement downward while retreating from unsuitable conditions near the surface.

Because *Pleocoma* larvae are known to be capable of burrowing into very hard soil (Davis, 1934), including a hard clay layer, the silicate clay horizon may only indirectly restrict the downward movement of the larvae through the direct effect of the clay layer on tree roots. An obstructing layer such as a fragipan will cause a proliferation of Douglas-fir roots (and no doubt roots of other conifers) resulting in a greater density of rooting just above the fragipan (McMinn, 1963).

When the silicate clay layer is shallow, larvae probably tolerate suboptimum temperature and moisture conditions in the presence of abundant food (coniferous roots) immediately above the clay hardpan rather than burrow down into or below the rootless hardpan, even though temperature and moisture conditions there might be more suitable. This would account for finding many *P. simi* and *P. carinata* larvae at very shallow depths at sites where the silicate clay horizon was correspondingly shallow, even during summer months when most larvae in soils without shallow hardpans are deeper in the soil. In orchard soils, Ellertson and Ritcher (1959) found the character of the subsoil affected penetration of orchard tree roots and the vertical distribution of *P. crinita* and *P. minor.*

At the McDonald Forest study area, many prepupal *P. dubitabilis* larvae were found at depths less than 30 cm during the summer months when all other larvae at that area were deeper in the soil. This indicates that the intrinsic behavioral trait to pupate at shallow depths outweighed the effect of warmer and drier soil—apparently unfavorable to most larvae. In these cases then, the physiological or developmental state of the larvae is yet another factor influencing the vertical distribution of *Pleocoma* larvae in the soil.

With other Scarabaeids a complex interaction of factors is responsible for the vertical movements of larvae (Fidler, 1936; Smith and Hadley, 1926; Nakashima, 1952; McCulloch and Hayes, 1923; Granovsky, 1956).

Different types of soil probably influence the spatial distribution and density of *P. dubitabilis, P. simi,* and *P. carinata,* as they apparently do larvae of other species of *Pleocoma.* The larvae of *P. behrensii* LeConte are found in soils that are "... usually of a rich loamy or clayey nature, intermixed with humus ..." (Rivers, 1890). And in collecting *P. fimbriata* LeConte, Hopping (1920) always found females "... in the red soil." At the type locality of three new sympatric *Pleocoma—P. marquai* Hovore, *P. rubiginosa* Hovore, and *P. hirticollis reflexa* Hovore (all described by Hovore, 1972)—larvae showed no apparent preference for a particular soil type as the soils vary from hardpacked, decomposing granite to a loose clay loam. Stein (1963) summarized the available information and, though fragmentary, it clearly demonstrates that species of *Pleocoma* inhabit a variety of soils. With other Scarab genera, lighter soils are more heavily infested with *Phyllophaga* than heavier ones (Seamans, 1956), and highly impervious soils are detrimental to Japanese beetle larvae (Smith and Hadley, 1926).

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Morphological Malformations Among Scorpions of Puerto Rico and the Adjacent Islands

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Abstract.—Twenty-eight different malformations are detected and illustrated in scorpions of Puerto Rico and adjacent islands. Malformations are more common in buthids (17.5% of examined specimens) than in diplocentrids (4.7%). Pectinal malformations are the most common among buthids (9.2%) whereas the arisal of terminal leg spurs from tarsomere I instead of II is the most frequent among diplocentrids (1.6%).

The "normal pattern" is a construct made after noticing a phenomenon repeatedly in approximately the same way. Great deviations from the so-called "normal pattern" are called abnormalities or, for this paper, malformations. Malformations can be intuitively viewed as very extreme values or "outliers" in a frequency-class plot.

Malformations are one of the manifestations of biological phenomena, and, therefore, are of interest to biology. They might be related to environmental events such as radiation (Heatwole et al., 1970) or accidents, or to internal aspects of the organisms in question such as molting (Ćurčić et al., 1983) or teratologies (Holmberg et al., 1983; Walton et al., 1983).

When malformations affect structures of taxonomic importance problems might arise in deciding whether the structure represents a character of taxonomic value (Kaston, 1982; Lourenço, 1984; Mayr, 1968; Quintero, 1983; Tennenson and Gotlfried, 1983). Usually, a thorough inspection of additional characters of the specimen, especially if the malformation occurs in one member of paired structures, and a good acquaintance with the group under study is very useful for decision-making.

In scorpions striking malformations such as double tailed specimens have received much attention (Franganillo, 1937; Vachon, 1953). Less evident malformations are only occasionally reported (Armas, 1977a; Lourenço, 1984) and mostly in connection with taxonomic studies (Armas, 1976, 1977b; Francke, 1978). To my best knowledge, only two preliminary attempts to evaluate the relative occurrence of malformed structures in scorpions have been done and they show that leg and pectine malformations are the most common and those on the telson, pedipalps, and chelicera less frequent (Armas, 1977a; González, 1984). These data might be of importance in the evaluation of possible changes in the intensity of factors causing malformations and, perhaps, might open new research avenues to the understanding of their possible genetic basis (Ćurčić et al., 1983).

The purpose of this paper is to enumerate and illustrate most of the malfor-

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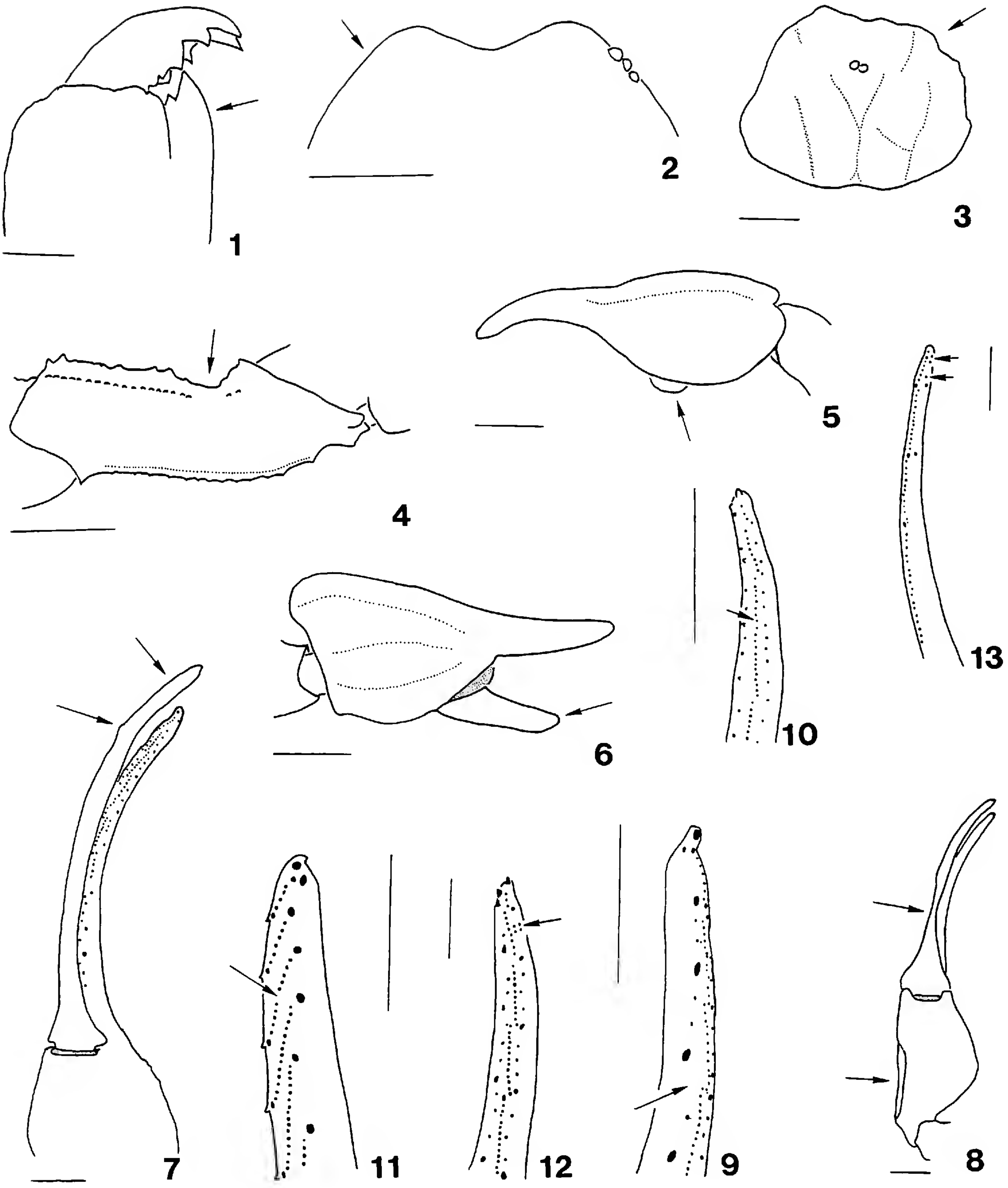


The acronyms herein used and their meanings are: AES (Agricultural Experiment Station, Entomology Museum, Río Piedras, PR), BM (Biology Museum, University of Puerto Rico), JASB (author's personal collection), MSC (miscellaneous scorpion collections of several individuals available through the author), UZM (Universitets Zoologisk Museum, Copenhagen, Denmark), WO (William Ortiz personal collection available through BM), and ZM (Zoologisches Museum an der Humbolt Universitat, Berlin). Field data for each illustrated case follows figure title and scale.

Figures 1–13. 1. Reduced chelicera fixed finger of *Centruroides* sp. Scale line = 0.5 mm. MONA IS: Trail from Sardinera to Capitán, 1979 (M. Alvarez and C. Aranda) (BM XVI-29). 2. Absence of a lateral eye group of *Heteronebo portoricensis* Francke, 1978. Scale line = 1 mm. GUAYACAN IS: 1 ♂, 22.IV.82, under rock (JASB) (JASB-196). 3. Asymmetrical carapace of *Cazierius* sp. Scale line = 1 mm. MONA IS: 1 ♂, Bajura de los Cerezos, 29.VIII.82 (C. Cianchini) (BM XVI-99). 4. Incomplete pedipalp femur keel of *Centruroides griseus.* Scale line = 1 mm. BRITISH VIRGIN ISLANDS: 1 ♀ (subadult), Little Tobago Island, 4.IV.66 (Island Project Staff) (BM XVI-150). 5. Extra protuberance on pedipalp chela of *H. portoricensis.* Scale line = 1 mm. PUERTO RICO: 1 ♀, Guánica, 12.III.72

mations found during the examination of 1245 specimens from Puerto Rico and the adjacent islands and to evaluate the relative frequency of the most common ones.

RESULTS AND DISCUSSION

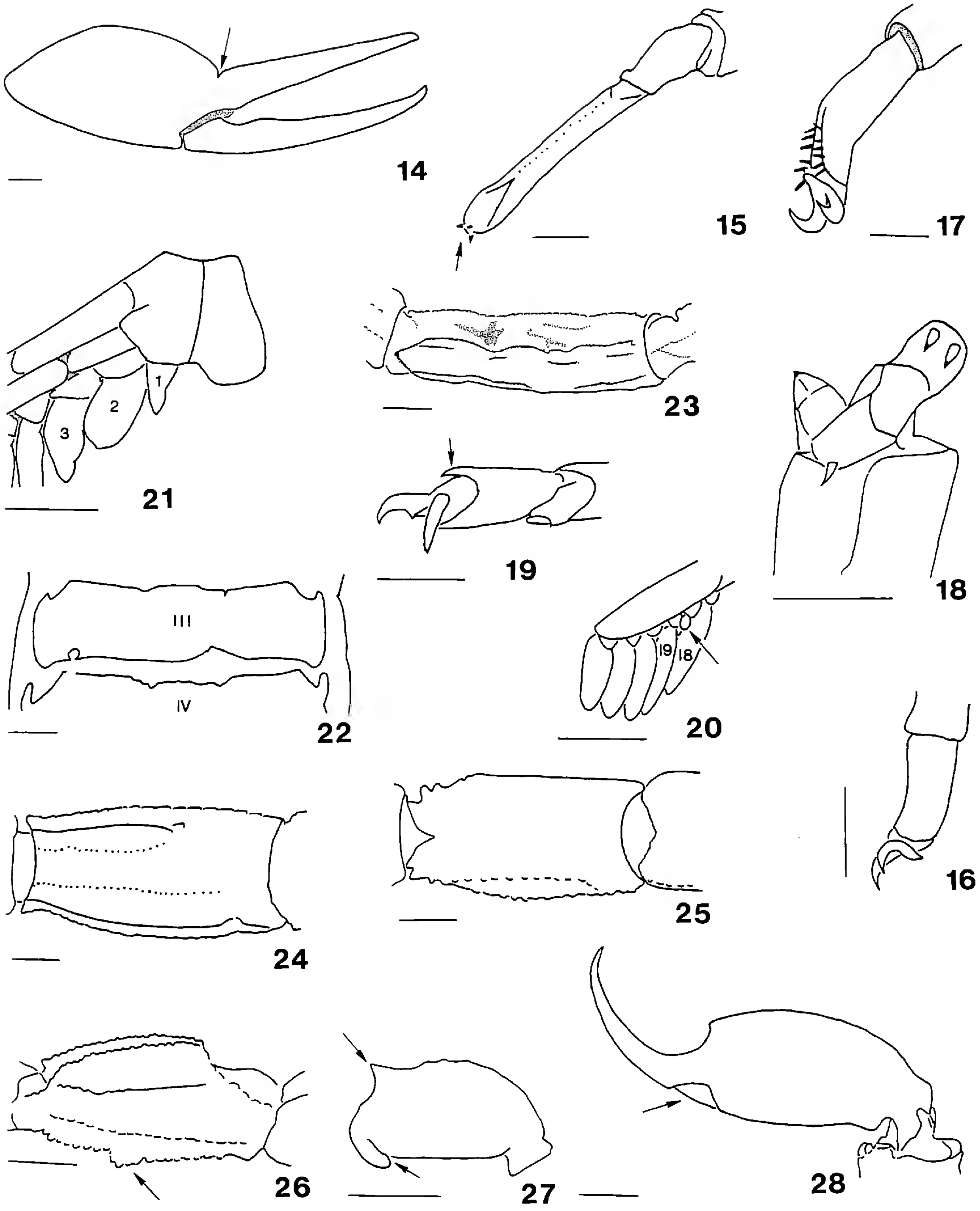
The following malformations were detected among the specimens studied: chelicera fixed finger not reaching the level of the movable finger apex (Fig. 1), absence of a lateral eye group (Fig. 2), carapace front margin deformed (Fig. 3), pedipalp femur keel incomplete (Fig. 4), protuberance on pedipalp manus (Fig. 5), pedipalp movable finger small (=not reaching the level of the fixed finger) (Fig. 6), pedipalp movable finger large (Fig. 7), pedipalp manus and finger scarps (Fig. 8), absence of supernumerary granules (Fig. 9), coalescence of non basal primary denticle rows (Fig. 10), absence of primary row denticles (Fig. 11), extra supernumerary granules (Figs. 12, 13), palp-fixed finger area incisioned (Fig. 14), terminal spurs of legs arising from femur (Fig. 15), spurs arising from tarsomere I (Fig. 16), tarsomeres I–II coalesced (Fig. 17), enlarged and bifid terminal spur (Fig. 18), enlarged terminal dorsal leg spine (Fig. 19), extra pectinal tooth very reduced (Fig. 20) or deformed pectinal teeth (Fig. 21), scars on mesosomal terga (Fig. 22), metasomal segment keels deformed (Fig. 23), incomplete (Fig. 24), or absent (Fig. 25), protuberance on metasomal keel (Fig. 26), aculeus and subaculear tubercle deformed (Fig. 27), and telson vesicle with a scar (Fig. 28).

Malformations were found in 17.5% of the buthid specimens examined. Reduced or deformed teeth in the pectines is the most common malformation (9.2%) among specimens of this family. For example, 7.1% of the *Centruroides griseus* (Koch, 1845) specimens and 3.9% of the *Tityus obtusus* (Karsch, 1879) examined bear this malformation. Other commonly found malformations are: deformed metasomal keels (3.7% of the *C. griseus,* 1.8% of the *T. obtusus*), joined primary denticle rows (1.7% of the *C. griseus,* 1.4% of the *T. obtusus*), and split primary denticle rows (due to the absence of one or more of the denticles) (1.1% of the *C. griseus,* 2.3% of the *T. obtusus*).

Among diplocentrid scorpions, malformations were found in 4.7% of the examined individuals the most common being the arisal of the terminal leg spurs from tarsomere I instead of II, which was detected in 1.6% of the diplocentrid studied.

←

(unknown collector) (BM XVI-107). 6. Reduced movable finger of *Cazierius* sp. Scale line = 1 mm. MONA IS: 1 ♂ (subadult), 4.VII.67 (unknown collector) (BM XVI-94). 7. Enlarged movable finger of *Centruroides griseus.* Proximal arrow points possible origin of malformation. Scale line = 1 mm. PUERTO RICO: 1 ♀, Guánica State Forest, 3.IV.63 (F. Torres) (BM XVI-1). 8. Palm and movable finger scarps of *Tityus* sp. Scale line = 1 mm. PUERTO RICO: 1 ♀, Cayey, Guavate Forest, 3.III.77 (W. Ortiz) (WO-2). 9. Absence of a supernumerary granule of *Centruroides* sp. Scale line = 1 mm. MONA IS: trail from Sardinera to Capitán, 1979 (M. Alvarez and C. Aranda) (BM XVI-29). 10. Coalescence of non-basal primary denticle rows of *Centruroides griseus.* Scale line = 1 mm. PUERTO RICO: 1 ♂ [South West Puerto Rico], on a beach, 1.III.82 (R. Soto) (JASB-115). 11. Absence of a denticle on a primary row of *Tityus obtusus.* Scale line = 1 mm. PUERTO RICO: 1 ♀, Villalba, Toro Negro Forest, 20.VII.82, "dry pinus" (C. J. Cianchini) (BM XVI-112). 12. Extra supernumerary granules of *Centruroides* sp. Scale line = 1 mm. MONA IS: 1 ♀, no more data. 13. Extra supernumerary granules of *Isometrus maculatus* (DeGeer, 1778). Scale line = 1 mm. PUERTO RICO: 1 ♀, El Yunque, near La Mina, 1.X.63, loose bark (F. Torres) (BM XVI-42).



Figures 14–28. 14. Palm-fixed finger junction area of *C. griseus* incisioned. Scale line = 1 mm. PUERTO RICO: 1 ♀ (juvenile), 18.XII.1888 (L. Krug) (ZM-7623). 15. Terminal leg spurs arising from femur of *C. griseus*. Scale line = 1 mm. PUERTO RICO: 1 ♂, Faro Beach, 4.III.82 (W. Irizarry) (JASB-145). 16. Terminal leg spurs arising from tarsomere I of *Cazierius* sp. Scale line = 0.5 mm. MONA IS: Bajura de los Cerezos, 25.XI.80, under rocks (M. Alvarez and V. Quevedo) (JASB-18). 17. Coalescence of tarsomeres I–II of *H. portoricensis*. Scale line = 1 mm. PUERTO RICO: 1 ♀, Ponce, behind Holiday Inn Hotel, 30.VIII.81, under rock (M. E. Arroyo and JASB) (JASB-85). 18. Enlarged and bifid terminal spur of *C. griseus*. Scale line = 0.25 mm. DESECHEO IS: 1 ♂, 6.VI.80, in a *Tillandsia* sp. (R. Thomas and JASB) (JASB-1). 19. Enlarged dorsal projection on tarsomere II of *Centruroides* sp. Scale line = 0.5 mm. MONA IS: Mujeres Beach, 21.I.82, dry rotten tree (JASB) (JASB-11). 20. Extra protuberance (fulcrum ?) between pectinal teeth of *Centruroides* sp. Scale line = 0.5 mm. MONA IS: Meseta, unknown date (R. Santo Domingo) (BM XVI-30). 21. Deformed pectinal teeth of *T.*

Most of the buthids inhabiting the Puerto Rico region have about three times more pectinal teeth than the diplocentrids, and therefore have a greater probability of having a malformation in the pectinal teeth (assuming all other possible factors equal). However, diplocentrids were found to have proportionately less frequency of pectinal abnormalities than expected. On the other hand, diplocentrids tend to be soil dwellers and are more likely than buthids to use the terminal segments of the legs for digging in the ground (thus breaking segments and producing spurs where they are usually not present).

Interestingly, malformations of the chelicera, chela manus or fingers, and telson, all of which might decrease prey capture efficiency, were found very few times (<1%), although other malformations on structures not so directly related to prey capture such as those on the pedipalp femur and tibia were also not frequent.

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obtusus. Scale line = 0.5 mm. PUERTO RICO: 1 ♀, Orocovis, Sector Saltos Cabra, road 566, III.1983 (Saltos Cabra School Students) (JASB-497). 22. Scars on mesosomal terga margins of *T. obtusus.* Scale line = 1 mm. PUERTO RICO: 1 ♀, north side of Luquillo forest, 8.IV.61 (H. Heatwole) (BM XVI-276). 23. Completely deformed metasomal keels of *I. maculatus.* Scale line = 1 mm. "VESTINDIEN": 1 ♂, 12.VIII.1889 [M (=Meng)] (UZM). 24. Partially absent dorsal metasomal keel of *T. obtusus.* Scale line = 1 mm. PUERTO RICO: 1 ♀, north side of Luquillo forest, 8.IV.61 (H. Heatwole) (BM XVI-276). 25. Total absence of a dorsal metasomal keel of *T. michelii.* Scale line = 1 mm. PUERTO RICO: 1 ♀, 12.III.81 (A. Ramírez) (JASB-3). 26. Extra protuberance on a ventral metasomal keel of *Tityus* sp. Scale line = 1 mm. PUERTO RICO: 1 ♀, Toa Baja, road 2, km 21.3, pitfall trap, 28.V.82 (JASB) (JASB-35). 27. Partially deformed aculeus and subaculear tubercle of *C. griseus.* Scale line = 0.5 mm. UNITED STATES VIRGIN ISLANDS: 1 juvenile, St. John, Caneel Bay, 4.V.83 (W. I. Knausenberger) (MSC-2). 28. Vesicle scar of *C. griseus.* Scale line = 1 mm. PUERTO RICO: 1 ♂, Cabo Rojo, Boquerón, 12.II.82 (K. Rodríguez-Montalvo) (JASB-126).

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Scientific Note

Notes on *Valgus californicus* Horn (Coleoptera: Scarabaeidae)

Valgus californicus is found throughout the southern Cascades and mountainous areas of southern California. This species is mentioned as an inquiline in the nest of the termite *Zootermopsis angusticollis* Hagen in the Pacific coast region by Banks and Snyder (1920). Hinton (1930) remarked on collecting larvae, pupae and adults beneath loose bark at the base of termite infested Sugar Pine (*Pinus lambertiana* Dougl.). He commented on the fact that the pupae were found in cells constructed of termite castings. The third instar larvae of this species was described by Ritcher (1966).

Linsley and Ross (1940) collected *V. californicus* in several localities in the San Jacinto Mts., Riverside Co., California. All of the specimens were collected in association with *Zootermopsis* sp. beneath the bark of Ponderosa Pine (*Pinus ponderosa* Laws.).

During the months of April and May 1980, C. L. Bellamy, L. H. Shaw, R. K. Velten, and the author conducted several trips to the San Jacinto Mts. in search of this uncommon scarab. Individuals were found in various localities, but Keen Camp Summit, east of Mountain Center proved to be an ideal habitat. The area had been logged many years before, leaving a number two or three foot high stumps of *P. ponderosa* behind. Most of the stumps were heavily infested with *Zootermopsis*. Several *V. californicus* were found beneath the bark at the base of the stumps. By carefully chopping with a machete, the blind galleries in the dry, upper portion of the stump were exposed, revealing as many as 48 individuals in one stump. Both males, females, and copulating pairs were found in these galleries.

Termite activity was restricted to the moist environs below. Copious quantities of termite castings had accumulated in the lower chambers and in spaces beneath the bark. Third instar larvae were found in loose cells constructed from the castings. No pupae were found. Attempts to rear the larvae to the imaginal stage proved unsuccessful.

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Notes on the Nesting Biology of *Protosmia* (*Chelostomopsis*) *rubifloris* (Cockerell) (Hymenoptera: Megachilidae)[1]

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Abstract.—Nests of *Protosmia* (*Chelostomopsis*) *rubifloris* (Cockerell) (new combination) recovered from trap-nest blocks are described and aspects of the nesting biology compared with related species. Like other *Protosmia* and the closely related *Heriades, P. rubifloris* uses resin in constructing its nests. It apparently differs from *Protosmia* (*Protosmia*) in its choice of nest site, utilizing cavities in wood rather than snail shells, crevices in stones, or abandoned mud nests of other bees and wasps. No parasites were found in this study. *P. rubifloris* was found to overwinter as an adult, a condition uncommon among megachilids.

Protosmia (*Chelostomopsis*) *rubifloris* (Cockerell) is the sole representative in the Nearctic of an otherwise Palaearctic and Ethiopian genus. It has previously been regarded as belonging to the genus *Chelostomopsis* Cockerell, which is here relegated to subgeneric rank. (Justification will be presented in a forthcoming paper on the classification of heriadines.) This vernal bee is widely distributed in cismontane California and sparingly north into Oregon and Washington west of the Cascades. A disjunct population has also been recorded from the mountains of northern Arizona (Hurd and Michener, 1955). The only previous reference to the biology of *P. rubifloris* is a note that it was reared from the cones of *Pinus attenuata* Lemmon in northern California (Hurd and Michener, 1955). In this paper, notes are given on the nesting biology of another disjunct population, this one from the higher desert ranges of the eastern Mojave Desert.

METHODS

Trap-nest blocks were made from 2.5 × 15.2 cm (1″ × 6″) pine cut into 10 cm lengths. Blocks were made by binding three such sections together side by side with filament tape. Two burrows each of five hole sizes were drilled in a random pattern into the end of each section. Hole diameters and depths were as follows: 2 mm, 45 mm deep; 3 mm and 4 mm, 60 mm deep; 6 mm and 8 mm, 90 mm deep. An additional hole was drilled completely through the middle section to allow attachment of the block using a nail. The design proved faulty in that the filament tape deteriorated in the sun and heat. Consequently, the two outer sections

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[1] Contribution from Utah Agricultural Experiment Station, Utah State University, Journal Paper No. 3092 and USDA-ARS-Bee Biology & Systematics Laboratory, Utah State University.

fell to the ground. Traps were put out at the beginning of April in the Providence Mountains, New York Mountains, and the intervening Mid Hills of eastern San Bernardino County, California. Trap sites were chosen along an elevational cline (620–1730 meters), three traps to a site. Traps were nailed to trees (dead where possible) or fence posts, one to two meters above the ground with entrance holes facing southeast. They were recovered in early November. Rearing methods and pollen analysis were as described by Parker (1981).

RESULTS

Nesting habitat.—All nests of *P. rubifloris* were in the mountainous portion of the desert at elevations of 1370 to 1650 meters in the pinyon-juniper woodland plant community (Thorne et al., 1981). *Pinus monophylla* Torr. and Frem. and *Juniperus osteosperma* (Torr.) were common at all sites. Significant shrubby components of the vegetation included *Artemesia tridentata* Nutt., *Ephedra viridis* Cov., *Haplopappus* spp., *Guttierezia microcephala* (DC.), *Opuntia acanthocarpa* Engelm. & Bigel., *Prunus fasciculata* (Torr.), *Purshia glandulosa* Curran, *Rhus trilobata* Nutt., *Salvia dorrii* (Kell.), *Yucca baccata* Torr., and at the lowest elevation site, scattered *Yucca brevifolia* Engelm. Associated cavity nesters in the trap-nest blocks included *Ashmeadiella* (*Arogochila*) sp., *Osmia marginata* Michener, *O.* (*Chenosmia*) sp., *Anthidium maculosum* Cresson, *Dianthidium platyurum* Cockerell, and at the lower elevational limit, *Chalicodoma occidentalis* (Fox).

Nests.—Thirty-nine nests of *P. rubifloris* from five sites were recovered. These contained a total of 150 cells. Borings of 3 and 4 mm diameter were used exclusively by this bee. Assuming equal numbers of available holes, there appeared to be no preference between the two sizes, with 18 and 21 holes respectively, utilized ($\chi^2 = 0.2$, d.f. = 1, $P > 0.60$). The number of cells per nest ranged from 1 to 7 ($\bar{x} = 4.0 \pm 1.2$, $n = 37$ since nests with supersedure were excluded from the analysis). Again, no difference in number of cells was detectable between the two hole sizes within the sample size ($t = 0.929$, d.f. = 35, $P > 0.30$).

Nest construction.—Nest construction was initiated at the bottom of the burrow in nearly all cases. Rarely (5% of all nests), an initial thin layer of resin less than 1 mm thick was applied to the bottom of the burrow. Cells were arranged linearly in the burrow with 0.2 mm to 1 mm thick partitions composed of clear resin separating the cells. Cell walls were not lined with resin though resin extended slightly along the cell walls on both sides of the partition. Cells ranged in length from 5 to 14 mm ($\bar{x} = 7.7 \pm 1.8$, $n = 148$). There was no significant difference in length of cells between hole sizes ($t = 0.0003$, d.f. = 146, $P > 0.50$), perhaps due to variations in expansion and contraction of the wood. But the length of female cells ($\bar{x} = 8.5 \pm 1.8$, $n = 34$) was significantly greater ($t = 13.76$, d.f. = 77, $P < 0.001$) than the length of male cells ($\bar{x} = 7.0 \pm 1.2$, $n = 45$). Twenty-three nests (59%) had an interstitial cell between at least two of the brood cells. In 9 nests (23%) these were present between all provisioned cells. All nests were plugged upon completion of provisioning. Plugs varied in thickness from 1 mm to 8 mm ($\bar{x} = 4.4 \pm 1.9$, $n = 39$) and were composed of translucent, colorless to golden resin, sometimes with embedded bits of gravel. Plugs were either flush with the nest entrance (36%) or recessed (64%) 1–19 mm within the burrow. In the former case, the plug often bulged above the entrance. At least one vestibular cell (between the last provisioned cell and the entrance plug) was present in 85% of the nests.

Four nests had two vestibular cells while two nests had three such cells. Vestibular cells ranged in length from 3 to 29 mm ($\bar{x} = 11.8 \pm 7.5$, $n = 41$).

Provisions.—Pollen samples from ten cells covering four of the five sites were analyzed. At the two lower elevation sites these consisted exclusively of *Salvia* pollen. At the other two sites pollen was approximately equally divided among *Salvia,* a legume, and an unknown pollen.

Cocoon and feces.—Cocoons consisted of a thin transparent white layer occupying all or nearly all of the cell. There was no nipple on the end of the cocoon. Fecal pellets were yellow to amber, 0.6–0.8 mm long, 0.2 mm wide, sausage-shaped, straight or slightly curved, without a longitudinal groove, and bluntly pinched off at both ends. Most fecal pellets were loosely clumped outside of the cocoon at either end of the cell. A few were scattered along one side of the cell and adhered to the outside of the cocoon. These were often flattened and occasionally were located between loose outer strands of the cocoon and the main sheet-like layer.

Nest associates and mortality.—There were two incidents of supersedure. In both cases *P. rubifloris* nested above cells of another bee: *Ashmeadiella* (*Arogochila*) sp. in one case, *Osmia* (*Chenosmia*) sp. in the other. One nest was destroyed by an unknown predator which did not damage the plug or the outermost partition but tunneled through the adjacent wood. One cell was destroyed by mold. There was no parasitism. Immature mortality was extremely high (53%), and was likely due, in part, to the faulty block design, which allowed the outer sections to fall to the ground. The 62% mortality in the fallen sections was significantly higher than the 41% mortality in the sections remaining in place ($\chi^2 = 5.02$, d.f. = 1, $P < 0.025$).

Overwintering and sex ratio.—*Protosmia rubifloris* overwintered as an adult in diapause. The sequence of cells in the nest normally followed a pattern of females in interior cells and males in outer cells. In nests with two or more cells, 83% of the first cells were female, while 85% of the outermost cells were male. Occasional nests had the sexes intermingled or contained only male or female cells. A count of all emerging adults plus dead pupae recognizable to sex, gave totals of 45 males and 34 females resulting in a sex ratio of 1.32 males/females.

Discussion

Protosmia rubifloris uses resin in constructing its nests as do all other heriadines whose nesting biologies are known. Its high developmental mortality is paralleled by the 56.6% reported for *H. carinatus* by Matthews (1965). The extremely low combined rate of parasitism-predation in *P. rubifloris* is comparable to the 1.6% recorded for *Heriades carinatus* Cresson (Matthews, 1965) and appreciably less than Maciel (1976) reported for *H. truncorum* (Linnaeus) (21.2% and 11.7% in successive years), the only other heriadines for which such data exist. However, this low rate may not accurately reflect the average rate for *P. rubifloris* since the sample was small, and was from only one year.

The choice of nest site is similar to that recorded for most *Heriades,* but is in marked contrast to that reported for typical *Protosmia. Protosmia paradoxa* (Friese) (Mavromoustakis, 1939), *P. exenterata* (Perez) (Ferton, 1894), *P. stelidoides* (Perez) (Ferton, 1909), and *P. sideritis* Tkalcu (1978) all nest in empty snail shells, while *P. monstrosa* (Perez) uses crevices in stones (Mavromoustakis, 1939), and

P. glutinosa (Giraud) nests in the abandoned mud nests of other aculeates (Giraud, 1871).

Protosmia rubifloris differs from all other heriadines with known life cycles in overwintering as an adult. Most *Osmia* and a few *Megachile* are the only other megachilids reported to overwinter in this form (Stephen et al., 1969). Parker (pers. comm.) has found a third genus of Megachilidae, the parasitic *Dioxys,* overwintering as adults in the nests of *Osmia.* It has been suggested that this form of life cycle is an adaptation for early spring emergence (Stephen et al., 1969). This seems a plausible explanation for *P. rubifloris.* Collecting in the vicinity of the nesting sites showed it to be one of the first megachilids active in the spring. It was taken as early as mid April, flying with *Osmia.*

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New Synonymy, Host, and California Records in the Genera *Dioxyna* and *Paroxyna* (Diptera: Tephritidae)

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Abstract.—*Paroxyna corpulenta* (Cresson) is synonymized with *P. genalis* (Thomson). New host-plant rearing records are reported for this redefined species. *Paroxyna sabroskyi* Novak is initially recorded from a host plant, *Stephanomeria virgata* Bentham, and from California. New rearing records for *Dioxyna picciola* (Bigot) also are reported from the genus *Coreopsis* (Asteraceae).

Rearings of *Paroxyna* spp. from flower heads of Asteraceae collected in southern and central California by RDG have yielded new host-plant and State records and provided FLB new opportunity to study certain *Paroxyna* species taxonomically. Specimens of tephritids formerly designated as *P. genalis* (Thomson, 1869) and *P. corpulenta* (Cresson, 1907) by Foote and Blanc (1963), Foote (1967), and Novak (1974) were reared from single samples of flower heads from each of several plant genera and species, leading us, after close morphological examination, to the inescapable conclusion that they are the same species.

Critical taxonomic study of the reared flies by FLB showed an intergradation of morphological characters that until now have been used to separate populations of *genalis* and *corpulenta.* The separation character most commonly used has been the presence or absence of an amber color on the tip of the scutellum. Within groups of flies reared from single head samples in the present study, a wide variation occurred, ranging from flies with the scutellum amber over its terminal ⅓, to some with the scutellum amber only at the very tip, to some with amber only on the ventral portion of the tip, to those with a totally dark brown scutellum.

The number or absence of very small hyaline spots in the dark area of cell r_3 directly posterior to the pterostigma also has been used to separate *genalis* from *corpulenta.* Reared specimens in this study varied from none to three spots in this area.

The degree of distinctiveness of the borders of the hyaline wing spots, and the size of the hyaline spots in cell r_{4+5}, are additional characters often used to separate *genalis* and *corpulenta.* These characters were observed to be variable in all reared samples.

The geographical distribution of the two formerly separated populations are practically identical. *Paroxyna genalis*' records include California, Oregon, Washington, British Columbia, N.W. Territories, Alberta, Wyoming, South Dakota, Colorado, Utah, Arizona, and New Mexico. The distribution of *P. corpulenta*

Table 1. *Paroxyna* reared from Asteraceae flower heads in California.

Host-plant species	Sampling date	Location	No. reared as *corpulenta*	No. reared as *genalis*
Venegasia carpesiodes de Candolle	30 V 1980	Gaviota, San Bernardino Co.	22	8
Haplopappus linearifolius de Candolle	27 V 1980	Devil's Punchbowl, Los Angeles Co.	17	13
Haplopappus ericoides (Lessing) Hooker & Arnott ssp. *blakei* C. B. Wolf	12 XI 1980	Orcutt, Santa Barbara Co.	2	10
Eriophyllum staechadifolium Lagasca y Segura var. *artemisaefolium* (Lessing) Macbride	13 XI 1980	Point Buchon, Santa Barbara Co.	0	4
Layia platyglossa (Fernald & Macbride) Gray prob. ssp. *campestris* Keck	17 IV 1980	Howard Canyon, Santa Barbara Co.	2	4
Senecio douglasii de Candolle var. *douglasii*	12 XI 1980	Orcutt, Santa Barbara Co.	0	2
Haplopappus ericoides ssp. *blakei*	7 XII 1982	Orcutt, Santa Barbara Co.	1	7
	7 XII 1982	Los Osos, Santa Barbara Co.	2	3
Madia sp. prob. *elegans* D. Don	15 IV 1983	Santa Cruz Island, Santa Barbara Co.	5	1
Senecio canus Hooker	26 VII 1983	Troy Meadows, Sequoia Nat. Forest, Tulare Co.	11	6
	25 VII 1984	Bald Mountain, Sequoia Nat. Forest, Tulare Co.	4	2
Haplopappus linearifolius	17 IV 1984	Big Rock Canyon, Los Angeles Co.	3	5
Senecio integerrimus Nuttall var. *exaltatus* (Nuttall) Cronquist	20 VI 1984	Jackass Meadow, Sequoia Nat. Forest, Tulare Co.	1	1
Senecio douglasii var. *monoensis* (Greene) Jepson	29 IV 1984	Silurian Hills, San Bernardino Co.	5	4
Senecio serra Hooker	25 VII 1984	Rattlesnake Creek, Sequoia Nat. Forest, Tulare Co.	3	3
Haplopappus pinifolius Gray	16 X 1984	McCain Valley, San Diego Co.	2	1

includes California, Oregon, Washington, British Columbia, Yukon, Alaska, N.W. Territories, Montana, Idaho, Wyoming, Colorado, Nevada, Utah, Arizona, and New Mexico (Novak, 1974; Blanc, unpublished data).

Rearing records of *Paroxyna* from mature flower heads of native Asteraceae from central and southern California are given in Table 1. Plant nomenclature follows that of Munz and Keck (1959) and Munz (1974). Both *corpulenta* and *genalis* were reared from 14 of 16 flower head samples, which represents a lengthy series of pairings of synphagous, congeneric species only observed by RDG this once during 5 years of extensive rearings of flower heads. No other *Paroxyna* species were reared from these 16 samples, which represent mostly new, host-plant records for the redefined *P. genalis* (Wasbauer, 1972; Novak, 1974).

The authors conclude from the above morphological, distributional, and ecological data that *Paroxyna corpulenta* (Cresson) is a synonym of *P. genalis* (Thomson).

Two males and one female of *P. sabroskyi* Novak were reared by RDG from a quantity of flower heads of *Stephanomeria virgata* Bentham collected at Kennedy Meadows, Sequoia Nat. Forest, SE Tulare Co., on 3 VIII 1983. This represents the initial host-plant record for this species and the first record of its occurrence in California (Novak, 1974).

New host-plant rearing records according to Novak (1974) for the closely related tephritid *Dioxyna picciola* (Bigot), from mature, flower heads of four species of *Coreopsis* (Asteraceae) are as follows: three males and five females from *C. bigelovii* (Gray) Hall, Long Valley, Sequoia Nat. Forest, SE Tulare Co., 6 VI 1984; one male and four females from *C. douglasii* (de Candolle) Hall, 3.3 km S of 29 Palms, SW San Bernardino Co., 27 IV 1982; large, unrecorded number from *C. gigantea* (Kellogg) Hall, Ocean Beach, Santa Barbara Co., 18 IV 1980; 18 males and 18 females from *C. maritima* (Nuttall) Hooker, Point Loma, San Diego Co., 7 IV 1980.

Acknowledgment

Our thanks to A. C. Sanders, Herbarium Scientist, Department of Botany and Plant Sciences, University of California, Riverside, who identified most of the plant species mentioned in this publication.

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Biological Notes on *Nomia heteropoda* Say (Hymenoptera: Halictidae)[1]

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Abstract.—Nests of *Nomia heteropoda* Say are described and illustrated. Nests were constructed in sandy soil with short series of vertical cells (1–8) constructed in lateral branches off the main burrow. Soil depth where the first cells were found averaged 51.5 cm. No nest associates were found. Overwintering prepupae were reared to adults. A brief comparison of nesting habits of related species is included.

The largest species of North American Halictidae, *Nomia heteropoda* Say, is found throughout the southern part of the United States, with its distribution in the Mississippi Valley extending northward (Hurd et al., 1980). Because females prefer to nest in sand or sandy soil, populations are discontinuous throughout this range (Blair, 1935). Surprisingly, biological information on this large and showy species is scattered and scant. Most information is found in papers that deal either with the systematics of the group or with biologies of other species. For example, notes on nests discovered by Mickel and Dawson were recorded in Blair's (1935) systematic study. Cross and Bohart's (1960) description of a single nest of *N. heteropoda* is found in a study on the biology of *N. triangulifera* Vachal. A cell containing a pollen ball made by *N. heteropoda* was illustrated by Stephen, Bohart, and Torchio (1969). Hurd et al. (1980) listed unpublished references on the biology of this bee. The recent Hymenoptera Catalog (Krombein et al., 1979) listed host plants, but failed to cite any references about its nesting habits.

This paper presents additional observations on the nests, cells, and immature stages of *N. heteropoda* from a population nesting in sand dunes near Capital Reef National Monument in Utah.

NESTING SITE

A large aggregation of females (> 100) was found nesting in a sand dune formed on the hills above the west bank of Sandy Creek, 5200′, SSE Notom, Garfield Co., Utah on September 16, 1983. The nesting site was in a 2500-m^2 blowout on the southern slope of the dune. The nests were made in the bottom and along the margins where the sides sloped at a 45-degree angle. The nests were characterized and easily found by the large accumulation of sand surrounding the entrance. The general area had abundant flowering plants of *Helianthus petiolaris* Nutt. which both sexes of *Nomia* visited.

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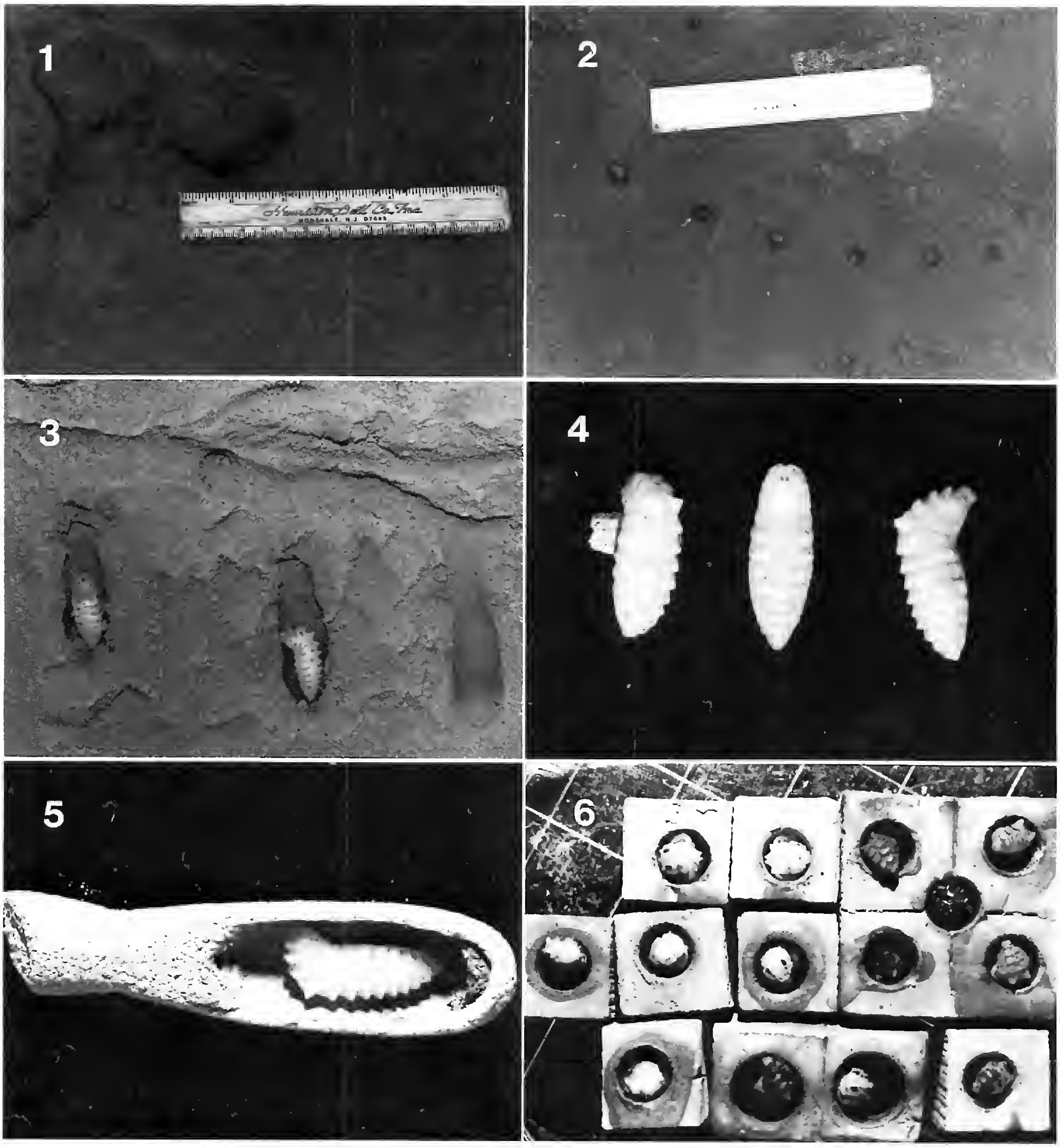
[1] Contribution from Utah Agricultural Experiment Station, Utah State University, Journal Paper No. 3129, and USDA-ARS-Bee Biology & Systematics Laboratory, Utah State University.



Figures 1–6. 1. Tumulus surrounding nest entrance. 2. Partially excavated cells made in a lateral branch as seen from above. 3. A 3-celled series illustrating nest architecture in lateral branches. The last cell is finished (waxed) but not provisioned. 4. Three views (dorsal, ventral, lateral) of overwintering prepupae. Note the characteristic and extended dorsal lobes. 5. A typical cell that was excavated, dried, and the loose sand removed. 6. Clay blocks with wax-lined holes used to rear *Nomia* larvae.

Nest Architecture

The entrance to each nest was surrounded by a large tumulus of sand. The tumuli varied in shape both because of the frequent winds in the area and the differences in ground slope. The tumuli were unusually large (about 10 cm wide by 5 cm high, Fig. 1) and visible from a considerable distance. Nest entrances were plugged when bees had ceased activities but were open when the bees were foraging. Often, nest entrances were at the side of the tumulus where a vestibular chamber was formed. These chambers appeared lined with some type of material because they held together when the tumulus was blown away. In some nests, however, the entrance was exposed when even this vestibular chamber had been erased by the wind.

The initial slope of the 11–12 mm wide burrow varied from 45 degrees to vertical. The lower portion of the burrow was vertical in all nests and extended to an average depth of 71.8 cm ($n = 4$). In two nests, the burrow ended in a small chamber where a dead female was found. The main shaft did not appear to have a lining, although it was smooth. Cells were constructed in lateral burrows at a 60-degree angle downward from the main burrow. The average depth when branching began was 51.5 cm ($n = 9$). The direction of these lateral burrows was variable and not influenced by compass direction. There were series of cells in each lateral burrow, and more than one lateral in two nests. The lateral burrows were separated by as much as 10 cm between branching points along the main tunnel.

The first cell in a lateral was 4.5 to 6 cm from the main burrow. Subsequent cells in a series were 3 to 8.5 cm apart ($n = 24$) and progressively deeper (Fig. 2). The number of cells in a lateral varied from 1–9 and averaged 3.6 ($n = 13$). Individual cells were large and ranged from 33 to 45 mm long and from 10 to 12 mm wide. The top of the cell was narrowed subapically and formed a slight neck (Fig. 3). At the time of excavation (in early November), most cells contained overwintering prepupae (Fig. 4), but details of construction were evident in a few incomplete cells. The basal portion of the finished cell was lined by a coating of wax that extended up the side for 12 to 15 mm. No pollen provisions were found during our excavations; however, Stephen et al. (1969) illustrated a pollen ball made by this bee.

Some cells were cut from the surrounding soil and taken to the laboratory for further study. After the sand had dried, it could be removed away from the cell walls by gently rubbing it between the fingers. The resulting cells were elongate (Fig. 5) and firm. Apparently, the female incorporated some type of material with the sand during construction. The cell walls averaged 1–2 mm thick. The cells were closed at the top by a plug of sand formed in a concentric circle with the center left open. Above this plug, the entrance to the cell was filled with sand (Fig. 3).

Larval feces at the bottom of the cells were deposited in short links that were stacked on one another in a pile several mm high (Fig. 5).

No nest associates were found in this study and none were observed when the nests were active. In some cells, spores of an unknown fungus were found on the lining of the cell walls.

Some overwintering larvae were kept at 3°C from November until June and then transferred to wax-lined clay blocks that were moistened and placed in petri dishes (Fig. 6) and incubated at 30°C. Several larvae transformed to the pupal stage and later both males and females emerged. These voucher specimens were deposited in the collection at this Laboratory.

DISCUSSION

The nesting biology and larval forms are similar to *N. triangulifera* (Cross and Bohart, 1960). The details of nest architecture were similar; for example, the arrangement of lateral burrows and placement of cells along the branches. More cells/laterals were found in nests of *N. triangulifera* than in nests of *N. heteropoda.*

Also, the short lateral pockets along the main shaft reported in *N. triangulifera* nests were not found in those of *N. heteropoda*. The pollen ball was similar in both species, but obviously that of *N. heteropoda* was much larger. The depth of the nests in this study were comparable, but other observers have reported *N. heteropoda* nests to be much deeper (Blair, 1935). Nest depth is likely influenced by soil moisture conditions and may be variable from site to site.

ACKNOWLEDGMENTS

We would like to thank P. Torchio of this laboratory for use of his technique for rearing the *Nomia* larvae. Our thanks to the following persons who offered helpful manuscript suggestions: N. Youssef (Utah State University), R. Rust (University of Nevada, Reno), and V. Tepedino (this laboratory).

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Tachysphex peruanus, a New Species Related to *Tachysphex galapagensis* Williams (Hymenoptera: Sphecidae)

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Abstract.—*Tachysphex peruanus,* previously unknown, is a sister species of *Tachysphex galapagensis* and occurs in the coastal area of Peru.

A species not included in my revision (Pulawski, 1974) of Neotropical *Tachysphex* was found in material recently received for study. Relevant information is presented below. I sincerely thank Mary Ann Tenorio for taking the SEM picture and for drawing the distributional map.

Tachysphex peruanus, NEW SPECIES

Name derivation.—Peruanus is a neo-Latin adjective derived from Peru, where the specimens have been collected.

Diagnosis.—Like other members of the *terminatus* species group, *peruanus* has a swelling behind each hindocellus combined with a flat, nonprominent labrum and punctate mesopleuron. Like *clarconis* W. Fox and *galapagensis* Williams, but unlike the remaining species of the group, the metapleuron of *peruanus* is simple (without carina or prominence in its upper part), and the metapleural flange is not expanded. Unlike all other species of the *terminatus* group, the clypeal lobe of the male is markedly angulate in *peruanus* (instead of truncate or arcuate), and the inner mandibular angle is simple (rather than dentate). Unlike *clarconis,* the vertex of *peruanus* is narrow (width to length ratio 1.3–1.4 in the female and 1.6–1.7 in the male instead of 1.9–2.2 and 2.1–2.6) and in the male the foretarsal rake is absent. Unlike *galapagensis,* the propodeal side is ridged in *peruanus* (nonridged or partly microridged in the former).

Description.—Mesopleural punctures more conspicuous posteriorly than in *galapagensis,* but less than in *clarconis.* Metapleural flange narrow. Upper metapleuron with a few simple, longitudinal ridges in front of propodeal spiracle, without prominence in its posterior part, without oblique carina beneath fore end of flange. Propodeum finely sculptured between dorsum and side, side ridged. Basal tooth of hindcoxa low, obtuse.

Vestiture partly obscuring integument between antennal socket and orbit. Setae length: on vertex about 1.5 times midocellar diameter in female and about 1.7 in male; about 1 midocellar diameter on scutum anterolaterally.

Head, thorax and legs black, except the following: mandible reddish yellow at about two-thirds of its length, and tarsal apex brown. Color of gaster variable,

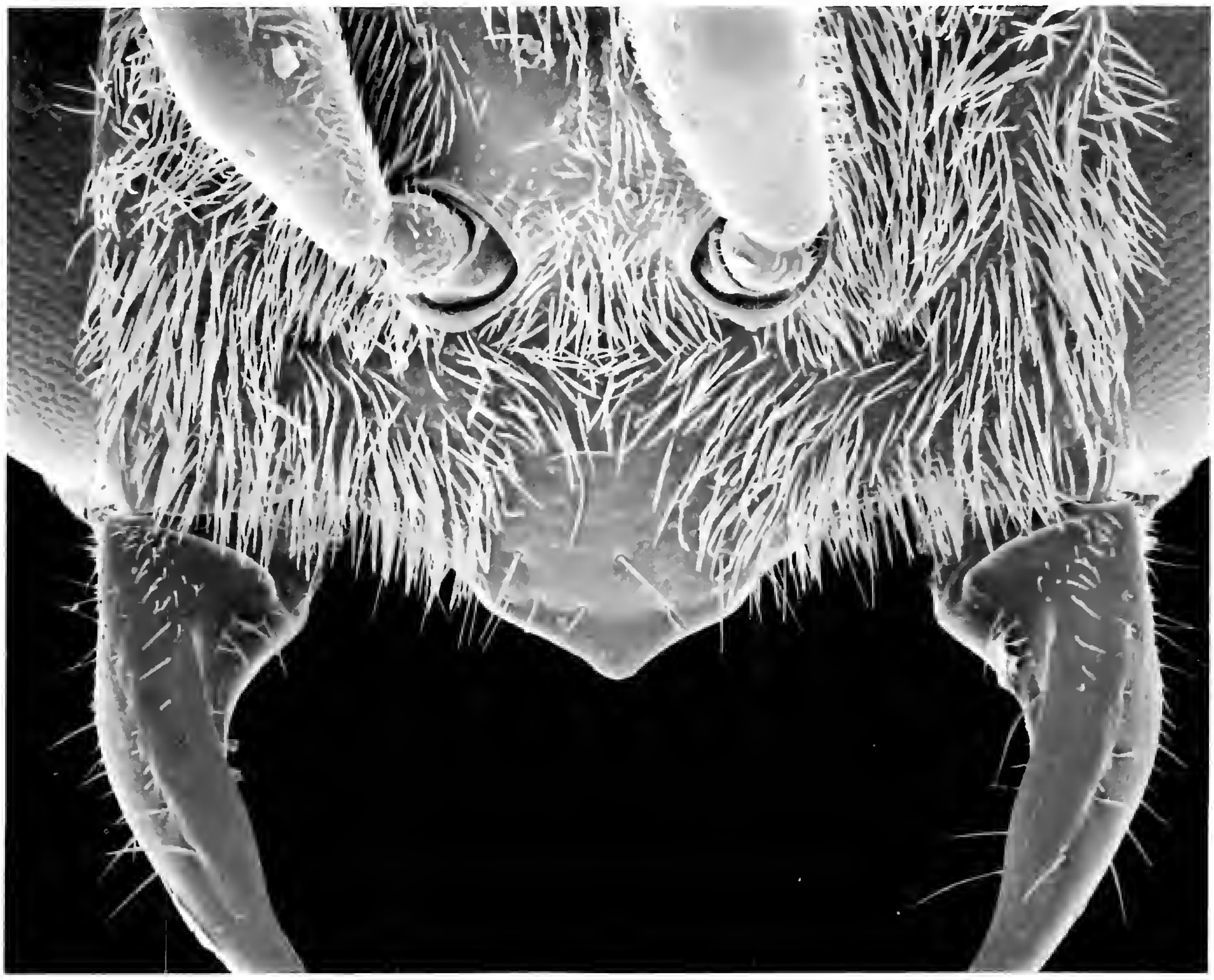

Figure 1. *Tachysphex peruanus* species nova—clypeus of male.

gastral terga I–IV fasciate apically (fascia of tergum IV less conspicuous than the remaining ones). Wings weakly infumate.

♀: Clypeus width 2.8 times its midlength; bevel poorly defined; lip arcuate or very obtusely angulate, without median projection. Dorsal length of flagellomere I 2.4–2.5 times its apical width. Frons dull, microsculptured between punctures. Vertex width 1.3–1.4 times its length. Length 7.3–9.8 mm. Gaster all red or with dark, irregular spots.

♂: Mandibular inner margin nondentate (Fig. 1). Clypeus width 2.8 times its width; lip angulate, with free margin concave on each side of apex (Fig. 1). Dorsal length of flagellomere I 1.3–1.5 times its apical width. Frons punctatorugose. Vertex width 1.6–1.7 times its length. Gastral sterna pubescent throughout. Forefemur notched. Foretarsomeres without preapical rake spines. Length 6.0–7.3 mm. Gaster differently colored in each specimen studied: all black, black basally (segments I–III) with the remaining segments red, and predominantly red (only segment I black).

Discussion.—The simple, unspecialized metapleuron of *clarconis, galapagensis,* and *peruanus* is a symplesiotypic character and therefore does not demonstrate close relationship. However, it does indicate that the three species are rather distinct from the remaining members of the group (in which the metapleuron is variously modified). Two derived characters are shared by *galapagensis* and *peruanus,* a narrow vertex and a reduced (some *galapagensis*) or absent foretarsal rake in the male, thus demonstrating their common origin. This is of great interest, since *peruanus* lives in an area from which ancestors of *galapagensis* most prob-

Figure 2. Geographic distribution of *Tachysphex galapagensis* Williams and *peruanus,* n. sp.

ably colonized the Galapagos Archipelago. However, each of the two species has at least one specialized character absent in the other (nonridged or barely ridged propodeal side in *galapagensis,* peculiar male clypeus and nondentate male mandible in *peruanus*), obviously precluding the latter from being the ancestor of the former. Clearly, the two are sister species, and must have evolved in parallel after their common ancestor colonized the Galapagos.

Geographic distribution (Fig. 2).—Coastal Peru, including foothills.

Material examined.—Holotype: ♀, Peru, Lambayeneque Province, Lambayeneque sand dunes, 2 Sep 1979, M. E. Irwin (1 ♂, University of California, Davis).

Paratypes (all from Peru): Lambayeneque Province: Same data as holotype (1 ♂, California Academy of Sciences; 1 ♂, University of California, Davis). Lima Province: Chosica, 2800 feet, 11 June 1914, H. S. Parish (1 ♂, Cornell University); Matucana, 17 May 1920, Cornell Univ. Expedition (1 ♀, Cornell University).

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Contents of a Nest of the Desert Ant, *Pheidole grallipes* Wheeler, in Baja California, México

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Abstract.—Nest contents of the desert ant, *Pheidole grallipes* Wheeler, sampled from a crack in granitic rock in the Central Desert of Baja California, México, were analyzed to inventory: number, weight, caste, and life stage of *P. grallipes*; number and kinds of associated arthropods; and composition of food items. Major workers, although they made up only 2% of the nest population, comprised 31% of the ants' biomass. Guests included Coleoptera (adults and larvae) and other arthropods. A variety of plant material was present, including leaves, stems, and flowers. A high number (250) of seeds of the California poppy, *Eschscholzia californica,* was found, as well as 54 fruits from the same species. Contents suggest that *P. grallipes* may be granivorous as well as entomophagus.

Resumen.—El contenido de un nido de la hormiga desierta, *Pheidole grallipes* Wheeler, se cató de una grieta en una roca de granito en el Desierto Central de Baja California, México, se analizeó para determinar estas cosas: el número, el peso, la casta, y las etapas de la vida de *P. grallipes*; el número y las clases de los arthópodos asociados; y la composición de los alimentos. Los trabajadores mayores, aunque solamente 2% de la populación del nido, comprendieron 31% de la biomasa de las hormigas. Los convidados incluyeron Coleóptero (las adultos y las larvas) y otros arthópodos. Una variedad de material de plantas estaba presente incluyente las hojas, los tallos y las floras. Pasmosamente, un número elevado de *Eschscholzia californica* (la semilla) se encontró y también las frutas de la misma especie. El contenido sugere qué *P. grallipes* sea granívoro y también entomófago.

Nest contents of the desert ant, *Pheidole grallipes* Wheeler, were sampled from a granitic crevice in the Central Desert of Baja California, México, by Clark and Blom, 11 April 1978, to determine the food items and myrmecophiles. The collection was made 9 km NW Rancho Santa Inés, a midpeninsular location (Lat. 28°46'N, Long. 114°46'W, Elevation 550 m). The area is a boulder field with sandy soil and scattered vegetation. Average precipitation is 85–100 mm and average temperatures for January are 10–18°C and for July and August 20–29°C

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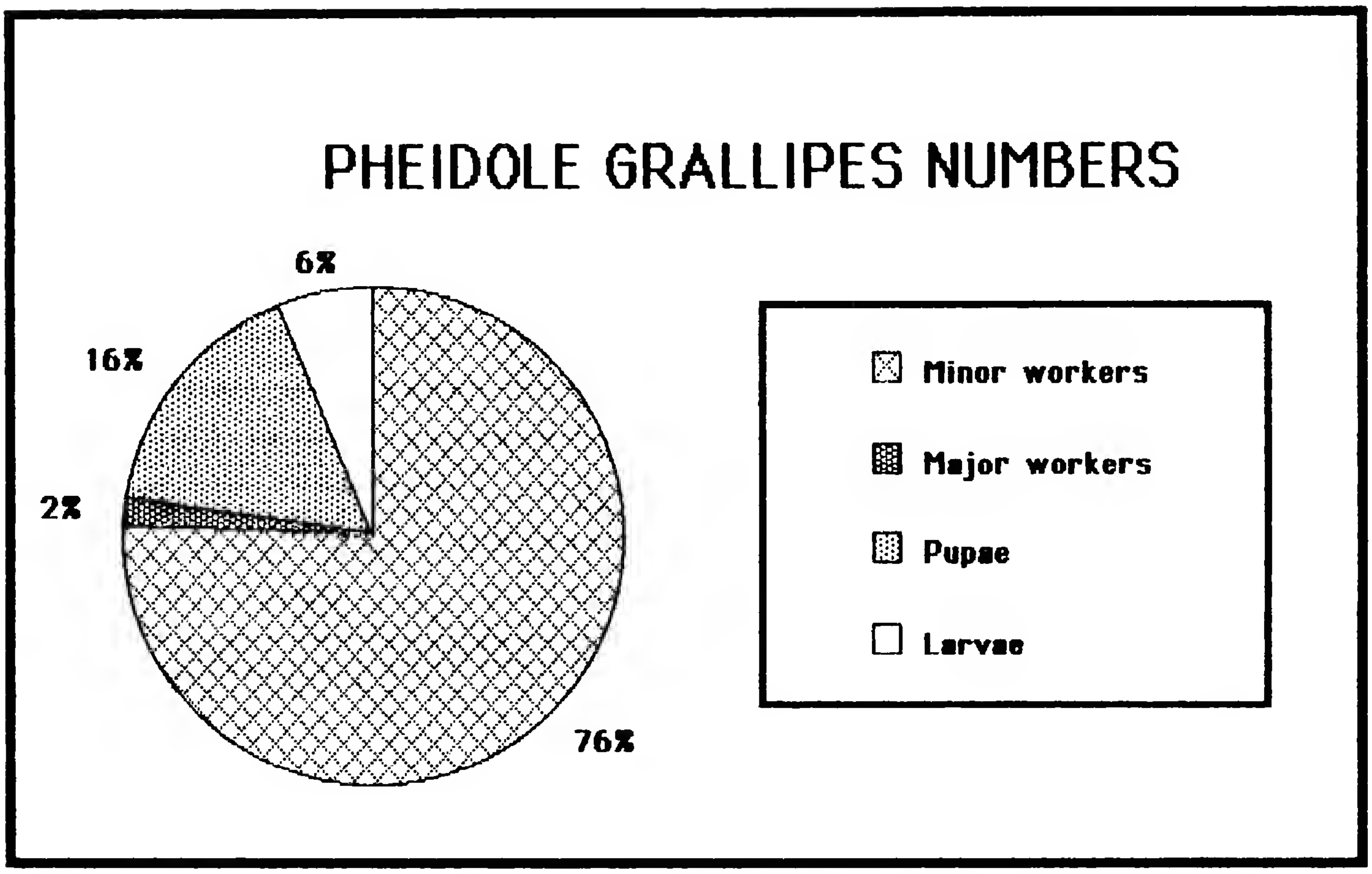

Figure 1. Distribution of stages and castes of *Pheidole grallipes* from a nest in the Santa Inés area, Baja California, México, 11 April 1978.

(Hastings and Humphrey, 1969). Dominating the landscape are granite boulders, the boojum, barrel and cardon cactus. For more detailed description see Blom and Clark (1980, 1984). The *P. grallipes* nest was extracted from a crack, 50 cm in depth and 30 cm in length. Field observations recorded the presence of several species of live arthropods in the nest in addition to the ants.

Materials and Methods

Using hand tools the rock crack was split apart as far as possible. All ants and other live arthropods encountered were collected to alcohol with aspirators and forceps. Dry contents were sampled with plastic vials and stored for later sorting.

The ants were inventoried to determine the number of minor, callow minor, and major workers; pupae; and larvae within that sample. Weights for each category were measured with a Sartorius analytical balance.

Results and Discussion

The nest was in a rock crack which when excavated was found to be 50 cm deep and 30 cm long. Other nests of *P. grallipes* at this site also appear to be associated with rock cracks. Mallis (1941) reported a nest of the species located in sandy soil at the base of a shrub in southern California.

Minor workers far outnumbered major workers. There were 568 minors, 37 callow minors (for a total of 605 minor workers, 76%), compared to 16 majors (2%), 123 pupae (16%), and 49 larvae (6%) (Fig. 1).

While major workers comprised only 2% of the nest's ant population, their weight (mean 22 mg) comprised 31% of the ants' biomass; and minor workers (less callows), with 5% of the ant biomass (mean = 1.0 mg), totaled 71% of the

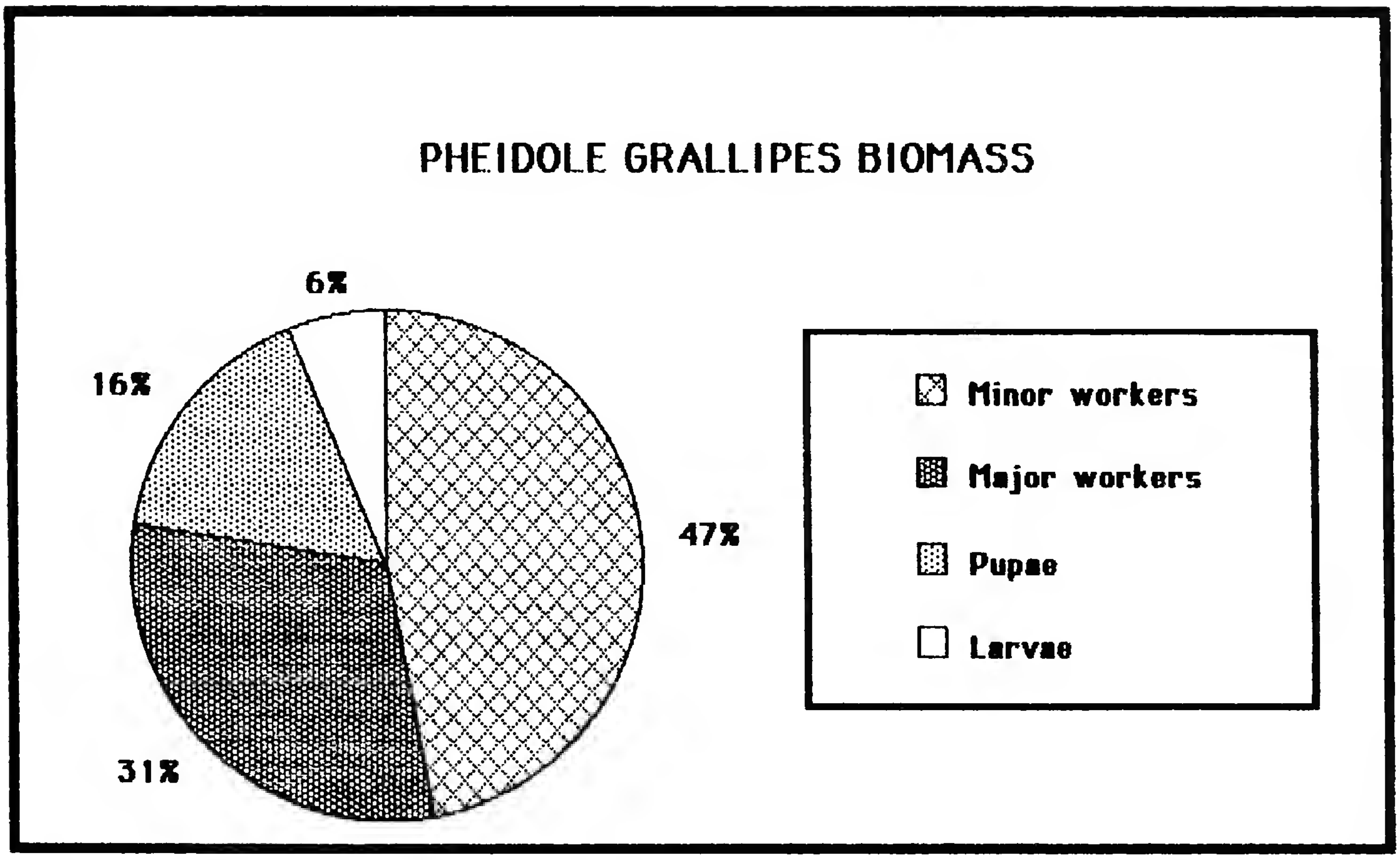

Figure 2. Distribution of biomass within the stages and castes of *Pheidole grallipes* from a nest in the Santa Inés area, Baja California, México, 11 April 1978.

nest's ant population. Callow workers (mean = 1.0 mg) formed 3% of the biomass, while pupae and larvae were collectively 15%. The function of the major workers is unknown, but it must be important for the colony to have such an energy investment. Usually only the minor workers are observed foraging.

Myrmecophiles included the following Tenebrionidae: *Conibius opacus* (LeConte) (7); *Araeoschizus* sp. (prob. *antennatus*) (2), and *Argoporis a. apicalis* Blaisdell (3), and 11 larvae. *Araeoschizus* sp. has also been reported as a guest of this ant in southern California (Wheeler and Wheeler, 1973). Papp (1981) reported *Araeoschizus antennatus* Blaisdell from one of our non-ant associated collections at this locality. One scorpion (*Vejovis* sp.) was also found in the rock crack. Its relationship with the ants is unknown.

Animal material consisted mainly of exoskeletons of Coleoptera, Tenebrionidae; Diptera; and Hymenoptera, Formicidae. Most ant fragments were of *P. grallipes* individuals and probably do not represent food items. Tenebrionidae and other Coleoptera comprise the largest portion of this component, though it is difficult to say how much of this can be considered food.

There was a variety of vegetative material in the nest. Leaves, stems and flower parts were found. It is always possible for material of this sort to be carried into the nest by the ants for purposes other than food, or for its deposition by wind; however, the accumulation of 250 seeds of the California poppy, *Eschscholzia californica* Cham., and 54 of its fruits seemed more than accidental. *E. californica* var. *peninsularis* (Green) Munz is known from the Cataviña area (Santa Inés area) in the Central Desert (Wiggins, 1980). The seeds are small and round. Among other materials were 8 seeds of a leguminous species.

Other ants nesting in the immediate vicinity include a new species of *Pheidole* (10 m distant), *Pheidole yaqui* Creighton and Gregg (12 m), *Crematogaster depilis*

(15 m), and *Pogonomyrmex tenuispina* Forel (16 m) (Blom and Clark, 1980). Of these species all but *Crematogaster depilis* are known seed harvesters. *C. depilis* gathers extrafloral nectar (Blom and Clark, 1980).

Pheidole grallipes is a species thought to be exclusively entomophagus (Pullen, 1961), though Blom and Clark (1980) have since recorded it as a frequent visitor to the extrafloral nectaries of the barrel cactus, *Ferocactus gracilis* Gates. No previous evidence has established *P. grallipes* as a seed foraging species, though the genus is considered granivorous (Wheeler and Wheeler, 1973; and others). With examination of these nest contents it appears *P. grallipes* may be a diversified feeder utilizing both animal and plant (seed and nectar) resources.

ACKNOWLEDGMENTS

Mary and Ellen Clark assisted with the field work. Dr. C. A. Triplehorn provided the Tenebrionidae identifications, C. S. Papp an identification of *Araeoschizus* from the site, and D. R. Frohlich the scorpion identification. I. L. Wiggins identified the plant seeds. We thank Susan Lowman and Mary Clark for review of the manuscript and other assistance during this report.

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Are Mutillids Scarce? (Hymenoptera: Mutillidae)

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Mutillid wasps are familiar, often brightly colored species that may be seen rapidly running across open or sandy areas. Yet mutillid wasps are rarely observed in large numbers; rather, collectors usually find isolated individuals or small numbers in any given habitat. In the western part of the U.S., mutillids are rarely observed in large numbers. The general acknowledgment that mutillids exist in low population densities is so accepted that the rare occurrences of large numbers of individuals in an area are given special note (Manley and Taber, 1978; Schmidt and Hook, 1979).

The question arises: because many brightly colored mutillid species are readily, yet infrequently, seen, can we safely assume their population densities are low? Our present observations indicate that mutillid wasps may not be as scarce as generally believed.

In the course of ecological and population studies of the bee *Diadasia rinconis rinconis* Cockerell (Anthophoridae) 90 × 90 cm emergence traps were placed April 13, 1985 over a nesting aggregation located northwest of Tucson, Arizona. The traps were monitored until May 14 for emergence of hosts and parasites (13 *D. rinconis,* 5 Bombyliidae, 3 *Anthidium* bees [Megachilidae], and 1 rhipiphorid beetle were trapped) and then left until August 6, 1985. At that date the three traps contained the following mutillid wasps: trap 1, 77 male *Dasymutilla foxi* (Cockerell); trap 2, 6 male and 1 female *D. foxi*; trap 3, 8 male *D. foxi* and 1 male *D. vestita* (Lepeletier). These findings confirm that *D. rinconis* is a host of *D. foxi* and suggest it is a possible host of *D. vestita* (see Krombein et al., 1979 for host records).

Based on these three traps we can estimate the numbers of parasitic mutillids produced by this nesting aggregation of *D. rinconis.* The traps catch at most only one-half of the mutillid wasps produced—the males (92 males to 1 female caught). The apterous, fossorial females appear to crawl or dig under the trap rims and escape. Thus, 2.4 m^2 of this cactus bee nesting aggregation produced approximately 184 mutillids, or 76 individuals per m^2. The average nesting density of this *D. rinconis* nesting aggregation is estimated to be approximately 25 nests/m^2 (Buchmann, unpubl.) and based on an average of 7.0 cells/nest (E. Ordway, unpubl.) we estimate a cell density of 175/m^2. The nesting aggregation covered an estimated 446 m^2 and therefore produced approximately 78,000 cells. If our survey was representative, 34,000, or 43%, of these cells were parasitized by mutillid wasps.

The above figures are remarkable not only because of their magnitude, but also because in six years of investigating *D. rinconis* we have never seen a *D. foxi* in a nesting aggregation. *D. foxi* is not rare by comparison with other Mutillidae and was at least once recorded in large numbers (Manley and Taber, 1978). This suggests either the species is active at times other than when we are present, or that a vast percentage of the population simply is behaviorally cryptic. We suggest that both factors are probably involved, but that the second is more important than might be anticipated.

Supportive evidence that mutillid wasp populations may be higher than generally perceived comes from ultraviolet (u.v.) light trap data. Neither male nor female individuals of nocturnal mutillid species are captured by routine collecting activities such as searching ground and soil litter, and turning over rocks. Moreover, nocturnal seaching with head lamps almost never results in finding female nocturnal Mutillidae. However, in spite of their apparent rarity by these collecting methods, male nocturnal mutillids are exceedingly abundant at u.v. lights. Based on our preliminary emergence trap data and on u.v. light observations we suggest that mutillid populations are likely much higher than usually believed and that these species are highly successful and ecologically important parasites of many species of Hymenoptera.

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Designation of Chrysidid Lectotypes

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Abstract.—Lectotypes are designated from syntype series for 98 species of Chrysididae from the Palearctic, Neotropical and Ethiopian regions.

The Chrysididae comprises approximately 4000 species. Many of these species are based on syntype series. Because of the possibility of a syntype series containing individuals of more than one species or even genera, lectotypes need to be designated to prevent confusion. In preparation of a world revision of the Chrysididae with R. M. Bohart it has become necessary to designate lectotypes before the final revision is completed.

Type material was examined from the following institutions and individuals: BUDAPEST—Zoological Department, Hungarian Natural History Museum, Budapest (L. Zombori, J. Papp); CAPETOWN—Department of Entomology, South African Museum, Capetown (V. Whitehead); LENINGRAD—Zoological Institute, Academy of Sciences, Leningrad, USSR (V. A. Trajpitzyn, Y. A. Pesenko, E. Budrys); LONDON—Department of Entomology, British Museum (Natural History), London (M. C. Day, C. Vardy); OXFORD—Hope Entomological Collections, Oxford University Museum, England (C. O'Toole); PARIS—Museum National d'Histoire Naturalle, Laboratoire d'Entomologie, Paris, France (M. Kelner Pillault); PRETORIA—Department of Entomology, Transvaal Museum, Pretoria, South Africa (R. Toms, M. C. Scoble), and VIENNA—Zweite Zoologische Abteilung, Naturhistorisches Museum, Vienna, Austria (M. Fischer).

The following list of types is organized alphabetically by genus. The type repository is indicated in parentheses, followed by the correct genus if that name differs from that of the original description.

Acrotoma arnoldi Edney, 1940:51. Lectotype male; Southwest Africa: Okahandja, #13.177 (LONDON). =*Hedychridium*

Acrotoma discrepans Edney, 1940:54. Lectotype male; South Africa: Cape Prov., Matjesfontein, #13.179a (LONDON). =*Hedychridium*

Acrotoma discrepans candida Edney, 1940:56. Lectotype male; Southwest Africa: Aus, #13.178a (LONDON). =*Hedychridium*

Actineuchrum soloriens Semenov, 1954:144. Lectotype male; USSR: Turkmenia, Imam-Baba (LENINGRAD). =*Hedychridium*

Amisega aeniceps Ducke, 1903:130. Lectotype male; Brazil: Itatuba (PARIS).

Chrysidea dido Zimmermann, 1956:149. Lectotype female; Madagascar: Bekily, II–III/1940, A. Seyrig (Seyrig Coll., PARIS).

Chrysis aurotecta Abeille, 1878:3. Lectotype female; Sardinia (Abeille Coll., box IV, PARIS).

Chrysis chevrieri Abeille, 1877:67. Lectotype female; no data on specimen ("nos environs" given in text) (Abeille Coll., box IV, PARIS).

Chrysis dallatorreana Mocsary, 1896:2. Lectotype female; "Hongrie" (Buysson Coll., box 22, PARIS). =*Spinolia*

Chrysis fervida Fabricius, 1781:456. Lectotype female; "Env. de Paris," coll. Lepeletier (Buysson Coll., box 11, PARIS). =*Holopyga*

Chrysis fugax Abeille, 1878:5. Lectotype sex ? (no abdomen); no data ("Lorgues" given in text) (Abeille Coll., box II, PARIS).

Chrysis gemma Abeille, 1878:3. Lectotype male; Meudon (Abeille Coll., box IV, PARIS).

Chrysis hydropica Abeille, 1878:4. Lectotype male; La Seyne (Abeille Coll., box II, PARIS).

Chrysis insignis Lucas, 1849:307. Lectotype female; "Algerie: La Calle" (Buysson Coll., box 22, PARIS). =*Spinolia*

Chrysis lais Abeille, 1877:66. Lectotype male; no data ("Lorgues" given in text) (Abeille Coll., box III, PARIS).

Chrysis mulsanti Abeille, 1878:3. Lectotype male; Montpellier (Abeille Coll., box II, PARIS). =*Chrysura*

Chrysis rugulosa Mocsary, 1909:8. Lectotype male; Turkey: Karatangebirge bei Djulek (BUDAPEST). =*Euchroeus*

Chrysis spinifer Abeille, 1878:5. Lectotype female; Montpellier (Abeille Coll., box V, PARIS).

Chrysis varidens Abeille, 1878:6. Lectotype female; Montpellier (Abeille Coll., Box III, PARIS).

Chrysis viridula fenestrata Abeille, 1877:67. Lectotype male; no data ("nos environs" given in text) (Abeille Coll., box IV, PARIS).

Cleptes abeillei Buysson, 1887:6. Lectotype male; Allier (Buysson Coll., box 2, PARIS).

Cleptes afra Lucas, 1849:315. Lectotype female; Algeria: Oran (Buysson Coll., box 2, PARIS).

Cleptes anceyi Buysson, 1891:74. Lectotype male; Algeria: Tlemcen, May '88 (Buysson Coll., box 2, PARIS).

Cleptes aurora F. Smith, 1874:452. Lectotype female; Brazil: Ega, #13.3 (LONDON). =*Cleptidea*

Cyrteuchridium breviceps Semenov. *In* Semenov and Nikoskaya, 1954:101. Lectotype female; Armenia: Darschichag (LENINGRAD). =*Hedychridium*

Cyrteuchridium cyanellum Semenov and Nikolskaya, 1954:101. Lectotype female; USSR: Tadzhikistan, Shurobad (LENINGRAD). =*Hedychridium*

Cyrteuchridium fulvago Semenov and Nikolskaya, 1954:102. Lectotype female; USSR: Tadzhikistan, Stalinabad (LENINGRAD). =*Hedychridium*

Ellampus auratus trianulifer Abeille, 1877:65. Lectotype female; St. Baume (Abeille Coll., box I, PARIS). =*Omalus*

Ellampus conifer Semenov, 1932:24. Lectotype male; USSR: Shipovo (LENINGRAD). =*Omalus*

Ellampus gussakovskii Semenov and Nikolskaya, 1954:95. Lectotype female; USSR: Tadzhikistan, Kondara (LENINGRAD). =*Omalus*

Ellampus hirsutus Semenov, 1932:29. Lectotype male; USSR: Turkestan, Fergana, Chedzu-tshiburgan (LENINGRAD). =*Omalus*

Ellampus hirtus Semenov, 1932:28. Lectotype female (not male); USSR: Turkestan, Alatau Talassicum Mnts. (LENINGRAD). =*Omalus*

Ellampus kuznetzovi Semenov, 1932:25. Lectotype male; USSR: Transcaucasia, Kodzhory Prov., Tiflisensis (LENINGRAD). =*Omalus*

Ellampus margianus Semenov, 1932:15. Lectotype female; USSR: Turkmenia, Imam-Baba Dist., Mervensis (LENINGRAD). =*Omalus*

Ellampus nikolskii Semenov, 1932:30. Lectotype male; USSR: Bucharia orientalis, Roshan, Kalai-vamar (LENINGRAD). =*Omalus*

Ellampus olgae Semenov, 1891:383. Lectotype female; central Russia (LENINGRAD). =*Elampus*

Ellampus potanini Semenov, 1932:11. Lectotype male; China: Setschuan Prov., Sjao-tzhin-cho (LENINGRAD).

Ellampus ruthenus Semenov, 1932:39. Lectotype male; USSR: Shipovo (LENINGRAD). =*Omalus*

Ellampus scrutator Semenov and Nikolskaya, 1954:94. Lectotype female; USSR: Tadzhikistan, Kondara (LENINGRAD). =*Omalus*

Ellampus sculpticollis Abeille, 1878:2. Lectotype male; "Mlle" ("nos environs" given in text) (Abeille Coll., box I, PARIS). =*Omalus*

Ellampus shokalskii Semenov, 1932:24. Lectotype male; Mongolia: Urga (LENINGRAD). =*Omalus*

Ellampus smaragdulus Semenov, 1932:37. Lectotype female; USSR: Turkestan, Maracandica Prov., Samarkand (LENINGRAD). =*Omalus*

Ellampus speculifer Semenov, 1932:18. Lectotype male; USSR: Bucharia Merid., Termez, Oxum (LENINGRAD). =*Omalus*

Ellampus stella Semenov and Nikolskaya, 1954:93. Lectotype female; USSR: Tadzhikistan, Stalinabad (LENINGRAD). =*Omalus*

Ellampus subopacus Semenov and Nikolskaya, 1954:95. Lectotype female; USSR: Tadzhikistan, Kondara (LENINGRAD). =*Omalus*

Ellampus tarnanii Semenov, 1920:40. Lectotype male; Bucharia australis: Termez, Oxum (Amu-darj'ja) (LENINGRAD). =*Omalus*

Ellampus timidus Nurse, 1902:305. Lectotype male; Peshin, #13.10a (LONDON). =*Omalus*

Euchroeides oblatus Nurse, 1904:23. Lectotype male; Quetta, #13.161b (LONDON). =*Spinolia*

Euchroeus purpuratus orientis Semenov, 1910 (1909):214. Lectotype female; "Dzhungaria chinens. orient.": Hami (LENINGRAD).

Hedychridium aegyptiacum Buysson, 1898:126. Lectotype female; Egypt: Koubbeh (Buysson Coll., box 13, PARIS).

Hedychridium alpestre Semenov, 1954:100. Lectotype male; USSR: Tadzhikistan, Kok-kyu (LENINGRAD).

Hedychridium bergi Semenov, 1954:98. Lectotype female; USSR: Tadzhikistan, Peter the Great Range (LENINGRAD).

Hedychridium capensis Mocsary, 1889:136. Lectotype female; "Le Cap" (Buysson Coll., box 15, PARIS).

Hedychridium coloratum Edney, 1940:74. Lectotype male; South Africa: Cape Prov., Matjesfontein, #13.175b (LONDON).

Hedychridium elegantulum Buysson, 1887:173. Lectotype female; Gallia: Meridion (Buysson Coll., box 13, PARIS).

Hedychridium latifrons Edney, 1940:72. Lectotype female; South Africa: Cape Prov., Somerset East, #13.173a (LONDON).

Hedychridium malagassum Buysson, 1910:124. Lectotype male; Madagascar (Buysson Coll., box 16, PARIS).

Hedychridium minutum homeopathicum Abeille, 1878:3. Lectotype male; no data on specimen (Abeille Coll., box II, PARIS).

Hedychridium minutum infans Abeille, 1879:3. Lectotype male; no data on specimen (Abeille Coll., box II, PARIS).

Hedychridium perversum Nurse, 1902:306. Lectotype male; Peshin, #4.02 (LONDON).

Hedychridium planifrons Buysson, 1900:129. Lectotype male: Egypt: Heloun, M. Pic (Buysson Coll., box 15, PARIS).

Hedychridium rhodinum Semenov and Nikolskaya, 1954:99. Lectotype male (not female); USSR: Tadzhikistan, Ruidasht (LENINGRAD).

Hedychridium scintilla Semenov, 1954:96. Lectotype female; USSR: Kazakhstan, Peter the Great Range (LENINGRAD).

Hedychridium wroughtoni Buysson, 1896:466. Lectotype female; "Prov. centralis, Inde ciriglaise" (Buysson Coll., box 16, PARIS).

Hedychrum chloroidea Dahlbom, 1854:66. Lectotype female; "Env. de Paris," Lepeletier Coll. (Buysson Coll., box 11, PARIS). =*Holopyga*

Hedychrum jacobsoni Semenov, 1954:109. Lectotype female; USSR: Tadzhikistan, Balamurun, Karatau foothills (LENINGRAD).

Hedychrum katbergense Edney, 1940:116. Lectotype male; South Africa: Cape Prov., Katberg, #13.40 (given as holotype) (LONDON).

Hedychrum longicolle Abeille, 1877:65. Lectotype female; Toulon (Abeille Coll., box I, PARIS).

Hedychrum micans Lucas, 1849:313. Lectotype; Algeria: La Calle (Buysson Coll., box 17, PARIS).

Hedychrum minutum Lepeletier, 1806:122. Lectotype female; Soissons (Buysson Coll., box 16, PARIS). =*Hedychridium*

Hedychrum nigrocyaneum Edney, 1940:98. Lectotype male; South Africa: Cape Prov., Ceres, #13.46a (LONDON).

Hedychrum nigromaculatum Edney, 1940:108. Lectotype female; South Africa: Cape Prov., Katberg, #13.45 (LONDON.

Hedychrum penultimum Edney, 1940:110. Lectotype male (given as holotype); South Africa: Cape Prov., Mossel Bay (LONDON).

Hedychrum rubrum Edney, 1940:97. Lectotype female; South Africa: Belmont, #13.170b (LONDON).

Hedychrum stilboides Walker, 1871:9. Lectotype male; Egypt, #79.22 (no BM type #) (LONDON).

Holopyga capensis Edney, 1940:44. Lectotype male; South Africa: Cape Prov., Bloukrans, near Calvinia, #13.18a (LONDON).

Holopyga crassepuncta Semenov, 1954:110. Lectotype female; USSR: Tadzhikistan, Balamurun, Karatau foothills (LENINGRAD).

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New Record and First Observations of Adult Flight Activity for *Deuterophlebia coloradensis* Pennak (Diptera: Deuterophlebiidae) in Idaho[1]

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Abstract.—Adults and immature stages of the mountain midge *Deuterophlebia coloradensis* Pennak were collected from a small river in northern Idaho, and represent the first records for this family from the state. The adult emergence of this species was observed over two-week periods in 1984 and 1985. Flight activity lasted for 25–45 min beginning about 8:30 AM PST. Differences were noted in sex ratios of netted adults between 1984 and 1985, with females outnumbering males in the latter portion of the first year and males outnumbering females in the second. However, the pupal sex ratio monitored during the adult emergence indicated that the overall sex ratio was near 1:1. Observations of the adult emergence and flight activity are the first reported for this species.

The present distribution of *Deuterophlebia coloradensis* Pennak extends throughout the Rocky Mountain system as first suggested by Pennak (1951), and now includes Colorado, Wyoming, Utah, Alberta and perhaps Oregon. This paper is the first record of this species from Idaho.

We undertook this study in order to learn more about the biology and adult habits of this poorly known midge. All life stages for the species involved in this study were collected. The species was identified initially as *D. coloradensis* primarily from pupae gathered at the study site and keyed in Kennedy (1960). Adult males collected subsequently compared well with features used by Kennedy (1958) to distinguish this species. Identity of adults and immatures was confirmed by G. Courtney, University of Alberta, Edmonton.

MATERIALS AND METHODS

We used several methods to sample the different life stages. Larvae and pupae were found by searching surfaces of submerged rocks. Drift nets trapped adults rising from the substrate and those dropping into the water. Empty pupal skins or those with partially-emerged adults also occurred in these drift samples. Most adults were captured on the wing using 30 cm aerial nets; additional imagos were found in spider webs, on riparian vegetation, and on ephemeral rain puddles in nearby roadways.

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All field studies on *D. coloradensis* were conducted during May, June and July in 1984, and May and June in 1985, along a stretch of the Potlatch River, ca. 5 km S Helmer (Latah County), Idaho (Fig. 1). This area can be characterized as mixed conifer forest with Douglas fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and grand fir (*Abies grandis*) as dominant trees. Snowberry (*Symphoricarpos albus*), serviceberry (*Amelanchier alnifolia*), wild rose (*Rosa* sp.) and willows (*Salix* spp.) are the primary understory plants. Additional visits to the study site were made on July 13 and November 1, 1984, and March 10, 1985, but no midges in any stage of development were found. During late summer and fall the stream flow is greatly reduced exposing many large rocks. At this time submerged rocks are typically covered by a thick coating of algae and trapped sediments.

Observations were made at several riffle areas located ca. 0.8 km upstream and downstream of the Little Boulder Campground. Elevation at the study site was 800–815 m. At this point the river is 10–15 m wide, 30–60 cm deep and flows along a shallow gradient at a velocity of 0.65 to 1.1 m/sec. The substrate was primarily small boulder and cobble of black basalt with some quartz and granite. Areas of gravel, mud and sand bars are common, especially along the banks. Additional riffle areas occur both above and below the primary study sites.

River conditions vary considerably from spring to summer. In early May of 1984, when most larvae were found, the river was cooler and ran higher due to snow melt further upstream. Water covered all rocks except those at the margins. By June the water level had dropped so that many of the larger rocks were partially exposed or remained covered by only a few cm of water, unless rains swelled the river to near May levels. We estimated that the river conditions in 1985 were advanced 3 weeks for the same interval in 1984. This accelerated season was due to a smaller snowpack and unseasonably warm, dry spring weather.

Sex ratios were analyzed using a Chi-square test. Ratios given in the following text should read males : females.

RESULTS

1984

Larvae of *D. coloradensis* were first discovered on May 5. All larvae were closely associated with upper and lateral surfaces of submerged rocks which were without apparent algal growth and in water 30–50 cm deep. The larvae were found only in riffles at midstream; none were on rocks in slower water near the river margins. About 30 larvae of various sizes and 2 male pupae were collected. No additional pupae could be located.

Other immature aquatic insects found in this same riffle habitat included: *Leucotrichia* and *Ochrotrichia* spp. (Trichoptera: Hydroptilidae), *Agathon elegantulus* von Roder (Diptera: Blephariceridae), *Maruina* sp. (Diptera: Psychodidae), *Antocha* sp. (Diptera: Tipulidae), and *Parargyractis* sp. (Lepidoptera: Pyralidae).

On June 3, additional *D. coloradensis* immatures were collected. Later larval instars and pupae replaced many of the smaller larvae seen earlier. The pupae were tucked into small, shallow depressions and cracks on the upper and lateral surfaces of the rocks. From the sample of pupae collected, the sex ratio (19:16) was not significantly different from 1:1 ($P > 0.5$). Several pupal cases were empty but otherwise intact suggesting that adults had recently emerged. All larvae and

Figure 1. Typical riffle area habitat of *Deuterophlebia coloradensis* on the Potlatch River during May 1985.

pupae were located beneath the water line and none were found on exposed surfaces or within the splash zone.

Flights of adult *D. coloradensis* were first observed on the morning of June 11. Additional adults were seen on subsequent visits to the study area on June 13, 15 and 24. No larvae or adults and only one fragmented pupal case were found on July 13. Adult flight was limited to ca. 30 min periods between 8:30–9:00 AM PST on each of the mornings except the last (June 24) when adults were present from 8:05–8:30 AM PST.

The adults, although small, were recognizable by the characteristic blue gray color of their wings when contrasted against the background of the darkened opposite shore and early morning shadows. The color is accentuated further by sunlight reflected from the wings as the midges moved from shaded areas into full sunlight. This reflective property of the wings made identification at a distance possible, even when the adults moved among other flying insects (e.g., chironomids and hydroptilid caddisflies).

Individual adults seemed to emerge directly from the water and fly upward at a steep angle with little or no pause at the surface. None were observed clinging to rocks before or during the emergence period. Once airborne, their movement was primarily upstream and along the water course at midstream. Few adults flew over the stream margins and fewer still along the adjacent bank. Individual flight was erratic, although adults were readily netted when the collector stood at midstream. Once within the net, the midges either clung to the side in the position described by Kennedy (1958), or pushed off and fluttered about the confined space.

Flight of the delicate adults was dictated by almost any perceptible air movement. On June 11, flight was especially heavy with hundreds of individuals on the wing at once. The regular upstream flight pattern was periodically interrupted by a shifting breeze up to ca. 5 km/hr which concentrated and propelled the midges before it, either upstream or downstream. In lulls between gusts, some upstream movement continued, but the midges would appear again in numbers as wind velocity increased. Many individuals were easily captured by holding the net into the wind.

Equitability in the sex ratio was found for the total specimens taken on June 11 (25:23) and 13 (8:6) ($P > 0.75$), but the ratio shifted and females increasingly outnumbered males on subsequent days (June 15 and 24) to 9:24 and 1:24 ($P > 0.05$), respectively. On the first morning air movement wafted most midges into our nets held at all levels from the water surface up to 3 m. On the last 3 days wind velocities were reduced and flight of the midges was straight or slightly coursing but at eye level (ca. 2 m) and not much above. None were seen to dip down and touch or land on the water surface. Attempts to identify and collect males from these flights, especially on the latter 2 days (June 15 and 24), were singularly unsuccessful and only females were netted.

Following each flight period, dead and dying adults were sought on objects or vegetation in the area immediately adjacent to the river. Fourteen intact midges were picked from spider webs on June 10, the day before the flight of adults was first observed. Three males were in webs attached to vegetation just above (ca. 15 cm) the water's edge and 11 (10 males, 1 female) in webs higher (ca. 1.5 m) on shrubs overhanging the river. One additional female was swept from a grassy bank flanking the riffle area. On June 11, 8 males were recovered from the surface of small rain puddles in a dirt roadway that paralleled the river. All puddles were separated from the river by a moderately high (2.5–3 m) barrier of shrubs including *Salix, Amelanchier,* and *Symphoricarpos.*

Potential predators of *Deuterophlebia,* besides spiders, included predaceous flies, especially species of dance flies (Diptera: Empididae). Several species of dance flies were active during the time the deuterophlebiids were in flight. Two small species each of *Hilara* and *Rhamphomyia* (*R.* [*Megacyttarus*] *anthracodes* Coquillett and *R.* [*M.*] sp. nr. *scaurissima*) were observed skimming the water surface apparently hunting prey. *R.* (*M.*) *disparilis* (Coquillett), a larger species, was seen swarming at a height of 2.5 m above the water. Although none of the empidids was carrying prey when netted, all can be considered possible predators of emerging deuterophlebiids, especially the smaller empidid species active at the surface. Predation on newly emerged black flies (Simuliidae) and mosquitoes (Culicidae) by empidids has been reported by several workers (Frohne, 1952; Hubert, 1953; Peterson and Davies, 1960).

1985

In 1985, the study area was first visited on March 10; no larvae or pupae were found. It was on May 18 when the first larvae (174) and pupae (124) were collected. The larvae showed a high degree of variability in size. The pupae ranged from newly pupated forms to mature and tanned individuals. No empty puparia were found on this date indicating that emergence had not yet begun. The number of male to female pupae was 50 to 74, respectively, which was significantly different from a 1:1 ratio ($P \leq 0.05$). Spider webs near the river were checked for adults and none were found. Water conditions and location of larvae on the substrate during adult emergence were similar to those of 1984, although 3 weeks earlier.

On May 24, an emergence of adults was observed with flight activity commencing at ca. 8:30 AM PST and lasting for ca. 45 min. Adults were observed flying immediately above the water surface and rarely exceeding 15 cm in height. Unlike the previous year, they were more difficult to see when viewed from above against the stream surface and extremely difficult to capture with insect nets. The distribution of adults appeared to be clumped rather than random. Groups of adults moved swiftly above riffle areas and remained together as cohesive units. Estimates of the group size ranged in number from 6 to over 50 individuals. No pairing was observed within these groups. Only once, due to a gust of wind, were adults sighted anywhere but directly above the surface of the riffle area of the river. Immediately following this event, midges were again seen directly above the water surface. During the first 15 min of flight, the sex ratio of adults collected was approximately 7:1 ($n = 105$), and for the remainder of the flight period (8:45–9:15), the sex ratio was 15:1 ($n = 158$). The overall sex ratio for the flight period was 10:1 ($n = 302$). Adults were found in spider webs in close proximity to the water. Only one adult was seen in a spider web more than 1 m above the water. Of the 433 specimens collected from spider webs nearer the water than 1 m, 418 were males indicating a 28:1 sex ratio. Spiders constructing these webs were determined to be *Tetragnatha* (Araneae: Tetragnathidae). However, these spiders were not observed feeding on the midges.

Ten stones were sampled on May 24 from one riffle area where the majority of the adults were netted during the flight period. Rocks were removed from the water and all observable immature stages of *D. coloradensis* collected. We found fewer male than female pupae (67:86). However, the difference was not significant ($P > 0.1$). Pupal exuviae were also collected from these rocks. The male : female ratio (9:16) did not differ significantly from 1:1 ratio ($P > 0.1$). Pupae were more abundant than larvae, 153 to 32.

Drift samples were taken above and below riffle observation areas. The drift sample from above the riffle was positioned near the end of a slow-moving section of the river. From both drift samples, adults, empty puparia and adults partially eclosed from puparia were collected. The samples taken just downstream of the riffle area generally trapped more deuterophlebiid midges than the samples from above the riffle. The sex ratio of puparia collected was 38:40 which was not significantly different from 1:1 ($P > 0.75$). Few eclosed adult midges were collected in these samples. Three live adult females, 2 of which had lost both wings, were found in a drift net sample just after the flight period.

On June 11 another emergence of deuterophlebiid midges was recorded. The flight period began approximately at 8:30 AM and lasted for 45 minutes. Considerably fewer adults were flying as compared to May 24. The sex ratio of netted adults was 10.5:1 ($n = 92$) which was significantly different ($P < 0.05$). Flight activity on this date was similar to that observed on May 24 with adults typically moving about in groups just above the water surface. Again, no pairings were seen in these groups. Following the emergence, spider webs near the water were inspected for midges, but few were found.

DISCUSSION

Kennedy (1981) reported that larvae of mountain midges were collected from light colored rocks. We discovered that larvae could also be collected from black basalt boulders, the predominant component of the substrate of the Potlatch River. Further, the larvae apparently showed no preference for light colored rocks over dark ones. The small, essentially transparent larvae were almost invisible on dark rocks but were more easily detected on light ones. We were able to see larvae on black basalt by first removing these dark rocks to the shore and allowing them to dry. The larvae were more apparent when their outline became defined on the drying rock. This observation and collecting method may provide additional distribution records when other stream systems with essentially black substrates are checked.

The collections made of adult *D. inyoensis* Kennedy (Kennedy, 1960), *D. nielsoni* Kennedy (Kennedy, 1958), and *D. coloradensis* (Pennak, 1950) have indicated adult sex ratios greatly favoring males even though pupal sex ratios of approximately 1:1 have been found for those same populations. Conclusions by Pennak (1950) were made from collections of adults taken from the surface of calm backwaters of a mountain stream sometime after the flight period. Our 1985 collection of netted adults and adults collected from spider webs also indicates a skewed sex ratio favoring males (15:1, $n = 827$). The overall sex ratio of pupae was not significantly different from 1:1 ($n = 277$, $P > 0.05$). The observations of 1984 differed greatly from those of 1985. Kennedy (1958) reported the adults to be rapid fliers that spend most of their time flying near the surface as we observed in 1985. In 1984 our observations were made under breezier conditions as compared to those in 1985. On May 24, 1985, a gust of wind caused the midges to rise from immediately above the water surface to a height of ca. 1.5 m above the water. This incident approximated the conditions under which most observations were made in 1984. We believe that air movement was responsible, at least in part, for the differences in observed flight behavior between years. In 1984 we focused our observations on flies at 1.5 m and may have overlooked swarm activity at the surface.

Under normal conditions, as occurred in 1985, it is hypothesized that females are mated soon after taking flight and encountering a group of males. It is not known if the pair *in copula* remains in the swarm. Once mated, the females probably leave the swarm area above the water and begin to oviposit. However, we do not know where oviposition occurs. The males may then return to a swarm to continue looking for and mating with other females. This scenario may explain the observed discrepancy between adult and pupal sex ratios. On May 24 collections of adults from the first half of the emergence period showed a greater number of females than in the second half by a 2 to 1 margin. This trend may indicate a decrease in the number of females in the swarm due to successful matings after which the females leave the swarm. At this point it is impossible to tell whether males were joining the swarms and increasing the male : female sex ratio. If the latter were true the swarm size should have doubled, but no increase of this magnitude was observed. When conditions were breezy, as in 1984, it is possible that low level swarms were blown upward from the water surface and females were not intercepted and mated, hence their increased presence in our samples.

However, this hypothesis cannot explain the increased number of females above a 1:1 ratio which was the case in 1984 when a 1:1.8 male: female ratio was observed. Kennedy (1958) also reported netting males with eggs and sperm adhering to their bodies, which implies that aerial mating occurs and that males probably continue to swarm following mating. No pairing or mating pairs were observed during any periods of observations.

Drift net samples on May 24, 1985, collected a number of empty puparia. These puparia were assumed to be from that morning's emergence since several contained fresh, partially-emerged adults. These data also seem to indicate that even though a collection of adults yielded a male skewed sex ratio, the total numbers of males and females that emerged that day were approximately identical.

SUMMARY

This work represents the first report of *D. coloradensis* in Idaho and records observations of its adult flight activities. In Idaho, this species apparently produces one generation yearly resulting in a single, daily adult emergence which extends seasonally over at least 2 weeks in May and/or June, depending upon conditions.

The immatures can be found on both light- and dark-colored stream rocks. However, transparent larvae are more evident when dark rocks were allowed to dry slightly.

The midge exhibits strictly matinal flight activity with periods of swarming lasting from 25–45 min. Imagos course just above the water surface, typically in riffle areas, unless wind movement forces them upward to heights of 1–3 m. Besides our observations, evidence of higher flight was confirmed by the discovery of dead, adult males on the surface of puddles well separated from the river by high (2–3 m) vegetation and in spider webs positioned at ca. 1 m above the water. Mating and oviposition were not observed.

Under normal conditions, the sex ratio of netted adults shifts from equal numbers early in the flight period toward predominantly males later. Females probably leave the swarm in order to oviposit after mating, unless conditions disrupt the normal mating activity. Their departure would significantly reduce the number of females, as we observed. The sex ratio of pupae collected during most sampling periods was equal. Our conclusion is that the pupal cases, especially empty ones, are good indicators of the true sex ratio for *D. coloradensis.*

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PUBLICATIONS RECEIVED AND BRIEFLY REVIEWED

Systematics and Biogeography of the Longicorn Beetle Tribe Tmesisternini. By J. Linsley Gressitt. Pacific Insects Monograph, No. 41, iv + 263 pp., 20 figs., 12 pls. (4 colored). Publication date given on review card as 30 December 1984. Received by PCES at CAS on 20 February 1985. Published and distributed by Bishop Museum Press, P.O. Box 19000-A, Honolulu, Hawaii 96817, USA. Price $23.50 paperbound. ISSN 0078-7515.

The abstract states:

> The range of the cerambycid (lamiine) tribe Tmesisternini essentially covers the area known as Melanesia plus Wallacea (in the original sense—Sulawesi, Lesser Sunda Is), as well as Maluku, the south fringe of the Sunda Is and the NE fringe of Australia. The group has not yet been recorded from Vanuatu (New Hebrides) or Fiji, though it is known from New Caledonia. The tribe comprises 15 genera and 422 species, of which 1 genus and 99 species are described as new in this paper. The majority of the species occur in New Guinea, with distribution now known as follows: New Guinea mainland, 291 species; New Guinea offshore islands, 42; Aru, 19; Kei, 6; Maluku, 35; Sulawesi, 9; Sunda Is, 2; Lesser Sunda Is, 14; Bismarcks, 20; Solomon Is, 12; New Caledonia, 11; Australia, 19. Relatives of this tribe are mostly concentrated in New Caledonia, Wallacea (broad sense including Philippines), SE Asia, Japan, Sri Lanka, Micronesia, Samoa, Fiji and New Zealand, with areas in between, including NE Australia. Several of the Tmesisternini have been recorded as borers of living cacao trees. Original host-plants probably include many rain forest tree species, but several bore in larger ferns, including bracken and tree-fern petioles.

—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

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Scientific Note

Spider Prey of *Trypoxylon tridentatum* (Hymenoptera: Sphecidae) from Arizona and California

The solitary spider-hunting wasp, *Trypoxylon tridentatum* Packard, is the most widespread species of the subgenus *Trypargilum* in North America, occurring in southern British Columbia and Ontario in Canada, most of the United States, and in Mexico as far south as Chiapas (Coville, 1982, Univ. Calif. Publ. Entomol., 97:1–147). The species is polytypic but only the Floridian population has been considered distinct enough to be recognized as a subspecies, *archboldi* Krombein. Krombein (1967, Trap-nesting wasps and bees, Smithsonian Press, Washington, D.C., 570 pp.) gave prey records for *T. tridentatum* from North Carolina, Arizona, and Florida. Recently, O'Brien (1982, Pan-Pacific Entomol., 58:288–290) presented prey records from Oregon. In this paper I provide the first prey records from California along with additional prey records from Arizona and discuss the pattern of prey preferences demonstrated by different populations of the wasp. The spiders, obtained from trap-nests, were identified by H. W. Levi (Museum of Comparative Zoology, Harvard), W. J. Gertsch (Portal, Arizona), and C. Griswold (Dept. of Arachnology, Natal Museum, Pietermaritzburg, 3201 Natal, South Africa).

1. Prey from 2 nests at Madera Canyon, Santa Rita Mountains, Arizona, collected on September 29, 1974.

ARANEIDAE (10): 1 ♀ *Araneus apache* Levi (?); 9 imm. *Larinia directa* (Hentz).
MIMETIDAE (2): 2 ♀ *Mimetus* sp.
THERIDIIDAE (5): 3 imm. *Latrodectus hesperus* Chamberlain and Ivie; 1 ♀ *Theridion kawea* Levi; 1 ♀ *Theridion* sp. near *timpanogos* Levi.

2. Prey from 3 nests at Miller Canyon, Huachuca Mountains, Arizona, collected on September 27, 1974.

ARANEIDAE (19): 9 imm. *Araneus* sp.; 1 ♀ *Hyposinga singaeformis* (Scheffer); 7 imm. *Larinia directa* (Hentz); 2 ♀ *Metepeira grinelli* Coolidge.
THERIDIIDAE (47): 1 imm., 2 ♂, 9 ♀ *Euryopis texana* Banks, 31 imm. *Latrodectus hesperus* Chamberlain and Ivie; 3 ♀ *Theridion kawea* Levi; 1 ♀ *Theridion neomexicanum* Banks.
SALTICIDAE (1): 1 imm. *Metaphidippus* sp.

3. Prey from 17 nests at the University of California Hopland Field Station, Hopland, Mendocino Co., California, collected on July 17 and 18, 1974.

ARANEIDAE (130): 17 imm., 1 ♀ *Araneus bispinosus* (Keyserling); 64 imm., 3 ♀ *Araniella displicata* (Hentz); 3 imm. *Argiope trifasciata* (Faskäl); 37 imm. *Eustala* sp.; 3 ♀ *Metepeira ventura* Chamberlain and Ivie; 2 imm. *Metepeira* sp.
DICTYNIDAE (6): 6 ♀ *Mallos pallidus* (Banks).
MIMETIDAE (3): 1 imm., 2 ♀ *Mimetus hesperus* Chamberlain.
THERIDIIDAE (210): 10 imm., 1 ♂ *Latrodectus hesperus* Chamberlain and Ivie;

10 imm. *Latrodectus* sp.; 2 ♀ *Theridion crispulum* Simon; 30 ♀ *Theridion lawrencei* Gertsch and Archer; 1 ♀ *Theridion melanurum* Hahn; 30 ♀ *Theridion michelbacheri* Levi; 80 ♀ *Theridion murarium* Emerton; 2 imm., 3 ♀ *Theridion positivum* Chamberlain; 1 imm., 40 ♀ *Theridion* sp.

4. Prey from 20 nests at Del Puerto Canyon, Stanislaus Co., California, collected during July and August 1974.

ARANEIDAE (372): 16 imm., 2 ♀ *Araneus bispinosus* (Keyserling); 33 imm., 1 ♂ *Argiope trifasciata* (Faskäl); 317 imm. *Eustala* sp.; 2 imm., 1 ♀ *Metepeira* sp.
DICTYNIDAE (9): 1 ♀ *Mallos pallidus* (Banks); 8 ♀ *Dictyna saepei* Chamberlain and Ivie.
MIMETIDAE (61): 51 imm., 1 ♀ *Mimetus eutypus* Chamberlain and Ivie; 9 imm. *Mimetus* sp.
THERIDIIDAE (73): 2 imm. *Euryopis* sp.; 33 imm. *Latrodectus* sp.; 3 ♀ *Theridion michelbacheri* Levi; 35 imm. *Theridion* sp.

In my studies, *Trypoxylon tridentatum* preyed most heavily on spiders in the families Araneidae and Theridiidae, which together comprised 86–98% of the spiders from each locality. The same two families contained 98–100% of the prey at localities in North Carolina, Arizona, and Florida studied by Krombein (1967). The relative proportions of the two families varied from one locality to another here and in Krombein's study, but in general araneids were more abundant (59–83% of the prey). Exceptions were at Miller Canyon, where araneids represented 28% and theridiids 70% of the prey in a small sample, and the Hopland Field Station where prey included 37% araneids and 60% theridiids. These differences suggest to me that *T. tridentatum* maintains the same hunting behavior throughout its range but the relative abundances of prey species differ among localities during the season of wasp activity. *Trypoxylon tridentatum* typically take many genera of araneids and theridiids. Nevertheless, in a study conducted in southeastern Oregon in an area dominated by sagebrush (*Artemisia*) and rabbit-brush (*Chrysothamnus*) O'Brien (1982) found prey from 21 cells to consist exclusively of the araneid *Metepeira grandiosa.* I suspect that either *M. grandiosa* was especially abundant or other prey species were extremely scarce, but as noted by O'Brien conditioning of the wasps cannot be ruled out.

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New Species of the Genus *Sierolomorpha* from New Mexico (Hymenoptera: Sierolomorphidae)

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The family Sierolomorphidae is largely restricted to the Nearctic region. Evans (1961) recognized six species from North America, one from Hawaii and an undescribed species from Panama. Nagy (1971) described two species of *Sierolomorpha* from east and central Asia. The southwestern United States has the greatest diversity of species and to this a new species is added named in honor of William F. Barr a prolific and inspired collector of this region.

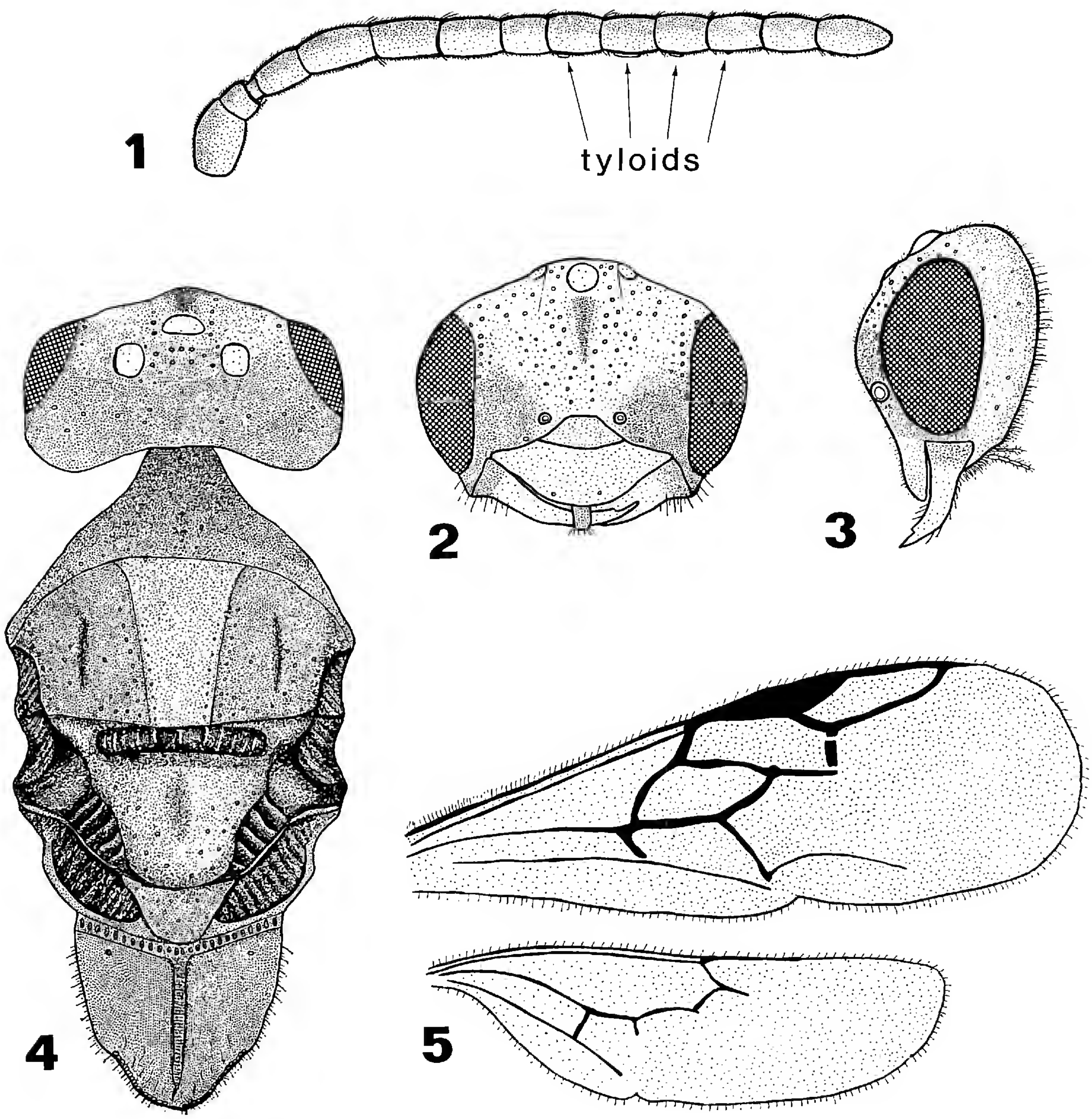
***Sierolomorpha barri,* NEW SPECIES**
(Figs. 1–5)

Male.—Color largely piceus to fuscous; head piceus; antennae uniformly fuscous with fulvescent tyloids; mandibles basally piceus, medially fulvous and apically brunneus; mesosoma piceus except lateral margins of pronotum fuscous; coxae fuscous; trochanters fusco-rufous; femora fusco-rufous with ochraceous apices; tibiae and tarsi ochraceous; tegulae brunneus; wings hyaline; metasoma fulvescent to apically ochraceous.

Length: Approximately 5.8 mm.

Head about 1.3 times as wide as high; minimum width of front 1.2 times eye height; ocelli of moderate size, diameter of anterior ocellus 0.18 times minimum width of front; postocellar line 1.1 times ocello-ocular line. Antennal segments 1–4 in a ratio of 17.5:8:13:17; segment three 1.5 times as long as wide; segment four 1.9 times as long as wide; segment eleven 1.6 times as long as wide; tyloids present as low polished carinae on segments 8–11 (Fig. 1). Front of head conspicuously tumid, with dispersed, well defined setiferous punctures separated by at least 1–2 times their own diameters; median groove well developed, extending slightly more than half the distance from anterior ocellus to the antennal fossae (Fig. 2); malar space, base of mandibles and lower lateral margins of front finely colliculate (Fig. 3); clypeus nearly impunctate; supraclypeal area atomarius; genae polished and with dispersed setiferous punctures; vertex polished, with dispersed setiferous punctures and lightly impressed laterad of hind ocelli; occiput finely colliculate.

Mesosoma (Fig. 4) about two times as long as wide; pronotum colliculate anteriorly, polished and puncticulate posteriorly, and strongly polished and impunctate laterally; mesoscutum largely impunctate and strongly polished between notauli, parapsides polished and puncticulate; notauli well developed, diverging as approaching anterior margin; parapsidal impressions moderately well developed; scutellum polished and puncticulate, anterior margin mostly depressed and costate, median longitudinal impression conspicuous, lateral margins declivous



Figures 1–5. *Sierolomorpha barri.* 1. Antenna. 2. Face. 3. Head, lateral view. 4. Head and mesosoma, dorsal view. 5. Wings.

and porcate; metanotum smooth and puncticulate medially, exculptate laterally; propodeum dorsally elute, denudate except for lateral margins, anterior margin scrobiculate, median sulcus conspicuous, extending the full length of dorsum and merging with a slightly oblique carina on the posterior face, posterior margin foveate, lateral surfaces colliculate; propleuron smooth and setiferously puncticulate; mesopleuron gibbose, lower half setiferously puncticulate, upper half denuded and strigulate-carinate; metapleuron denudate, lower half polished, upper half rugulose.

Metasoma fusiform, depressed; metasomal terga 1 and 2 with no indication of a constriction between them; tergum 1 polished and puncticulate except anterior face which is atomarius; terga 2–5 aciculate anteriorly, polished and puncticulate posteriorly; tergum 6 strigulate-rugose; tergum 7 rugose; metasomal sternum 1 finely colliculate medially, smooth laterally; sterna 2–7 puncticulate.

Female. —Unknown.

Type material.—Holotype, male, Valley of Fires, Lincoln Co., New Mexico, 3–5 September 1985, W. F. Barr collector. Holotype to be deposited at the California Academy of Sciences.

This species of *Sierolomorpha* is distinguished from others by the presence of tyloids on antennal segments 8–11 and by the distinct sculpturing of the mesosoma.

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PUBLICATIONS RECEIVED AND BRIEFLY REVIEWED

The Ticks of California (Acari: Ixodida). By Deane P. Furman and Edmond C. Loomis. Bulletin of the California Insect Survey, vol. 25, viii + 239 pp., 75 pls. (with 356 figs.), 23 maps, 19 tables. Issue date on review card given as July 1984. Received by PCES at CAS 1 April 1985. Published and distributed by University of California Press, 2223 Fulton Street, Berkeley, California 94720, U.S.A., telephone (415) 642-4562. Price $25.00 paperbound. ISBN 0-520-09685-1.

A profusely illustrated volume with 356 figures. The introduction states:

> Ticks are obligatory, blood-sucking parasites of mammals, birds, and reptiles. There are about 850 species described for the world, most of them in two families: the hard ticks, or Ixodidae, and the soft ticks, Argasidae. A third family, the Nuttalliellidae, is known only from a single species in Africa. In California 7 genera containing 49 species of ticks are known to be established. Two additional species, *Amblyomma americanum* and *Boophilus annulatus*, have been introduced repeatedly into the State and are included here in keys and text. Other occasional introductions of exotic ticks are reported by state and federal agencies, but none of these have become established in California.
>
> This publication provides a guide to the identification of adult and immature instars of ticks occurring in California and information on the geographic and seasonal distribution of ticks in the State and on their host associations and their importance to the health and welfare of man and domestic and wild animals. Host association and other collection records are summarized in tabular form for all species encountered frequently. Numbers of specimens per collection are not indicated in the tables. Distribution maps include only precise collection sites.

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Foraging Success of Neotropical Robber Flies: Variation with Attack Distance and Angle

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Adults of most robber fly species are sit-and-wait predators that attempt aerial capture of flying insect prey. Attack flights are discrete, easily observed actions, and previous investigators (e.g., Dennis and Lavigne, 1975; Scarbrough and Norden, 1977; Shelly, 1984a) have estimated rates, distances, and success probabilities of attack flights for a variety of asilid species. Success probability (or more commonly capture efficiency) has usually been expressed as the proportion of all attack flights that result in prey capture (e.g., Scarbrough, 1978; Lavigne, 1982; Shelly, 1984b). Although this measure conveniently provides a single estimate for a species, it ignores possible variation in success probability among attack flights of varying distance and angle. Several studies (Scarbrough, 1978, 1981, 1982; Scarbrough and Sraver, 1979; Lavigne et al., 1983) have reported that most prey captures result from relatively short attack flights. However, this finding provides no information regarding the relationship between success probability and attack distance, since no data are given regarding the frequencies of attack flights of differing distances. While conducting a comparative study of asilid foraging behavior (Shelly, 1984a), I obtained visual estimates of the distances and angles for both successful and unsuccessful attack flights for two closely related species at the study site. Here I compare success probabilities among attack flights of varying distance and angle.

Data were collected during May–August 1979–1981, within the moist evergreen forest of Barro Colorado Island (BCI), Panama. Complete geologic, climatic, and floristic descriptions of BCI are given in Croat (1978) and Leigh et al. (1982). On BCI, *Oidardis* sp. and *Eumecosoma gibbum* [Fisher (unpubl.) suggests that this species actually belongs in the genus *Oidardis* and was incorrectly placed in *Eumecosoma*] perch in deep shade on twig tips between 0.5–0.75 m above ground (Shelly, 1985a, 1985b). Mean wet weight and body length for a sample of 5 ♂ and 5 ♀ were 4.2 mg and 4.8 mm for *Oidardis* sp. and 9.4 mg and 6.1 mm for *E. gibbum.* Individuals of both species feed primarily on nematocerous Diptera and Coleoptera; these taxa made up 71% of the diets for both species (Shelly, 1985a, 1985b). Prey were usually <4 mm in body length, and 85% and 57% of the prey were between 0.5–2.0 mm for *Oidardis* sp. and *E. gibbum,* respectively (Shelly, 1985a, 1985b).

Observations were made between 1000–1500 hr and were recorded on tape for later transcription. Observations were made during sunny conditions, and light levels (measured with a cadmium-sulphide photographic light meter, Shelly, 1984a) within the shaded understory were usually between 150–500 lux. Individuals were observed for 15 min unless lost from view prior to that time. Individuals were

Table 1. Success probabilities (% successful attacks) for attack flights of varying angle and distance. Values in parentheses represent sample sizes for the different combinations of angle and distance.

	Distance (cm)			
Angle	1–15	16–30	31–45	>45
>45° AH	42.4 (33)	33.3 (27)	20.0 (10)	10.0 (10)
1–45° AH	46.1 (78)	34.0 (50)	22.3 (22)	15.4 (13)
1–45° BH	47.8 (69)	38.6 (57)	19.0 (21)	14.3 (14)
>45° BH	18.7 (32)	9.5 (21)	0.0 (8)	0.0 (8)

quite easy to approach, and observations were generally made from a distance of 0.75–1.0 m. Field determination of sex was difficult, and consequently the sex of individuals observed was unknown.

Data are presented only for those attack flights for which I obtained estimates of both distance and angle and actually saw the prey item that elicited the attack. Distances were assigned to intervals of 15 cm, and angles were categorized as >45° above horizontal (hereafter AH), 1–45° AH, 1–45° below horizontal (hereafter BH), and >45° BH. The few attack flights judged to be perfectly horizontal were omitted from analysis. Although restricting analysis to attacks with "known" targets greatly reduced sample sizes (since prey were small and often difficult to see), it also eliminated the possibility of including flights made in response to movement of "non-prey" items, e.g., birds, falling or swaying leaves, or sun flecks. To increase sample sizes, data from *Oidardis* sp. and *E. gibbum* were pooled. This computational procedure was considered justified given the species' similarity in perching site, dietary composition, and foraging behavior. Since data regarding rates of attack and relocation flights were being collected simultaneously as part of the comparative study (Shelly, 1984a), I did not disrupt normal foraging activity through collection of captured prey (which are affixed to the proboscis of a feeding asilid). As a result, I could not assess the possibility that attack flights of differing distances or angles resulted in the capture of differing sizes or types of prey (see Scarbrough, 1978, 1981). Within angle and distance categories, heterogeneity among success probabilities was tested using a G-test (Sokal and Rohlf, 1969:575).

Success probabilities varied significantly with attack distance for attacks between 1–45° AH and 1–45° BH ($P < 0.01$ in both cases; Table 1). In these categories, success probabilities decreased from 34%–48% for attacks <30 cm to approximately 15% for attacks >45 cm. Data for attacks >45° AH display a similar trend, and the lack of a statistically significant effect ($P < 0.20$) probably reflects inadequate sample sizes. Although small sample sizes may have precluded detection of a significant distance effect for attacks >45° BH as well, the available data suggest that such an effect may be much less pronounced for these attacks. Capture probabilities for attacks >45° BH ranged only between 0–19% among the 4 distance intervals.

Success probability was dependent upon attack angle for flights of 1–15 cm and 16–30 cm ($P < 0.05$ in both cases; Table 1). For these intervals, success probabilities were similar among attacks >45° AH, 1–45° AH, and 1–45° BH, and these probabilities were in turn much greater than those noted for attacks >45° BH.

Among flights of 1–15 cm, for example, the capture probability of attacks >45° BH was only 19% compared to values of 42%–48% among the 3 other angle intervals. By comparison, success probabilities for attacks >45 cm varied only between 0–15% among all angle intervals.

I interpret these data in the following manner. The trend for capture probabilities to decrease with increasing attack distance probably reflects a combination of two factors. First, more distant prey may be more likely to detect and successfully evade an attack than prey flying close to a perching asilid. In addition, an asilid's ability to accurately assess the suitability of a potential prey (in terms of its palatability, hardness, defensive armature etc.) may decrease with increasing distance to the prey. As a result, a greater proportion of longer attack flights may not involve an attempted capture at all but result only in an investigation (a "closer look") of the potential prey. Given the short duration (<1–2 sec) of most attack flights, however, it was not possible to distinguish between "active" prey escape and "investigation only" in accounting for unsuccessful attack flights.

Regarding attack angle, several workers (Melin, 1923; Lavigne, 1970, 1971; Hespenheide, 1978; Scarbrough, 1982) have speculated that attack flights of asilids are more likely to be successful if prey are well back-lighted, i.e., distinctly silhouetted against the sky. Perhaps, then, the species were less able to accurately perceive and track prey flying beneath them, since the background was a mixture of very dark shades (e.g., fallen leaves, mud etc.). If so, both the potential for prey escape and the aforementioned tendency for investigation flights may have been greater for steep, downward attacks. The similarity of capture probabilities among attacks >45 cm suggests that differences in back-lighting have less effect upon prey capture among these longer flights.

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Developmental and Ecological Comparisons of *Trichogramma minutum* and *Trichogramma platneri* (Hymenoptera: Trichogrammatidae)

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Abstract.—Immature development, longevity, fecundity, mating and ovipositional behavior, and the effects of different host ages, densities and parasite densities on parasitization by *T. minutum* and *T. platneri* were compared. Few differences were noted. *T. platneri* engaged in host feeding and repiercing while *T. minutum* did not. *T. platneri* superparasitized hosts under stressful conditions (low host density, high parasite density) while *T. minutum* did not; neither it nor *T. minutum* did at less stressful conditions. At 27 ± 1°C and 50% RH *T. minutum* had a greater increase rate than *T. platneri.*

These differences, if indicative of all *T. minutum* and *T. platneri* populations in nature, support species status for *T. platneri* according to the methods of Doyen and Slobodchikoff (1974).

The members of the genus *Trichogramma* (Hymenoptera: Trichogrammatidae), first described by J. O. Westwood in 1833, are minute endoparasites of the eggs of many insect species, mainly Lepidoptera. Due to their short generation time, ease of culturing, and propensity to attack a variety of lepidopterous pests, their use as biological control agents has been widespread (Riley, 1879; Peterson, 1930; Oatman and Platner, 1971).

Morphological homogeneity and phenotypic plasticity have made the designation of *Trichogramma* species difficult. For example, expression of certain features such as color, which have been widely used in past taxonomic keys, is believed to be affected by developmental temperature (Flanders, 1930, 1931; Quednau, 1960). An additional problem has been the failure of most workers to refer to type material to verify identifications. These problems have resulted in a series of misidentifications that have plagued the literature to this day (Pinto et al., 1978). Certain advances in defining species morphologically, such as the male genitalic characters noted by Sudha Nagarkatti in 1971, have been achieved. This, along with breeding studies and re-examination of existing type material, has helped systematists identify *Trichogramma* species more accurately.

Breeding study results posed some new problems. Many morphologically distinct *Trichogramma* species have distributions covering much of North America (Pinto et al., 1978). Crosses between cultures of these species initiated with material collected at different localities failed to produce female progeny indicating a total lack of hybridization due to the arrhenotokous reproduction of these wasps

(Nagarkatti and Fazaluddin, 1973). One such species is *Trichogramma minutum* Riley. A culture from a Riverside, California population failed to interbreed with topotypic *T. minutum* from Missouri or with a *T. minutum* culture from Chula Vista, California (Oatman and Platner, 1973). Based solely on the interbreeding results the Riverside form was treated as a sibling species of *T. minutum* by Nagarkatti (1975) and named *Trichogramma platneri* Nagarkatti.

The importance of accurate classification has been demonstrated again and again through biocontrol projects. A classic example involves the control of the California Red Scale, *Aonidiella aurantii* (Maskell) (Homoptera: Diaspididae). The failure to recognize *Aphytis lignanensis* Compere and *Aphytis melinus* DeBach, the 2 species of primary control importance in southern California, as separate from *Aphytis chrysomphali* (Mercet) (Hymenoptera: Aphelinidae) resulted in delays of 16 and 25 years, respectively, before importation (DeBach, 1969). Doyen and Slobodchikoff (1974) have suggested a classification method which involves stepwise comparisons of phenetic, geographic, reproductive, and ecological properties. To help clarify the relationship of *T. minutum* and *T. platneri* I compared such ecological parameters as immature development, longevity, fecundity, mating and ovipositional behavior, and the effects of different host ages, densities, and parasite densities on parasitization.

MATERIALS AND METHODS

Cultures of *T. minutum* and *T. platneri* were reared on eggs of the cabbage looper, *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae), in chambers maintaining a temperature of 27 ± 1°C and 50% relative humidity. All observations during this study were made at these conditions. *T. ni* larvae were reared on an artificial medium adapted from that of Shorey and Hale (1965). Egg deposition occurred on paper towels exposed to adult *T. ni*. Eggs were collected within 12 hours of deposition and stored at 3–5°C until use. Storage lasted no longer than 24 hours. The *T. minutum* culture was initiated on 3 October 1973 with parasites reared from *Manduca* eggs on *Datura* collected at Chula Vista, California. The *T. platneri* culture was started on 10 July 1979 with parasites reared from codling moth eggs on apple collected at Riverside, California.

Cultures were housed in one-half pint plastic containers with snap-on lids. A piece of filter paper (10 cm square) held in place by the lid allowed air flow through a hole in the lid. A streak of honey inside the container provided food for the adult wasps. New cultures were started by exposing wasps to a piece of paper towel with several hundred attached *T. ni* eggs (24–48 hours old) for 4–24 hours depending upon the number of wasps present in the parent culture. All wasps were removed following exposure and the *T. ni* eggs were placed in an empty culture container. Cultures of *T. minutum* and *T. platneri* were isolated in separate chambers to prevent contamination.

During each experiment wasps and host eggs were kept in clear plastic vials (8.5 cm high, 3 cm diameter). Filter paper (5 cm square) was secured by a snap-on lid with a hole in it for air exchange. A streak of honey inside provided food. A piece of paper towel was glued (Wilhold® White Glue) onto a rectangular piece of filter paper (3.5 cm by 7 cm) which fit snugly into the vial. This egg card was notched once on the bottom and 3 times on each side to allow free parasite movement.

The immature development of *T. minutum* and *T. platneri* was observed by exposing at least 500 *T. ni* eggs to recently mated female wasps for 2 hours. Immediately after exposure and thereafter following a set time schedule at least 12 host eggs were removed per sampling time. Host eggs were detached from paper towels by soaking in a very dilute sodium hypochlorite solution for 3–5 minutes. They were mounted singly on microscope slides in Hoyer's medium and ruptured by gently pressing the cover slip. After drying for 2–4 weeks, each coverslip was ringed with Glyptal® to prevent crystalization of the Hoyer's medium. The number and developmental stage(s) of parasites were determined with a phase contrast compound microscope (100× and 250×). To compare size changes during development, 10 individuals of each instar present per age group were randomly selected. The width and length of each parasite and mandibular length of second and third instar larvae were measured.

Fecundity was examined by randomly selecting 10 newly emerged male-female pairs of each species. Each pair was placed in a vial containing ca. 50 host eggs. New host material was added every 24 hours until the female wasp died, the previously exposed eggs being kept for progeny emergence. From longevity, fecundity, and progeny sex ratios, life tables were constructed for each species using the methods of Krebs (1978). Values of the innate capacity for increase (r) were approximated with the following equation (Krebs, 1978).

$$r = R_o \log_e R_o / \Sigma\ x l_x m_x$$

About 50 wasps (24 hours old, ca. 1:1 sex ratio) were placed on a circular (5 cm diameter) piece of filter paper in a plastic petri dish (0.8 cm deep, 5 cm diameter) with a snap-on lid to watch mating behavior. Virgin females were reared by isolating single parasitized hosts in small glass vials (6.4 cm long, 0.9 cm diameter) 2 days before parasite emergence. Cotton plugs prevented escape and facilitated CO_2 anesthetization. Besides intraspecific observations both interspecific crosses were watched. Females observed mating with males of the other species were allowed to parasitize hosts which were held for progeny emergence. Conspecific matings were retained as a control. Ten mated females from each cross (intra- and interspecific) were dissected to determine the occurrence of insemination.

Oviposition behavior was observed by placing ca. 50 wasps (ca. 1:1 sex ratio) into a plastic petri dish (0.8 cm deep, 5 cm diameter) with a snap-on lid. About 20–30 host eggs on a paper towel were inserted and observed with a dissecting microscope (15× and 45×).

To see if host eggs of a certain age were preferred for parasitization 5 groups, each consisting of a pair of egg cards (ca. 50 eggs per card) and a set of 10–20 eggs were set up. Each group was incubated a different length of time resulting in age groups (±6 hours) of 6, 18, 30, 42, and 54 hours. Each card was then exposed to five 24-hour-old mated females for 6 hours. The small (10–20 eggs) sets were not exposed. After parasite removal, 50% of the host eggs were slidemounted in Hoyer's medium. The remainder were kept for progeny emergence. Host embryological development was determined by slidemounting unexposed hosts. This experiment was repeated once per species.

Host density effects were examined by preparing 6 sets (1 set each of 1, 5, 10, 15, 20, 25 host eggs per card) of 10 egg cards per set for both parasite species.

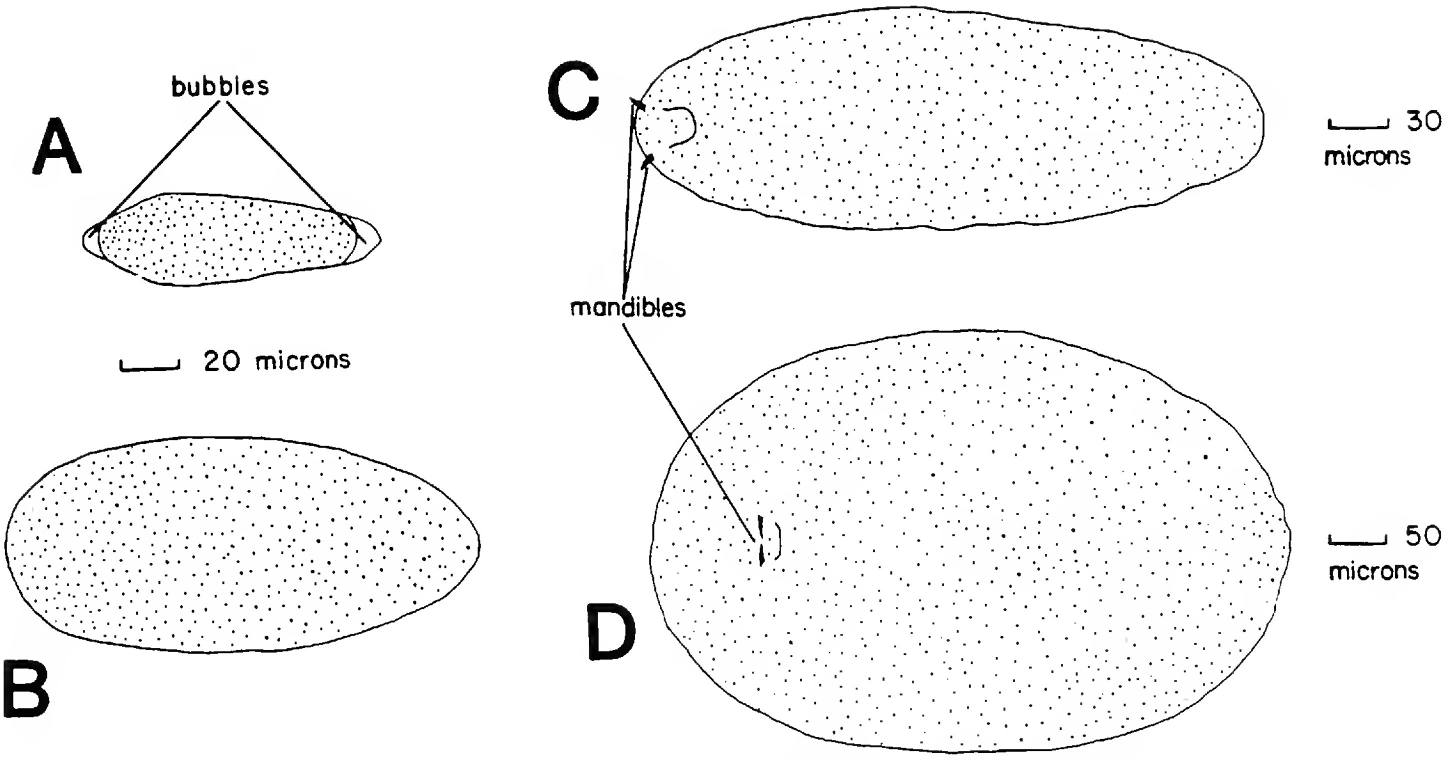

Figure 1. *T. minutum* egg (A), first instar larva (B), second instar larva (C), and third instar larva (D).

Each card was exposed to a single 24-hour-old mated female for 8 hours and retained for progeny emergence.

Parasite density effects were compared by assembling 1 group of 40 egg cards, one-half with 4 host eggs per card (limited) and the other half with ca. 50 eggs per card (control) for each parasite species. Each group was divided into 4 subgroups of 10 cards each (5 limited and 5 control). Each card was exposed to five 24-hour-old mated females, 1 subgroup for 2 hours, another for 4 hours, another for 8 hours, and the last for 24 hours. One host egg per limited card was slidemounted, the remainder being held for progeny emergence. This experiment was repeated once per species.

RESULTS

The egg of *T. minutum* and *T. platneri* is elongate, 92–124 μ (microns) long and 32–48 μ wide (Fig. 1A). It is distinguished by an air bubble which occurs at each end inside the chorion. No significant size increase occurred during its 18–22 hour developmental period. Upon emerging the first instar larva (Fig. 1B), recognizable by its lack of mandibles and air bubbles, began to grow especially in girth. At full size, 8 hours after eclosion, it ranged from 139.2–155.6 μ long and 71.6–75.2 μ wide. Growth accelerated during the second instar (Fig. 1C), identifiable by mandibles measuring 8.4–9.6 μ long. During this very short stage (2–3 hours) body length and width increased to 278.6–316.4 μ and 112.6–152.9 μ, respectively. The third instar (Fig. 1D), distinguished by its large mandibles (22–22.4 μ long), lasted 82–87 hours. Full larval size was reached about 32 hours after the end of the second instar. Size then remained steady at 539–576 μ long and 382–406 μ wide. The only recognizable morphological feature on the ellipsoid mass of both this and the previous instar is the mandibles. Their use is unknown but they provide an excellent way to recognize instars since mandibular length changes only between instars but not during them. Urate crystals began to appear

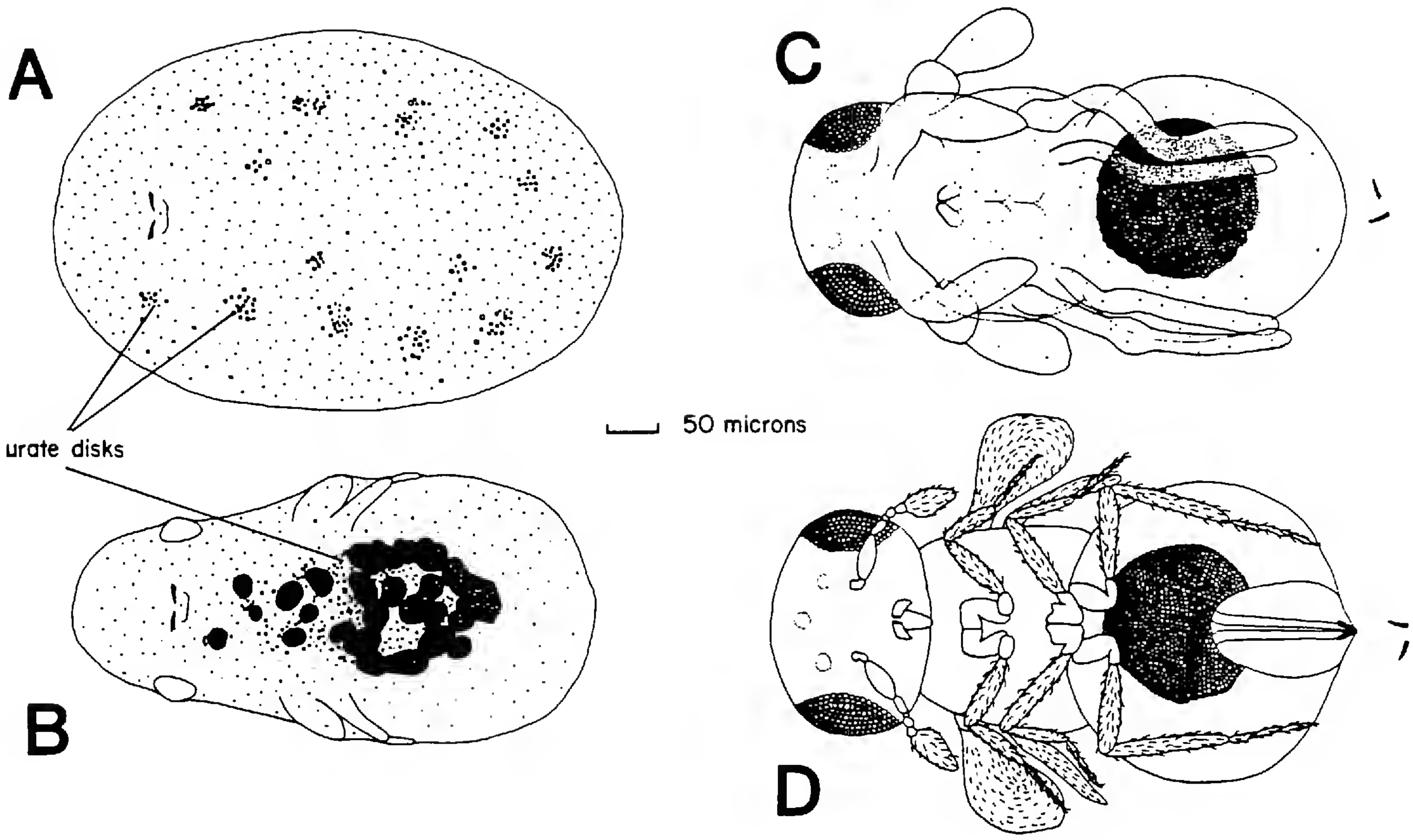

Figure 2. *T. minutum* early (A) and late (B) prepupa and early (C) and late (D) pupa.

(Fig. 2A) soon after growth ceased. Coinciding with this the host egg chorion acquired a dark black pigment which remained throughout the rest of parasite development.

Previous investigators have divided the last larval instar into 2 stages, the "final instar" and prepupa (Flanders, 1923; Pak and Oatman, 1982). What they designated as a prepupa was actually a final instar larva in which urate crystals have become visible (Fig. 2A). In this study I divided the third instar based on urate crystal presence to facilitate comparisons with previous investigations.

As the prepupa developed urate crystals formed several disks situated in a loose ring around the center of the parasite. These disks became more dense and opaque as they slowly condensed into a central mass (meconium) just posterior of the parasite's center. Near the end of the 50–55 hour prepupal developmental period some pupal characteristics began to appear (Fig. 2B).

The pupal instar began with the shedding of the mandibles and third instar larval skin (Fig. 2C). No significant size change occurred. This stage lasted 70–72 hours. As development progressed the overall color changed to a deep amber; red compound eyes and ocelli appeared and the genitalia, wings, antennae, and legs became very distinct (Fig. 2D).

The life cycles of *T. minutum* and *T. platneri,* from egg deposition to adult emergence, required about 8 days at 27 ± 1°C and 50% relative humidity. No interspecific difference was found in the length of time from oviposition to when each developmental stage was most abundant (ANOVA, $P > 0.05$) (Steel and Torrie, 1960) (Table 1). Developmental size increases of *T. minutum* and *T. platneri,* as indicated by length, were not significantly different (ANOCOVA, $P > 0.05$) (Steel and Torrie, 1960). Interspecific comparisons of mandibular length during the second and third instars indicated no significant differences (Wilcoxon Two-Sample Test, $P > 0.05$) (Steel and Torrie, 1960).

Table 1. Estimates of the time of greatest abundance (hours after egg deposition) of immature developmental stages using second degree polynomial regression (Munem and Yizze, 1974; Steel and Torrie, 1960).

Stage	*T. minutum*	*T. platneri*
First instar	22.9	23.1
Second instar	29.5	33.5
Third instar	45.2	46.6
Prepupa	98.3	93.4
Pupa	138.1	139.1

At 27 ± 1°C and 50% relative humidity *T. minutum* had a greater increase rate ($r \approx 0.4334$) than *T. platneri* ($r \approx 0.3682$). *T. minutum* had a shorter generation time (8.874 days) than *T. platneri* (9.545 days).

Male and female longevities were very similar for both species (*T. minutum*; male = 4.2 days (2–8), female = 6.9 days (2–12): *T. platneri*; male = 4.0 days (3–6), female = 6.7 days (3–11)) (Wilcoxon Two-Sample Test, $P > 0.05$). Neither the total number of progeny per day nor the number of hosts parasitized per day by *T. minutum* and *T. platneri* were significantly different (Wilcoxon Two-Sample Text, $P > 0.05$).

Mating behavior was similar in *T. minutum* and *T. platneri.* The wasps moved in a seemingly random manner. Males did not seem to be able to distinguish females unless physical contact occurred. Upon contact the male began rapidly drumming his antennae in an alternating fashion over the body of the other wasp. When a male was contacted the initial male left; in the case of a female the male quickly moved to her rear and mounted. He crawled forward until the posterior half of his abdomen extended behind hers. He then curled his abdomen under hers from behind and inserted his aedeagus into her genital opening. The male dismounted after 2 to several hundred seconds. Females never initiated sexual behavior but sometimes would vigorously try to dislodge the male. Almost no females were successful in preventing copulation and ceased resisting once copulation was achieved. Conspecifics and non-conspecifics of the opposite sex were accepted although no preference tests were possible since *T. minutum* and *T. platneri* are not morphologically distinguishable. Every dissected female was inseminated. Interspecific crosses gave rise to 100% male progeny. Conspecific matings resulted in about 75% female and 25% male progeny.

Oviposition behavior of *T. minutum* and *T. platneri* was very similar. Females scurried about until they ran into a *T. ni* egg. Upon contact the female climbed onto the egg, examined it by drumming her antennae in an alternating fashion over its surface for 10–60 seconds and either left the egg or touched the chorion with the apex of her abdomen. She then inserted her ovipositor into the chorion and raised her abdomen enough to unsheath her ovipositor and orient it nearly perpendicular to the egg surface. Pressure was applied to drive the ovipositor through the chorion and 70–95% of its length into the host. Piercing the chorion required 2–60 seconds. After 1–2 minutes the female withdrew her ovipositor, usually leaving the host immediately.

One female *T. minutum* was observed examining an egg which had been par-

Table 2. Number of parasitized hosts per parasite and progeny per parasitized host. ($\bar{x}$ = mean, SD = standard deviation.)

Host age (±6 hr)	Parasitized hosts per parasite		Progeny per parasitized host	
	$\bar{x} \pm$ SD	Range	$\bar{x} \pm$ SD	Range
		T. minutum		
6	2.2 ± 0.849	1.6–2.8	1.285 ± 0.304	1.1–1.5
18	0.8 ± 0.283	0.6–1.0	1.100 ± 0.141	1.0–1.2
30	1.7 ± 0.424	1.4–2.0	1.100 ± 0.141	1.0–1.2
42	1.1 ± 0.990	0.4–1.8	1.000 ± 0.000	1.0
54	1.5 ± 0.707	1.0–2.0	1.000 ± 0.000	1.0
		T. platneri		
6	2.5 ± 2.121	1.0–4.0	1.625 ± 0.177	1.5–1.8
18	1.9 ± 1.838	0.6–3.2	1.135 ± 0.191	1.0–1.3
30	2.6 ± 1.131	1.8–3.4	1.965 ± 1.209	1.1–2.8
42	2.1 ± 0.990	1.4–2.8	1.905 ± 0.375	1.6–2.2
54	0.2 ± 0.283	0.0–0.4	1.000 ± 0.000	1.0

asitized only a few minutes before. She left after about 10 seconds of antennal drumming and proceeded to parasitize an adjacent unparasitized egg. *T. platneri* was not observed to discriminate between parasitized and unparasitized hosts. Several female *T. platneri* repierced the chorion of a host they had just pierced while *T. minutum* was never seen doing this. Upon completing parasitization most *T. platneri* females fed on liquid exuding from the puncture. *T. minutum* did not show this behavior.

No preference for any developmental stage of the host was discovered. No significant differences in the number of parasitized hosts per parasite or number of progeny per parasite were revealed by intra- and interspecific comparisons (Tukey's Test, $P > 0.05$) (Steel and Torrie, 1960) (Table 2).

Significant differences in the responses of the 2 species to different host densities were observed. Regression lines of the number of parasitized hosts per wasp were not significantly different (ANOCOVA, $P > 0.05$) (Fig. 3). The rate of change of the number of progeny per parasitized host for *T. platneri* was significantly different than that of *T. minutum* (*t*-test, $P < 0.05$) (Fig. 4). It was positive while the analogous rate for *T. minutum* was negative. At low host densities the number of progeny per host for *T. platneri* was near 0 while that of *T. minutum* was near 3. As host density increased to 20–25 hosts the value for both species became nearly equal at about 1.6.

There were no significant intraspecific differences for control groups of either species in the number of hosts parasitized or number of progeny per parasitized host (ANOVA, $P > 0.05$) (Table 3). Interspecific comparisons of the number of hosts parasitized revealed no significant differences (ANOVA, $P > 0.05$) but the number of progeny per parasitized host was significantly higher for *T. platneri* (ANOVA, $P < 0.05$).

Comparisons of limited group data revealed 2 significant differences. For *T. platneri* the number of parasite eggs per host after a 24 hour exposure to parasites was significantly larger than after a 2 or 8 hour exposure (Tukey's Test, $P < 0.05$) (Table 4). A similar difference for *T. minutum* was not found (Tukey's Test, $P >$

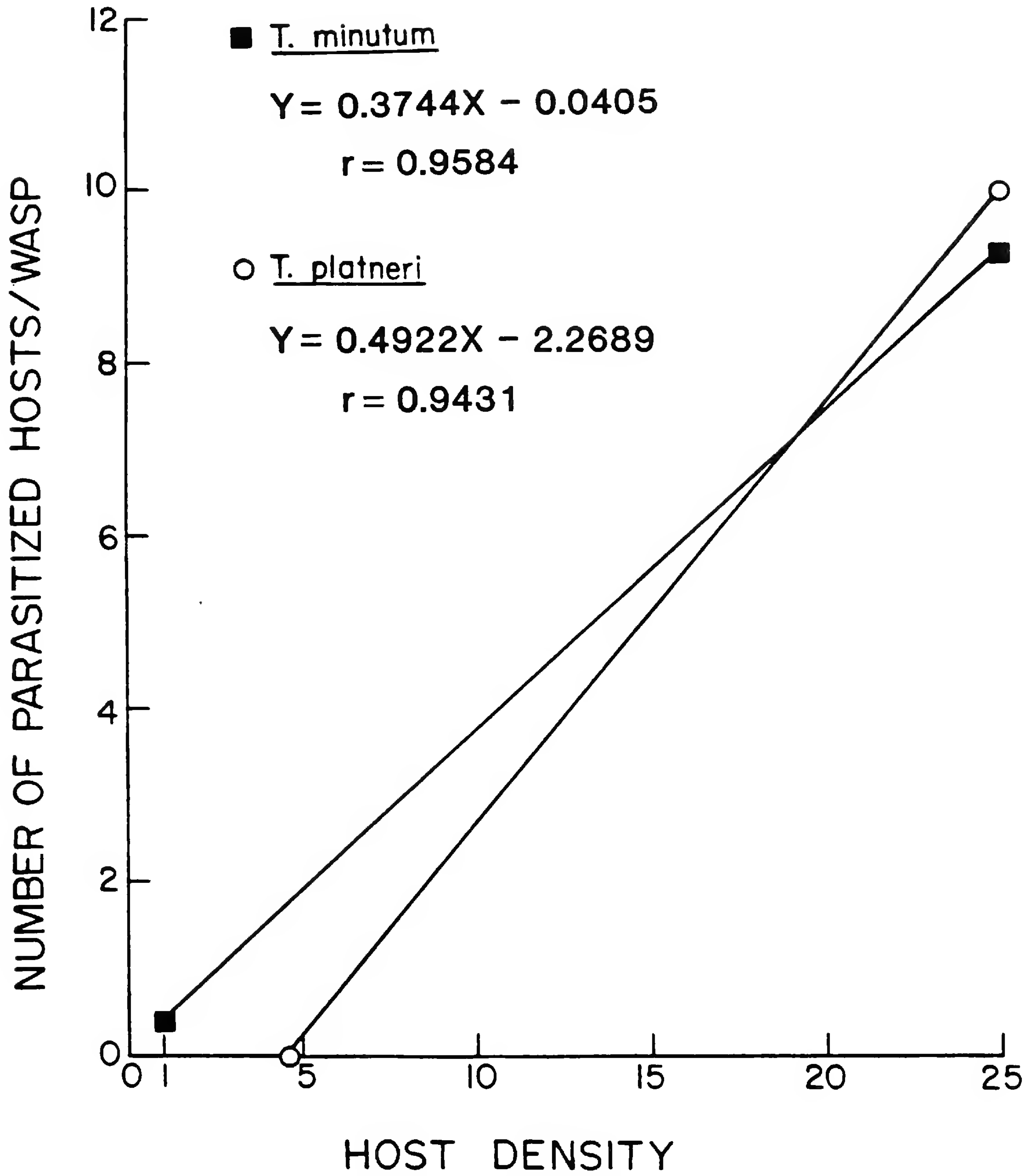

Figure 3. Number of parasitized hosts per parasite at different host densities (number of host eggs available).

0.05). The number of parasite eggs per host after a 24 hour exposure to *T. platneri* was significantly larger than after an equal or shorter exposure to *T. minutum* (Tukey's Test, $P < 0.05$). The number of progeny per parasite, and number of hosts parasitized were similar in *T. minutum* and *T. platneri* (Tukey's Test, $P > 0.05$).

DISCUSSION

The few ecological differences found here indicate properties of the lab cultures tested. They may not represent true differences between these 2 nominal species. That these species are closely related is evident from their extreme morphological

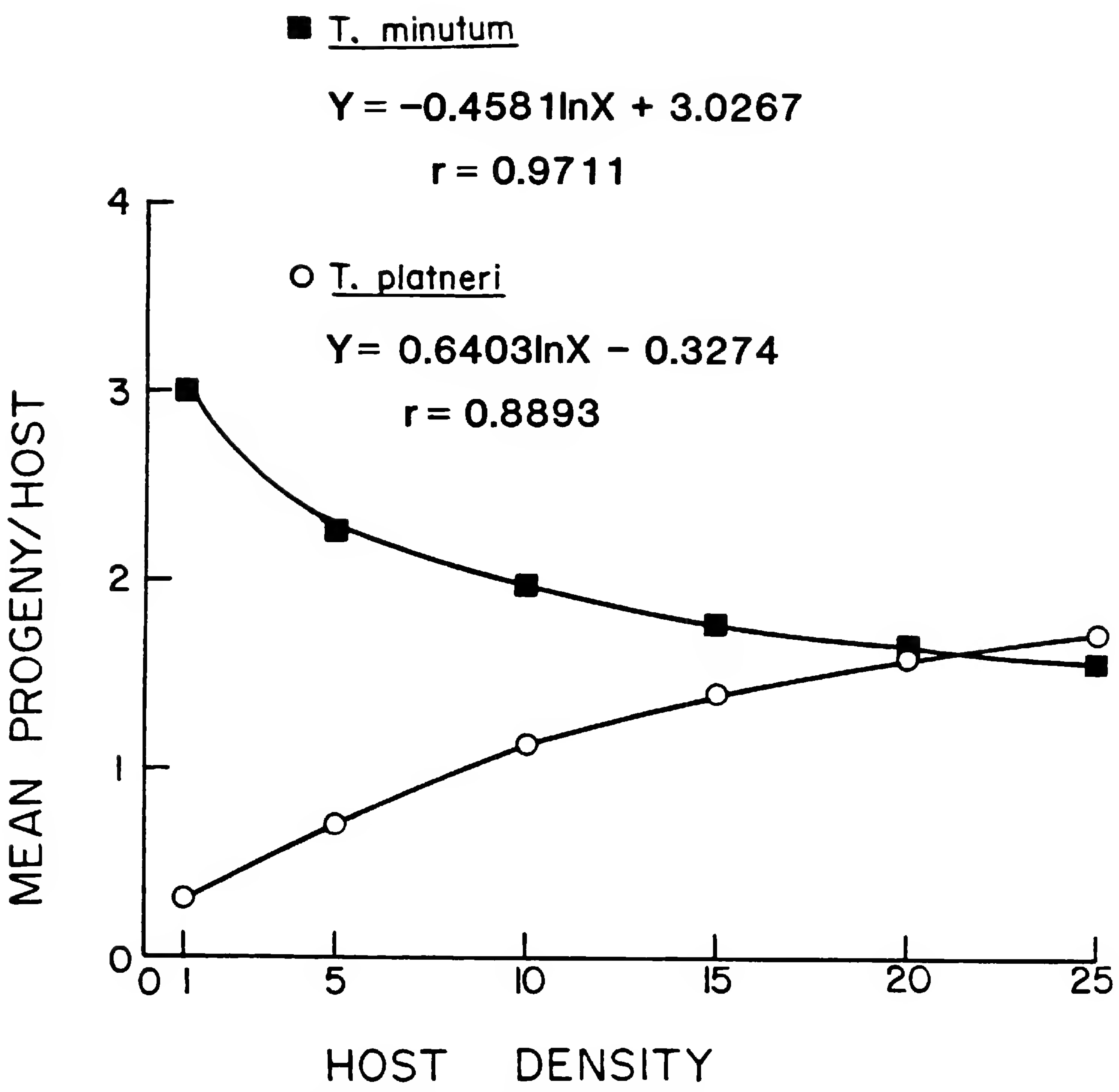

Figure 4. Number of progeny per parasitized host at different host densities (number of host eggs available).

similarity and essentially identical immature development, mating and ovipositional behavior.

One criticism against testing material which has been cultured in the laboratory for long periods is that it no longer possesses the same properties as wild material due to different selection pressures in the lab, small gene pools, genetic drift etc. Many *Trichogramma* colonies are initiated with parasites reared from a single host (i.e., probably siblings). Whether they adequately represent the variation present in wild populations is unknown. Cultures started with siblings experience severe inbreeding and receive no new genetic diversity (except mutations) unless wild material is added periodically. The rate of loss of genetic diversity is proportional to the amount of inbreeding. This increase in homozygosity is inversely correlated with the initial homozygosity level (Festing, 1979). As homozygosity increases a phenomenon known as inbreeding depression occurs as deleterious recessive alleles become homozygous. This most severely affects organisms which are outbreeders. Those which are inbreeders in nature are not affected as much in the lab (Festing, 1979). The haplo-diploid reproduction of Chalcidoids facili-

Table 3. Number of parasitized hosts and progeny per parasitized host at different exposure periods (control group). ($\bar{x}$ = mean, SD = standard deviation.)

Exposure (hr)	Parasitized hosts		Progeny per parasitized host	
	$\bar{x} \pm$ SD	Range	$\bar{x} \pm$ SD	Range
		T. minutum		
2	16.0 ± 8.277	9–26	1.571 ± 0.360	1.111–2.100
4	23.0 ± 3.937	17–27	1.693 ± 0.306	1.217–2.000
8	14.2 ± 12.133	0–29	1.551 ± 0.352	1.167–2.000
24	17.6 ± 6.388	11–25	1.861 ± 0.215	1.564–2.000
		T. platneri		
2	4.0 ± 5.657	0–8	2.000 ± 0.000	2.000
4	28.0 ± 15.556	17–39	1.956 ± 0.228	1.795–2.118
8	35.0 ± 11.314	27–43	1.880 ± 0.039	1.852–1.907
24	35.0 ± 22.627	19–51	1.977 ± 0.116	1.895–2.059

tates the elimination of deleterious recessives through haploid males (Askew, 1968). High degrees of natural inbreeding, such as the prevalent sibmating of *Trichogramma,* seem characteristic of many Chalcidoids, at least when parasite density is low. One would predict low amounts of inbreeding depression in lab cultures. However, Legner (1979) noted a lower net intrinsic reproduction rate in 2 cultured Pteromalids when compared to wild conspecifics. For this reason and to examine the extent of intraspecific variation present in wild *T. minutum* and *T. platneri* populations, more samples of each need to be examined.

Adult longevity and immature mortality (through increased host mortality) did not seem to be affected by either the repiercing or host feeding engaged in by *T. platneri.* Although *T. platneri* superparasitized hosts after a 24 hour exposure to low host and high parasite density, neither it nor *T. minutum* did at less stressful conditions probably more like those in nature. The low level of parasitization behavior of *T. platneri* at low host and parasite densities seems to contradict high parasitization rates seen in nature (Oatman et al., 1983). This may indicate a lab induced loss of vigor analogous to Legner's Pteromalids (Legner, 1979).

The lack of preference for host eggs of a certain age contradicts the findings of Marston and Ertle (1969). They noted that *T. ni* eggs between the ages of 19–39 hours were parasitized (or killed) significantly less often than younger or older eggs. Eggs of all ages were punctured just as often; evidently oviposition was restrained. Their experiments were performed at the same conditions as mine. Possibly their *T. ni* culture was different as eggs from it hatched in 69 hours while mine hatched in 60–62 hours. Their *T. minutum* originated from a Rincon Company culture which had been maintained in the lab for 10 years.

Taxonomically the results are inconclusive. If they are indicative of *T. minutum* and *T. platneri* populations in nature they support the validity of species status for *T. platneri* (rather than being a strain of *T. minutum*) according to the methods of Doyen and Slobodchikoff (1974). Some sort of postmating isolating mechanism operates between the lab cultures tested. Whether such a mechanism separates all populations which are compatible with the *T. platneri* culture tested here from all other *T. minutum* morphotypes is unknown. Only examination of more samples without long periods of lab rearing will answer these questions.

Table 4. Number of parasitized hosts per parasite, progeny per parasitized host and parasite eggs per parasitized host at different exposure periods (limited group). ($\bar{x}$ = mean, SD = standard deviation.)

Exposure (hr)	Parasitized hosts per parasite		Progeny per parasitized host		Parasite eggs per parasitized host	
	$\bar{x} \pm$ SD	Range	$\bar{x} \pm$ SD	Range	$\bar{x} \pm$ SD	Range
			T. minutum			
2	1.6 ± 0.548	1–2	2.00 ± 0.612	1.5–3.0	2.00 ± 1.414	1–4
4	1.8 ± 0.837	1–3	2.27 ± 0.453	2.0–3.0	2.60 ± 1.817	0–5
8	1.6 ± 1.140	0–3	2.17 ± 0.527	1.5–2.7	4.00 ± 1.581	2–6
24	2.0 ± 1.000	1–3	2.47 ± 1.017	1.7–4.0	3.67 ± 2.517	1–6
			T. platneri			
2	0.0 ± 0.000	0.0	–	–	0.00 ± 0.000	0.0
4	1.5 ± 2.121	0–3	3.70 ± 0.000	3.7	3.00 ± 4.243	0–6
8	1.0 ± 0.000	1.0	3.00 ± 1.414	2–4	1.50 ± 0.707	1–2
24	0.5 ± 0.707	0–1	4.00 ± 0.000	4.0	11.00 ± 1.414	10–12

From a biocontrol perspective the parasitization efficacy and growth rate differences would suggest that *T. minutum* (the culture tested) would be the better choice for controlling an applicable pest at 27 ± 1°C and 50% relative humidity. Examination of these and other cultures at different environmental conditions to outline optima and tolerance limits would help indicate under which conditions which culture would be the most effective. Repeated examination of these cultures over an extended period of time could help indicate to what degree inbreeding altered their ecological characteristics.

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A New Species of *Strangalia* (Coleoptera: Cerambycidae) from Western Mexico

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Abstract.—A new lepturine species, *Strangalia hamatipes,* is described from the Mexican state of Jalisco. A revision of the most recent key to males of the genus, and a figure are provided. *Strangalia linsleyana* is proposed as a replacement name for *S. linsleyi* Giesbert, 1985, a name preoccupied by *S. linsleyi* Gressitt, 1951 from China.

The following paper is presented as an addition to the recent work on the genus *Strangalia* Audinet-Serville in Mexico and Central America (Giesbert, 1985). The new species described is closely related to *S. opleri* Chemsak and Linsley (1976) from Costa Rica, and *S. palaspina* Chemsak (1969) from Sinaloa, Mexico.

The key to males in the previous paper may be modified to include males of the present species as follows:

2(1). Metatibiae without distinct carinae or preapical tubercles 3
– Metatibiae carinate at least apically along inside edge from base of inner spur, or with a preapical tubercle on inside edge 11
13(12). Metatibiae arcuate, apices with a single spur in addition to broad plate; abdomen exceeding elytral apices by about 1½ segments. Sinaloa, Mexico .... *S. palaspina*
– Metatibiae nearly straight, apices with 2 spurs in addition to broad plate; abdomen exceeding elytral apices by about 2 segments 13a
13a(13). Pronotum and elytra yellow and black; profemora and protibiae modified with obtuse processes; apices of metafemora black. Costa Rica .... *S. opleri*
– Pronotum and elytra orange-testaceus; profemora and protibiae modified with acute triangular processes; metafemora orange. Jalisco, Mexico .... *S. hamatipes*

Strangalia hamatipes, NEW SPECIES
(Fig. 1)

Male.—Form moderate sized, elongate, strongly tapering posteriorly; integument orange testaceus, with tips of mandibles, eyes, antennae, distal ⅙ to $\frac{1}{10}$ of metatibiae, metatarsi, concave faces of coxae, and anterior borders of episterna blackish; mesotarsi fuscous. Head with front elongate, finely, shallowly punctate; vertex finely, densely punctate, finely, inconspicuously micropubescent, with fine longitudinal median impression; antennae nearly attaining elytral apices, segments

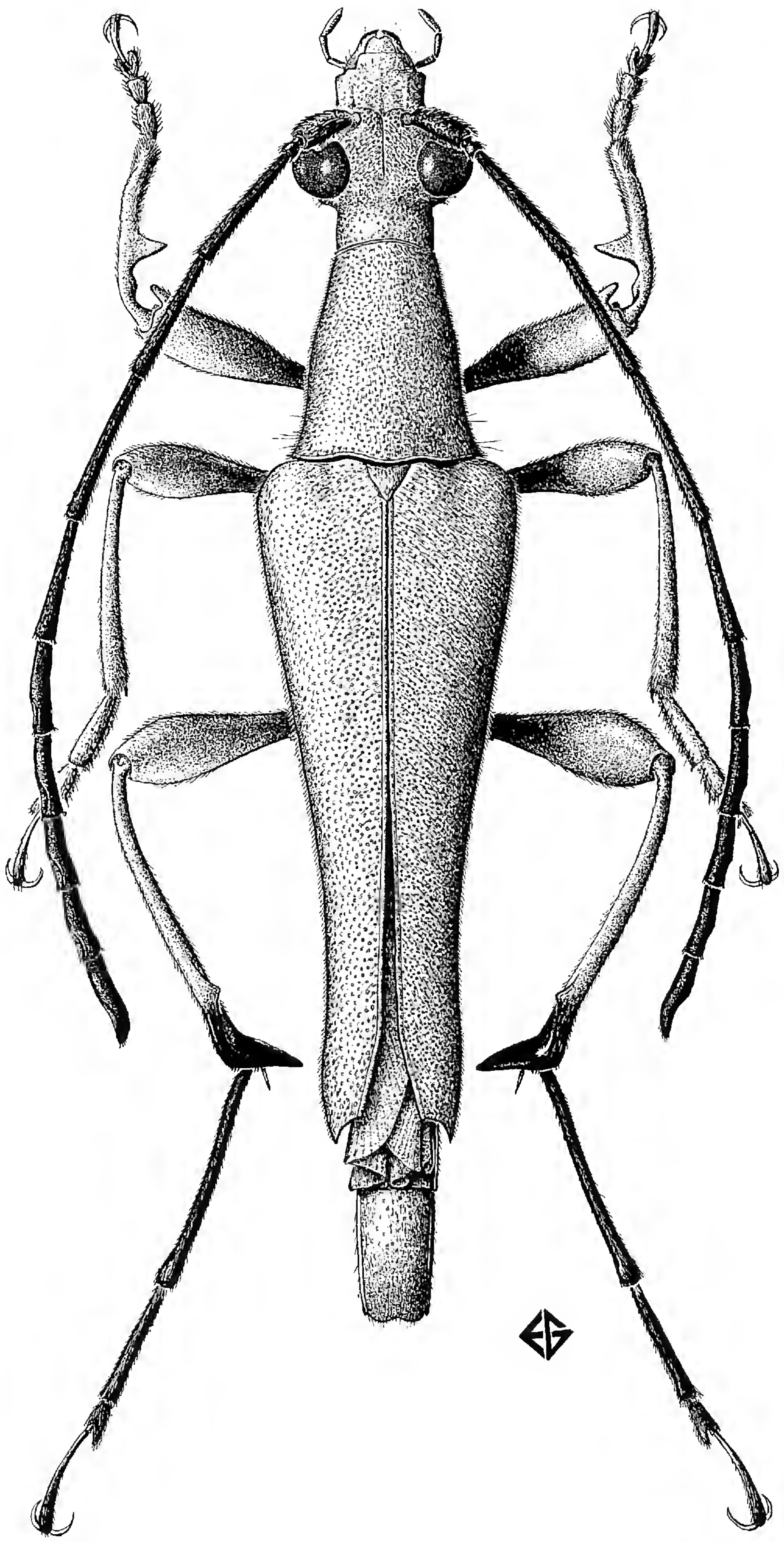

Figure 1. *Strangalia hamatipes,* new species. Male.

7–11 slightly thickened and provided with moderate sized sensory pits, segments to 6th with depressed black pubescence, remaining segments micropubescent. Pronotum longer than basal width, sides nearly straight, tapering anteriorly; disk evenly convex, with fine dense punctures becoming feebly, transversely subrugose on basal ½; pubescence short, suberect, golden, with a few long erect hairs laterally near base. Prosternum finely, shallowly punctate near coxae, finely pubescent; mesosternum and metasternum finely, densely punctate and pubescent, less so in proximity to a closely placed centro-apical pair of small acute tubercles on metasternum. Elytra slightly less than 3 times as long as basal width, sides tapering to apical ⅙, slightly dehiscent before obliquely emarginate apices; punctures distinct, small, moderately dense; pubescence short, suberect, moderately dense, golden. Legs moderately slender, protibiae arcuate at base, with acute triangular flat process on inside at basal ⅓; profemora thickened, abruptly narrowed near base, apex with small excavation bordered dorsally by a distinct flat triangular process; metatibiae nearly straight, with apices modified internally into triangular flat plates, preceded by a short carinate tubercle, and each with an unequal pair of apical spurs. Abdomen narrow, elongate, extending 2 segments beyond elytral apices; sternites finely, densely punctate and pubescent basally, with punctures becoming coarser and sparser apically on each segment; terminal sternite about 1½ times as long as basal width, nearly cylindrical, not excavated, with obtuse longitudinal carina, apex finely crenulate. Length 14–18 mm.

Female. — Form slightly more robust than male; metatibiae blackish throughout; antennae surpassing middle of elytra; protibiae, profemora, and metatibiae unmodified; abdomen more robust, not elongate, extending about 1 segment beyond elytral apices; terminal sternite apically subtruncate to feebly bisinuate, outer angles acute. Length 14–18 mm.

Holotype male, *allotype* (UNAM, Mexico City), and 9 *paratypes* (6 males, 3 females) from MEXICO, Jalisco, Estación de Biología "Chamela," July 10–20, 1985 (E. Giesbert), July 11, 1985 (Chemsak, Katsura & Michelbachers) 7 additional male *paratypes* from MEXICO, Jalisco, 7 km S El Tuito, 1600′, on blossoms of *Croton* sp., July 21, 1985 (E. Giesbert).

Remarks. — Males of this species may be easily recognized by the unusual modification of the prolegs, which may function as a grasping mechanism during mating. Modification of the metatibiae is similar to that of *Strangalia opleri* Chemsak & Linsley of Costa Rica. A strong resemblance to *S. palaspina* Chemsak in basic form, color, and general area of distribution may have led to the determination of *S. hamatipes* as *S. palaspina* in some collections, the females, in particular, being quite similar. In the series of *S. hamatipes* at hand, no evidence of the black markings usually present on the dorsum and metafemora of *S. palaspina* is seen, however.

A series of male specimens collected in company with *S. hamatipes* at the El Tuito locality, although easily distinguished from the latter, differs also from typical *S. palaspina* by the presence of a small tubercle on the inside of the protibiae at the basal ⅓, and by a somewhat increased melanism. This population would seem at the present time to be best assigned to *S. palaspina,* which it resembles closely in all other respects.

***Strangalia linsleyana,* REPLACEMENT NAME**

The recently proposed *Strangalia linsleyi* Giesbert, 1985 has been found to be a homonym, being preoccupied by *S. linsleyi* Gressitt, 1951 from China. In order to preserve the patronym, *S. linsleyana* is here proposed as a replacement name for *S. linsleyi* Giesbert.

ACKNOWLEDGMENTS

The author wishes to thank Luis Alfredo Pérez J., Dr. Stephen J. Bullock, and Dr. Thomas H. Atkinson of the Instituto de Biología, UNAM, Mexico, for their help and hospitality at the Chamela Biological Station; and John A. Chemsak for his helpful input both in the field and with the manuscript.

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Construction of a Compact Submersible Aquatic Light Trap

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Abstract.—Instructions are provided for the assembly of a two funnel submersible light trap. This qualitative sampler can be used for collecting a broad range of photrophic macroinvertebrates from both lentic and lotic habitats. The body and funnels are constructed from plastic to prevent corrosion and breakage.

Over the years there have been nearly as many aquatic light trap designs as there are entomologists who use them in the field. Each of these is a variation of the basic design consisting of a light, a funnel trap and a power source. All were found to have their little foibles. They were either too large to be carried into the field in great numbers or the trap portion was made of glass and easily broken. Traps made from glass or other transparent material wasted much of their energy by the insects being attracted to the sides of the jar rather than being directed into the funnel.

The trap described below is compact, durable and efficient over a broad spectrum of neustonic invertebrates which are attracted to light.

Suggestions for improvements were made by the many people who field tested this trap, especially Clifford Kitayama who helped from the time of its inception through the final design.

CONSTRUCTION

The body (item 1, list of materials) is made from a 4 in. I.D., ¼ in. wall, polyvinylchloride pipe cut into 8 in. lengths. A 1⅛ in. hole is drilled through the side of the pipe, at an equal distance from each end. Four ¹⁄₁₆ in. holes are drilled, two into each end, at 90° to the 1⅛ in. hole and ½ in. number 4 pan head screws (item 2) are inserted. A combination square with a center finding head aids in aligning the holes prior to drilling (Fig. 1).

The 4 in. kitchen funnels (item 3) are notched at opposite sides on the lip at 45° and 135° to the tab that is used to hang it on a cup hook. Squeeze-type paper punch pliers were used to make these hemispherical notches. If an 8 oz. Lustroware funnel manufactured by Borden is used, there are four equally spaced lines molded into the funnel which simplify centering of the notches. Cut off the small end of the funnel to prevent the ends from touching the light when the unit is assembled (Fig. 2). The amount removed is at the discretion of the builder. The larger the hole, the larger the insect that will be admitted. The funnels are installed by aligning the notches with the screws and rotating the lip of the funnel under the inner side of the head of the screw so that there is a slight resistance of the lip to the under side of the head of the screw when rotating the funnel (Fig. 3).

The light is constructed by soldering a 3 volt, 6 volt or 12 volt light bulb (item

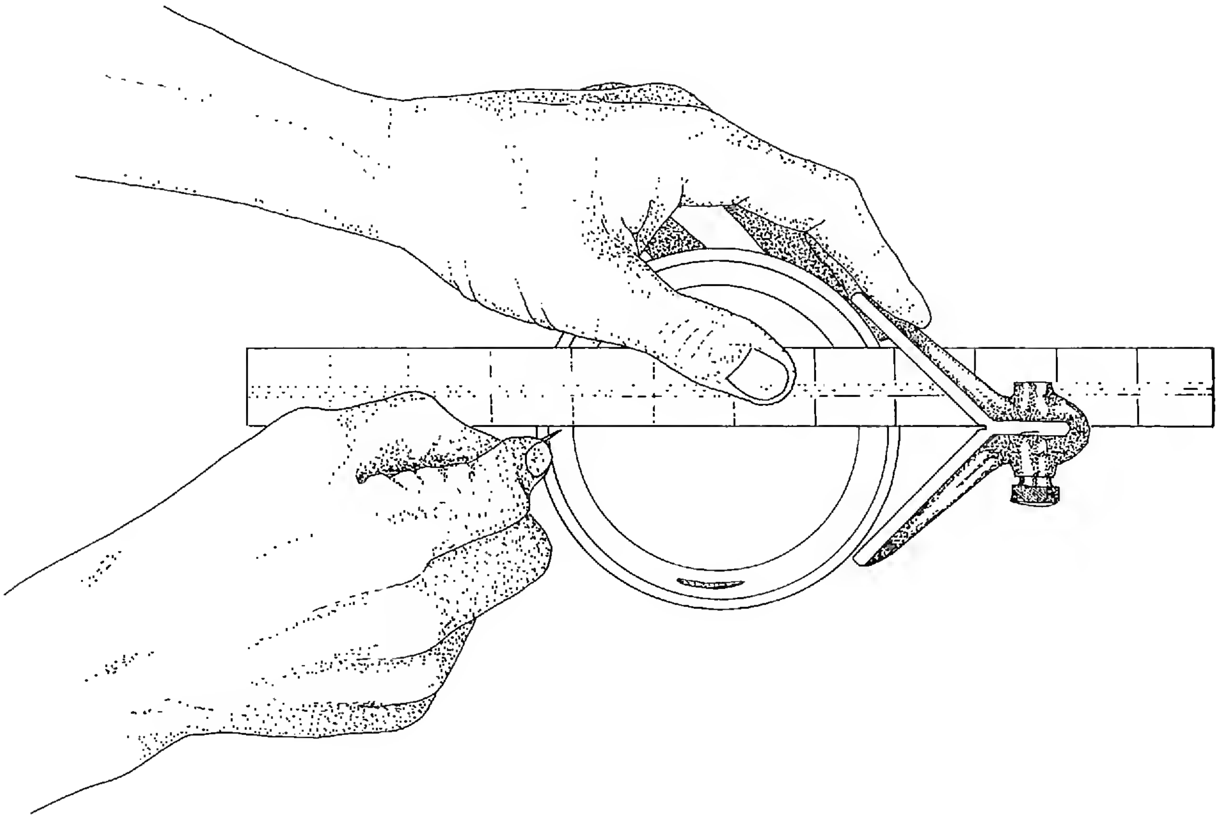

Figure 1. A center finding head is used to locate positions for drilling $^1/_{16}$ in. holes.

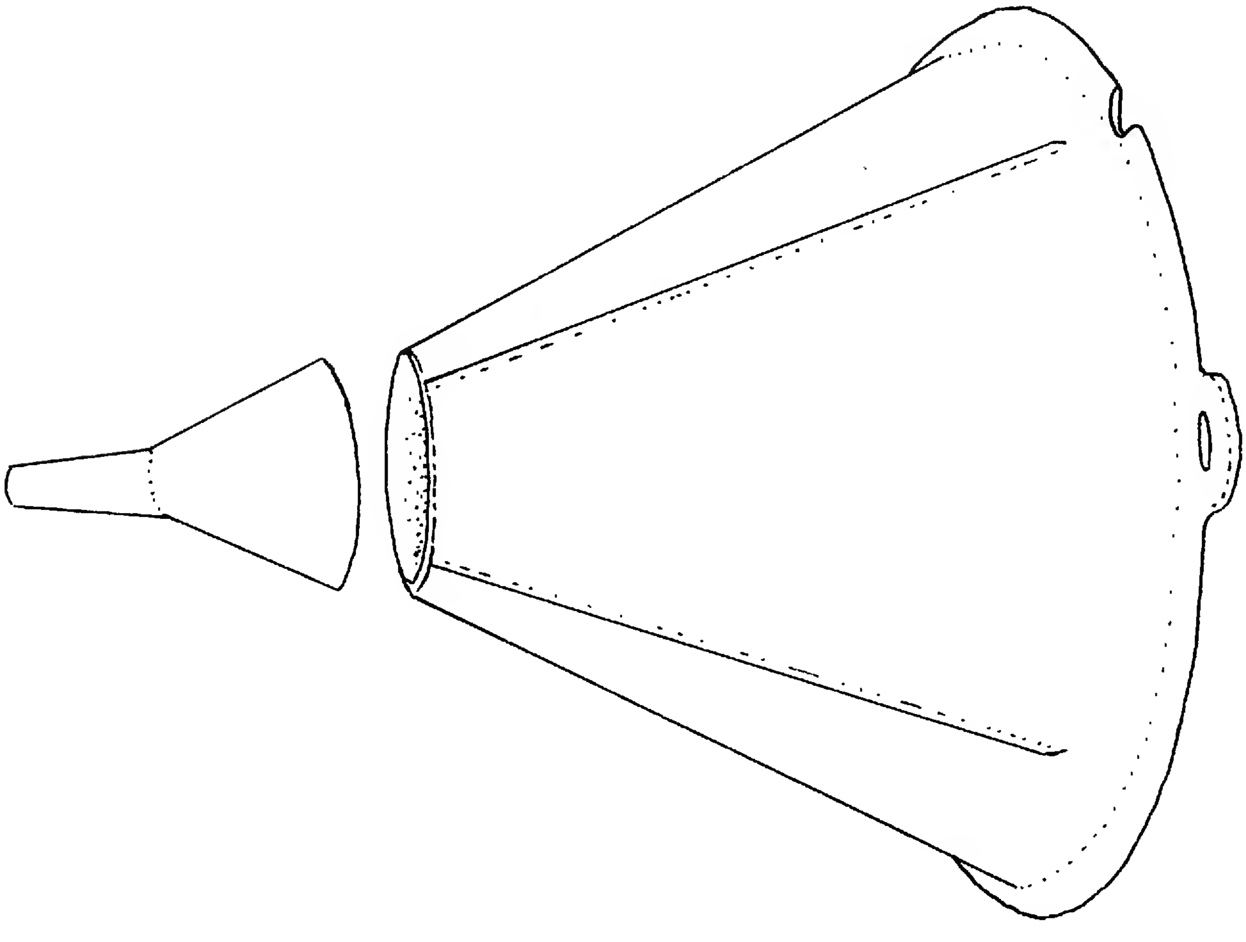

Figure 2. Cut off the end of the funnel to produce the desired size hole.

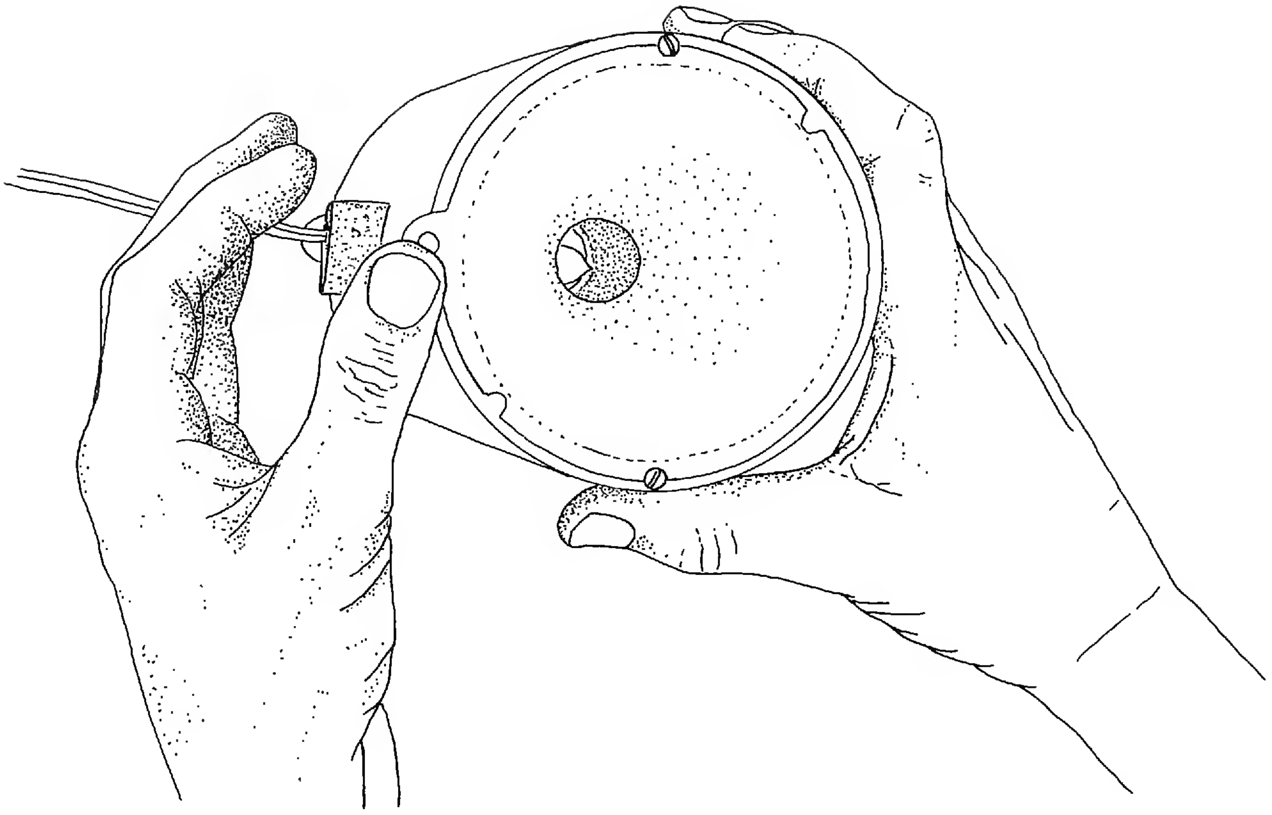

Figure 3. Align the hemispherical notches with the two screws, then rotate the lip of the funnel under the heads of the screws.

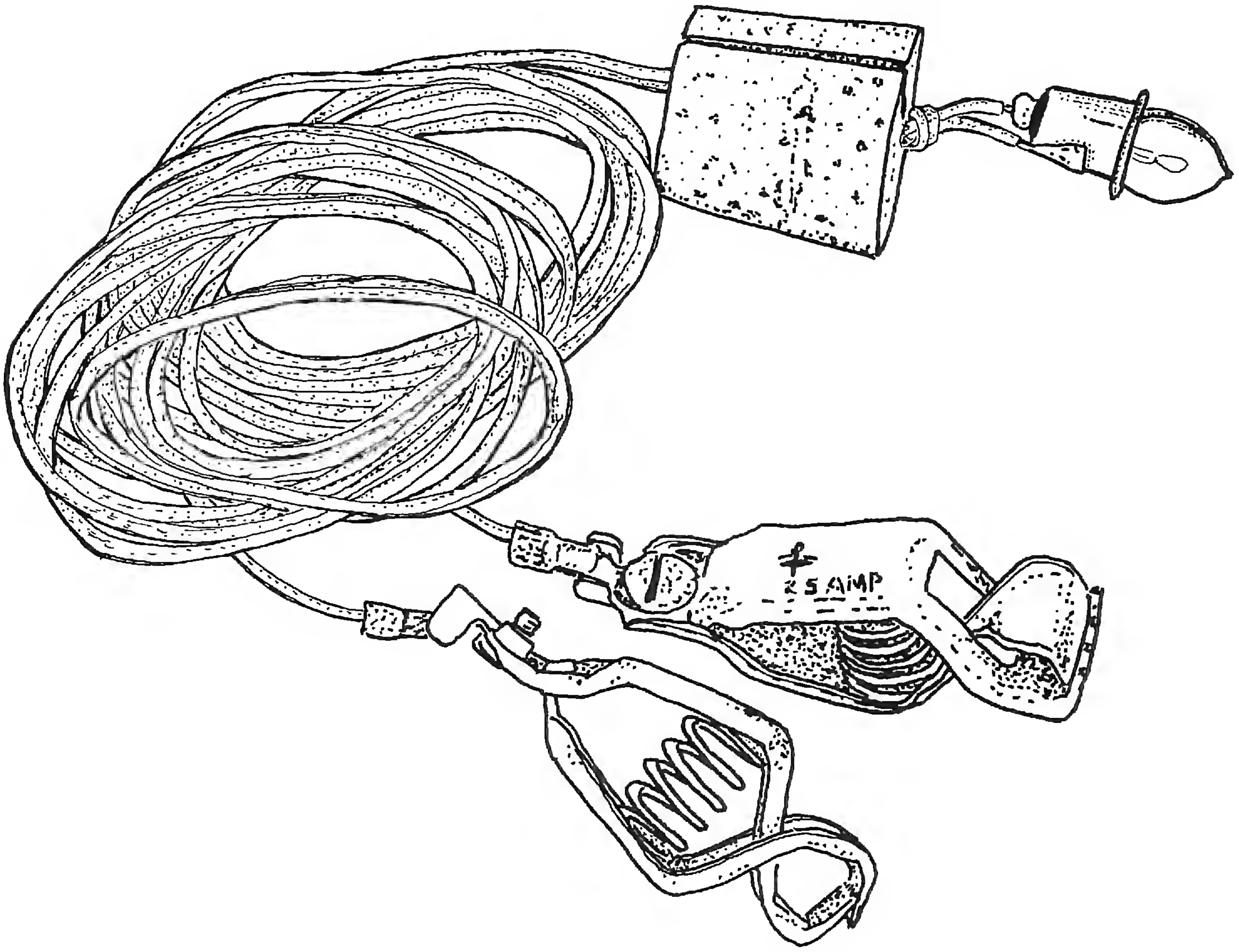

Figure 4. Assembled light for use with 12-volt auto battery.

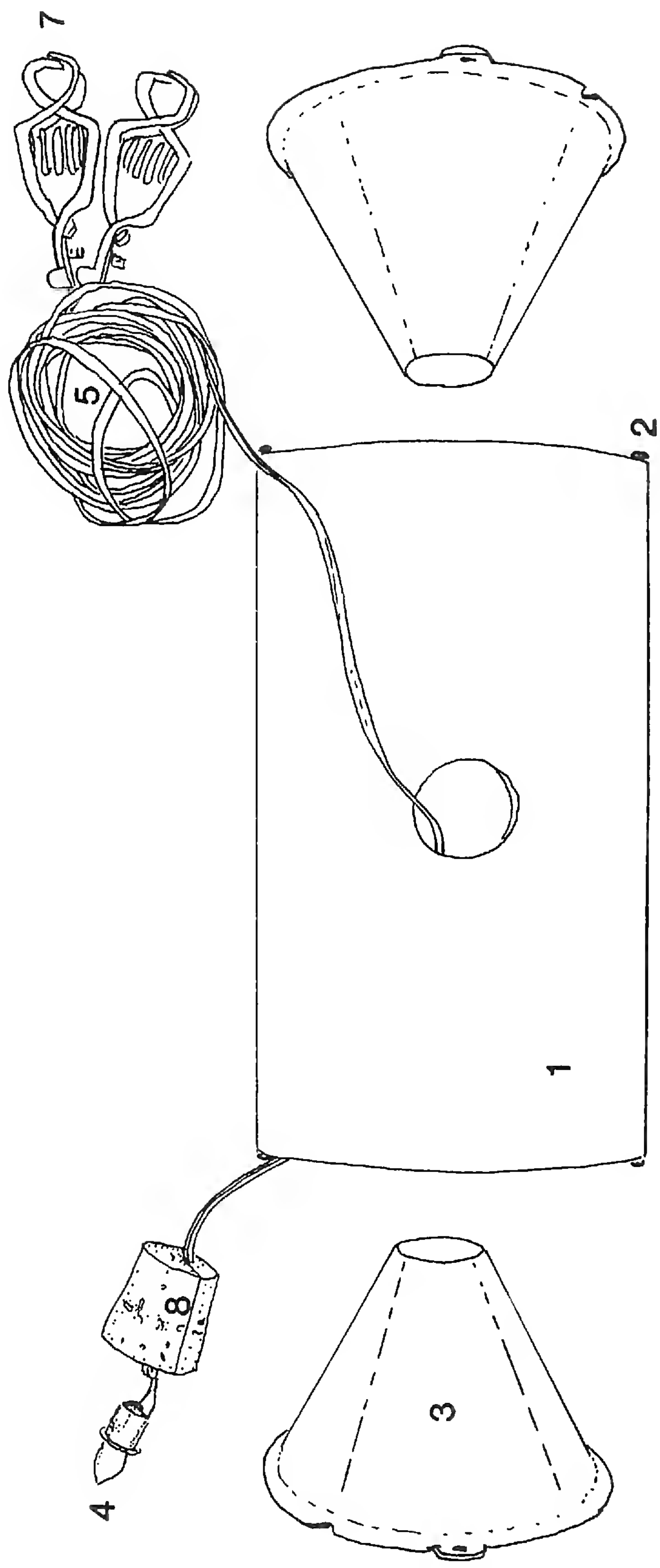

Figure 5. Exploded view of completed light trap.

4) to the end of a 22 gauge 2-strand wire (item 5). A 7 m (20 ft) length of wire is convenient, but the length may be varied to meet different requirements. Cut the end of the wire that is soldered to the center of the light bulb slightly shorter than the wire that is soldered to the side of the bulb (Fig. 4). This will relieve strain and prolong the life of the wires. The free ends of the wires are stripped and a $\frac{3}{16}$ in. lug (item 6) can be crimped or soldered to the end of the wires. This allows the lug to be used directly on a 6 volt lantern battery with screw posts. If charging clips (item 7) are attached to the wires they can be connected to a 6 volt spring-type battery or to a 12 volt automotive battery. If rechargeable D-cells are used with a 3 volt light, hook four batteries in parallel sets of two. This will prevent the batteries from becoming too greatly discharged if they are allowed to run all night. Cut a number 6 cork (item 8) longitudinally halfway through with a saw. Tie a knot in the wire at the base of the light bulb and insert the wire into the cut in the cork with the knot towards the larger end of the cork. Remove the funnels from the pipe body and thread the wire through the $1\frac{1}{8}$ in. hole from the inside. The cork stopper is tightened into the hole by pulling on the wire. If you wish to attach the funnels to the trap so as not to lose them, tie a double knot in the wire about six inches from the light and attach a piece of cord to the tab on one of the funnels and run the cord through the loop in the wire and attach the free end of the line to the tab on the other funnel.

DISCUSSION

This trap was found to be a rugged versatile unit that is extremely efficient in lentic and slow lotic water. Simple modifications are possible for different situations. To allow entry of crawling insects a piece of waterproof contact sandpaper is attached to the entire lower surface of the funnel. Cut the sandpaper slightly longer than the lip of the funnel so that it comes in contact with the substrate.

This trap is more dense than water and sinks. To collect on the surface, attach pieces of styrofoam to the trap with waterproof tape. Conversely, collecting at a given height from the bottom can be achieved with a weight and a desired length of tether. Variations in the design are larger or smaller diameter pipe and corresponding funnels. A three inch trap can easily be backpacked into the most inaccessible high mountain lakes leaving ample room in the pack for a fishing pole.

Do not leave the trap unattended for more than about thirty minutes until it is apparent what is being collected. If not removed frequently, the more voracious predators will leave you with few good specimens. The trap must also be emptied just before daylight to prevent the insects from being lured out by the light entering through the holes in the funnels.

On several occasions swarms of aquatic insects could be seen swimming around the trap but only a few were found inside the trap when emptied. Closer examination showed the insects were being eaten by the fish as rapidly as they were approaching the funnel openings. In situations where extreme fish predation occurred, a 3 ft × 3 ft × 3 ft, five-sided cage made of $\frac{1}{2}$ in. hardware screen was placed over the trap.

LIST OF MATERIALS (Fig. 5)

1. (1) 4 in. inside diameter × ¼ in. wall polyvinylchloride pipe, 8 in. long.
2. (4) ½ in. number 4 pan head tapping screw, type AB.
3. (2) 4 in. kitchen funnel, 8 oz.
4. (1) 3 volt, 6 volt or 12 volt light bulb.
5. (7 m (20 ft)) 22 gauge two-strand wire.
6. (2) $^{3}/_{16}$ in. lug, size 22-18 gauge.
7. (2) charging clips, 25 amp.
8. (1) number 6 cork.

PUBLICATIONS RECEIVED AND BRIEFLY REVIEWED

A Revision of the Subfamily Coelidiinae (Homoptera: Cicadellidae). V. New tribes Hikangiini, Youngolidiini, and Gabritini. By M. W. Nielson. Pacific Insects Monograph, No. 40, 78 pp., 252 figs. 1983 (issued prior to 13 September 1983, at which time a notice was mailed by editor correcting an error on the subtitle on the front cover—not to read "IV. Coelidiini"). Published and distributed by Bishop Museum Press, P.O. Box 19000-A, Honolulu, Hawaii 96817, USA. Price $16.50 paperbound. ISSN 0078-7515.

The abstract states:

> This paper is the 5th and last part of a worldwide revision of the subfamily Coelidiinae. The first 4 parts covered the tribes Tinobregmini, Sandersellini, and Tharrini (Part 1), Thagriini (Part 2), Teruliini (Part 3), and Coelidiini (Part 4). Three new tribes, Hikangiini, Youngolidiini, and Gabritini, are described. A revised key to all of the known tribes is given to show a more reasonable phylogenetic relationship than has been presented heretofore. Keys, descriptions, and illustrations are provided for 41 species in 8 genera. Two genera and 6 species are treated in the tribe Hikangiini, all from the Ethiopian Region. Five genera, 2 from the Ethiopian Region and 3 from the Neotropical Region, with 31 species are elucidated in the tribe Youngolidiini. In the tribe Gabritini, 1 genus and 4 species are treated. A separate checklist, with synonyms, is given for the genera and species of each tribe.

—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

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Polistes major (Hymenoptera: Vespidae) Predation of the Treehopper, *Umbonia crassicornis* (Homoptera: Membracidae)

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Abstract.—*Polistes major* Palisot de Beauvois hunted for the treehopper, *Umbonia crassicornis* Amyot and Serville, by randomly contacting with their mandibles any object that protruded beyond the branch surface until they found a treehopper. They then altered their behavior and repeatedly attacked the prey. When female treehoppers were attacked, they usually sat quietly throughout the attack and none were captured. When nymphs were attacked, they moved away from the wasp while the parent female actively repulsed the paper wasp.

Umbonia crassicornis Amyot and Serville is a membracid that is an occasional pest of leguminous trees and shrubs in southern Florida (Butcher, 1953; Mead, 1962). A female will oviposit in host plant tissue which can be encircled with the metathoracic legs (Dowell and Wood, pers. comm.). She will guard her eggs until just before eclosion at which time the parent female will make a series of feeding slits in the host plant tissue below the egg mass. The female actively maintains the nymphs in an aggregation and defends them against predators. Eggs or small nymphs without an attendant female have low survival rates (Wood, 1974, 1976).

Predation is considered a major factor influencing the evolution of presocial behavior in membracids (Wood, 1974) and a number of predators have been observed feeding on *U. crassicornis,* including spiders, assassin bugs, coccinellids, lygaeids, anthocorids, and pentatomids (Wood, 1976). Beyond this, little is known of the predator-prey relationship for *U. crassicornis.* We describe the predatory behavior of *Polistes major* Palisot de Beauvois on *U. crassicornis,* and the responses of the prey.

METHODS

We observed individual paper wasps hunting on powder puff plants (*Calliandra* sp.) at two sites at Fort Lauderdale, Broward County, Florida in May and June 1978, 1979, and 1980. Three to 7 days were spent each year observing the behavior of the wasps and membracids. A wasp ($n = 60$) was observed as it flew near the powder puff plants and was followed until it left the area. We noted the behavior of the wasp, the number of times it contacted individual branches, whether *U. crassicornis* was present and its instar, whether the wasp successfully captured prey and the instar captured, and the responses of the *U. crassicornis* nymphs and adult females to the wasp attack.

RESULTS

A paper wasp would fly to the powder puff plant and began to fly slowly in an up and down pattern within 1–2 cm of the outer branches. The wasp made contact with any object protruding from the underside of the branch surface. Contact was made with the mandibles, as in other *Polistes* spp. (Rabb and Lawson, 1957). Leaf bracts were encountered more frequently ($n = 421$) than *U. crassicornis* ($n = 291$). Each wasp made contact with an average of 12.5 ± 3 ($\bar{x} \pm$ S) branches per minute. A wasp seldom made more than one contact with a branch lacking prey (1.1 ± 0.05, $n = 392$ branches). The paper wasp continued this search pattern until it contacted an *U. crassicornis* nymph or adult. The wasp then began to fly rapidly in an up and down pattern in a series of attempts to seize the treehopper with its mandibles. A wasp made significantly more contacts with branches having *U. crassicornis* (4.9 ± 4.8, $n = 59$ branches) than without. When a parental female was the intended prey, the attacks were directed accurately toward her. In contrast, the wasp attacked any nymph within 4 cm of the initial contact point.

Twenty-one parental females guarding eggs were attacked, but none were captured. When attacked, a female on eggs either sat motionless on the branch or fanned her wings and tilted forward. The adult treehopper appeared to be too large for *P. major* to seize in its mandibles although we observed several *Sphecius speciosus* (Drury), a larger wasp that preys on cicadas, capturing *U. crassicornis* adults in 1980.

When nymphs were attacked, they moved away from the wasp. The parent female quickly responded to the nymphs' alarm pheromone (Wood, 1976) by moving toward the wasp while fanning her wings, twisting and tilting forward. She attempted to physically intervene and drive the wasp away. The wasp generally redirected its attack toward the parent female. This behavior was effective in repulsing 81% of the attacks by individual paper wasps.

The paper wasp continued its attacks against the nymphs until driven off by the parent female or until it captured a nymph. A wasp made more contacts with an aggregation from which it captured a nymph (7.6 ± 5.4 contacts, $n = 11$ aggregations) than with those where they were unsuccessful (4.3 ± 4.5, $n = 48$). An unsuccessful paper wasp continued hunting. A successful wasp flew to a nearby branch and chewed the nymph into a ball before leaving the area. Variation in the color pattern of the paper wasps allowed us to ascertain that individual wasps were returning to the powder puff trees over several successive days.

When the parental female was absent, the wasps were successful in capturing nymphs 90% of the time. The low number of aggregations without a female ($n = 2$) precludes statistical analysis.

Nymphs captured were 1st (9%), 2nd (28%) and 3rd (63%) instars. We observed no nymphs larger than 3rd instar being captured despite attempts by 17 wasps.

The defensive behaviors exhibited by *U. crassicornis* to the paper wasps are the same as those observed against other predators (Wood, 1976) and are similar to those observed in other treehoppers (Hinton, 1977). In 1978 and 1979, the wasps ceased hunting for *U. crassicornis* after 1–2 weeks, despite the continued presence of nymphs. Only 1–2 wasps were observed searching each tree. In 1980, the wasps discontinued hunting on powder puff plants only after virtually all nymphs were gone, a behavior more typical of *Polistes* spp. (Kasuya, 1980; Rabb and Lawson, 1957; Yamasaki et al., 1978). In 1980 7–10 wasps were observed per tree.

Although *P. major* is a predator of *U. crassicornis,* it is difficult to estimate the effect it has on treehopper numbers. Treehopper females can effectively repulse the wasps from their progeny. However, large numbers of persistent paper wasps can eventually capture most nymphs as they did in 1980.

ACKNOWLEDGMENTS

We thank Dr. L. Stange, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Florida for identifying the *Polites* wasp, and Ray Gill and John Sorensen for reviewing an earlier draft of this manuscript.

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Two New Species of *Spalangiopelta* from Oregon (Hymenoptera: Chalcidoidea), with a Discussion of Wing Length Variation

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A major source of confusion in the higher classification of the Chalcidoidea is the composition of the family Pteromalidae. It is generally accepted that the Pteromalidae are not monophyletic, but rather a paraphyletic or polyphyletic assemblage. A high priority for a revised classification of the Chalcidoidea is to investigate the distribution of character states among and within monophyletic groups traditionally referred to the "Pteromalidae" as subfamilies. Comparative studies of these key taxa are necessary to provide a rational basis for the subdivision of the assemblage into monophyletic taxa.

In this paper we treat one such taxon, the Ceinae, a subfamily comprised of only two genera: *Cea* Walker, monotypic and previously recorded only from the Palearctic; and *Spalangiopelta* Masi, with 4 Palearctic and a single Nearctic species (see Graham, 1969 for key to Palearctic species and Yoshimoto, 1977). Diagnostic characters of Ceinae are: spiracles situated halfway between the front and hind margins of propodeum (Figs. 1, 2), antennal toruli separated from oral fossa by a distance less than diameter of torulus (Fig. 3), antennal formula 11353 (Figs. 3, 4, 5–10), and mandibles bidentate. *Spalangiopelta* is further characterized by an apomorphic configuration of the mesosoma: the hind margin of mesopleuron partly overlapping metapleuron (Fig. 1). Graham (1969), in his key to the subfamilies of Pteromalidae, stated that the malar sulcus is absent in Ceinae. However, a distinct malar sulcus is present in a new species of *Spalangiopelta* described herein (Fig. 3). This emphasizes the need for comprehensive descriptive work in evaluating the distribution of character states, which in turn is the basis for phylogenetic inference.

In this paper we summarize information demonstrating that the Ceinae is much more speciose and widespread in North America than previously realized. In particular, we 1) describe two new species of *Spalangiopelta,* both sympatric in western Oregon, 2) discuss variation in the development of wings in one of the new species, 3) summarize the data associated with undescribed species of *Spalangiopelta,* and 4) report for the first time the occurrence of *Cea* in the North America.

METHODS AND TERMS

Morphological terms follow Graham (1969) and Richards (1977) except 'prepectus' is used instead of 'postspiracular sclerite.' We refer to the transparent circular areas on the uncus of the forewing (Figs. 12, 18, 20) as 'sensilla,' following

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usage in the Eulophidae (e.g., Miller, 1970) and Mymaridae (e.g., Schauff, 1984). Sculpture and color are best viewed and are described under diffuse light. Sculpture patterns are difficult to discern with light microscopy in *Spalangiopelta* due to the small size of specimens (about 1 mm total length). Scanning electron micrographs were used both to describe and to illustrate surface sculpture; the terms for sculpture types follow Harris (1979). Measurements and their abbreviations are as follows: OOL, length of ocular-ocellar line; POL, postocellar line, distance between posterior ocelli; PN, length of pronotum along midline; MSC, length of mesoscutum along midline; and SC, length of scutellum along the midline. Length, width, and height, refer to the maximum value obtained by rotating the specimen so that both end points of the structure are in focus.

Type material will be deposited in the following collections: British Museum (Natural History), BMNH; California Academy of Sciences, CAS; Canadian National Collection, CNC; D. Christopher Darling, personal collection; currently housed at the Royal Ontario Museum, DCD/ROM; James A. DiGiulio, personal collection, JAD; Oregon State University Entomology Museum, OSU; United States National Museum, USNM; Paul E. Hanson, personal collection, PEH; and the University of California, Berkeley, UCB.

Specimens of *Spalangiopelta* were first encountered in the Systematic Entomology Collection at Oregon State University. This material was collected on January 26, 1971, by David Carlson, in McDonald State Forest, northwest of Corvallis (elevation about 150 meters). On the basis of Dr. Carlson's field notes, we were able to pinpoint both the precise habitat and the method of collection. The specimens were obtained by Berlese funnel extraction of the needle mat from the base of Douglas fir, *Pseudotsuga menziesii,* located at the interface between secondary growth forest and a meadow adjacent to Oak Creek.

A concerted effort was made during the winter of 1984–1985 to recollect this species and to document aspects of the life history. Litter samples were collected at 4 times during the winter and spring, and a total of approximately 50 cubic meters of litter was examined. Litter beneath different tree species was kept separate in some collections to assess possible habitat specificity. Only Douglas fir duff yielded specimens. Leaf-mining Diptera larvae were also individually reared in the winter of 1984; in Europe *Spalangiopelta alata* Bouček has been reared from a leaf mine of *Scaptomyza flaveola* Meigen (Diptera: Drosophilidae, cited *in* Bouček, 1961). However, no specimens of *Spalangiopelta* were obtained from this limited rearing program.

Considerable care has been taken to ensure that the species described herein as new are not previously described species with holarctic distributions. To date, we have been able to examine representatives of only two of the four Palearctic species (the holotype of *S. procera* Graham and a specimen of *S. alata* Bouček, determined by Bouček). Our contention that the Oregon material represents new species is based on these specimens and on descriptions and diagnoses in the European literature (Masi, 1922; Bouček, 1952, 1961; Erdös, 1955; Graham, 1966, 1969). Specific comparisons are presented for each species in the "Diagnosis" sections.

Spalangiopelta felonia **Darling & Hanson, New Species**

(Figs. 1–6, 11–16, 21, 23)

Type locality.—U.S.A. Oregon, Benton County, McDonald State Forest, 3 miles northwest of Corvallis.

Type material.—This species is described from 36 female specimens. The holotype was chosen from the largest single collection of this species (*n* = 20, collected Feb. 14, 1984) and is a fully-winged female with the following labels: "OR: Benton Co. 3 mi NW Corvallis McDonald Forest February 14 1985," "D. C. Darling J. A. DiGiulio P. E. Hanson," "Ex: needle litter *Pseudotsuga menziesii,*" "Holotype ♀ *Spalangiopelta felonia* D. C. Darling & P. E. Hanson 1985" [DCD/ROM]. Thirty-four female paratypes are designated from the type locality: January 17 1985, *n* = 1, D. C. Darling, P. E. Hanson, J. A. DiGiulio; January 26 1971, *n* = 8, D. Carlson; January 31 1985, *n* = 4, J. A. DiGiulio, P. E. Hanson; April 11 1985, *n* = 2, D. C. Darling. An additional female paratype is also designated: OR: Benton Co. 14 mi W Corvallis, Marys Peak, January 24 1985, G. L. Parsons and J. D. Oswald, Ex: moss, lichens and bryophytes [BMNH, CAS, CNC, DCD/ROM, JAD, OSU, PEH, USNM, UCB].

This species is known only from the type material and the hosts are unknown.

Derivation of specific epithet.—The specific epithet is an allusion to furtive and clandestine habits of this species.

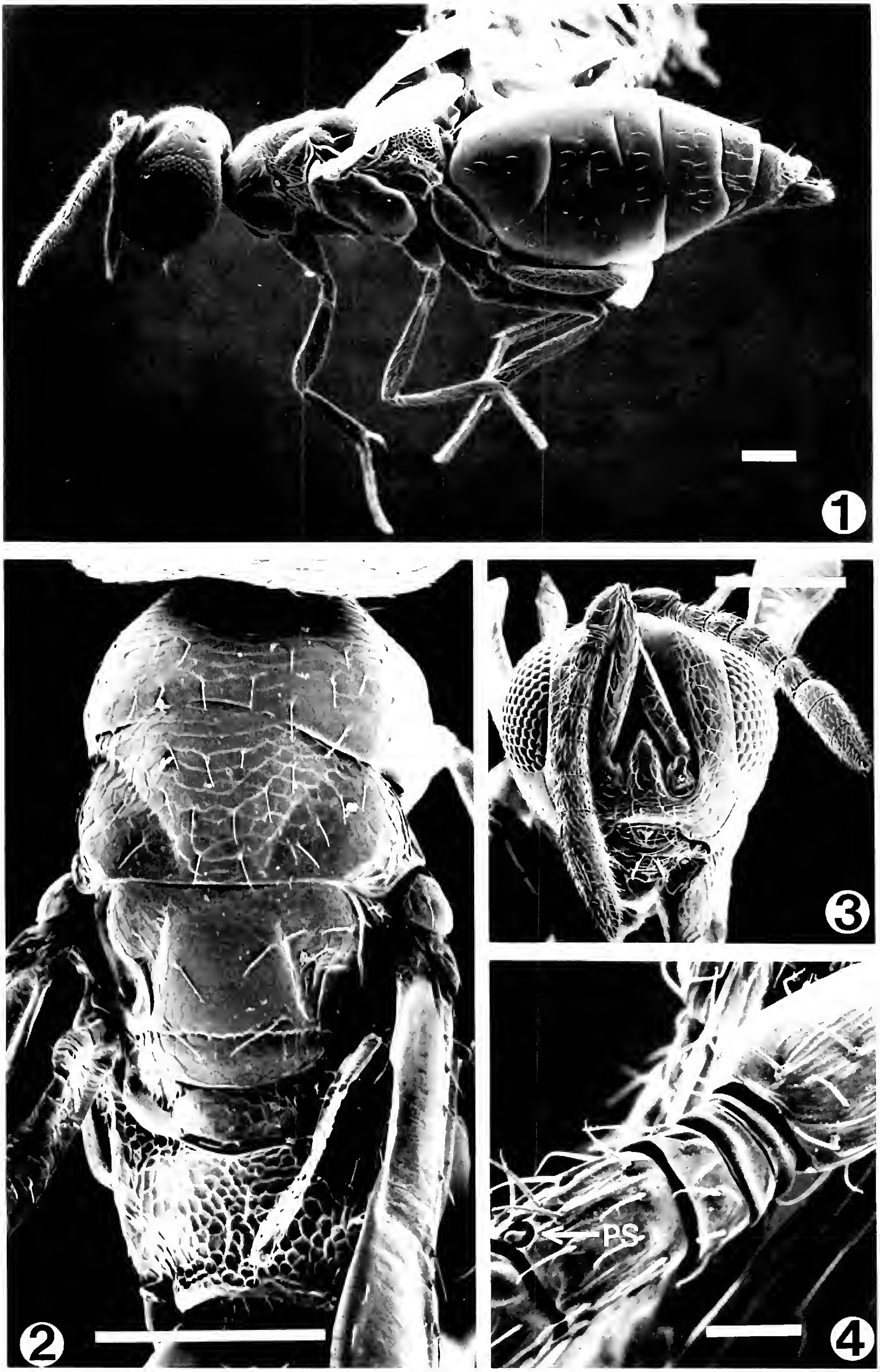
Diagnosis.—*S. felonia* females can be distinguished from the sympatric congener, *S. apotherisma,* by the more slender habitus (Fig. 21), the mesosoma narrower with respect to head width (cf. Fig. 22), the shorter ovipositor (Fig. 21; cf. Fig. 22), differences in forewing venation (Figs. 11–13, 15; cf. Figs. 17, 18) and the shape of the anelli and first funicular segments (Figs. 5, 6; cf. Figs. 7, 8). This species can be readily distinguished from *S. ciliata* Yoshimoto by the short, transverse petiole (Figs. 1, 2; cf. elongate, Yoshimoto, 1977, Fig. 1E, F), and the imbricate sculpture on the midlobe of the mesoscutum and scutellum (Fig. 2; cf. longitudinal microstriations, Yoshimoto, 1977, Fig. 1C, D).

Considering the Palearctic species, short-winged females of *S. felonia* most closely resemble *S. brachyptera* Masi. Only 1 out of 36 specimens of *S. felonia* have wings as short as *S. brachyptera* (reaching only to the level of the middle of the propodeum). Also, the coxae are darker in color in *S. felonia.* Long-winged *S. felonia* females would terminate as *S. alata* in Graham's key but can be distinguished by shorter funicular segments, lighter colored legs, more elongate thorax, and stigmal vein with a stouter, less linear uncus. The short ovipositor of *S. felonia* will serve to distinguish this species from the remaining Old World species (*S. dudichi* Erdös and *S. procera*) in which the ovipositor sheaths protrude markedly beyond the apex of the metasoma.

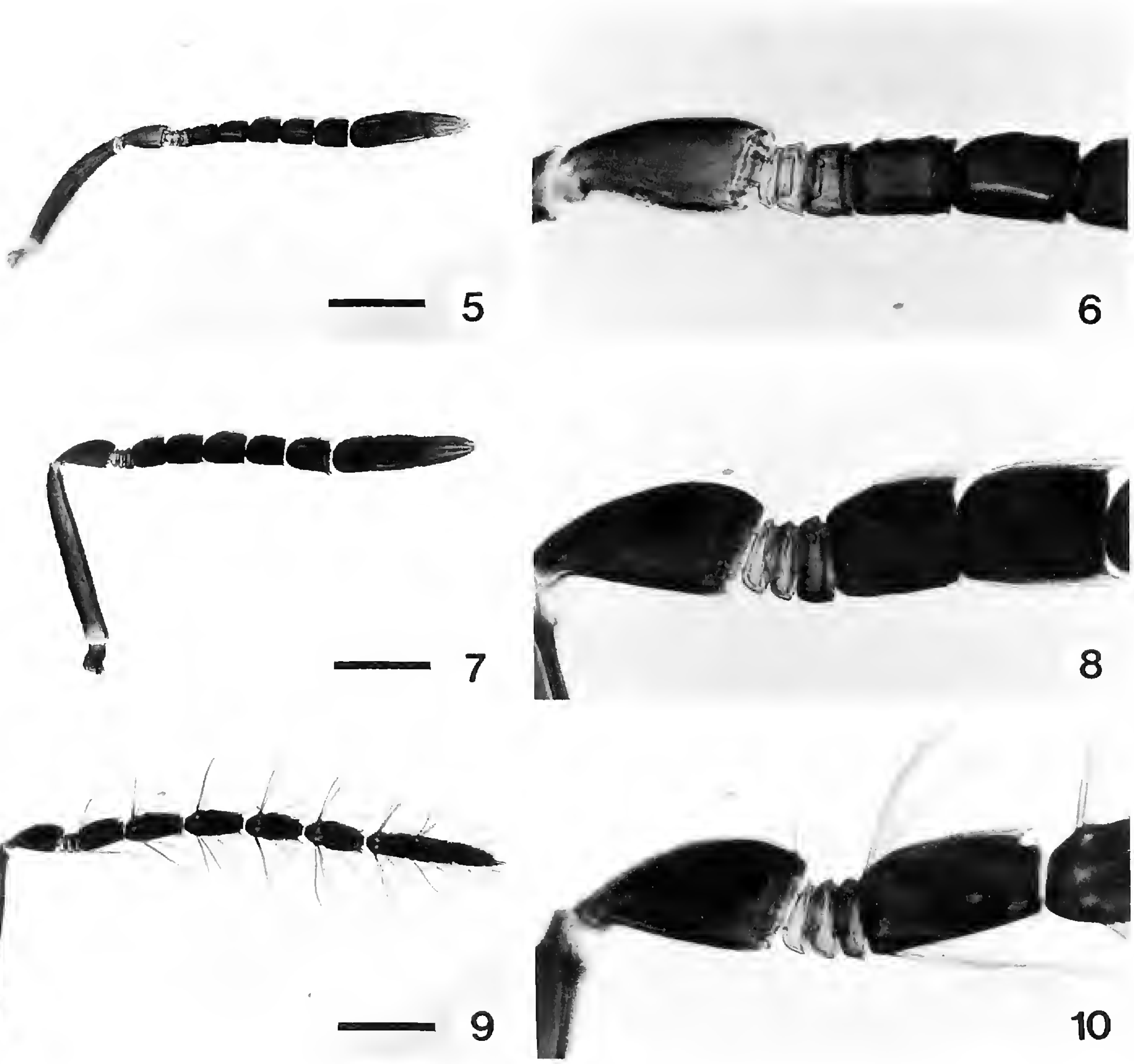
Description.—This description is based on both long-winged and short-winged females. Measurements are based on a total of 13 females, representing every collection locality and date and the full range of wing development. Description of wings and venation ratios are based on fully-winged specimens [*n* = 5]. Measurements and specific comments pertaining to the holotype are indicated by the notation [HT].

Female: Length, 0.9 mm to 1.4 mm [HT], slender in habitus. Head, mesosoma and metasoma black with faint metallic reflections, blue-green on mesosoma and blue-green to bronze on head; antenna and femora dark brown; tibiae and tarsi yellowish-brown. Forewing (Figs. 11, 12) weakly infumate, darker in region bounded by basal and stigmal veins.

Head (Fig. 3): In dorsal view, subquadrate (Fig. 21), width 1.4–1.8 [HT = 1.6] length; maximum width 0.9–1.2 [HT = 1.1] height; length of malar space 0.6 eye height; OOL less than POL, OOL/POL = 0.4 [HT]; head sculpture faintly im-

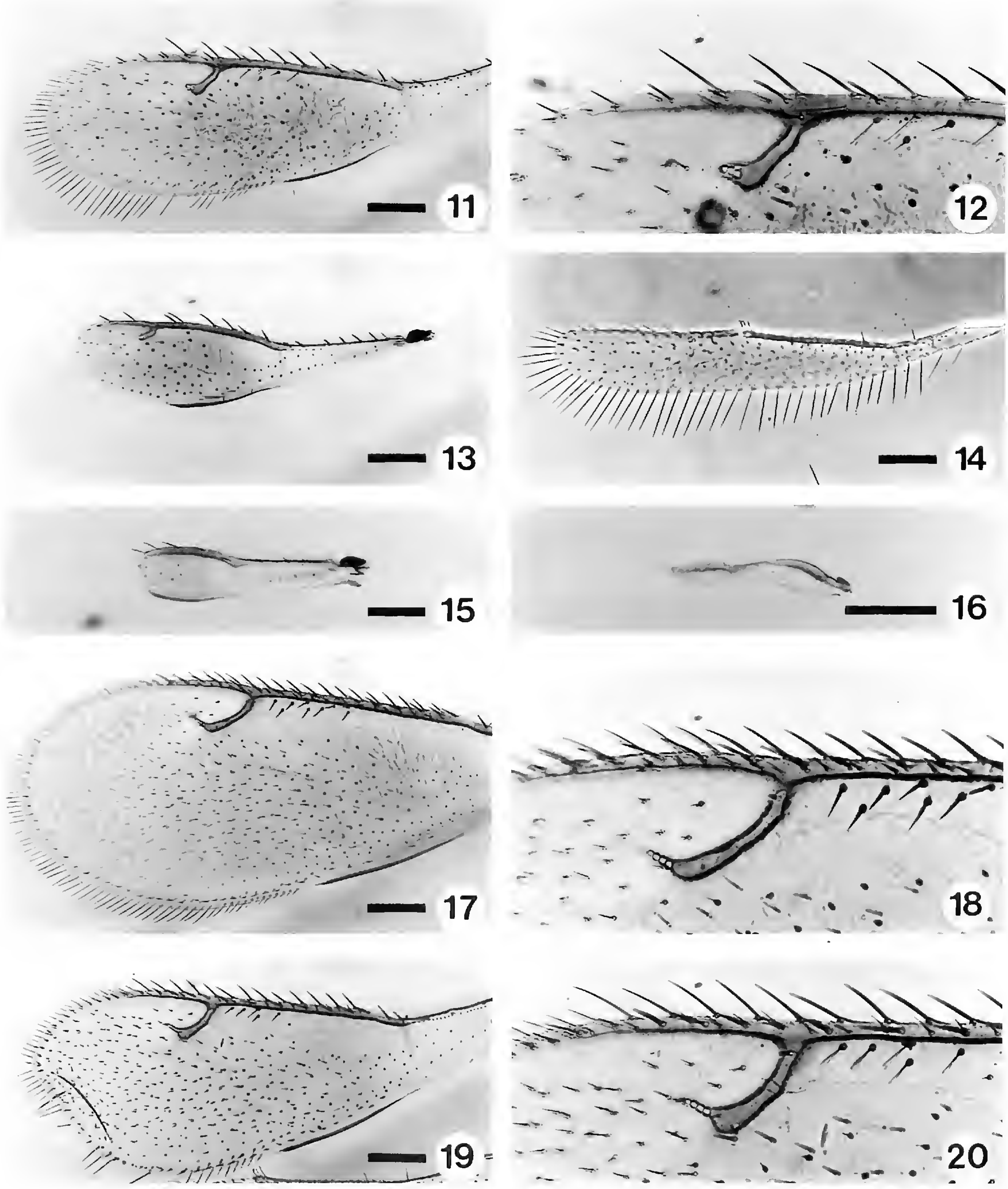


Figures 1–4. *Spalangiopelta felonia,* paratype female. 1. Lateral habitus. 2. Dorsal view of mesosoma. 3. Head, frontal view. 4. Detail of antenna, anelli and first funicular segment (left); PS, papilliform sensillum. Scale lines: Figures 1–3, 0.1 mm; Figure 4, 0.01 mm.



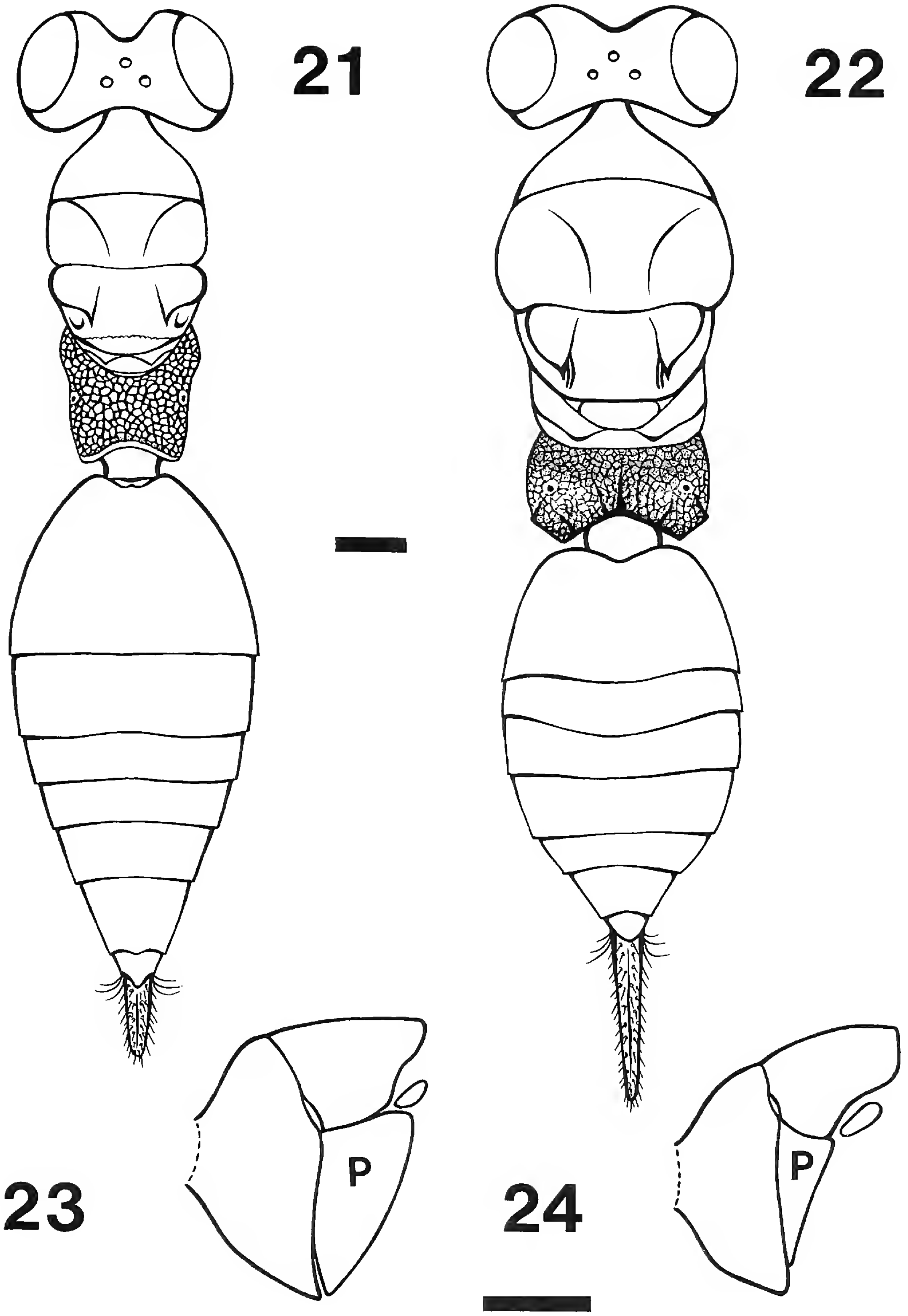
Figures 5–10. Antennae. 6, 8, 10. Detail of pedicel, anelli, and basal funicular segments. 5, 6. *S. felonia,* paratype female, DCD Slide #329. 7, 8. *S. apotherisma,* paratype female, DCD Slide #379. 9, 10. *S. apotherisma,* paratype male, DCD Slide #377. Scale lines 0.1 mm.

bricate; antennal scrobes deep, nitid, with high median callus; clypeus very reduced, anterior tentorial pits nearly touching oral fossa; gena with malar sulcus; eyes with minute hairs; occipital sulcus evident medially, about one-half distance between vertex and foramen. Antenna (Figs. 5, 6): scape with imbricate sculpture, length = 7 maximum width, slightly greater than eye height [HT, 20:19]; length of pedicel almost twice maximum width, longer than first funicular segment; anelli transverse and very small, combined length slightly less than first funicular segment, anelli 1 and 2 each 3 times as wide as long, anellus 3 more elongate, 2 times as wide as long, length subequal to anelli 1+2; first funicular segment elongate, subequal in width to anelli, remaining funicular segments wider and more quadrate; clava elongate, subequal in length to 4 preceding funicular segments, clava 2 and 3 each longer than last funicular segment, clava 3 conical; multiporus plate sensilla present on funicular segments 2–5, claval segments 2–3 and papilliform sensilla (Fig. 4) present distally on funicular segments 1–5 ($n = 2$). Mouthparts: maxillary palp 3-segmented; labial palp 2-segmented; labrum transverse, width greater than 3 times length along midline, distinctly emarginate with 5 long tapered marginal setae.



Figures 11–20. Wings. 12, 18, 20. Detail of stigmal region. 11–16. *S. felonia*. 11, 12. Forewing, long-winged paratype female, DCD Slide #353. 13. Forewing, paratype female with wings of intermediate length, DCD Slide #375. 14. Hindwing, long-winged paratype female, DCD Slide #353. 15. Forewing, short-winged paratype female, DCD Slide #359. 16. Hindwing, short-winged paratype female, DCD Slide #359. 17–20. *S. apotherisma*. 17, 18. Forewing, paratype female, DCD Slide #378. 19, 20. Forewing, paratype male, DCD Slide #376. Scale lines 0.1 mm.

Mesosoma: Slender, width 0.7–0.8 head width (Fig. 21), with imbricate sculpture except as noted; pronotum, mesoscutum, scutellum, and propodeum subequal in length, PN:MSC = 0.8–1.2 [HT], SC:MSC = 1.0–1.3 [HT]; dorsum depressed, metanotum and propodeum subhorizontal (Fig. 1); pronotum campanulate, wider than long, without a distinct collar; notauli present [HT] but less distinct in shorter-



Figures 21–24. Comparison of *S. felonia* (Figs. 21, 23) and *S. apotherisma* (Figs. 22, 24) paratype females. 21, 22. Dorsal habitus, sculpture illustrated only on propodeum. Note head shape relative to width of mesosoma, shape of mesosoma, and ovipositor length. 23, 24. Lateral view of mesosoma; P, prepectus. Scale lines 0.1 mm.

winged specimens; scutellum anterior to frenal groove almost smooth, apex broadly rounded, axillula with longitudinal costulae (Fig. 2); metanotum subequal in length to frenum, sculpture alveolate anterolaterad, indistinct on dorsellum, smooth posterolaterad (Fig. 2); propodeum distinctly alveolate, evenly convex, acarinate and afoveate, smooth along posterior margin (Figs. 2, 21); prepectus broadly triangular (Fig. 23). Forewing (Figs. 11, 12): length of apical setae longer than length of stigmal vein, with strong setae on marginal and postmarginal veins and below marginal vein on under surface; marginal vein 3 times postmarginal, postmarginal vein 2 times stigmal; submarginal vein slightly shorter than marginal, stigma slightly enlarged, uncus short with 3 sensilla. Hindwing (Fig. 14): linear, with setae on apical and posterior margins subequal in length to width of hindwing.

Metasoma: Petiole 3 times as wide as long, with longitudinal costulae (Fig. 2); gaster smooth and shining with sparse white setae (Fig. 1); first tergite longer than following two combined; hypopygium reaching over half length of gaster; pygostyle not elongate, with 4 bristles (Fig. 1); ovipositor short, sheaths only slightly protruding beyond apex of metasoma (Figs. 1, 21), protruded distance one-third or less length of hind tibia.

Male: UNKNOWN.

Notes on wing length variation.—Figure 25 illustrates the relationship between the length of the forewing and body size, total length in millimeters. Wing length exhibits continuous variation and is not distributed as discrete morphs; the use of the terms brachypterous and macropterous should therefore be used with care. All small individuals have very short wings, but a range of wing lengths are found in larger specimens and almost the entire range of variation in wing length is found in specimens 1.2 mm in total length. Figures 11, 13, and 15 illustrate the forewings of long, intermediate and short-winged females. Wing reduction seems to proceed from the apex to the base of the wing and does not involve an overall reduction in the form of the wings, as evidenced by the vestiges of venation present in the shorter-winged forms. The submarginal vein is largely unaffected by the wing reduction and often accounts for the entire venation in short-winged individuals. The apical setae are completely absent in the shortened wings. The reduction in hind wings (Fig. 16; cf. Fig. 14) shows similar patterns, again with a marked reduction in the apical setae.

Spalangiopelta apotherisma **Darling & Hanson, New Species**

(Figs. 7–10, 17–20, 22, 24)

Type locality.—U.S.A. Oregon, Benton County, McDonald State Forest, 3 miles northwest of Corvallis.

Type material.—This species is described from 3 female specimens and a single male. Two females were collected at the type locality April 14, 1985 by sweeping the understory vegetation around the bases of Douglas fir and a single female was collected in a pan trap in the vicinity of Ottawa, Canada. The male was also collected in Benton Co., Oregon, in a yellow pan trap. The holotype female bears the following labels: "OR: Benton Co. 3 mi NW Corvallis McDonald Forest," "14 April 1985, D. Chris Darling," "sweeping open Douglas fir forest," "Holotype ♀ *Spalangiopelta apotherisma* D. C. Darling & P. E. Hanson 1985" [DCD/ROM]. One paratype female has the same collection data as the holotype and an additional label: "Slide # 378—wings, 379 antenna, D. Chris Darling" [DCD/ROM]. The female paratype from Canada bears the following labels: "Ont; Nepean Slack Road Pan tr. 17–24.VI.1985 (sands) L. Masner" in addition to the paratype label [CNC]. The male paratype bears the following labels: "OR: Benton Co. 1984 5 mi WNW Corvallis IX,15–X,1 DC Darling" "slide # 376—wings, 377 antenna,

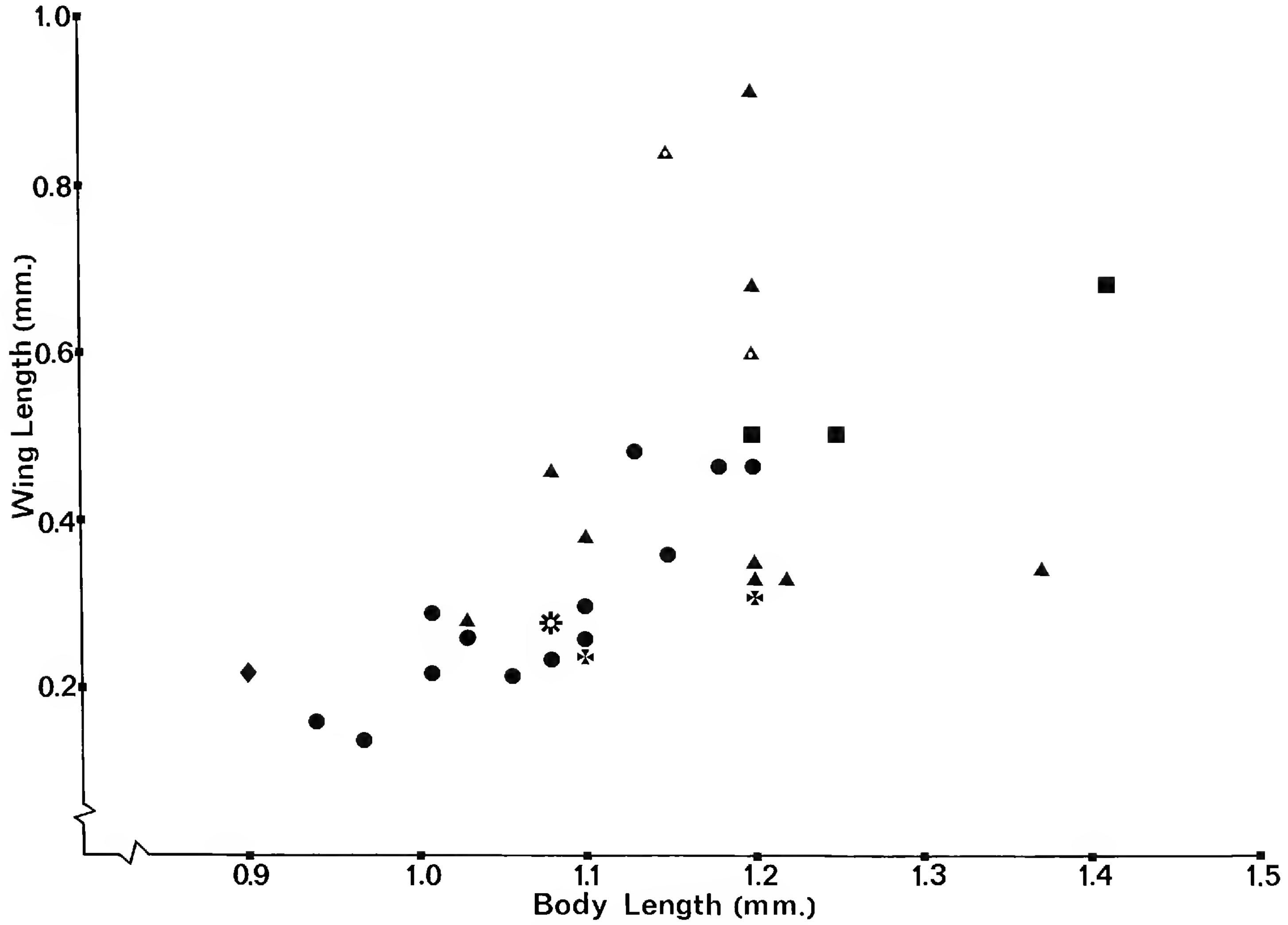


Figure 25. Relationship between forewing length and total body length in *S. felonia.* All specimens from McDonald Forest, except where noted. Legend: triangles (▲), specimens collected in January; circles (●), collected February 14; squares (■), collected March 3; crosses (+), collected April 11; diamond (◆), collected January 24 at Marys Peak; asterisk (*), collected in January ($n = 1$) and February 14 ($n = 3$). The open symbols indicate specimens illustrated in Figures 11, 13, 15.

D. Chris Darling" "Paratype ♂ *Spalangiopelta apotherisma* D. C. Darling & P. E. Hanson 1985" [DCD/ROM].

This species is known only from the type material and the biology and hosts are unknown.

Derivation of specific epithet.—The specific epithet is derived from the Greek, *apo,* "separate" and *therismos,* "harvest" referring to the collection of this species in sympatry and synchrony with the preceding species but by a different collection method, thus a separate harvest.

Diagnosis.—*S. apotherisma* females can be distinguished from the sympatric congener, *S. felonia,* by the more robust habitus (Fig. 22; cf. Fig. 21), the longer ovipositor (Fig. 22; cf. Fig. 21), differences in forewing venation (Figs. 17, 18; cf. Figs. 11–13, 15) and the shape of the anelli and first funicular segments (Figs. 7, 8; cf. Figs. 5, 6). This species can be readily distinguished from *S. ciliata* by the short, transverse petiole (Fig. 22; cf. elongate, Yoshimoto, 1977, Fig. 1E, F), and the imbricate sculpture on the midlobe of the mesoscutum and scutellum (as in *S. felonia,* Fig. 2; cf. longitudinal microstriations, Yoshimoto, 1977, Fig. 1C, D).

On the basis of the greatly protruding ovipositor sheaths, *S. apotherisma* is most similar to the European species, *S. procera* and *S. dudichi* (see key in Graham, 1969). *S. apotherisma* differs from *S. procera* by a wider mesosoma and from *S. dudichi* by the color of the scape and tibiae (lighter), the length of the malar space (one-half versus less than one-half eye height), and scape length (greater than versus equal to or less than eye height). In addition, *S. dudichi* is illustrated with elongate pygostyles (Erdös, 1955, Fig. 2, mislabelled) which are absent in *S. apotherisma.*

Description.—Measurements are based on the Oregon material and specific comments pertaining to the holotype are indicated by the notation [HT].

Female: Length, 1.3 [HT] to 1.6 mm. Head, mesosoma and metasoma dark brown to black with faint metallic bronze reflections; scape yellowish on anterior surface, tibiae and tarsi yellowish-brown. Forewing (Figs. 17, 18) infumate, forewing darker in region bounded by basal and stigmal veins.

Head: Transverse (Fig. 22), width 1.8 [HT]–1.9 length; maximum width = 1.2 height; length of malar space = 0.5 eye height; OOL = 0.7 POL. Head as in *S. felonia,* except malar sulcus evanescent. Antenna (Figs. 7, 8): as in *S. felonia,* except all three anelli more similar in size and shape, each about 3 times as wide as long; first funicular segment quadrate, similar in shape to distal funicular segments transverse; multiporus plate sensilla present on all funicular and claval segments, papilliform sensilla absent. Mouthparts not examined.

Mesosoma: Subequal in width to head (Fig. 22), 0.9 head width, pronotum more transverse than in *S. felonia,* PN:MSC = 0.6 [HT]–0.7, mesoscutum and scutellum equal in length, length of propodeum along midline about one half length of scutellum; dorsum of mesosoma arched in lateral view; mesoscutum sculpture imbricate, more distinct than in *S. felonia,* notauli present; scutellum, axillula, and metanotum as in *S. felonia*; propodeum alveolate, with longitudinal carinae and foveae posteriorly (Fig. 22), prepectus forming a narrow triangle (Fig. 24). Forewing (Figs. 17, 18): reaching apex of metasoma, 0.7 total body length, as in *S. felonia* except: length of marginal setae shorter than length of stigmal vein; postmarginal vein slightly shorter than 2 times stigmal vein; stigmal vein slender, and curved, stigma not enlarged, uncus elongate with 4 sensilla arranged in line at about 45 degree angle to postmarginal vein. Hindwing: setae on apical and posterior margins distinctly less than one-half width of hindwing.

Metasoma: As in *S. felonia* except: ovipositor long, sheaths protruding noticeably beyond apex (Fig. 22), protruded distance about one-half length of hind tibia.

Male: Length 1.4 mm. Color as in female. Sculpture and structure as in female except: head width twice head length, malar space 0.4 eye height, length of scape equal to eye height, only 6 times as long as broad. Antenna (Figs. 9, 10): funicular segments elongate, at least twice as long as wide, each with a basal whorl of setae; length of clava less than length of 3 preceding funicle segments, each also with a basal whorl of setae. Forewing (Figs. 19, 20) with stigma slightly enlarged. Mouthparts and genitalia not examined.

DISCUSSION

There are now seven described species of *Spalangiopelta* (4 Palearctic, 3 Nearctic) and these can be tentatively arranged in three groups. *Spalangiopelta ciliata* is quite distinct from the other species; unique characters of the females include the elongate petiole, the sculpture of mesoscutum, and the cupped forewings with very long setae. The remaining six species fall into two groups: with short ovipositors (*S. brachyptera, alata, felonia*) and those with long ovipositors (*S. dudichi, procera, apotherisma*).

Further studies will be necessary to test the naturalness of these groupings.

However, it is interesting to note that the only two species to display marked wing reduction (*S. brachyptera, felonia*) have short ovipositors, a character not obviously correlated with wing reduction. The only obvious character accompanying wing reduction in *S. brachyptera* and *felonia* is the reduction of the size of the mesonotum, most evident as the reduction of the thorax width relative to head width (Fig. 21). In brachypterous Hymenoptera, the mesonotum is the first external structure to become modified (Reid, 1941); further modifications involving the fusion of the thoracic segments have not occurred in short-winged Ceinae.

Many of the problems encountered in the systematics of Ceinae are the result of the rarity of specimens in collections which is probably due to a combination of factors: small size (about 1 mm), phenology (adults often collected in winter or early spring), and association with litter habitats. Collecting methods such as yellow pan traps, Malaise traps, and screen sweeping will often fail to collect species that frequent cryptic habitats, such as leaf litter, and therefore heat extraction techniques (Berlese or Tulgren funnels) should be added to the sampling arsenal.

The Ceinae remain very incompletely sampled in North America; recent museum visits have revealed additional undescribed species, each represented by 1 or 2 specimens. We refrain from describing these species until additional material is available for study but provide the label data and a brief summary to facilitate the collection of additional material.

Spalangiopelta appears to be widely distributed in California on the basis of material in the California Department of Food and Agriculture Collection: 2 short-winged females (Humbolt [sic] Co., 2 mi N Redway, III-1-72, T. R. Haig, berlese oak duff; Inyo Co., nr. Westgard Pass 7300′ III-1975 ex Pinyon duff D. Giuliani, Coll.) and a short-winged male (Riverside Co. Whitewater Canyon, XII-27-1979, KW Cooper 79-127, berlese abandoned Neotoma nest at base of Prosopis). Note that these specimens were all collected during the winter and early spring in association with litter habitats. Specimens from Biosystematics Research Institute in Ottawa, Canada document the following: 1) there is an undescribed or perhaps holarctic species of *Spalangiopelta* that is sympatic with *S. ciliata* in the vicinity of Ottawa; 2) there is an additional undescribed or holarctic species of *Spalangiopelta* from Nova Scotia, Cape Breton National Park; and 3) *S. ciliata* occurs in Texas (San Jacinto Co., 5 km S Coldspring, Double Lk Cpgd, 22–24.V.83, M. Kaulbars). This is a considerable extension of the range; this species has only previously been recorded from central Canada. We also report here the first record of the genus *Cea* in North America based on two males provisionally identified as the European species *Cea pulicaris* Walker (Texas: Travis Co. Austin, Breckenridge Field Lab, 500′ April 1984, J. A. DiGiulio, Yellow Pan Trap).

In addition to the new species and records of Nearctic Ceinae, this investigation has prompted many biological questions. *S. felonia* exhibits continuous variation in wing length and males have yet to be recorded in a rather large sample ($n = 36$), suggesting at least the possibility of thelytokous parthenogenesis. Its sympatric congener, *S. apotherisma,* is apparently fully winged and bisexual. These contrasts are amplified by the fact that the two species were collected in the same place, at the same time of the year, but by differing collecting techniques (Berlese funnels versus sweeping and pan trapping). Obviously additional biological information is needed, particularly the host association(s).

These results also serve to emphasize some of the complexities associated with the taxonomy of the Ceinae. Intraspecific variation in the development of wings is now known in both genera. The long-winged and short-winged forms of *Cea pulicaris* were originally described as separate species (Graham, 1969). This suggests that future descriptions of "brachypterous" species of *Spalangiopelta* be based on long series of specimens and made in comparison with fully winged forms. Also, the collection of this species exclusively through Berlese funnel sampling emphasizes the need to employ this technique more often and to search existing litter samples, not only for Ceinae but for litter-associated parasitic Hymenoptera in general. Although the description of *S. felonia,* and *S. apotherisma* should perhaps have awaited a more comprehensive revisionary treatment, we felt it was necessary to provide these descriptions and notes in order to stimulate interest and the accumulation of additional material; DCD is currently assembling material for a more extensive review of Nearctic Ceinae and would appreciate receiving additional specimens.

Acknowledgments

We are particularly grateful to David Carlson for the effort expended in collecting, preparing and depositing the initial specimens of *Spalangiopelta* in the Oregon State University Collection. We would also like to thank: J. A. DiGiulio (Oregon State University) for assistance with the field work, sorting litter samples, and for reviewing the manuscript; L. Masner (Biosystematics Research Institute, Ottawa) and M. Wasbauer (California Department of Food and Agriculture, Sacramento) for providing additional specimens of *Spalangiopelta*; Z. Zichmanis for the preparation of the drawings; and N. F. Johnson for reviewing the manuscript.

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Scientific Note

Occurrence of the Palearctic Tortricid, *Clepsis consimilana* (Hübner), in Oregon

During a brief visit to Eugene, Oregon, I collected a specimen of *Clepsis consimilana* (Hübner) (=*unifasciana* Dup.) (Tortricinae; Archipini). This appears to be the first record of this Palearctic species in western North America, although it has been known in the northeastern U.S. for nearly 50 years (Powell and Burns, 1971, Psyche, 78:38–48). The specimen, a living adult male, was taken from a motel wall, adjacent to the Willamette River, near the University of Oregon campus on June 15, 1985. While it may be argued that one moth does not necessarily indicate an established colony, such logic is more reasonable if the unique is collected during a lengthy or intensive survey. The probability of discovery of an isolated introduction by a casual visitor to an area seems slight; most likely there is a resident population in Eugene, one that may have been undetected for years.

Clepsis consimilana is widespread in the Old World, in Europe, Asia Minor and North Africa (Bradley et al., 1973, British tortricoid moths. Cochylidae and Tortricidae: Tortricinae, Brit. Mus (Nat. Hist.), London) and has been reported in east Siberia, although Razowski (1979, Acta Zool. Cracov., 23:101–198) doubts the latter record. A disjunct subspecies, *C. c. placida* (Diakonoff) occurs in Madagascar. The species was first reported in North America in 1939 at Long Island (Klots, 1961, Bull. Brooklyn Ent. Soc., 36:126–127), and although it is characteristic of hedgerow and garden situations, *C. consimilana* had not spread far from Long Island Sound by the mid 1960's (Powell and Burns, 1971, loc. cit.). The larvae commonly feed on privet (*Ligustrum*), especially on dead or withered leaves, but several other unrelated plants are recorded as hosts as well (Bradley et al., 1973, loc. cit.), so the species may be polyphagous in some circumstances.

The adults, which are nondescript tortricids with rust-colored forewings and dark gray hindwings, have been illustrated in black and white photographs (Powell and Burns, 1971, loc. cit.) and in color paintings (Bradley et al., 1973, loc. cit.). They somewhat resemble another polyphagous European tortricid that is common in Oregon, *Archips rosanus* (L.), although they are smaller, and may have been overlooked by survey entomologists owing to the similarity. The distinctive genitalia (Razowski, 1979, loc. cit.) are unlike any other species in the Nearctic fauna; my preparation of the Oregon specimen (JAP #5400) compares well with those from Long Island (JAP #2133) and Sunninghill, Berks., England (JAP #4482).

It is interesting that several introduced Palearctic tortricine moths have been reported from the Vancouver-Puget Sound region in recent years, e.g., *Croesia holmiana* (L.), *Pandemis herparana* (D. & S.), *P. cerasana* (Hbn.), and *Archips podanus* (L.) (Doganlar and Bierne, 1978, J. Entomol. Soc. Brit. Columbia, 75: 23–24; 1979, Canad. Entomol., 111:970), but not *Clepsis consimilana.* Similarly, another polyphagous European species, *Cacoecimorpha pronubana* (Hbn.), was discovered at Portland, Oregon, in 1964 (Powell, 1969, Pan-Pacific Entomol., 45: 70), and has been reared from garden and nursery plants at several sites in the

Portland area, as recently as 1982 (V. M. Carolin, UCB), yet seems not to be established in the Puget Sound region.

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PUBLICATIONS RECEIVED

Entomology of the California Channel Islands: Proceedings of the First Symposium. Edited by Arnold S. Menke and Douglass R. Miller. Pp. 1–178, figs. and tables, with detailed maps of eight California Channel Islands in accompanying envelope. Received by PCES at CAS at end of September 1985. Published by the Santa Barbara Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, California 93105. Price $20.00 paperbound.

Arnold S. Menke and Douglass R. Miller organized a symposium "Entomology of the California Channel Islands" that was held at a session with the Annual Meeting of the Entomological Society of America in December 1981, at San Diego, California. Of the seven papers presented at that symposium, six are published here in revised and augmented form, and three additional papers on Channel Island Insects are included in this volume because it seemed appropriate. Those interested in the affinities of our California Channel Island Insects will want this volume. It includes "A symposium introduction," pp. 1–2, by Arnold S. Menke, and articles by Scott E. Miller (The California Channel Islands—Past, present, and future: An entomological perspective, pp. 3–27), Richard Rust, Arnold Menke, and Douglass Miller (A biogeographic comparison of the bees, sphecid wasps, and mealybugs of the California Channel Islands (Hymenoptera, Homoptera), pp. 29–59), David B. Weissman (Zoogeography of the Channel Island Orthoptera, pp. 61–68), Jerry A. Powell (Faunal affinities of the Channel Islands Lepidoptera: A preliminary overview, pp. 69–94), Lawrence F. Gall (Santa Catalina Island's endemic Lepidoptera. II. The Avalon hairstreak, *Strymon avalona,* and its interaction with the recently introduced gray hairstreak, *Strymon melinus* (Lycaenidae), pp. 95–104), Christopher D. Nagano (Distributional notes on the tiger beetles of the California Channel Islands (Coleoptera: Cicindelidae), pp. 105–112), Douglass R. Miller (Symposium conclusions and summation, pp. 113–116), Richard W. Rust (Bees of Anacapa Island, California (Hymenoptera: Apoidea), pp. 117–119), Scott E. Miller and Pamela Mercer Miller (Beetles of Santa Barbara Island, California (Coleoptera), pp. 121–136), Scott E. Miller (Entomological bibliography of the California Islands. Supplement I, pp. 137–169), and Arnold S. Menke (Maps and place-names of the California Channel Islands, pp. 171–178, with 8 maps in accompanying envelope).—P. H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

PAN-PACIFIC ENTOMOLOGIST
62(2), 1986, p. 167

George Pearson Holland
1911-1985

Paul H. Arnaud, Jr. and Hugh B. Leech

California Academy of Sciences, San Francisco, California 94118.

George Pearson Holland, retired and former Director of the Entomology Research Institute, Ottawa [now Biosystematics Research Institute], monographer of Canadian and northern America Siphonaptera, died tragically on 10 November 1985 from the result of a fall while hunting in remote bush country near Sharbot Lake, about 100 kilometers west of Ottawa. After leaving a hunting party to hunt on his own on 6 November, he was not found until the morning of 9 November suspended unconscious in a tree half way down a 30-meter rock face. He died the next morning at Civic Hospital, Ottawa without regaining consciousness.

George P. Holland was born on 27 August 1911 at Vancouver, British Columbia, where he obtained his B.A. degree in 1933 and the M.A. in 1937, from the University of British Columbia. He had the good fortune to have the late G. J. Spencer, an understanding and inspiring teacher as his major professor, and that wise man's philosophy influenced George's outlook on entomology and life. He received a D.Sc. from Carleton University in 1963. He was successively Assistant Entomologist at the Dominion Livestock Insect Laboratory, Kamloops (1936–1948), and Director of the Entomology Research Institute, Ottawa (1948–1969). In this latter period the Canadian National Collection of insects and related arthropods grew from about one million to 10 million specimens, with good representation from many countries and special coverage of the arctic region of North America. He served as President of the Entomological Society of Canada (1957–1958).

He retired from Public Service on 27 August 1976, and then gave as much time as possible to his magnum opus, his excellent monograph of "The Fleas of Canada, Alaska and Greenland (Siphonaptera)," published in early 1985 (Entomological Society of Canada Memoir 130, 631 pp., 508 figs., 109 maps) which increased the valid forms to 183 from the 127 species and subspecies recorded in his earlier 1949 monograph of "The Siphonaptera of Canada" (Technical Bulletin 70, Canada Department of Agriculture, 306 pp., 350 figs., reprinted in 1968). His many publications also included a "Contribution towards a monograph of the fleas of New Guinea" (1969, Entomological Society of Canada Memoir 61, 149 pp., 216 figs.).

George Holland was a delightful companion, a humorist, an enthusiastic collector, and a musician (his playing of the piano accordion was professional). His personal correspondence was often enlightened with James Thurber-like drawings of turtles, salamanders, fleas and entomologists. He is survived by his wife Jennie (Harritt), son George, daughters Judith and Penelope, four grandchildren, and his brother Leonard.

"The George P. Holland Memorial Fund" has been established and donations may be sent to the CanaColl Foundation, K. W. Neatby Building, Room 4058, 1010 Carling Avenue, Ottawa, Ontario K1A 0C6, Canada.

PAN-PACIFIC ENTOMOLOGIST
62(2), 1986, pp. 168–169

PACIFIC COAST ENTOMOLOGICAL SOCIETY

STATEMENT OF INCOME, EXPENDITURES AND CHANGES IN FUND BALANCES

Years Ended September 30, 1985 and 1984

	1985	1984
Income		
Dues and subscriptions	$ 9,714	$13,048
Reprints and miscellaneous	20,504	21,050
Sales of Memoirs	47	515
Interest	5,708	5,552
Dividends	463	448
Increase in value of capital stock: American Telephone & Telegraph Company and Pacific Telesis Group	402	665
	$36,838	$41,268
Expenditures		
Publication costs—Pan-Pacific Entomologist	$25,165	$46,455
Reprints, postage and miscellaneous	514	1,337
IBM Personal Computer	2,400	
	$28,079	$47,792
Increase (Decrease) in fund balances	$ 8,759	$ (6,524)
Fund balances October 1, 1984 and 1983	78,471	84,995
Fund balances September 30, 1985 and 1984	$87,230	$78,471

STATEMENT OF ASSETS

September 30, 1985 and 1984

	1985	1984
Cash in bank		
Commercial account	$ 3,941	$10,766
Savings accounts & Certificates of Deposit		
General Fund	17,832	6,658
Charles P. Alexander Fund	34,282	31,961
Fall Memoir Fund	24,918	23,231
Total cash in bank	$80,973	$72,616
Investment in 80 shares of American Telephone & Telegraph Co. common stock and 66 shares of Pacific Telesis Group at market value	$ 6,257	$ 5,855
	$87,230	$78,471

See accompanying notes to the financial statements.

PACIFIC COAST ENTOMOLOGICAL SOCIETY

NOTES TO THE FINANCIAL STATEMENTS

Year Ended September 30, 1985

Summary of significant accounting policies.

Accounting Method: Income and expenses are recorded by using the cash basis of accounting. *Capital*

Expenditures: Annual capital expenditures of $5,000 or less are charged to expense. *Marketable Securities:* American Telephone & Telegraph Co. and Pacific Telesis Group common stock are carried at market value. Increases and decreases in value are reflected in income. *Income Tax:* The Society is exempt from Federal income and California franchise tax. *Accounts Receivable:* As of September 30, 1985, accounts receivable aggregated $5,204. *Accounts Payable:* As of September 30, 1985, there was no material amount of unpaid bills.

As Chairman of the Auditing Committee, and in accordance with its bylaws, I have reviewed the financial records of the Society.

During the course of this review nothing was noted which indicated any material inaccuracy in the foregoing statements.

H. Vannoy Davis
Chairman of the Auditing Committee

THE PAN-PACIFIC ENTOMOLOGIST

Information for Contributors

Members are invited to submit manuscripts on the systematic and biological phases of entomology, including short notes or articles on insect taxonomy, morphology, ecology, behavior, life history, and distribution. Non-members may submit manuscripts for publication, but they should read the information below regarding editing and administrative charges. Manuscripts of less than a printed page will be published as space is available, in Scientific Notes. All manuscripts will be reviewed before acceptance. Manuscripts for publication, proofs, and all editorial matters should be addressed to the editor.

General. — The metric system is to be used exclusively in manuscripts, except when citing label data on type material, or in direct quotations when cited as such. Equivalents in other systems may be placed in parentheses following the metric, *i.e.* "1370 m (4500 ft) elevation".

Typing. — **Two copies** of each manuscript must be submitted (original and one xerox copy or two xerox copies are suitable). All manuscripts must be **typewritten, double-spaced** throughout, with ample margins, and be on bond paper or an equivalent weight. **Carbon copies** or copies on paper larger than 8½ × 11 inches are not acceptable.

Underscore only where *italics* are intended in the body of the text. **Number all pages** consecutively and put authors name on each sheet. References to **footnotes** in text should be numbered consecutively. Footnotes **must** be typed on a separate sheet.

Manuscripts with extensive corrections or revisions will be returned to the author for retyping.

First Page. — The page preceding the text of the manuscript must include (1) the complete title, (2) the order and family in parentheses, (3) the author's name or names, (4) the institution with city and state or the author's home city and state if not affiliated (5) the complete name and address to which proof is to be sent.

Names and descriptions of organisms. — The first mention of a plant or animal should include the full scientific name with the author of a zoological name *not* abbreviated. Do not abbreviate generic names. Descriptions of taxa should be in telegraphic style. The International Code of Zoological Nomenclature must be followed.

Tables. — Tables are expensive and should be kept to a minimum. Each table should be prepared as a line drawing *or* typed on a separate page with heading at top and footnotes below. Number tables with Arabic numerals. Number footnotes consecutively for each table. Use only horizontal rules. Extensive use of tabular material requiring typesetting may result in increased charges to the author.

Illustrations. — No extra charge is made for line drawings or halftones. Submit only photographs on glossy paper and original drawings. Authors *must* plan their illustrations for reduction to the dimension of the printed page (117 × 181 mm; 4⅝ × 7⅛ inches). If possible, allowance should be made for the legend to be placed beneath the illustration. Photographs should not be less than the width of the printed page. Photographs should be mounted on stiff card stock, and bear the illustration number on the face.

Loose photographs or drawings which need mounting and/or numbering are not acceptable. Photographs to be placed together should be trimmed and abut when mounted. Drawings should be in India Ink, or equivalent, and at least twice as large as the printed illustration. Excessively large illustrations are awkward to handle and may be damaged in transit. It is recommended that a metric scale be placed on the drawing or the magnification of the *printed* illustration be stated in the legend where applicable. Arrange figures to use space efficiently. Lettering should reduce to no less than 1 mm. *On the back of each illustration* should be stated (1) the title of the paper, (2) the author's complete name and address, and (3) whether he wishes the illustration returned to him. Illustrations not specifically requested will be destroyed. **Improperly prepared illustrations will be returned to the author for correction prior to acceptance of the manuscript.**

Figure legends. — Legends should be typewritten double-spaced on separate pages headed EXPLANATION OF FIGURES and placed following LITERATURE CITED. Do not attach legends to illustrations.

References. — All citations in text, e.g., Essig (1926) or (Essig 1958), must be listed alphabetically under LITERATURE CITED in the following format:

Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2:211–212.
Essig, E. O. 1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York, 1050 pp.

Abbreviations for titles of journals should follow a recent volume of *Serial Sources for the Biosis Data Base,* BioSciences Information Service. For **Scientific Notes** the citations to articles will appear within the text, i.e. . . . "Essig (1926, Pan-Pac. Entomol., 2:211–212) noted . . .".

Proofs, reprints, and abstracts. — Proofs and forms for the abstract and reprint order will be sent to authors. Changes in proof will be charged to the author.

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Announcement

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Vol. 1 (16 numbers, 179 pages) and vol. 2 (9 numbers, 131 pages). 1901–1930. Price $5.00 per volume.

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Vol. 1 (1924) to vol. 51 (1975), price $10.00 per volume of 4 numbers, or $2.50 per single issue. Vol. 52 (1976) to vol. 57 (1981), price $15.00 per volume, or $3.75 per single issue, except for vol. 57, no. 1, $10.00. Vol. 58 (1982) and subsequent issues, $20.00 per volume or $5.00 per single issue.

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THE
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Application for membership in the Society and changes of address should be addressed to the Secretary, Vincent F. Lee, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118-9961.

Manuscripts, proofs, and all correspondence concerning editorial matters should be addressed to Editor, Pacific Coast Entomological Society, 201 Wellman Hall, University of California, Berkeley, CA 94720. See back cover for instructions.

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Pacific Coast Entomological Society

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PAN-PACIFIC ENTOMOLOGIST
62(3), 1986, pp. 171–202

The *Sternidius* of America North of Mexico (Coleoptera: Cerambycidae)

Arthur E. Lewis

1360 Paseo Redondo, Burbank, California 91505.

The genus *Sternidius* has presented a difficult taxonomic problem because of the extreme intraspecific variability exhibited by so many of its members. This has resulted in numerous synonymies and recombinations at different times. The following revision represents my conclusions based on the examination of approximately 2500 specimens, and the necessary types including those of John L. LeConte, and T. L. Casey. Descriptions, range, and host data, where known, are presented for sixteen species. (Much of the host data included in this paper was taken directly from label information on individual specimens.)

Study of the available types necessitates the following changes in present nomenclature: *Sternidius alpha vicinus* (Haldeman), *S. alpha coloradensis* Dillon, and *S. suturalis* Dillon have been synonymized with *S. alpha* (Say). *S. alpha nigricans* Dillon with *S. fascicularis* (Harris); *S. fascicularis maculipennis* (Blatchley) with *S. punctatus* (Haldeman); *S. rusticus* (LeConte), *S. punctatus* (Haldeman), and *S. texanus* (Casey) have been resurrected, and *S. alpha misellus* (LeConte) has been raised to full species designation. Two species previously included with *Sternidius* were found to belong in other genera and represent new synonymies. *Leiopus setipes* Casey is *Trichastylopsis albidus* (LeConte), and *Leiopus crinicornis* Casey is *Ceratographus biguttata* (LeConte).

Sternidius LeConte

Amniscus Haldeman, 1847, Trans. Amer. Phil. Soc. (2), 10:27–66 (part).

Liopus; LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, 2:170 (part); Horn, 1880, Trans. Amer. Entomol. Soc., 8:123; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:121; Blatchley, 1910, The Coleoptera of Indiana, p. 1073 (misdet.).

Sternidius LeConte, 1873, Smithsonian Misc. Coll., 265:234; Dillon, 1956, Ann. Entomol. Soc. Amer., 49(3):208; Arnett, 1960, Beetles of the United States, pp. 872, 891; Dillon and Dillon, 1961, A manual of common beetles of eastern North America, p. 640; Lewis, 1977, Pan-Pacific Entomol., 53:195.

Leiopus; Casey, 1913, Mem. Coleoptera, 4:310; Knull, 1946, Ohio Biol. Surv. Bull., 39:248 (misdet.).

Form usually small (less than ten millimeters), moderately robust, oblong, covered with short pubescence which is usually cinereous to tawny; elytra usually containing small spots or callosities and separate discal and epipleural maculae. Head impunctate except for a few setigerous punctures, especially near eyes; frons usually subconvex; eyes strongly emarginate with lower lobes larger than upper; antennae linear, cylindrical, annulate, distinctly longer than body, and subequal in both sexes. Pronotum usually wider than long with acute lateral tubercles at basal third, basal transverse sulcus complete beneath; disk usually minutely punctate with punctures much smaller than those of elytra, frequently obscured by pubescence, three small callosities in the form of an inverted triangle usually present. Elytra about twice as long as broad, densely punctate, becoming less so apically, sides subparallel to about apical third, then convergent to sutural margin; costae four in number (not including sutural margin or ventrum of epipleura), variable in prominence within each species, each usually containing a variable number of minute callosities (larger callosities usually present at or behind middle, commonly associated with a macula which is variable in position and extent between species, and at times within species); epipleural maculae present or not; disk lacking distinct tubercles, apices obliquely truncate, or rounded to suture. Scutellum small, rounded to triangular, pubescent. Ventral surface densely punctate, pubescent, mottled or not; prosternal process between one-tenth and one-fourth as wide as procoxal cavity, mesosternal process usually one-half to three-fourths as wide as mesocoxal cavity. Legs with posterior tibiae usually dark at distal one-third; posterior tarsi dark, with first segment about as long as two following. Abdominal sternites with fifth segment at least twice as long as fourth in females, less than twice as long in males, apex notched to emarginate.

This genus is characterized by its small size, lack of distinct tubercles on the pronotal and elytral disks, placement of the acute lateral pronotal tubercles at the basal third and the uninterrupted basal transverse sulcus. It may be separated from other small acanthocine genera inhabiting the geographical area covered in this paper as follows: *Amniscus,* by the nontuberculate disk of the pronotum and the shape and position of the lateral tubercles; *Styloleptus,* by the absence of acute lateral pronotal tubercles; *Astyleiopus,* by the uninterrupted basal transverse sulcus; *Ceratographis* by the absence of long flying hairs on the elytral disk; and from *Lepturges* and *Urgleptes* by the lateral pronotal tubercles which are placed behind the basal third and project strongly backward, and the absence of the three discal callosities.

LeConte separated *Sternidius* from its Old World counterpart *Leiopus* because of differences in the shape of the mesosternum.

Type species.—Lamia alpha Say (Dillon desig., 1956).

Many members of this genus have been and are difficult to define because of the structural variation which may be constant in one species and variable in others. The placement of the maculae appears to be the most reliable character for species diagnosis. In forms where the integument is especially dark, preventing macular contrast, determination is much more difficult. This is also true for many worn, faded and rubbed specimens, since the placement of epipleural pubescence is important in the differentiation of some species. In these specimens, mottling, antennal segment ratios, width of the procoxal process, and other characteristics will have to be employed for diagnosis. Some individuals cannot be placed with certainty.

KEY TO THE SPECIES OF *STERNIDIUS* OF AMERICA NORTH OF MEXICO

1. Pronotum not distinctly mottled; elytral disk with less than three distinct maculae, usually less than 8 mm in length 2
 Pronotum distinctly pale and dark mottled; elytra with three dis-

cal maculae, usually more than 8 mm in length. Southern Texas .... *wiltii*

2(1). Antennae with fourth segment subequal to or shorter than scape or if fourth segment slightly longer, form robust with top of humeri dark or black 3

Antennae with fourth segment usually distinctly longer than scape .. 5

3(2). Elytra with post median dark maculae elongate, extending obliquely backward, usually attaining lateral margin; top of humeri black or very dark 4

Elytra with discal maculae short, not extending laterally beyond middle of elytral disk; tops of humeri rarely distinctly dark. Southern Arizona to Texas .... *centralis*

4(3). Epipleural maculae distinct, usually well demarcated and extending onto elytral disk; elytra with post median maculae distinctly interrupted. Texas .... *mimeticus*

Epipleural maculae absent or vague, usually not extending onto elytral disk; elytra with post median maculae not interrupted. Eastern United States to eastern Texas .... *schwarzi*

5(2). Epipleura without distinct maculae 6

Epipleura with dark maculae 9

6(5). Elytral apices obliquely truncate to emarginate 7

Elytral apices acutely rounded; disk usually with a paler area behind basal gibbosities. Montane southern Arizona .... *chemsaki*

7(6). Antennae not or scarcely mottled; elytra with or without post median maculae, post median callosities larger than costal callosities 8

Antennae distinctly mottled; elytra without post median maculae, post median callosities small, usually about the size of the costal callosities; punctures distinct. Eastern United States to Texas ... . *punctatus*

8(7). Elytra with post median maculae usually absent; integument light brown to piceous. Eastern United States to Texas .... *misellus*

Elytra with distinct post median maculae which may ascend along sutural margin to attain scutellum, usually with a less distinct parallel macula behind; integument usually light reddish brown. Southeastern United States .... *vittatus*

9(5). Epipleural maculae poorly delineated, or if more or less well defined, triangular or irregular in outline, not primarily linear or semilunar 10

Epipleural maculae usually distinct, well demarcated, linear or commonly semilunar 11

10(9). Epipleural maculae arising at or behind humeri at about basal fifth, then continuing obliquely to include lateral third of disk stopping diffusely at approximately mid-elytra. See Figure 8; fourth antennal segment usually subequal to or shorter than scape. Southern Texas .... *texanus*

Epipleural maculae indistinct, diffuse, usually enveloping superior portion of epipleura, the humeri and basal gibbosities, and may connect posteriorly with lateral margin of discal macula; fourth antennal segment longer than scape. Southeastern United States to Texas . . . . *floridanus*

11(9). Epipleural maculae extending forward to include tops of humeri . . 12
Epipleural maculae not attaining humeri 14

12(11). Epipleural maculae distinctly vittiform, not or rarely extending onto disk 13
Epipleural maculae not vittiform, a portion extending dorsally to include part of disk. Eastern United States . . . . *rusticus*

13(12). Elytra with apices rounded to suture, costae and post median macula without callosities; antennae with fifth segment longer than scape. Montane southern Arizona . . . . *incognitus*
Elytral apices obliquely truncate (rarely rounded to sutural margin), costae and post median macula containing callosities; fifth segment usually subequal to scape. Eastern United States to California . . . . *alpha*

14(11). Elytral apices rounded to suture, or if rarely slightly truncate, pubescence generally uniformly grey. Species of western United States . . 15
Elytral apices emarginate to obliquely truncate; pubescence primarily tan or shades of brown. Eastern United States to New Mexico . . . . *fascicularis*

15(14). Elytra with lateral boundaries of post median macula obscure, attaining lateral margins or not; epipleural maculae with bases arising from ventrum of epipleura. Arizona . . . . *decorus*
Elytra with epipleural maculae small, well demarcated, with bases arising from about dorsal half of epipleura and surrounded by condensed white pubescence; discal maculae well defined, not attaining lateral margin, surrounded by white condensed pubescence. Arizona to western Texas . . . . *imitans*

Sternidius wiltii (Horn)

Liopus wiltii Horn, 1880, Trans. Amer. Entomol. Soc., 8:124; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:123.

Leiopus wiltii; Casey, 1913, Mem. Coleoptera, 4:310; Linsley and Martin, 1933, Entomol. News, 44:182; Vogt, 1949, Pan-Pacific Entomol., 25(4):181.

Sternidius wiltii; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:209; Turnbow and Wappes, 1978, Coleop. Bull., 32(44):370.

Male.—Form large, generally robust; integument dark reddish brown, covered predominantly with greyish white or tan pubescence; elytra usually with three distinct macular areas on disk. Head densely pubescent; eyes with lower lobes about one and one-half times height of genae; antennae annulate and distinctly mottled with hoary pubescence, fourth segment variable in length relationship to first and shorter than third; third segment subequal to or longer than first (fifth segment shorter than first, third, or fourth); remaining segments gradually decreasing in length. Pronotum about one and one-half times wider than long, basal margin subequal or wider than anterior margin; discal callosities usually absent or reduced; punctures distinct, obscured by pubescence which is dense, usually hoary and distinctly mottled (tan influence may be present on each side of middle of disk). Elytral apices rounded or obliquely truncate, costae indistinct, bearing a variable number of well defined distinct black tufted callosities, larger posterior median callosities absent; basal gibbosities black, prominent; punctures decreasing in depth, size and proximity apically; macular pattern quite constant, consisting of black epipleural maculae at basal third arising from about mid portion of epipleura extending dorsally to include about one-third of elytral disk, a dark area over basal gibbosities, and two slightly undulating discal maculae, one placed at or behind middle extending to lateral margin, and the other parallel posteriorly (Fig. 1); pubescence primarily hoary, mottled and demarcated by the three dark discal fasciae; tawny pubescence when present, usually on basal third and along inferior border of the maculae. Ventral surface distinctly pubescent with abdominal and thoracic sternites mottled; prosternal process narrow, one-eighth to one-fifth as wide as anterior coxal cavity; mesosternal process broader than one-half mesocoxal cavity. Legs with femora mottled, posterior tibiae with distal one-fourth dark. Abdomen with fifth sternite a little shorter than twice length of fourth.

Female.—Fifth abdominal sternite more than twice as long as fourth, otherwise similar to male.

Length.—7.4–9.6 mm.

Type locality.—Texas.

Range.—Southern Texas.

Flight period.—May and June.

Host plants.—*Acacia farnesiana* (L.) Wild., and probably *Prosopis* (F. T. Hovore, pers. comm.).

Diagnosis and discussion.—This species is distinctive by its large size, mottled pronotal disk, and the trimaculate elytral disk. Although it appears somewhat out of place in this genus, its characters adhere to the generic definition, and it does not appear to have close affinities with other United States acanthocine genera.

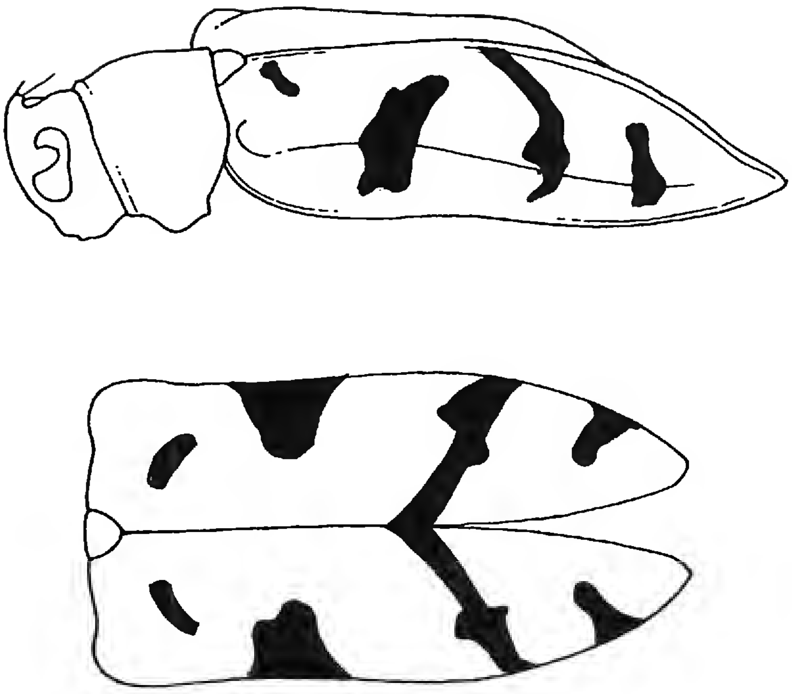
***Sternidius centralis* (LeConte)**

Liopus centralis LeConte, 1884, Trans. Amer. Entomol. Soc., 12:24; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:123.

Leiopus centralis; Casey, 1913, Mem. Coleoptera, 4:310.

Sternidius centralis; Dillon, 1956, Ann. Entomol. Soc. Amer., 49(3):218; Lewis, 1977, Pan-Pacific Entomol., 53:196.

Male.—Form small, moderately robust; integument reddish brown to piceous, densely clothed with a combination of hoary and tawny pubescence; elytra with black maculae and minute black tubercles. Head mottled with dense brownish and hoary pubescence; eyes with lower lobes variable in height relationship to genae; antennae annulate and distinctly mottled becoming less so distally; fourth segment subequal to first (rarely shorter than first), third segment longer than first or fourth, fifth segment shorter than first, third or fourth, combined fourth and fifth segments shorter than combined first and third. Pronotum transverse, basal margin subequal to or narrower than apical margin; disk usually with three callosities; punctation dense, shallow, minute, at least partially obscured by pubescence; pubescence variable, but predominately hoary on side margins and lateral disk, and mixed with fulvous in the middle, forming a more or less distinct vittate pattern. Elytra twice as long as wide; apices obliquely truncate to rounded with



Figures 1–17. Diagrammatic representations of elytral maculae of maculate species.

Figure 1. *S. wiltii* (Horn).

feeble truncations at sutural margin; costae variable, but usually distinct, partially obscured by pubescence and containing distinct, minute black tufted tubercles; discal post median callosities reduced in number; limited to an elongated callous on second costa; basal gibbosities moderate; integument brown with epipleural maculae placed just behind basal one-fourth, extending inferiorly to just behind middle, and dorsally to barely incorporate a small portion of the disk (Fig. 2), and a common discal, more or less triangular, black macula with the apex at mid elytra, the base at apical third, and lateral extension terminating before middle of disk; punctures subconfluent, partially obscured by pubescence, much larger than those on pronotal disk, largest behind humeri; pubescence made up of hoary and tawny, occasionally condensed over humeri, along suture at basal half and along costae at apical half. Ventral surface with thoracic sternites distinctly mottled, abdominal sternites uniformly hoary to cinereous pubescent; prosternal process one-fourth to one-third as wide as procoxal cavity; mesosternal process one-half to two-thirds as wide as mesocoxal cavity. Legs with femora mottled, distal portion of tibiae and tarsi black. Abdomen with fifth sternite less than twice as long as fourth.

Female.—Fifth sternite about twice as long as fourth, otherwise similar to male.

Length.—4.9–7.1 mm.

Type locality.—Arizona.

Range.—Southern Arizona to Culberson County, Texas.

Flight period.—July to September.

Host plant.—Reared from *Prosopis juliflora* (Schwartz), D.C., Sabino Canyon, Pima County, Arizona, July 1919 (G. Hofer).

Diagnosis and discussion.—This species has been confused with *S. decorus* (Fall). It differs from that species in having distinct costal callosities, a well circumscribed post median macula (which never reaches the lateral elytral border), and the relatively short fourth and fifth antennal segments. The host plant is also different. It does not appear to have any close relatives within the boundaries of

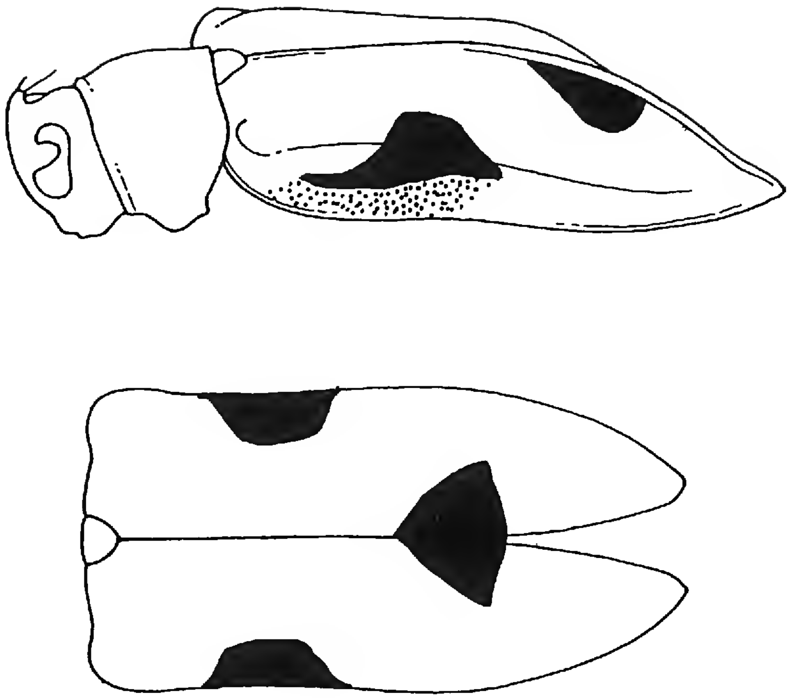


Figure 2. *S. centralis* (LeConte).

the United States. One specimen was examined from Van Horn, Texas, collected by W. F. Barr, July 4, 1941.

***Sternidius mimeticus* (Casey)**

Leiopus mimeticus Casey, 1891, Ann. New York Acad. Sci., 6:49; Casey, 1913, Mem. Coleoptera, 4:315 (part).

Leiopus houstoni Casey, 1913, Mem. Coleoptera, 4:315; Vogt, 1949, Pan-Pacific Entomol., 25(4):182.

Sternidius mimeticus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:210; Dillon, 1961, A manual of common beetles of North America, p. 640.

Male.—Form small, moderately robust; integument reddish brown, obscured by grey and tan pubescence; elytra with discal and lateral maculae. Head with face usually densely pubescent and mottled; eyes with lower lobes one and one-half to one and three-fourths genal height; antennae slender, distinctly mottled (mid portion of fourth segment may be dark), fourth segment usually shorter than first (occasionally subequal), fifth distinctly shorter than the first, third or fourth segments, third usually longer than fourth and subequal to or longer than first, remaining segments gradually decreasing in length. Pronotum about one and one-half times wider than long, sides diverging from anterior margin to lateral tubercles placed at basal third, then abruptly constricted to form basal transverse sulcus; basal margin usually as wide or slightly wider than apical margin; callosities usually inconspicuous, and frequently hidden by pubescence; punctures usually hidden beneath pubescence which is dense, recumbent, and quite uniformly composed of tan, brown, or cinereous and hoary; pubescence may be unicolorous or tinted with different proportions of tan and cinereous or with a lateral condensation of hoary. Elytra slightly more than twice as long as wide; apices obliquely truncate; costae usually prominent, containing a variable number of small callosities (numerous to essentially absent except along suture); costal callosities absent behind post median macular demarcation, larger posterior median callosities obscured

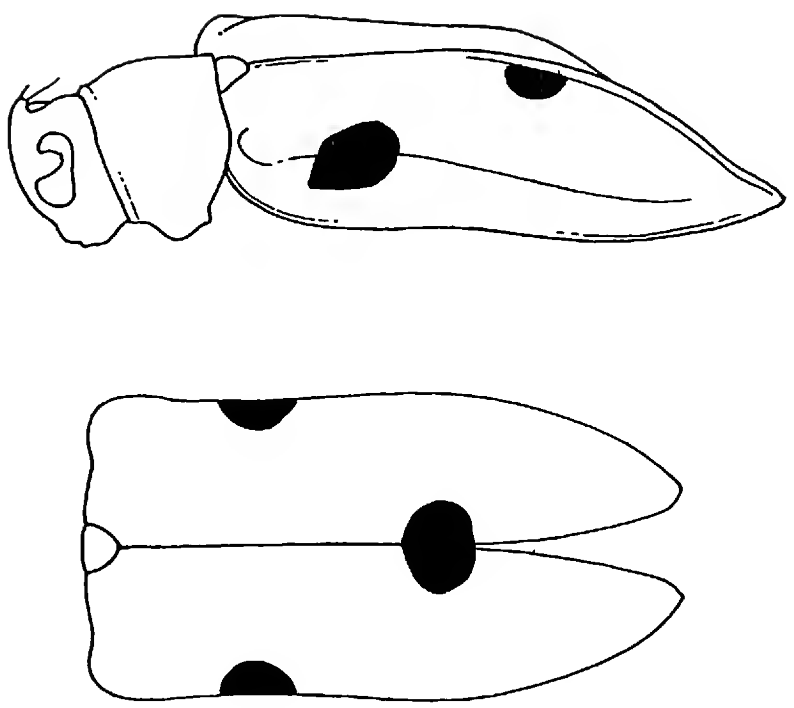


Figure 3. *S. imitans* (Knull).

and covered by pubescence (callosity on third costa inferior to fourth); basal gibbosities usually not prominent; punctures usually concealed by pubescence; elytral maculae represented by black or dark on top of humeri, epipleural maculae which are distinct, semilunar, and are placed behind humeri extending posteriorly to behind middle, and dorsally to include one-fourth to one-half of the disk, and a black discal oblique macula diverging from behind middle to third costae, undulating forward at that point then again diverging at about forty-five degrees to lateral margin (Fig. 7); pubescence dense, pattern variable, uniformly grey or tan, or composed of a mixture of tan, hoary and cinereous hairs (at times pubescence is hoary or grey in front of post median macula, and tan behind); hoary pubescence may coalesce along costae anteriorly, but posterior extension is rare; the pubescence extends laterally over humeri and behind middle demarcating epipleural maculae (a fine tan or black pubescence may be present over the macula partially obscuring its boundaries), discal macula and discal callosities are covered with black pubescence. Ventral surface densely pubescent with abdominal and thoracic sternites distinctly mottled; prosternal process one-seventh to one-third as wide as anterior coxal cavity, mesosternal process more than one-half as wide as coxal cavity. Legs with femora distinctly mottled, tibiae and tarsi dark distally.

Abdomen with tip of fifth sternite slightly concave, about one-half as long as fourth segment.

Female.—Fifth abdominal sternite approximately twice as long as fourth, otherwise similar to male.

Length.—4.2–8.2 mm.

Type locality.—Of *mimeticus,* Brownsville, Texas; *houstoni,* Brownsville, Texas.

Range.—Texas, from Jefferson Davis and Brewster Counties, east to Dallas and Bexar Counties, and south to Cameron County.

Flight period.—May to July.

Host plants.—*Celtis occidentalis* (L.), *Leucaenia pulverulenta* (Schlecht.) Benth. (F. T. Hovore, pers. comm.).

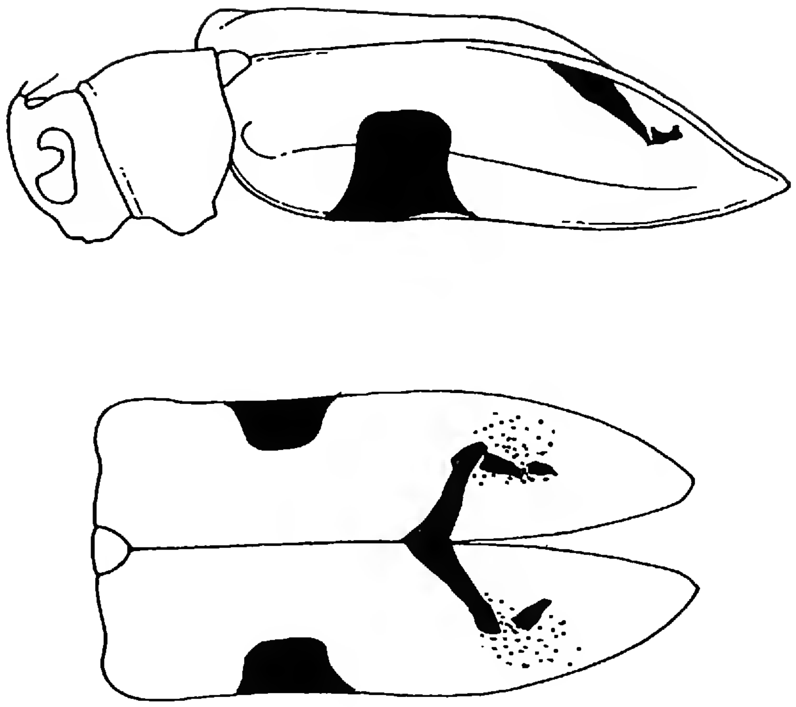


Figure 4. *S. decorus* (Fall).

Diagnosis and discussion.—This species appears to be closely related to *S. schwarzi* (Hamilton), but is separable from that species by its distinctly interrupted post median discal macula and distinct epipleural maculae. It differs from light forms of *S. fascicularis* (Harris) by its shorter fourth and fifth antennal segments and its dark anterior humeral margins. Separation from *S. centralis* (LeConte) should present no problem as the discal macula does not extend to the lateral margin in that species. *S. mimeticus* is commonly attracted to light.

Sternidius schwarzi (Hamilton)

Liopus schwarzi Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:124.
Leiopus schwarzi; Casey, 1913, Mem. Coleoptera, 4:316.
Sternidius schwarzi; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:212; Turnbow and Hovore, 1979, Entomol. News, 90(5):225.
Leiopus moderator Casey, 1913, Mem. Coleoptera, 4:314. New synonymy.
Sternidius moderator; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:212.

Male.—Form small, moderately robust; integument reddish brown, covered with tan and hoary pubescence; elytra with distinct maculae. Head with face pubescent; eyes with lower lobes variable in relation to genal height (generally one and one-half to two times as tall as genae); antennae distinctly mottled, fourth segment subequal to or shorter than first, third segment longer than fourth, subequal to or longer than first, fifth shorter than first, third or fourth. Pronotum about twice as wide as long; basal margin usually subequal in length to anterior margin; punctures, at least in part, obscured by vestiture which is dense and uniformly grey (rarely with increased density along sides). Elytra with apices obliquely truncate; costae variable in prominence but usually distinct and usually bearing uniform black callosities; larger post median callosities absent or hidden in discal macula; basal gibbosities variable in prominence; punctures obscured by pubescence; macular pattern includes black or dark anterior margins of humeri, indistinct epipleural maculae placed behind humeri, extending posteriorly to or slightly behind middle and rarely extending dorsally to include up to one-third

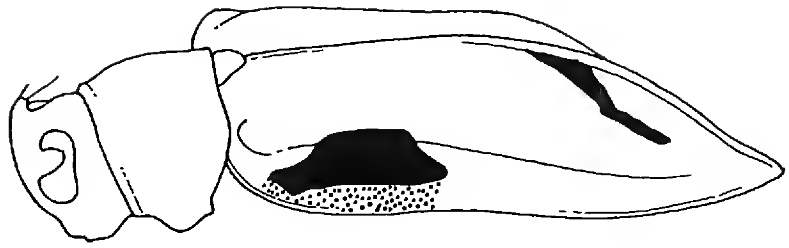


Figure 5. *S. fascicularis* (Harris).

of the elytral disk (the boundaries are poorly demarcated), and a distinct, linear oblique nonundulating discal post median macula placed well behind middle, composed of black pubescence extending backward from suture through callosities (forming an inferior sutural angle which is distinctly greater than forty-five degrees), attaining or not the lateral margin (Fig. 6), occasionally an indistinct parallel macula is present posteriorly composed of slightly darker tan pubescence; pubescence is commonly uniformly grey in front of post median macula (rarely with hoary coalescence along costae), and tan or rust colored behind it. Ventral surface with pubescence not obscuring surface; abdominal and thoracic sternites distinctly mottled; prosternal process about one-third as wide as procoxal cavity, mesosternal process more than one-half width of mesocoxal cavity. Legs with femora distinctly mottled; posterior tibiae with distal one-fourth to one-third usually dark. Abdomen with fifth sternite slightly concave at apex, less than twice as long as fourth.

Female.—Fifth abdominal sternite more than twice as long as fourth, otherwise similar to male.

Length.—5.5–7.8 mm.

Type locality.—Of *schwarzi,* Key West Florida; *moderator,* Washington, D.C.

Range.—This is primarily a southeastern species ranging from Washington D.C. to the Florida Keys, and west to Orange County, Texas.

Flight period.—April to June.

Host plants.—*Prunus serotina* Ehrh., *Morus, Diospyros virginiana* L., *Lysiloma* sp., *Metopium toxiferum* (L.) Krug and Urban, *Piscidia piscipuls* (L.) Sarg, and *Rhus.*

Diagnosis and discussion.—This species is closely related to *S. mimeticus* (Casey). It may be separated from that species by the nonundulating discal fascia which is placed further posteriorly at a less acute angle, and the poorly defined lateral maculae which rarely extend dorsally to include a portion of the disk. It may be differentiated from *S. texanus* (Casey) (another species with relatively short fourth and fifth antennal segments) by the presence of dark anterior humeral margins. Their ranges apparently are allopatric. *S. moderator* (Casey) is based on a specimen with relatively subobsolete costae, a variable character in many members of this genus.

Sternidius chemsaki **Lewis**

Sternidius chemsaki Lewis, 1977, Pan-Pacific Entomol., 53:196.

Male.—Form elongate; integument reddish brown to black, covered with cinereous pubescence; elytra with small linearly spaced black tufts and without black maculae. Head with frons covered with cinereous pubescence; antennae

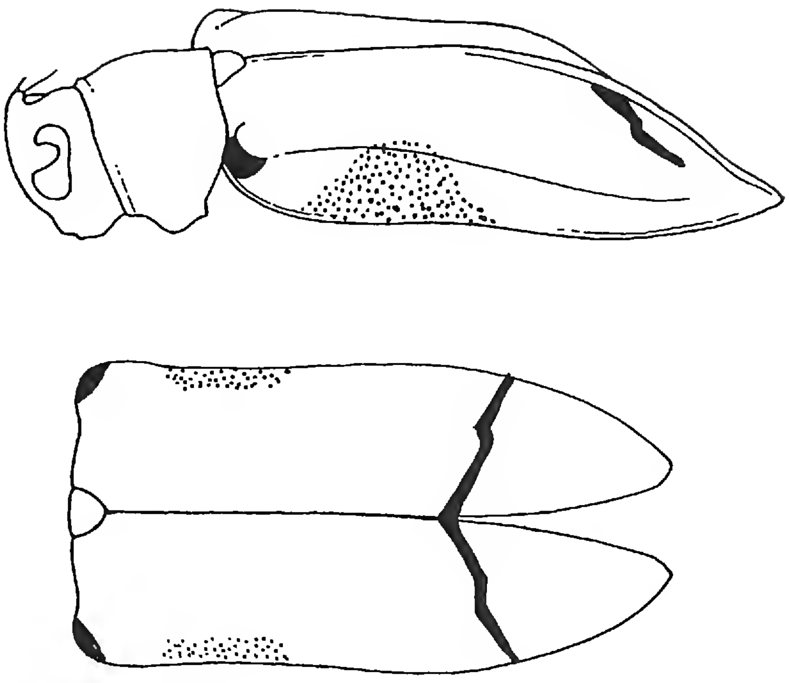


Figure 6. *S. schwarzi* (Hamilton).

scarcely mottled, fourth segment longer than first, subequal to or shorter than third which is longer than first, fifth segment subequal to or slightly longer than first, remaining segments gradually decreasing in length. Pronotum transverse, widest across lateral tubercles, apex wider than base; callosities present to obsolete; disk with punctures small, dense, noncontiguous, partially obscured by uniform cinereous pubescence. Elytra slightly more than twice as long as wide, apices prolonged and acutely rounded; disk with prominent piceous basal gibbosities, immediately behind which, on each elytron, is an obliquely placed more or less ferrugineus depression which contrasts with the darker integument behind; costae distinct, evanescent before apices and containing scattered black callosities in variable number with larger post median callosities on the second costae at about apical third; punctures dense, separate, partially obscured by pubescence; macular

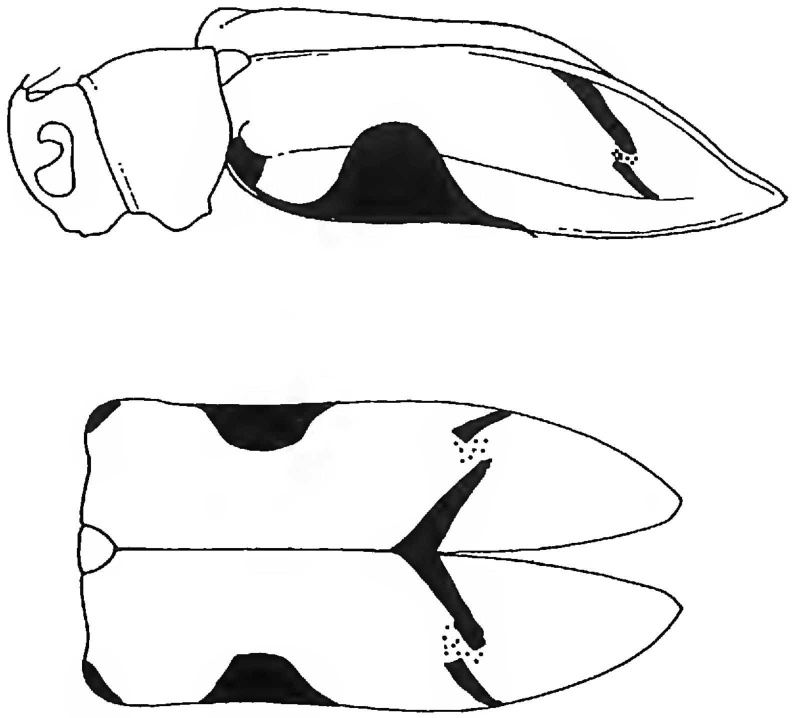


Figure 7. *S. mimeticus* (Casey).

areas absent; pubescence recumbent, cinereous (sometimes with tawny reflections) and with some condensation along costae, with black present on basal gibbosities, and on costal callosities. Ventral surface with pubescence scarcely mottled on thoracic sternites, uniform on abdominal sternites; prosternal process variable in size, usually one-sixth to one-fourth as wide as procoxal cavity; mesosternal process slightly more than one-half as wide as mesocoxal cavity. Legs with femora and tibiae indistinctly mottled, usually darker distally with cinereous to black pubescence. Abdomen with fifth sternite subequal to or slightly longer than fourth.

Female.—Fifth abdominal sternite at least twice as long as fourth, otherwise similar to male.

Length.—5.6–8.9 mm.

Type locality.—Madera Canyon, Santa Cruz County, Arizona.

Range.—Southern Arizona, Santa Rita, and Huachuca Mountains (Cochise and Santa Cruz Counties).

Flight period.—July to September.

Host plants.—*Quercus*?

Diagnosis and discussion.—This species resembles some larger specimens of *S. misellus* (LeConte). It differs from that species in having the elytra more than twice as long as wide with the apices acutely rounded. It is known only from Cochise and Santa Cruz Counties, Arizona.

***Sternidius punctatus* (Haldeman)**

Amniscus punctatus Haldeman, 1847, Trans. Amer. Phil. Soc., (2)10:49.

Sternidius punctatus; LeConte, 1873, Smithsonian Misc. Coll., 264:235.

Liopus punctatus; Horn, 1880, Trans. Amer. Entomol. Soc., 8:124; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:125; Blatchley, 1910, The Coleoptera of Indiana, p. 1075.

Leiopus punctatus; Casey, 1913, Mem. Coleoptera, 4:311; Knull, 1946, Bull. Ohio Biol. Surv., 39:249; Craighead, 1923, Canada Dept. Agri. Tech. Bull., (n.s.) 27: 117.

Leiopus maculipennis Blatchley, 1922, Can. Entomol., 45:31. New synonymy.

Sternidius fascicularis fascicularis; Dillon, 1956, Ann. Entomol. Soc. Amer., 49: 213 (part).

Sternidius fascicularis maculipennis; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:213.

Male.—Form small; integument reddish brown to blackish brown, covered with tawny pubescence and with a transverse hoary fascia about mid elytra; elytra usually with prominent costal callosities; post median callosities, discal and lateral maculae obsolete. Head with face slightly mottled; eyes with lower lobes variable in height relationship to gena, but usually subequal; antennae mottled, fourth segment longer than first, usually shorter than third, fifth segment shorter than third and fourth and usually shorter than first, remaining segments gradually decreasing in length. Pronotum about twice as wide as long; basal margin usually shorter than apical; callosities generally reduced; punctures minute, only partially obscured by pubescence; pubescence tawny, interspersed with hoary, and occasionally with hoary condensation laterally; sides without maculae, suffused with hoary pubescence. Elytra slightly more than twice as long as broad; apices obliquely truncate to emarginate; costae prominent or not, containing numerous uniformly spaced callosities, larger posterior median callosities linear or lacking; basal gibbosities usually not prominent punctation distinct with punctures only slightly finer and more shallow apically, not significantly obscured by pubescence; epipleural and discal maculae lacking; pubescence tawny with a hoary transverse slightly undulating fascia placed at or behind middle which usually extends to lateral margins and occasionally to ventrum of epipleura, the humeral portions of the disk may be suffused with hoary as well, with small scatterings over the remaining disk (when the humeral and median hoary fascia extend laterally to reach the epipleural ventrum, it makes the epipleura appear maculate). Ventral surface covered with greyish pubescence, thoracic sternites usually mottled; prosternal process about one-sixth to one-third as wide as anterior coxal cavity, mesosternal process two-thirds to three-fourths as wide as mesocoxal cavity. Legs with femora usually mottled, tibiae distally dark or not, frequently with a hoary annulation at apex and near base. Fifth abdominal sternite less than twice as long as fourth with apex usually slightly concave.

Female.—Fifth abdominal sternite at least twice as long as fourth, otherwise similar to male.

Length.—3.5–6.4 mm (usually 5.5–6 mm).

Type locality.—Of *punctatus,* not listed; *maculipennis,* Dunedin, Florida.

Range.—Eastern United States from New Jersey to Florida, west to Texas and Missouri.

Flight period.—May to July.

Host plants.—*Parthenocissus quinquefolia* (L.) Planch.; *Diospyros virginiana* L.; *Cornus florida* (L.); "Prunus" and plum.

Diagnosis and discussion.—This species is quite constant in form but when the humeral and discal hoary pubescence extends laterally to reach the ventrum of the epipleura, it makes the sides appear maculate, thus causing confusion with *S. fascicularis* (Harris). (The type of *S. fascicularis* has dark brown integument, with white pubescence over the humeri and behind the middle, but epipleural and discal maculae are present, although indistinct because of the dark integument. This, and the presence of well developed post median callosities make it distinct from *S. punctatus.*) The fourth antennal segment is usually shorter than the third and the fifth segment slightly shorter than the first in *S. punctatus,* whereas in *S. fascicularis* (Harris), the fourth and third, and fifth and first segments are subequal. It differs from *S. misellus* (LeConte) by having mottled antennae, subobsolete post median discal callosities, and generally uniform punctation which is rarely obscured by pubescence. From *S. floridanus* (Hamilton), it may be separated by the smaller lower lobe of the eye and absent discal maculae.

***Sternidius misellus* (LeConte)**

Liopus misellus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, 2:173.
Leiopus misellus; Casey, 1913, Mem. Coleoptera, 4:313.
Sternidius alpha misellus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:216.

Male.—Form generally small; integument light brown to piceous; pubescence usually quite uniform, greyish brown to cinereous; elytra with small, usually linear post median callosities, epipleura without distinct maculae. Head with face con-

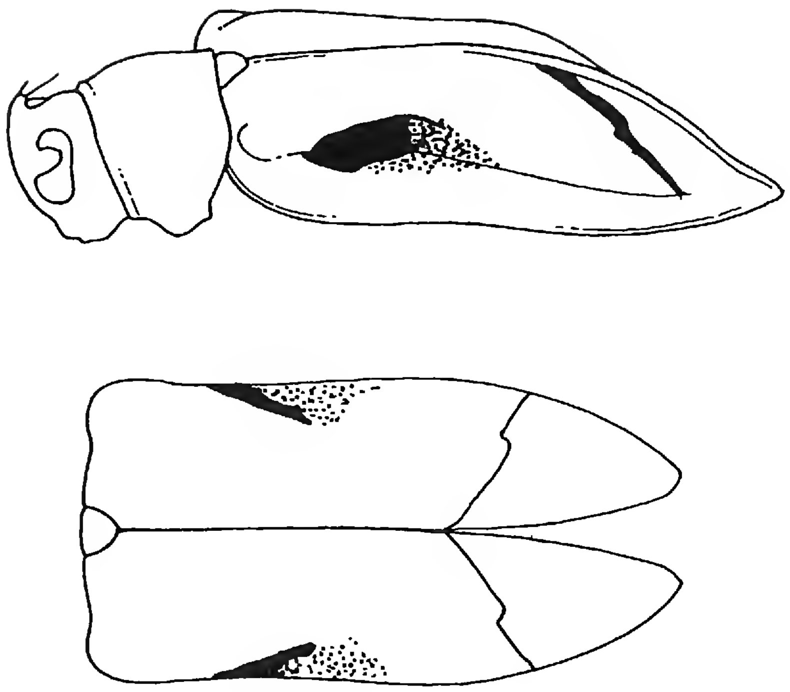


Figure 8. *S. texanus* (Casey).

taining sparse, recumbent, cinereous pubescence; eyes with lower lobes subequal to or slightly taller than genae; antennae not mottled except occasionally scape, fourth segment longer than first, subequal to third (rarely slightly shorter than third), fifth segment with length variable in relation to first, shorter than fourth, remaining segments decreasing in length. Pronotum not quite twice as wide as long; basal margin narrower than apical margin; discal callosities usually reduced; surface minutely, shallowly punctate, obscured by pubescence; pubescence cinereous to tawny, occasionally condensed laterally. Elytra about twice as long as wide, apices obliquely truncate, subtruncate, or emarginate; costae prominent or not, with or without a variable number of small, dark callosities; post median discal callosities usually linear and reduced, epipleural maculae absent or vague; discal maculae usually absent; basal gibbosities reduced; surface closely punctate, punctures largest at base, then gradually decreasing in size and density apically, partially obscured by pubescence; pubescence variable in color, tawny to cinereous, usually similar in hue to integument, occasionally condensed along anterior margin of median discal callosities, some white suffusion may be present but rarely does it extend behind middle of elytral disk. Ventral surface pubescent, rarely with slight mottling over thoracic sternites; abdominal sternites not mottled; prosternal process one-sixth or less as wide as procoxal cavity mesosternal process more than one-half as wide as mesocoxal cavity. Legs with femora not or indistinctly mottled, distal third of tibiae and tarsi darker. Fifth abdominal sternite with apex concave to notched, less than twice as long as fourth.

Female.—Fifth sternite at least twice as long as fourth, otherwise same as male.

Length.—3.4–7.2 mm (usually 4–5 mm).

Type locality.—Illinois.

Range.—Eastern United States from Connecticut to Florida, and west to Kansas and Texas.

Flight period.—May to July.

Host plant.—*Quercus* sp., *Quercus velutina* Lam., *Castanea dentata* (Marsh.) Borkh, *Parthenocissus quinquifolia* (L.), *Diospyros virginiana* L.

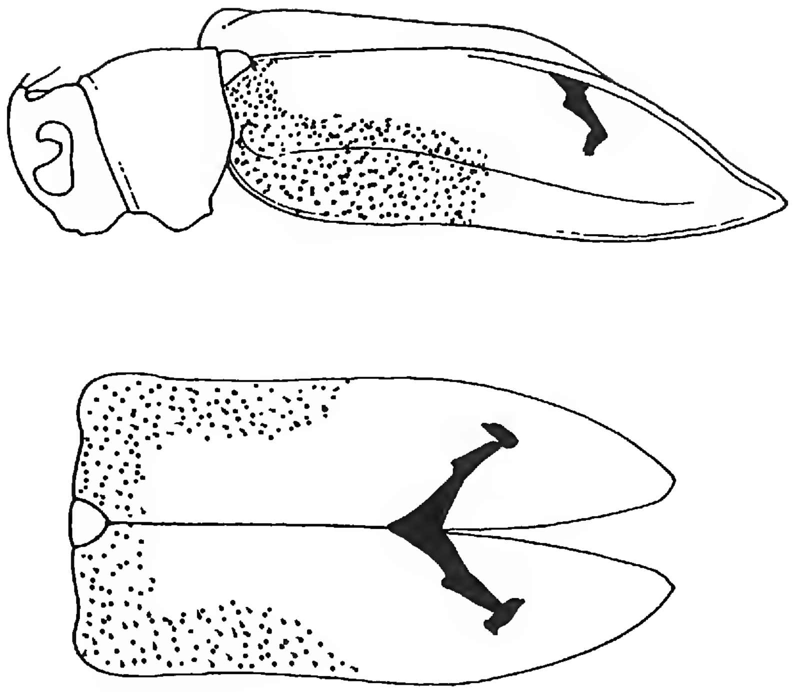


Figure 9. *S. floridanus* (Hamilton).

Diagnosis and discussion.—This species may be distinguished by its usually small form, the lower lobes of the eyes, which are usually subequal to or slightly taller than genae (very rarely twice as tall), relatively uniform pubescence of elytra, reduced or absent post median, and absent epipleural maculae. The pronotal discal callosities, which are usually reduced are more prominent in those forms with lighter pubescence. It can be separated from *S. alpha* (Say) by the absence of distinct epipleural maculae, and by the presence of uniform epipleural pubescence. The linear condensations of pubescence along the costae (frequently present in *S. alpha*) are not evident, and the two species utilize different host plants. *S. misellus* (LeConte) may be confused with *S. floridanus* (Hamilton), however it may be distinguished from that species by the nonmottled antennae, generally smaller lower lobe of the eye, and the (usually) subequal third and fourth antennal segments. From *S. vittatus* Dillon, it differs in lacking a distinct post median macula. From *S. punctatus* (Haldeman), it is readily separated by the lack of antennal mottling, the subequal third and fourth antennal segments, and the relatively narrow mesocoxal process. It appears to be related to *S. chemsaki* Lewis, but it lacks the prolonged elytra with rounded apices characteristic of that species.

***Sternidius vittatus* Dillon**

Sternidius vittatus Dillon, 1956, Ann. Entomol. Soc. Amer., 49:219.

Male.—Form small; integument light reddish brown; elytra with discal maculae sometimes extending forward along suture to scutellum; epipleural maculae obsolete; costal callosities sparse. Head with pubescence recumbent; eyes with lower lobes one and one-third as tall as genae; antennae with scape sometimes lightly mottled, remainder of segments not significantly so, fourth segment longer than first, subequal to or slightly shorter than third, fifth segment shorter than first, third or fourth, remaining segments gradually decreasing in length. Pronotum less than twice as wide as long; basal and apical margins subequal; dorsal callosities present, varying only slightly in prominence; punctations minute; pubescence cinereous, only partially obscuring surface, denser over lateral portion of disk, and uniform along sides. Elytra about twice as long as wide, apices obliquely truncate to emarginate; costae reduced, usually with only a few callosities; post median discal callosities prominent to vague (Fig. 10); basal gibbosities not prominent; punctures distinct, separated by their own diameter, decreasing in depth and density apically, partially or not obscured by pubescence; epipleural maculae absent, discal maculae extend obliquely backward through the post median callosities at an angle of about forty-five degrees, attaining or not the lateral elytral margin (a less distinct macula parallels this behind), and may extend forward along sutural margin to scutellum; pubescence tawny to white, not or only partially obscuring surface, with coalescence along anterior margin of discal macula, and the posterior half of the disk and epipleura (epipleura sparsely pubescent anteriorly). Ventral surface with thoracic sternites not or indistinctly mottled; prosternal process one-sixth to one-fourth as wide as procoxal cavity; mesosternal process about two-thirds as wide as mesocoxal cavity. Legs with femora not or indistinctly mottled, tibiae and tarsi dark distally. Fifth abdominal sternite with apex slightly concave, less than twice as long as fourth segment.

Female.—Fifth abdominal sternite twice as long as fourth, otherwise similar to male.

Length.—4.1–5.3 mm.

Type locality.—Lucedale, Mississippi.

Host plants.—Unknown.

Range.—Eastern United States from New Jersey to Mississippi.

Flight period.—April to June.

Diagnosis and discussion.—This species appears to be closely related to *S. rusticus* (LeConte) and may be synonymous with that species. It differs, however, by frequently exhibiting sutural extension of the discal maculae, and by the absence of distinct epipleural maculae.

Sternidius texanus (Casey)

Sternidius texanus Casey, 1913, Mem. Coleoptera, 4:315; Vogt, 1949, Pan-Pacific Entomol., 25(4):182.

Sternidius mimeticus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:210 (part).

Sternidius texanus; Hovore and Penrose, 1982, The S.W. Nat., 27:23–27.

Male.—Form small, moderately robust; integument dark brown to piceous; elytra with tan and hoary pubescence; epipleural maculae usually present. Head with face pubescent; eyes with height of lower lobes variable (from one to two times as tall as genae); antennae distinctly mottled, segmental relationships variable, fourth segment usually subequal to or smaller than first (occasionally slightly longer), shorter, subequal to or slightly longer than third, fifth segment shorter than first, third or fourth, remaining segments gradually decreasing in length. Pronotal width slightly more than twice the length, basal margin usually slightly narrower than apical margin, dorsal callosities not prominent; punctures partially obscured by pubescence, pubescence variably tan colored (an admixture of greyish or light tan may be present over lateral disk). Elytra about twice as long as wide with sides slightly rounded from humeri to basal third; apices broadly rounded to subtruncate; costae distinct to obsolete, small callosities present along the sutural margin and scattered, when present, on the remaining costae; posterior

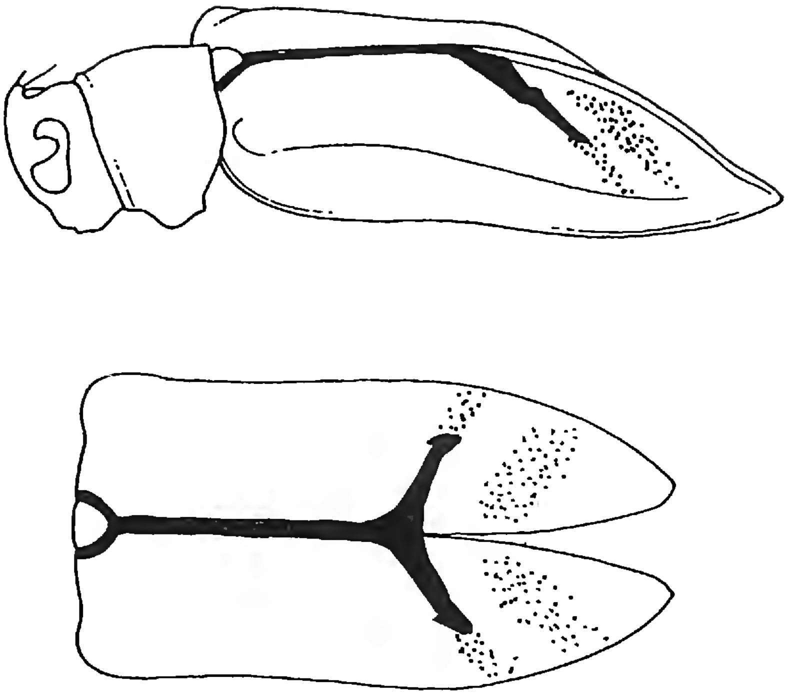


Figure 10. *S. vittatus* Dillon.

median callosities variably prominent, located behind middle, sometimes lacking on the third and fourth costae; basal gibbosities moderately developed to obsolete; punctures becoming finer and less dense apically, partially obscured by pubescence; epipleural maculae are located behind humeri at basal fourth on about dorsal fourth and extend dorsally and backward to include the lateral third of the disk, and inferiorly to or beyond mid elytra (Fig. 8) (they may be hidden by pubescence), discal maculae are commonly lacking, but when present, are formed by the coalescence of post median callosities; pubescence composed of varying shades of tan (which may be mottled), with whitish usually present along the anterior margins of post median callosities, and occasionally ascending along costae, a suffusion of white may be present over basal half of the disk in fully marked forms giving the appearance of a saddle, epipleural pubescence uniform, colored as apical portion of disk. Ventral surface pubescent, thoracic sternites mottled (sometimes indistinctly so), abdominal sternites uniformly pubescent; prosternal process narrow, from one-seventh to one-fifth as wide as procoxal cavity; mesosternal process more than one-half as wide as mesocoxal cavity. Legs with femora distinctly mottled; posterior tibiae usually not distinctly darker distally, posterior tibiae with first tarsal segment about as long as next two following. Fifth abdominal sternite with apex concave, less than one and one-half times as long as fourth.

Female.—Fifth abdominal sternite about twice as long as fourth, otherwise the same as in male.

Length.—4.5–6.6 mm.

Type locality.—Brownsville, Texas.

Range.—Southern Texas to southern Mexico.

Flight period.—May to July.

Host plants.—*Leucaenia pulverulenta* (Schlect.) Benth.

Diagnosis and discussion.—Fully marked specimens are very distinctive because of the placement of the epipleural maculae. This species is also characterized by its rounded form, relatively short fourth and fifth antennal segments, strongly mottled antennae, and usual lack of a distinct dark annulus on the distal third of the posterior tibiae. This character will separate it from *S. mimeticus* (Casey) which is found in the same area. It differs from *S. alpha* (Say), by its short fourth and fifth antennal segments, and from *S. misellus* (LeConte) by the short antennal segments, mottled antennae, and characters given in the key. Examples have been taken on the host plant nocturnally, and are readily attracted to light. I believe that *S. texanus* (Casey) is synonymous with *S. naeviicornius* (Bates), representing the northern extension of that species, but since I have not seen the Bates' type, I have not implemented the synonymy.

Sternidius alpha **(Say)**

Lamia alpha Say, 1826, Jour. Acad. Nat. Sci. Philadelphia, 5:270.

Amniscus alpha; Haldeman, 1847, Trans. Amer. Phil. Soc., (2)10:48.

Liopus alpha; LeConte, 1852, Jour. Acad. Nat. Sci. Phil., (2)2:172; Horn, 1880, Trans. Amer. Entomol. Soc., 8:124; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:124; Blatchley, 1910, The Coleoptera of Indiana, p. 1074 (misdet.).

Leiopus alpha; Casey, 1913, Mem. Coleoptera, 4:314 (misdet.); Brimley, 1938, Insects of North Carolina, p. 218; Knull, 1946, Ohio Biol. Surv. Bull., 39:250.

Sternidius alpha alpha; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:214 (part); Dillon, 1961, A manual of common beetles of eastern North America, p. 640.

Amniscus alpha var. *divergens* Haldeman, 1847, Trans. Amer. Phil. Soc., 2(10): 48; Leonard, 1926, Cornell Univ. Agr. Exp. Sta. Mem., 101:452.

Amniscus lateralis Haldeman, 1847, Trans. Amer. Phil. Soc., 2(10):48.

Liopus cinereus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2:173; Horn, 1880, Trans. Amer. Entomol. Soc., 8:124.

Leiopus cinereus; Casey, 1913, Mem. Coleoptera, 4:314 (misdet.); Leonard, 1926, Cornell Univ. Exp. Sta. Mem., 101:452; Brimley, 1938, Insects of North Carolina, p. 218; Knull, 1946, Ohio Biol. Sur. Bull., 39:250.

Amniscus vicinus Haldeman, 1847, Trans. Amer. Phil. Soc., 2(10):49.

Leiopus vicinus; Casey 1913, Mem. Coleoptera, 4:312; Leonard, 1926, Cornell Univ. Agr. Exp. Sta. Mem., 101:452.

Sternidius alpha vicinus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:214 (part); Kirk, 1969, South Carolina Agr. Exp. Sta. Tech. Bull., 1037:86.

Leiopus nelsonicus Casey, 1924, Mem. Coleoptera, 11:291.

Sternidius alpha misellus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:216 (part).

Sternidius alpha coloradensis Dillon, 1956, Ann. Entomol. Soc. Amer., 49:216. New synonymy.

Sternidius suturalis Dillon, 1956, Ann. Entomol. Soc. Amer., 49:218. New synonymy.

Male.—Form moderately small; integument reddish brown to piceous covered with variably colored pubescence; elytra with epipleural and discal maculae usually well defined. Head mottled or not; frons with recumbent pubescence; eyes with lower lobes usually one to one and one-half times (rarely twice) as high as genae; antennae annulate, mottled or not, fourth segment distinctly longer than first, third and fourth segments subequal, fifth segment subequal to first, shorter than third or fourth. Pronotum less than twice as wide as long, widest across lateral

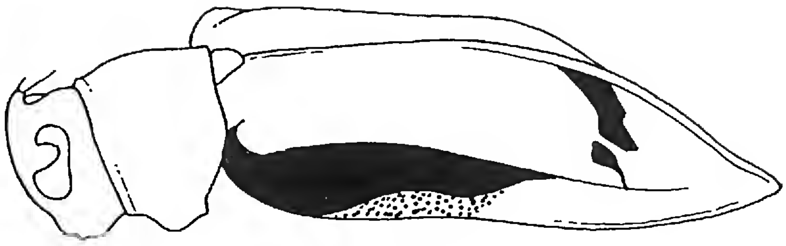


Figure 11. *S. alpha* (Say).

tubercles, basal and apical margins variable in relationship, callosities usually distinct; surface densely minutely punctate (punctures sometimes obsolete), partially obscured by pubescence; pubescence variable in color (usually tawny to cinereous), uniform or with coalescence over the lateral portion of the disk and between the callosities in varying degree, commonly sparse along middle of sides allowing the integument to show through and appear vittate. Elytra about twice as long as wide, apices obliquely truncate to emarginate (very rarely rounded); costae semiprominent to subobsolete, containing small callosities varying in prominence and number; post median callosities present behind middle on second, third, fourth, and occasionally fifth costae (lateral margin), most prominent on the second costae, third costal callosity usually inferior to second, and fourth adjacent to third (fourth callosity may be absent and the third reduced) (Fig. 14); basal gibbosities prominent to obsolete; punctures dense, closely, gradually decreasing in size, depth, and proximity apically, commonly obscured by pubescence especially in the greyish more uniformly pubescent forms; epipleural maculae linear, placed at about middle extending forward to top of humeri (the darkest portion placed along the dorsal half of each epipleuron); discal maculae, when present, variable, extending backward through the post median callosities and occasionally extending forward along the suture to the scutellum; pubescence usually dense, recumbent, varying from uniformly grey, whitish, tawny or cinereous, to a combination of these colors. Ventral surface pubescent, thoracic sternites usually mottled, abdominal sternites usually not mottled; prosternal process from one-tenth to one-fourth as wide as procoxal cavity (usually one-sixth to one-fourth); mesosternal process about one-half as wide as mesocoxal cavity. Legs with femora usually mottled, tibiae and tarsi dark. Fifth abdominal sternite subtruncate, slightly concave or shallowly notched, less than twice as wide as fourth.

Female.—Fifth abdominal segment at least twice as long as fourth, otherwise similar to male.

Length.—4.3–8.2 mm (usually 6–7 mm).

Type locality.—Of *alpha,* Pennsylvania; *nelsonicus,* Nelson Co., Virginia; *lateralis,* west New York; *divergens,* Pennsylvania; *vicinus,* not listed; *cinereus,* Georgia; *coloradensis,* Colorado Springs, Colorado; *suturalis,* Rockdale, Texas.

Range.—California, Arizona, Idaho, Colorado, to eastern seaboard, south to Florida.

Flight period.—April through July.

Host plants.—*Rhus glabra* (L.), *Rhus hytra* (L.), *Rhus copallina* (L.), *Rhus typhina* Torner, *Acer negundo* L., *Platanus, Carya,* "oak twigs"?, "*Salix*"?

Diagnosis and discussion.—This is a variable species with numerous color patterns. When whitish coalescence is present, it involves some or part of the following: the basal gibbosities, basal lateral margin, sutural margin and costae anteriorly, anterior margin of the discal macula when present, and frequently bordering the costae posteriorly. Note: in those forms which exhibit variably colored pubescence, the epipleural vittae may be less distinct, however the antennae are usually distinctly mottled in these forms which will help distinguish them from *S. misellus* (LeConte). *S. alpha* differs from *S. fascicularis* (Harris) by the linear epipleural maculae which extend to the top of the humeri (not attenuated by pubescence extending laterally over shoulder), by the usually smaller lower lobe of the eye, and by commonly possessing white pubescence along the costae posterior to discal maculae. It also is separable from *S. rusticus* (LeConte) by its generally larger form, lack of discal extension of the epipleural maculae, and the subequal third and fourth, and fifth and first antennal segments. From *S. incognitus* Lewis, it differs in having subtruncate to emarginate apices, the fifth antennal segment not usually longer than the first, and distinct callosities along the elytral costae. It may be separated from *S. misellus* (LeConte) by its distinct vittae and mottled ventral surface. *S. suturalis* Dillon is based on a specimen which has the median discal dark area extending forward along the sutural margin. This is seen often in forms with unicolorous discal pubescence, however, this is not a predictable characteristic of these forms. (A series reared from *Acer* in South Dakota exhibits a sutural vittae in some specimens and not in others.) *S. alpha coloradensis* Dillon is a typical *S. alpha* with reduced discal maculae and a relatively uniform pubescent pattern. *S. nelsonicus* (Casey) is a uniformly dark, pubescent specimen which is structurally indistinguishable from, and intergrades with, the other forms of *S. alpha*.

***Sternidius fascicularis* (Harris)**

Lamia (*Mesosa*) *fascicularis* Harris, 1836, Trans. Hartford Nat. Hist. Soc., 1:68, pl. 1, fig. 9.
Amniscus fascicularis; Haldeman, 1847, Trans. Amer. Phil. Soc., 2(10):48.
Leptostylus fascicularis; LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 170.
Liopus fascicularis; Blatchley, 1910, The Coleoptera of Indiana, p. 1074 (misdet.).
Leiopus fascicularis; Leonard, 1926, Cornell Univ. Agr. Exp. Sta. Mem., 101:452; Knull, 1946, Ohio Biol. Surv. Bull., 39:250.
Sternidius fascicularis fascicularis; Dillon, 1956, Ann. Entomol. Soc. Amer., 49: 213 (part).
Sternidius fascicularis; Kirk, 1969, South Carolina Agr. Exp. Sta. Clemson Univ. Tech. Bull., 1033:86.
Liopus xanthoxyli Shimer, 1868, Trans. Amer. Entomol. Soc., 2:7.
Leiopus dentatus Casey, 1913, Mem. Coleoptera, 4:310.
Leiopus testaceus Casey, 1913, Mem. Coleoptera, 4:311.
Leiopus pleuralis Casey, 1913, Mem. Coleoptera, 4:312.
Leiopus timidus Casey, 1913, Mem. Coleoptera, 4:313.
Leiopus obscurellus Casey, 1913, Mem. Coleoptera, 4:313; Leonard, 1926, Cornell Univ. Agr. Exp. Sta. Mem., 101:452.
Leiopus scapalis Casey, 1913, Mem. Coleoptera, 4:312.
Sternidius alpha alpha; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:214 (part).
Sternidius alpha vicinus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:215 (part).
Sternidius alpha misellus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:216 (part).

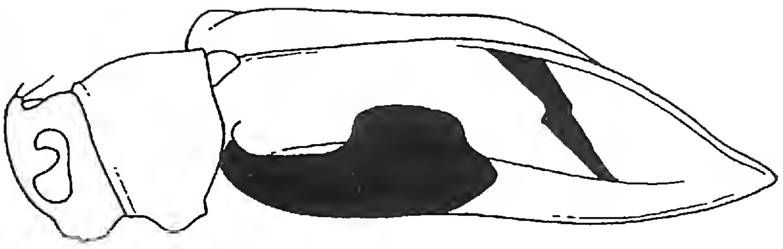


Figure 12. *S. rusticus* (LeConte).

Sternidius alpha nigricans Dillon, 1956, Ann. Entomol. Soc. Amer., 49:216. New synonymy.

Male.—Form small to medium sized; integument testaceous to reddish brown, usually densely pubescent; elytra with epipleural maculae well defined, discal maculae present or not. Head with face pubescent; eyes with lower lobe relatively large but variable in height relationship to genae, usually about one and one-half times as high; antennae annulate, scape sometimes slightly mottled, remaining segments usually not, fourth segment longer than scape, subequal to third, fifth segment subequal to first, subequal to or slightly shorter than third, remaining segments gradually decreasing in length. Pronotum less than twice as wide as long, basal margin usually slightly narrower than apical margin; callosities usually prominent; disk densely punctate with punctures small and at least partially obscured by brownish or tan pubescence (same hue as that of elytral disk); a lateral coalescence of lighter or hoary pubescence may be present on the disk. Elytra about twice as long as wide, obliquely truncate to emarginate; punctures gradually decreasing in size and depth apically, usually obscured by vestiture; costae semiprominent, containing a variable number of small black callosities which are absent behind the post median discal maculae except along suture; post median discal callosities variable in size and placement (Fig. 15); basal gibbosities usually moderately prominent; pubescence primarily tawny with whitish bordering the anterior margin of the post median discal maculae and occasionally extending forward along suture (the vestiture covers the humeri and superior portion of the epipleura hiding the integument and limiting the superior extension of the epipleural maculae), epipleural maculae placed in front of middle extending forward to about basal fifth and dorsally to include at least a portion of the elytral disk; discal maculae, when present, linear, extending backward from suture, through the post median callosities, at an angle of about forty-five degrees, sometimes attaining the lateral elytral margin (indistinct parallel maculae are commonly present behind). Ventral surface with abdominal and thoracic sternites usually not distinctly mottled; prosternal process one-eighth to one-third as wide as procoxal cavity; mesosternal process three-fourths to nearly as wide as mesocoxal cavity. Legs with femora mottled, tarsi and tibiae distally usually darker. Fifth abdominal sternite with setae at apex obscuring margin which is shallowly excavated or subtruncate (occasionally shallowly notched), less than two times as long as fourth.

Female.—Fifth abdominal sternite twice the length of fourth, otherwise similar to male.

Length.—3.7–7.8 mm (usually 6–7 mm).

Type locality.—Of *fascicularis,* Illinois; *testaceus,* Washington D.C.; *pleuralis,*

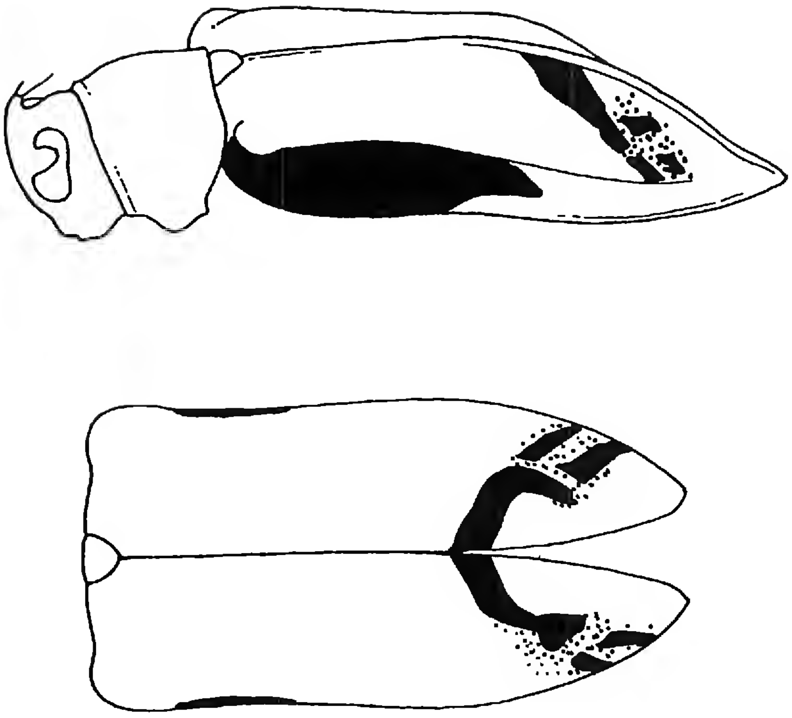


Figure 13. *S. incognitus* Lewis.

Washington D.C.; *timidus,* Pennsylvania; *scapalis,* Indiana; *dentatus,* Illinois; *obscurellus,* Bluff Point, Lake Champlain, New York; *nigricans,* Tajique, New Mexico; *xanthoxyli,* Mount Carrol, Illinois.

Range.—East coast of North America from Massachusetts to Florida and Michigan through Kansas and Nebraska south to Texas, and west to New Mexico.

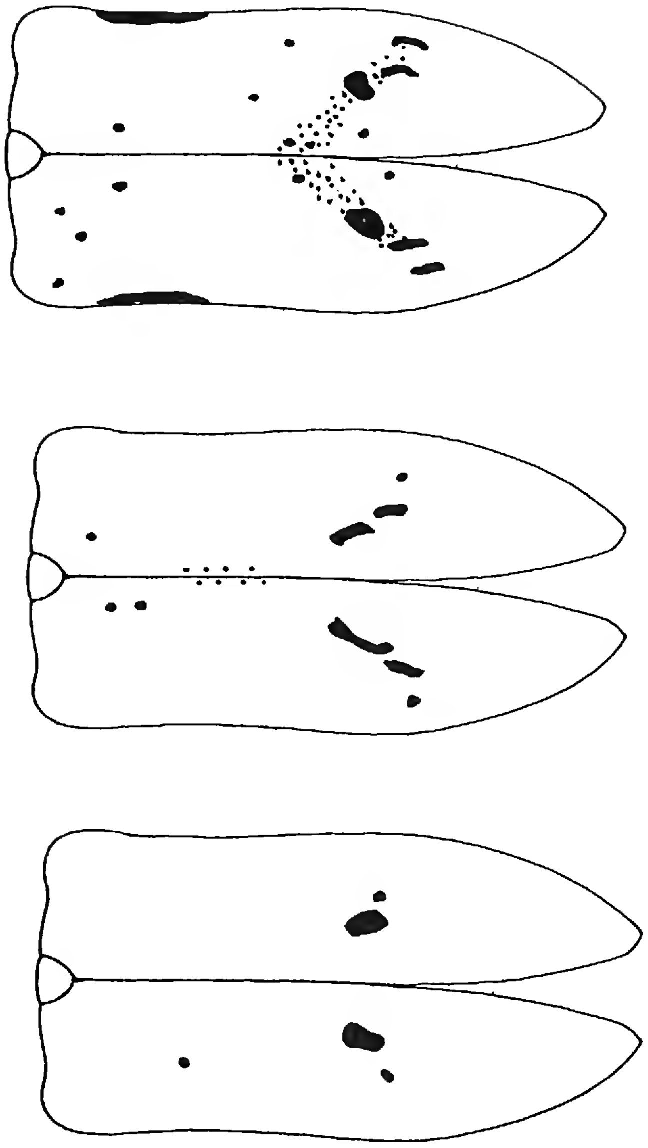
Flight period.—May to July.

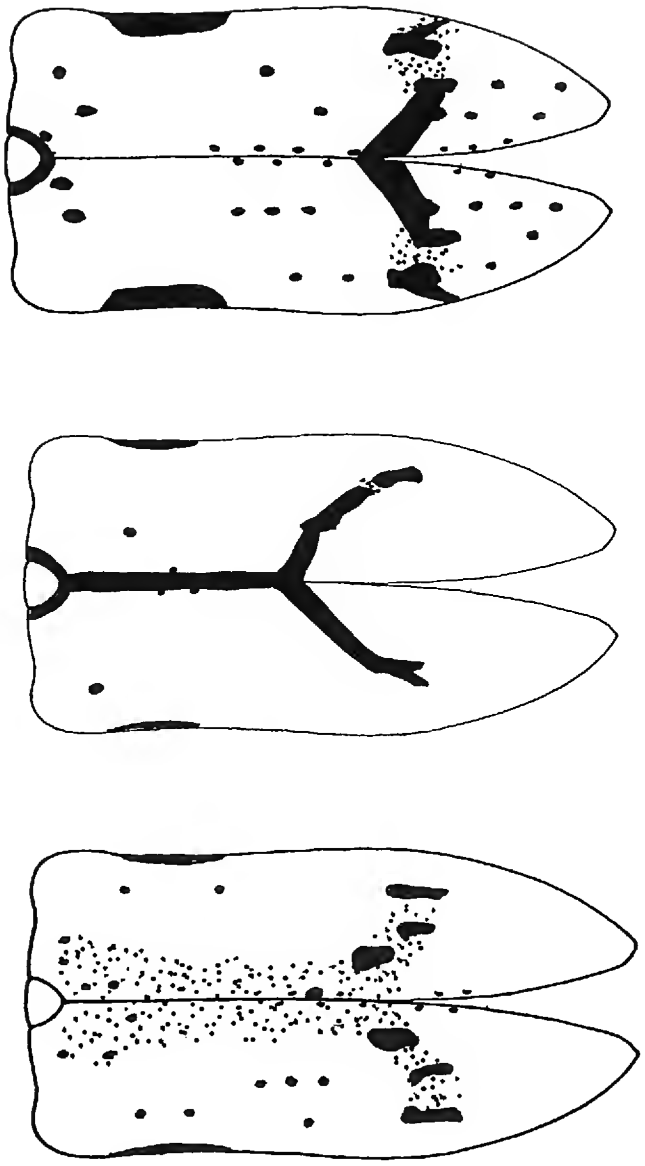
Host plants.—*Robinia pseudeacacia* L.; *Zanthoxylum americanum* Mill.; *Celtis*; and "*Wisteria*"?

Diagnosis and discussion.—Within this species, the color of the pubescence and integument is variable and the epipleural vittae may be greatly expanded dorsally occasionally reaching the suture. The type of *S. fascicularis* (Harris) has dark integument (the vestiture is dark over the macular areas with hoary pubescence in between) and grossly appears similar to specimens of *punctatus* (Haldeman), this may account for the taxonomic confusion. The type of *S. scapalis* (Casey) has markedly expanded discal extension of the epipleural maculae and represents the full development of maculation within *S. fascicularis. S. fascicularis* (Harris) has been confused with *S. alpha* (Say) but is distinguished from that species by the presence of pubescence over the humeri and superior fifth of the epipleura limiting the superior extension of the maculae, by covering the integument. The mesosternal process is usually relatively wider, and the lower lobe of the eyes are usually larger in genal height relationship. This species appears to be related to *S. rusticus* (LeConte), but the generally larger form, semi-distinct costae, usually larger lower lobe of the eye, as well as the characters given in the key should separate the two. The relatively long fourth and fifth antennal segments and the absence of black anterior humeri should distinguish this species from *S. mimeticus* (Casey).

***Sternidius floridanus* (Hamilton)**

Liopus alpha var. *floridanus* Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23:125.





Figures 14, 15. Elytral discal pattern variation.

Figure 14. *S. alpha* (Say).

Leiopus floridanus; Casey, 1913, Mem. Coleoptera, 4:316.
Sternidius floridanus; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:217.
Sternidius alpha floridanus; Kirk, 1969, So. Carolina Agr. Exp. Sta. Tech. Bull., 1033:1186.

Male.—Form moderately small, robust; integument usually dark reddish brown, covered with pubescence of variable color; elytra with epipleural maculae nebulous, lateral dark areas poorly demarcated, discal maculae distinct. Head with frons pubescent; eyes with lower lobes usually one and one-half to two times as high as genae; antennae usually distinctly mottled (especially scape), eleventh segment primarily dark, fourth segment longer than first, subequal to or shorter than third, fifth segment shorter than first, third or fourth, remaining segments gradually decreasing in length. Pronotum a little less than twice as wide as long; basal margin subequal to or wider than apical margins; callosities usually prominent; punctures fine, in part obscured by pubescence which is tawny to greyish white and occasionally condensed laterally over tubercles. Elytra about twice as long as wide; apices emarginate to obliquely truncate; punctures dense, separated by about their width, becoming finer apically, partially obscured by pubescence; costae subobsolete to distinct, bearing a variable number of small black callosities; post median callosities pronounced; basal gibbosities prominent, usually dark,

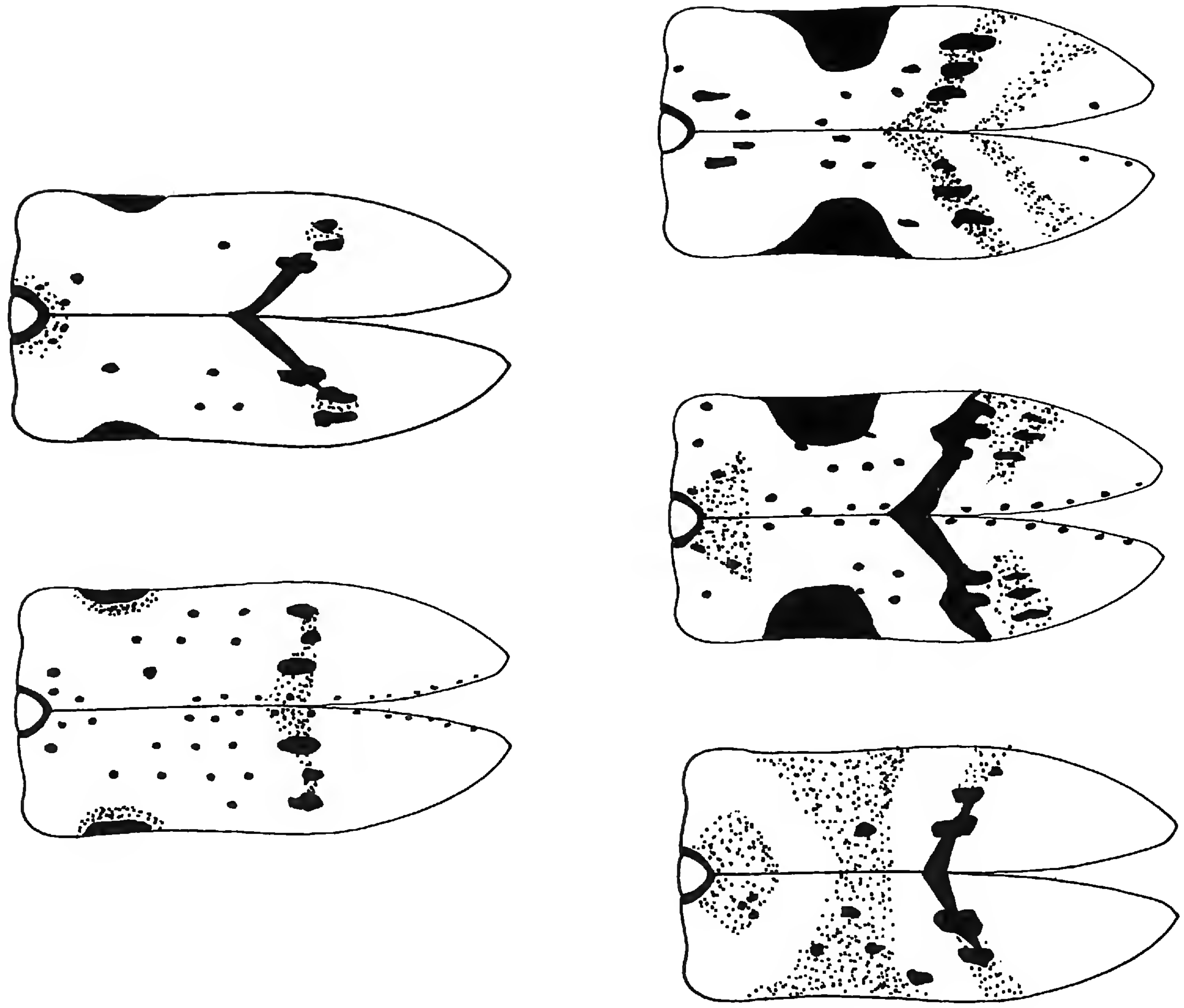


Figure 15. *S. fascicularis* (Harris).

integument lighter behind basal gibbosities and behind post median discal macula; epipleural maculae not well defined, extending forward to include humeri and usually in part dorsally onto disk (Fig. 9), posteriorly it may connect to the lateral extension of the median discal macula, discal macula placed at or behind middle, extending backward through the post median callosities (at times undulating) at an angle of about forty-five degrees, sometimes reaching the lateral elytral margin, with a parallel, less distinct macula commonly present behind; pubescence recumbent, made up of cinereous, dark tan, and whitish elements, whitish pubescence often bordering macula anteriorly and may extend along suture, black pubescence usually present over costal and post median callosities. Ventral surface with thoracic sternites mottled, prosternal process variable, from one-eighth or less to one-fourth width of procoxal cavity (usually about one-sixth); mesosternal process about two-thirds as wide as mesocoxal cavity. Legs with femora and tibiae mottled, tibiae and tarsi dark, distally. Last abdominal sternite with apex concave, less than twice as long as fourth.

Female.—Fifth sternite at least twice as long as fourth, otherwise similar to male.

Length.—4.2–7.4 mm (usually 6–7 mm).

Type locality.—Biscayne Bay, Florida.

Range.—Southeastern United States to Kansas and Texas. (One example seen from Pennsylvania.)

Flight period.—April through October.

Host plants.—Taken on *Satsuma* and "fig twigs."

Diagnosis and discussion.—The basal gibbosities and post median callosities are quite prominent in this species which help to differentiate it from *S. rusticus* (LeConte). It may also be separated from that species by the relatively larger lower lobes of the eyes, more distinctly mottled antennae and thoracic sternites, and the generally larger form. It may be separated from *S. fascicularis* (Harris) by the poorly defined, diffuse epipleural maculae which extend to the top of the humeri, the relatively shorter fourth and fifth antennal segments, and the distinctly mottled antennae and ventral surface. From *S. alpha* (Say), it differs by the relatively small fourth and fifth antennal segments (fourth smaller than third, fifth smaller than scape), relatively larger lower lobes of the eyes, and the epipleural macular configuration. It may be confused with *S. misellus* (LeConte), but by possessing distinct post median macula and mottled antennae, it should be separable from that species.

Sternidius rusticus **(LeConte)**

Liopus rusticus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2:173.
Leiopus fascicularis; Casey, 1913, Mem. Coleoptera, 4:311 (part).
Sternidius fascicularis; Knull, 1946, Ohio Biol. Surv. Bull., 39:250 (part).
Sternidius alpha alpha; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:214 (part).

Male.—Form small, somewhat robust; integument testaceous to piceous, densely clothed with pubescence; elytra with epipleural and discal dark areas. Head with face bearing recumbent pubescence; eyes with lower lobes equal to, or one and one-half times as high as genae; antennae annulate, scape usually slightly mottled, remaining segments with mottling obsolete, fourth segment longer than first (rarely subequal), slightly shorter than third, fifth segment subequal to or slightly shorter than first and shorter than third or fourth, remaining segments gradually decreasing in length. Pronotum nearly twice as wide as long, with basal and apical margins subequal; callosities variable in prominence; disk with punctures dense, shallow and minute; pubescence partially obscuring surface, tan to hoary or mixed without a definite pattern of condensation (sides with middle portion slightly less pubescent). Elytra about twice as long as wide, apices obliquely truncate to emarginate; costae subobsolete, small dark callosities commonly obsolete, but sometimes present along costae and sutural margin in variable number; post median discal callosities usually poorly defined, hidden in discal macula; punctures much larger than those of pronotum, largest behind basal gibbosities, gradually diminishing in size and depth toward apex; epipleural maculae extend from about mid elytra to top of humeri and dorsally along lateral one-fourth of disk (Fig. 12); discal macula, when present, placed at about middle, and extends obliquely backward from suture through callosities at about forty-five degrees, sometimes reaching the lateral elytral margins, a vague parallel macula is usually present behind; pubescence made up of tan to cinereous, and whitish hairs, in part obscuring surface, whitish outlining the discal macula anteriorly, and rarely extending forward along costae. Ventral surface pubescent with mottling reduced or obsolete, occasionally with slight mottling on thoracic sternites; prosternal process one-sixth to one-fourth as wide as procoxal cavity; mesosternal process between one-half to three-fourths as wide as mesocoxal cavity. Legs with femora sometimes indistinctly mottled, distal portion of posterior tibiae dark, tarsi dark. Fifth abdominal sternite with apex slightly concave, less than twice as long as fourth.

Female.—Fifth abdominal sternite about twice as long as fourth, otherwise similar to male.

Length.—4.0–5.4 mm (type, 4.6 mm), usually less than 5.0 mm.

Type locality.—Western New York.

Range.—Eastern North America from Canada to Louisiana, and west to Nebraska and Missouri.

Flight period.—May to July.

Diagnosis and discussion.—The individuals exhibit considerable variation in the color of the integument and prominence of the elytral maculae. This species has affinities with both *S. alpha* (Say) and *S. fascicularis* (Harris) and has previously been synonymized with both. It appears to be more closely related to *S. fascicularis* (Harris), differing from that species by the generally smaller size, smaller lower lobes of the eyes, extension of the epipleural maculae to top of the humeri, and the relative lengths of the first, third, fourth, and fifth antennal segments. It is separable from *S. alpha* (Say) by the generally smaller form, the dorsal extension of the epipleural maculae, the absence of its extension along the lateral pronotum, and the relatively shorter fourth and fifth antennal segments. From *S. vittatus* Dillon, it differs by the presence of distinct epipleural maculae.

***Sternidius incognitus* Lewis**

Sternidius incognitus Lewis, 1977, Pan-Pacific Entomol., 53:201.

Male.—Form small, moderately robust; integumental color brown to piceous, covered with predominantly cinereous pubescence; sides of pronotum and elytra with black markings. Head with face covered with cinereous pubescence; eyes with lower lobes one and one-half times as long as genae; antennae with first segment mottled, third segment much less so, fourth segment longer than first, subequal to third, fifth segment slightly longer than first, shorter than third and fourth, remainder of segments gradually decreasing in length. Pronotum transverse, basal and apical margins subequal; disk with calli more or less coalescent; punctures small, dense, shallow, partially obscured by vestiture; pubescence uniformly cinereous on disk, lacking on ventral half of sides (the integument thus forms a fuscous vitta on each side extending the entire length of the pronotum). Elytra about twice as long as wide; apices rounded; costae evanescent, containing small black spots in variable number (they represent denudations of pubescence exposing the integument); very obsolete callosities may be present in some specimens; post median callosities obsolete; basal gibbosities not prominent; punctures of disk dense, subconfluent, partially obscured by pubescence; epipleural maculae distinct, vittate extending from behind middle to basal margin (dorsal extension includes less than one-tenth of the disk) (Fig. 13), disk with macula triangular with apex at mid elytra and sides diverging from suture at an angle of about forty-five degrees or greater, reaching or not the lateral elytral margins, sometimes connecting to a parallel macula behind; pubescence cinereous with tawny components anterior to discal macula, darker behind, composed of black, cinereous, and tawny elements in variable combination. Ventral surface scarcely mottled; prosternal process narrow, about one-tenth as wide as procoxal cavity; mesosternal process about one-half as wide as mesocoxal cavity. Legs with tibiae distally black, annulate; tarsi black. Fifth abdominal sternite subequal in length to fourth.

Female.—Fifth abdominal sternite about twice the length of fourth, otherwise similar to male.

Length.—4.7–6.2 mm.

Type locality.—Madera Canyon, Santa Rita Mountains, Arizona.

Range.—Montane southern Arizona, Cochise and Santa Cruz Counties.

Flight period.—July and August.

Host plants.—*Quercus* sp.

Diagnosis and discussion.—This species has affinities with *S. alpha* (Say) but is readily separated from that species by the rounded elytral apices, lack of costal and post median callosities, the form of the discal macula which has an attached parallel extension behind, the narrow prosternal process (about one-tenth as wide as procoxal cavity), and the fifth antennal segment which is usually longer than the scape. It also resembles *S. decorus* (Fall), and *S. imitans* Knull, which agree in the grey pubescence, rounded elytral apices, a long fifth antennal segment, and are associated with oak. The differences of the epipleural and discal maculae will separate them. Examples of *incognitus* have been reared from dead twigs of *Quercus* sp. by D. G. Marqua (pers. comm.), and have also been taken by beating small branches of various species of oaks.

Sternidius decorus **(Fall)**

Liopus decorus Fall, 1907, Jour. New York Entomol. Soc., 15:84.

Sternidius decorus; Linsley, Knull, and Statham, 1961, Amer. Mus. Novit., 2050: 29; Lewis, 1977, Pan-Pacific Entomol., 53:200; Lewis, 1979, Pan-Pacific Entomol., 55:24.

Sternidius centralis; Dillon, 1956, Ann. Entomol. Soc. Amer., 15:218 (part).

Sternidius alpha arizonensis Dillon, 1956, Ann. Entomol. Soc. Amer., 49:217; Linsley, Knull, and Statham, 1961, Amer. Mus. Novit., 2050:29. New synonymy.

Male.—Form small, moderately robust; integument reddish brown to piceous, covered with cinereous pubescence, often with black and tawny reflections; elytra with black maculae and minute scattered black spots. Head covered with cinereous pubescence; antennae annulate, pubescence cinereous, distinctly mottled on scape and third segment, becoming less so on distal segments, fourth segment longer than first, subequal to or shorter than third, fifth segment shorter than third or fourth, usually longer than first, remaining segments gradually decreasing in length. Pronotum about twice as wide as long, basal margin subequal to or shorter than apical margin; disk with punctures small, dense, partially obscured by vestiture; pubescence scarcely mottled, cinereous, commonly with a mixture of brownish in the central portion of the disk. Elytra moderately robust, nearly twice as long as wide, apices rounded (rarely obliquely truncate); costae subobsolete, obscured

Figures 16, 17. Recorded geographical distribution.

Figure 16. #1 *S. centralis* (LeConte). #2 *S. decorus* (Fall). #3 *S. imitans* (Knull). #4 *S. mimeticus* (Casey). #5 *S. schwarzi* (Hamilton).

by pubescence, containing small black denudations of vestiture in variable number; post median callosities shallow, elongate or ill-defined; basal gibbosities moderate; punctures dense, distinct, subconfluent, largest behind humeri then gradually becoming smaller and more shallow apically, all partially obscured by vestiture; epipleural maculae (formed by break in pubescence), placed well behind humeri at about basal fourth, extending dorsally to involve at least the lateral third of the disk, and posteriorly to about middle (the epipleural integument is dark piceous including humeri, and the maculae are formed by a break in the cinereous pubescence which covers the sides); discal macula form a common triangle with apex behind mid elytra, and sides diverging at about forty-five degrees to meet a poorly formed and irregular base which sometimes extends to the lateral elytral margin, and may be attached to a smaller parallel macula behind (Fig. 4); pubescence is uniformly cinereous occasionally with tawny anterior to discal macula; posteriorly the vestiture is variable but usually darker consisting of cinereous, tawny and black elements, cinereous pubescence is absent over middle of epipleura exposing the integument, and thus forming the maculae, minute dark barely visible vestiture present over the maculae. Ventral surface uniformly pubescent, prosternal process usually very narrow, from one-eighth to one-tenth as wide as procoxal cavity; mesosternal process about one-half as wide as mesocoxal cavity. Legs with femora mottled, tibiae and tarsi black distally. Abdomen with fifth sternite about as long as fourth.

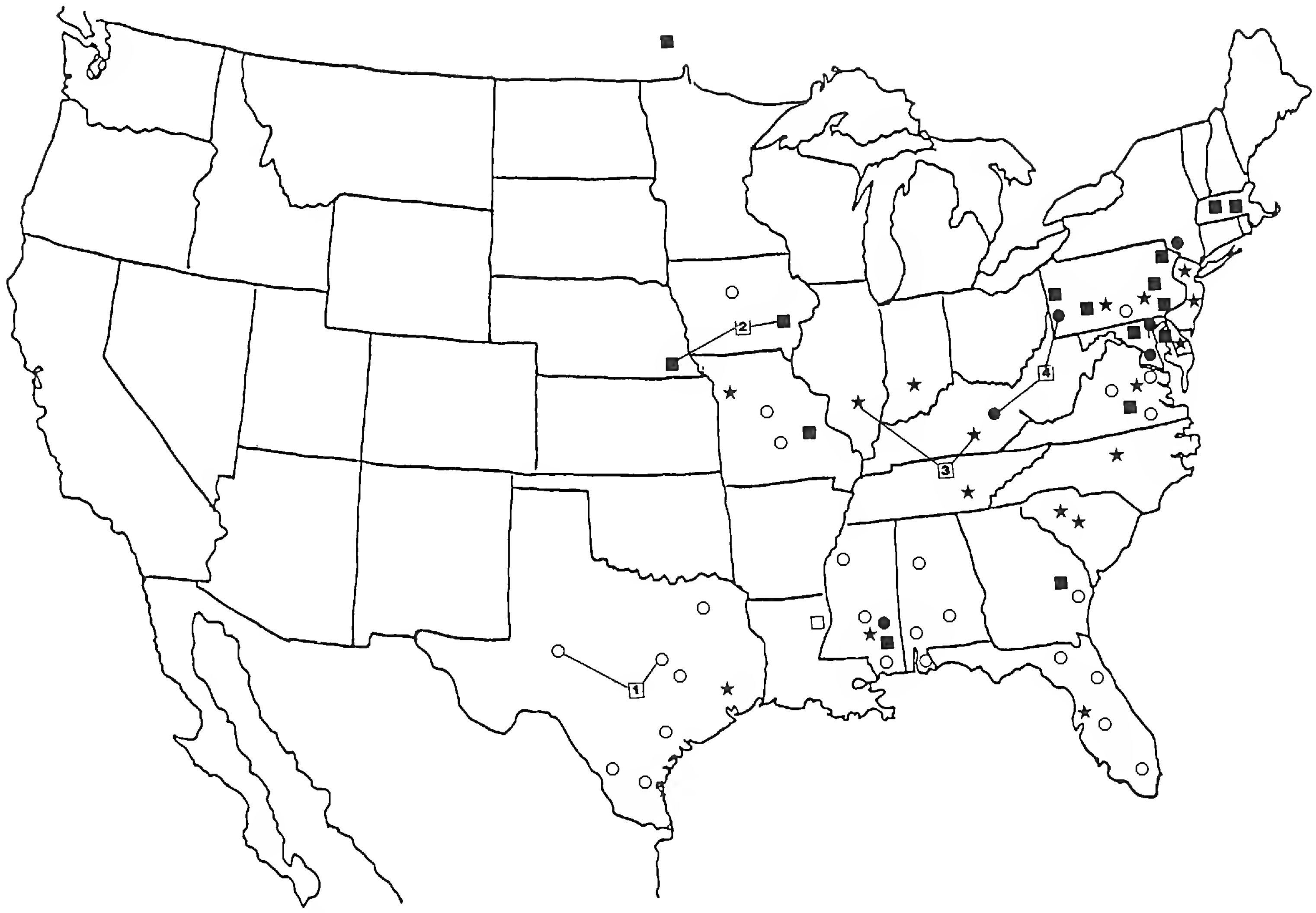


Figure 17. #1 *S. floridanus* (Hamilton). #2 *S. rusticus* (LeConte). #3 *S. punctatus* (Haldeman). #4 *S. vittatus* Dillon.

Female.—Fifth abdominal sternite twice as long as fourth, otherwise similar to male.

Length.—4.2–7.2 mm.

Type locality.—Of *decorus,* Williams, Arizona; *arizonensis,* Cave Creek, Chiricahua Mts., Arizona.

Range.—Montane areas of Arizona (Cochise and Santa Cruz Counties, to Mojave and Coconino Counties).

Flight period.—July and August.

Host plants.—*Quercus* sp.

Remarks.—This species is quite distinct by its grey vestiture and in the form of the elytral discal dark areas. It can be separated from *S. fascicularis* (Harris) by the grey pubescence, by having the elytral maculae and costal spots formed by breaks in the vestiture, and by the characters given in the key. Specimens are readily attracted to ultraviolet light, and have been reared from small branches of oak (*Quercus* sp.) by D. G. Marqua (pers. comm.).

Sternidius imitans **(Knull)**

Leiopus imitans Knull, 1936, Entomol. News, 107.

Sternidius imitans; Dillon, 1956, Ann. Entomol. Soc. Amer., 49:217, Linsley, Knull, and Statham, 1961, Amer. Mus. Novit., 2050:29; Lewis, 1977, Pan-Pacific Entomol., 53:198; Lewis, 1979, Pan-Pacific Entomol., 55:25.

Male.—Form small, moderately robust; integument dark brown to piceous, densely clothed with recumbent cinereous pubescence; elytra with black maculae and small black tufts. Head with recumbent greyish pubescence; antennae distinctly mottled, fourth segment longer than fifth and first, slightly shorter than third, fifth segment longer than first, shorter than third and fourth, remaining segments gradually decreasing in length. Pronotum wider than long; basal margin shorter than apical margin; punctures fine, dense, obscured by pubescence; callosities may be reduced and represented by maculae only; pubescence grey recumbent, with a minute black vestiture over callosities. Elytra about twice as long as wide, apices usually rounded but may be subtruncate; costae obsolete, containing numerous dark spots resulting from breaks in the vestiture; post median callosities absent or obsolete; basal gibbosities not prominent; punctures distinct, dense, partially obscured by vestiture; epipleural maculae represented by a spot on each epipleuron at basal third arising on dorsal half and extending dorsally to involve one-third or one-fourth of disk, discal macula in the form of a rounded to triangular spot at about apical third which does not extend laterally beyond middle of each elytron (Fig. 3); pubescence recumbent, uniform, cinereous without an admixture of fulvous hairs, usually with a slight hoary condensation surrounding the black macular areas, a minute black vestiture covers the maculae. Ventral surface densely pubescent, with thoracic sternites, distinctly mottled; prosternal process one-sixth to one-fourth as wide as procoxal cavity; mesosternal process about one-half as wide as mesocoxal cavity. Legs with femora and tibiae distinctly mottled with cinereous pubescence, tibiae and tarsi dark distally. Fifth abdominal sternite less than twice as long as fourth.

Female.—Fifth abdominal sternite twice as long as fourth, otherwise similar to male.

Length.—4.9–7.7 mm.

Type locality.—Davis Mountains, Texas.

Range.—Davis and Chisos Mountains, Texas, to mountains of Cochise, Santa Cruz, and Mojave Counties, Arizona.

Flight period.—June to September.

Host plants.—This species has been taken by beating foliage of various species of oak (*Quercus* spp.) and is attracted to ultraviolet light.

Diagnosis and discussion.—This species is distinct and quite constant in form and pubescent pattern. It appears to be related to *S. decorus* (Fall) and *S. incognitus* Lewis, each expressing grey or cinereous pubescence, rounded elytral apices, relatively long fifth antennal segment, obsolete discal costae, and by having costal black spots represented by breaks in the vestiture. The placement of the epipleural and discal maculae is diagnostic.

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Scientific Note

Occurrences of Diptera on Tree-Trunk Mosses in a Costa Rican Tropical Rain Forest

This brief communique summarizes the occurrence of Diptera on epiphytic mosses on two closely-spaced trees (*Pentaclethra macroloba* [Willd.] Ktze.-Leguminosae) in a Costa Rican tropical rain forest.

The study site is "Finca La Tigra," near La Virgen (10°23′N, 84°07′W, 220 m elev.), Sarapiqui District of the Heredia Province, Costa Rica.

The locality is characterized by sporadic, brief periods of dryness (Fig. 1). The study site is a mixed primary and secondary-growth forest bordering a cacao plantation. The two *P. macroloba* trees chosen for censusing dipterans on mosses (Diameter Breast Heights are 15.0 cm and 40.0 cm for Trees Nos. 1 and 2, respectively) are within a few meters of one another in dense shade. *Pentaclethra macroloba* is relatively common in this forest, as it is throughout much of the lowland-to-premontane rain forest region from Nicaragua to the Guianas (Whitmore, J. L., and G. S. Hartshorn, 1969, Literature review of common tropical trees, Contrib. No. 8, Inst. Forest Products, Univ. Washington, 113 pp.).

Between 2 December 1982 and 10 November 1983, I collected adult dipterans perched on patches of moss on these two trees (Fig. 2), between 0630–0900 hr and 1200–1300 hr, for each of four census dates. Diptera were collected, using dry glass vials, from ground level to about 1.5 m on each tree trunk. I rotated visits to each tree trunk at about 15-minute intervals. Between 10–20% of total dipterans seen during one morning or afternoon census period escaped capture. Dipterans were later sorted, preserved in 70% ethanol, and taxonomic determi-

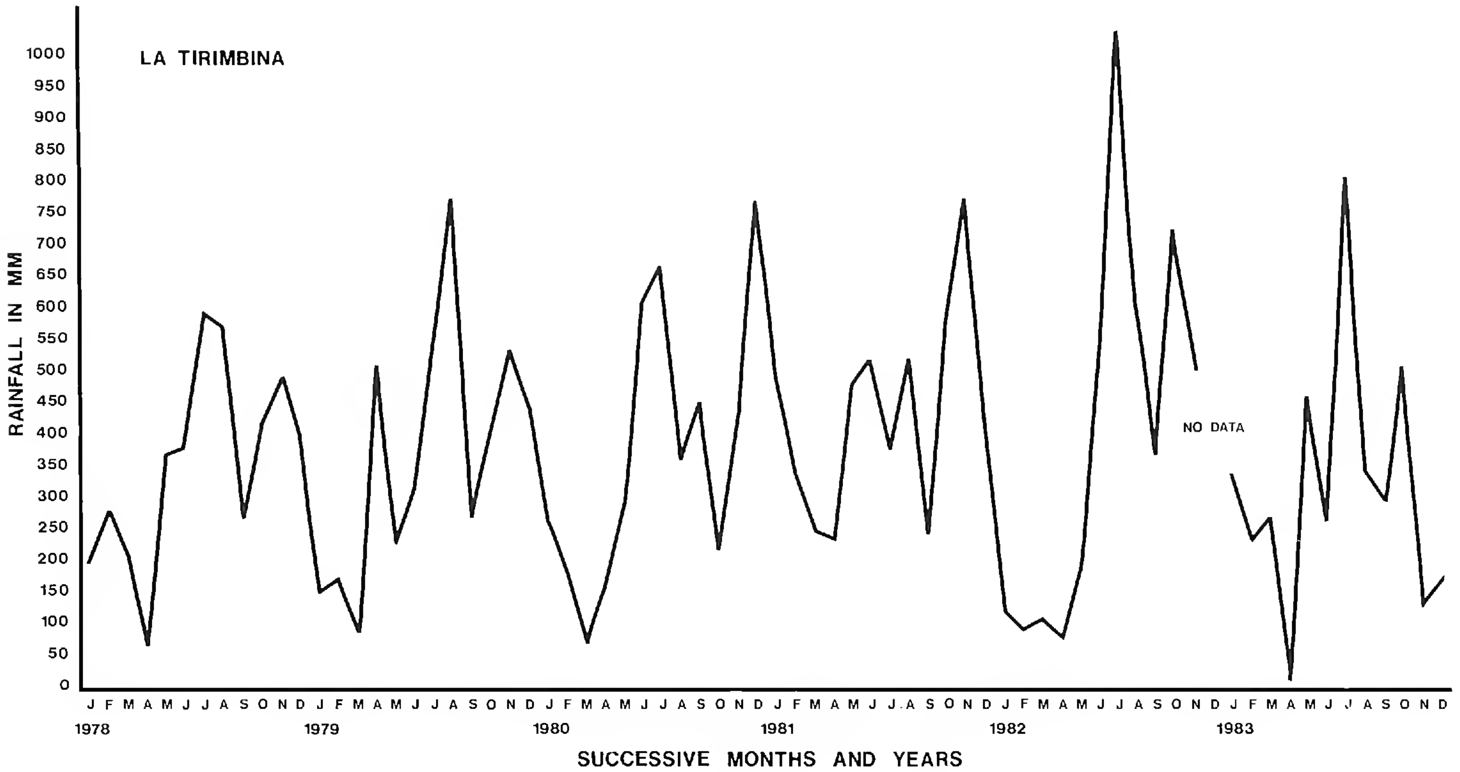

Figure 1. The monthly pattern of rainfall at "Finca La Tirimbina" over several successive years, and showing the 50–100 mm monthly totals associated with the "*veranillo*" typical of this tropical rain forest locality in Costa Rica.

Figure 2. Left: mosses on the trunk of Tree No. 1; Right: tropical rain forest understory habitat in the vicinity of the study site at "Finca La Tigra."

nations made with the cooperation of the Systematic Entomology Laboratory of the U.S. National Museum. A small sample of moss from each tree was taken for determinations.

Two species of moss were found on both tree trunks (Fig. 2): *Syrrhopodon incompletus* var. *berteranus* (Brid.) Reese (abundant); *S. erubescens* Bartr. (very rare).

For all four censuses combined, a total of nine species of Ceratopogonidae, the most frequently-encountered dipteran family, were collected, principally on Tree No. 2 (Table 1). Cecidomyiidae were far less numerous (Table 2). The sex ratios of these dipterans (both families) approached 1:1 (Tables 1 and 2). For the Ceratopogonidae, the genus *Atrichopogon* was represented by the highest number of species, followed by *Forcipomyia* (Table 1). The most abundant ceratopogonid species, *Atrichopogon* sp. 2, comprised 53.2% of the entire sample (all dates combined), followed by *A.*, n. sp. nr. *minuta* (Meigen) (13.8%) (Table 1). The sex ratio for *Atrichopogon* sp. 2 was 19 females: 31 males, or almost 1:2 skewed towards males. For *A.*, n. sp. nr. *minuta,* this bias towards males was even more pronounced: 1 female : 12 males. The genus *Atrichopogon* alone accounted for 86.8% of the total numbers of ceratopogonids collected from Tree No. 1, and was almost equally distributed between *A.* sp. 2 and *A.*, n. sp. nr. *minuta.* The same genus accounted for 78.6% of all ceratopogonids collected from Tree No. 2, but with *A.* sp. 2 accounting for 69.8% of the genus. While the genus *Forcipomyia* was diverse in terms of numbers of species collected, total numbers of individuals accounted for only 17.8% of all dipterans collected from both trees. The cecidomyiid genus *Clinodiplosis* accounted for 44.4% of all cecidomyiids collected on

Table 1. Distribution and taxonomic "diversity" of adult midges (Diptera: Ceratopogonidae) on two moss-covered tree trunks in the tropical rain forest at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica.*

"Tree No. 1"		"Tree No. 2"	
Species	Individuals	Species	Individuals
Dasyhelea soriai Wirth & Waugh	3	*D. soriai* Wirth & Waugh	2
Forcipomyia genualis (Loew)	1	*F. genualis* (Loew)	2
		F. fuliginosa (Meigen)	1
		F. (*Lasiohelea*), n. sp. 1	2
		F. (*Calaforcipomyia*) *caerulea* Macfie	2
		F. harpegonata Wirth & Soria	3
Atrichopogon, n. sp. nr. *minuta* (Meigen)	1	*A.*, n. sp. nr. *minuta* (Meigen)	2
A. sp. 1	1	*A.* sp. 1	3
A. sp. 2	11	*A.* sp. 2	39
A. sp. 3	2		
A. sp. 4	7		
A. glaber (Meigen)	1		
Culicoides, n. sp. nr. *metagonatus* Wirth & Bystrak	1		
Total genera: 4		Total genera: 3	
Total species: 9		Total species: 9	
Total individuals: 38		Total individuals: 56	
Total sample sex ratio (both trees): 36 females + 58 males			

* Data presented for a total of four census dates (2 December 1982, 3 March 1983, 8 August 1983, and 10 November 1983), and for two collecting periods each date (0630–0900 hr and 1200–1300 hr). See "methods" for other details.

Tree No. 1 and 55.6% on Tree No. 2. Most Cecidomyiidae were found to be "rare" in that they were represented by 1–2 individuals for all samples combined.

Both the greatest numbers of individuals and species of Ceratopogonidae were found in the late rainy season census (2 December 1982), and for Cecidomyiidae in the mid-rainy season (8 August 1983) at "La Tigra" (Table 3). There was a conspicuous absence of ceratopogonids on the mosses during the dry season (3 March 1983) (Table 3). For all Diptera collected, similar numbers of species and individuals were found in the morning and afternoon samples for all census dates combined (Table 4). For all other Diptera present, the following distributions of numbers of individuals per family were observed, considering all four census dates and times of the day: Drosophilidae (*Drosophila* spp.): 10; Psychodidae (*Psychoda* sp.): 4; Phoridae (*Megaselia* sp.): 2; Sciaridae (*Bradysia* sp.): 1; Mycetophilidae: 1; Chironomidae: 1; Chloropidae: 1. Interestingly, these families of Diptera were found on the mosses for only two rainy season censuses (December 1982 and August 1983).

Any conclusions drawn from the above data must be considered as tentative owing to (1) the small sample sizes of insects collected, and (2) the low number of censuses. Yet such data suggest the need to explore the effects of tropical seasonality on rain forest-inhabiting Diptera in some detail, since these organisms might serve as insightful indicators of the subtle ways in which changes in rainfall

Table 2. Distribution and taxonomic "diversity" of adult midges (Diptera: Cecidomyiidae) on two moss-covered tree trunks in the tropical rain forest at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica.*

"Tree No. 1"		"Tree No. 2"	
Species	Individuals	Species	Individuals
Clinodiplosis sp. A	4	*Clinodiplosis* sp. A	5
Clinodiplosis sp. C	1		
Mycodiplosis, n. sp.	2	*Mycodiplosis,* n. sp.	3
Youngomyia, n. sp.	1		
Kalodiplosis sp.	1		
		Contarinia sp.	1
		Total genera: 3	
Total genera: 4		Total species: 3	
Total species: 5		Total individuals: 9	
Total individuals: 9			
Total sample sex ratio (both trees): 11 females + 7 males			

* Data presented for a total of four census dates (see footnote in Table 1).

(Fig. 1) influence insect activity. Traditionally, studies of insect seasonality in the American tropics have largely ignored small-bodied dipterans (e.g., Janzen, D. H., and T. W. Schoener, 1968, Ecology, 49:96–110). A notable exception is a populational study of phlebotomine sand flies in Colombia (Porter, C. H., and G. R. DeFoliart, 1981, Arquivos de Zoologia, Mus. de Zool., Univ. de São Paulo, 30:81–158). Other studies indicate that some Diptera in general are restricted in their daily and seasonal activity cycles largely through direct or indirect effects of moisture in forest habitats (e.g., Vanhara, J., 1981, Acta Scient. Nat. Acad. Sci. Bohemoslov. Brno., 15:1–32; Willmer, P. G., 1982, Ecol. Ent., 7:221–231). Many species of Ceratopogonidae breed in moss and other similar substrates in the American tropics (e.g., Soria, S. de J. et al., 1981, Rev. Theobroma [Brasil], 11: 119–123), and such substrates may undergo notable changes in moisture content as a result of phenological patterns of rainfall. During the Costa Rican dry season,

Table 3. Summary of the distribution of midge species (Diptera: Ceratopogonidae and Cecidomyiidae) by census dates.*

	Ceratopogonidae			Cecidomyiidae		
Census date	Total genera	Total species	Total individuals	Total genera	Total species	Total individuals
2 Dec. 1982	4	11	73	1	1	3
3 Mar. 1983	0	0	0	2	2	2
8 Aug. 1983	2	5	18	3	3	10
10 Nov. 1983	1	1	3	2	2	3
Highest midge "biomass": 73/94 = 77.6% (late rainy season—Dec. 1982)				10/18 = 55.5% (mid-rainy season—Aug. 1983)		
Lowest midge "biomass": 0/94 = 00.0% (dry season—March 1983)				2/18 = 11.1% (dry season—March 1983)		
Highest midge species number: 11 (late rainy)				10 (mid-rainy)		

* See headings and footnotes of Tables 1 and 2 for details of census dates, etc.

Table 4. Difference in abundance and taxonomic "diversity" of midges (Diptera) on moss-covered trunks of two tropical rain forest trees (both *Pentaclethra macroloba*-Leguminosae) at "Finca La Tigra," near La Virgen, Sarapiqui District, in northeastern Costa Rica for morning versus afternoon activity periods.*

Species	0800–0900 hr No. of individuals	1200–1300 hr No. of individuals
Atrichopogon, n. sp. nr. *minuta* (Meigen) (Ceratopogonidae)	5	7
Atrichopogon sp. 1	1	1
Atrichopogon sp. 2	1	0
Forcipomyia genualis (Loew)	1	0
F. harpegonata Wirth & Soria	2	1
F. fuliginosa (Meigen)	0	1
F. (*Lasiohelea*), n. sp. 1	0	2
Clinodiplosis sp. A (Cecidomyiidae)	3	5
Clinodiplosis sp. C	0	4
Contarinia sp.	0	1
Megaselia sp. (Phoridae)	4	0
Mycomya sp. (Mycetophilidae)	1	0
Drosophila sp. (Drosophilidae)	3	3
Bradysia sp. (Sciaridae)	0	1
Psychoda sp. (Psychodidae)	0	1

Total morning species: 9 Total afternoon species: 11
Total morning individuals: 21 Total afternoon individuals: 27

Total distinct species for entire sample (morning & afternoon) combined: 13
% of species accountable by morning census: 9/13 = 69.2%; by afternoon: 11/13 = 85.4%
% of individuals ("biomass") accountable by morning census: 21/48 = 43.8%
% of individuals ("biomass") accountable by morning census: 27/48 = 56.2%

* One morning and one afternoon census taken on 8 August 1983 form the basis of the above comparisons.

for example, there is a sharp decline in the abundance of Ceratopogonidae and even other insects in leaf-litter and other ground-cover substrates at this time of the year (e.g., Young, A. M., 1983, J. Appl. Ecol., 20:801–831).

It is likely that some of the observed Diptera actually breed in the mosses. The occurrence of several species of *Atrichopogon* and *Forcipomyia* appears typical for these groups as seen for other organic substrates in Costa Rican rain forest areas (e.g., Young, A. M., 1982, J. Appl. Ecol., 19:47–63; 1983, J. Appl. Ecol., 20:801–831; 1984, Proc. Ent. Soc. Wash., 86:185–194). The observed low abundance of Cecidomyiidae, relative to the Ceratopogonidae, may be the result of these insects having specialized life cycles, often associated with fungi and rusts in the case of genera such as *Mycodiplosis* and *Clinodiplosis* (e.g., Gagne, R. J., 1977, Brenesia [Costa Rica], 12/13:113–131; R. J. Gagne, pers. comm.). The larvae of other cecidomyiids, such as the genus *Contarinia,* feed on living plant tissues, while those of *Youngomyia* are predators on other insects (R. J. Gagne, pers. comm.). Other cecidomyiids in Costa Rica do breed in moss (Young, A. M., 1985, Proc. Ent. Soc. Wash., 87:49–79).

These mosses also harbor decaying organic matter, providing additional breeding or feeding substrates for tropical rain forest Diptera. What my limited data do show is that there is a consistent pattern of "association" of several families of Diptera, with representative species known to be associated with mosses and accompanying organic debris as breeding substrates in the tropical rain forest.

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New Records of Longicorn Beetles from China with the Descriptions of a New Subgenus and Two New Species (Coleoptera: Cerambycidae)

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Abstract.—Eight species of longicorn beetles are reported as new to China. Two new species, *Apriona chemsaki* and *Thylactus pulawskii,* and a new subgenus, *Cristapriona,* erected for the former, are described and figured.

This paper is a result of my research at the University of California, Berkeley; California Academy of Sciences, San Francisco; American Museum of Natural History, New York; and National Museum of Natural History, Washington, D.C. form November 1985 through March 1986. Several hundred undetermined Chinese specimens were brought along for study. Eight species are reported as new from China for the first time. Two new species are described and figured. The specimens treated herein belong to the following institutions:

AAG, Agricultural Academy of Guangxi, Nanning, China;
AG, Academy of Guangxi, Nanning, China;
GIF, Guangdong Institute of Forestry Sciences, Guangzhou, China;
IEZU, Institute of Entomology, Zhongshan University, Guangzhou, China;
JAU, Jiangxi Agricultural University, Nanchang, China;
KZPQO, Kunming Zoology and Plant Quarantine Office, P.R.C., Kunming, China.

Cristapriona Hua, NEW SUBGENUS

Elytra with two distinct longitudinal ridges on the disk and with a tubercle on the humeral angle. Third antennal segment distinctly longer than the fourth.

Name derivation.—The name is a combination of the generic name *Apriona* and of the prefix *Crist-* which refers to the longitudinal ridges on the disk of the elytra.

Type species.—*Apriona chemsaki* Hua, n. sp.

This new subgenus is closely related to the nominate subgenus *Apriona* (*Apriona*) Chevrolat (Breuning, 1949; Gilmour, 1958) by the immaculate elytra and by the third antennal segment distinctly longer than the fourth. *Cristapriona* differs from the subgenus *Apriona* by possessing tubercles instead of spines on the humeral angles and by the distinct longitudinal ridges of the elytra.

Apriona (*Cristapriona*) *chemsaki* Hua, NEW SPECIES
(Fig. 1)

Name derivation.—Named in honor of Dr. John A. Chemsak of the University of California, Berkeley.

Male.—Form large, oblong; integument black; pubescence golden, moderately

Figure 1. *Apriona* (*Cristapriona*) *chemsaki* Hua, n. sp., holotype male. (Photograph by T. W. Davies.)

dense, long on the undersurface; head with frons longer than broad; antennae extending about three segments beyond the elytra, scape thick, dorsally plane, third segment longer than fourth, segments clothed with yellow-brown pubescence, sparsely fringed beneath, third segment whitish annulate at basal $1/4$, fourth annulate at basal $1/2$ and remaining segments at basal $3/5$. Pronotum transverse, broader than long, with acute lateral spines; apex with deeply transverse groove, base with two transverse grooves; disk with several transverse grooves and about five irregular rugae; mesosternum whitish pubescent at middle. Scutellum broadly rounded. Elytra elongate, subparallel behind humeri; humeri tuberculate; each elytron with two longitudinal ridges extending almost to apex, the outer pair

Figure 2. *Thylactus pulawskii* Hua, n. sp., holotype female. (Photograph by S. M. Middleton.)

longer; basal ⅓ with numerous glabrous tubercles, those on humeri, at the base of suture, and at the bases of the ridges, larger; margins and suture (except basally) with whitish pubescence; apices obliquely truncate, angles strongly spinose, sutural pair longer. Legs whitish pubescent, tibiae and tarsi with dark brown setae.

Length, 36.00 mm; width, 10.00 mm.

Holotype male.—China: Jiangxi: Liantang, VII.1956 (type depository: Jiangxi Agricultural University, Nanchang, China; temporarily deposited at Zhongshan University).

Thylactus pulawskii **Hua, New Species**
(Fig. 2)

Name derivation.—Named in honor of Dr. Wojciech J. Pulawski of the California Academy of Sciences.

Female.—Body near oblong, parallel, acute apically. Dark brown, clothed with golden-yellow to dark-brown pubescence, labrum, clypeus, the basal half of mandibles, maxillary palpi and labial palpi red brown, the apical half of mandibles pitchy black, legs and ventral surface dark brown. The lateral margins of pronotum silver-white pubescent, the underside of prothorax black-brown pubescent. Scutellum covered with brownish pubescence. Elytra with dark brown longitudinal bands on each side of suture extending from base to about ⅓, band broadening and extending toward but not reaching lateral margins, areas anterior to margins of divergent bands broadly pale, base finely, densely brownish pubescent, apical ⅓ behind median band brownish pubescent. Humeri dark pubescent beneath.

Frons transverse, sparsely punctate; eyes coarsely faceted, inferior lobes as long as the genae below; antennal tubercles widely separated; vertex shallowly depressed. Antennae slightly shorter than body, 3rd segment slightly longer than 4th, 4th distinctly longer than scape. Pronotum transverse, centrally with a ridged longitudinal line, lateral lines of disk with about nine irregular, oblique rugae, large pocklike punctures scattered between the rugae, each puncture with a small tubercle at center, tubercles each bearing a brownish seta; sides acutely tuberculate behind middle. Scutellum tongue-shaped. Elytra three times as long as head and prothorax together, slightly narrowed at basal ⅓, the sutural angles acute, each elytron with a shallow costa near suture extending from base and ending before apex, an arcuate costa extending from humerus and two costae beginning behind humeri and ending before apex; basal punctures coarse, separated, punctures behind middle smaller, arranged between the costae. Legs short, finely, densely pubescent. Abdomen minutely punctate, finely, densely pubescent; last sternite emarginate at apex.

Length, 28.00 mm; width, 8.00 mm.

Holotype female.—China: Guangxi: Lungsheng, at light, 1,000 m, 20.VI.1984, Li Jun (Academy of Guangxi, Nanning, China; temporarily deposited at Zhongshan University).

This new species differs from *Thylactus analis* Franz, 1954, *T. simulans* Gahan, 1890 and *T. chinensis* Kriesche, 1924 (Breuning, 1950) in having the sutural angles acute and not expanded into lobes, the body pubescence is fine and short instead of thick and long. It differs from *T. densepunctatus* Chiang et Li (1984) from China by having the sutural angles of the elytra acute instead of truncate.

New Records of Longicorn Beetles from China

Cerambycinae

Callichromatini Lacordaire

1. *Chloridolum jeanoinei* (Pic, 1932)

Material examined.—China: Guangdong: 1, Lungmen, 9.VI.1980 (GIF); 1, Hainan Island (Jianfengling), 19.V.1985 (IEZU); Guangxi: 2, Tienling, 12.VI.1981 (AAG).

Distribution.—Laos, Vietnam and China.

2. *Acrocyrtidus argenteofasciatus* Pic, 1903

Material examined.—China: Guangdong: 1, Hainan Island (Jianfengling), 18.III.1982 (IEZU).

Distribution.—Vietnam and China.

Lamiinae

Mesosini Thomson

3. *Mesosa indica* Breuning, 1935

Material examined.—China: Yunnan: 1, Yuangjiang, VII.1983 (KZPQO).

Distribution.—India, Sri Lanka, Burma and China.

4. *Mutatocoptops alboapicalis* Pic, 1925
Material examined.—China: Yunnan: 1 (KZPQO).
Distribution.—Malaysia, Indonesia, Laos and China.

Pteropliini Thomson

5. *Pterolamia strandi* Breuning, 1935
Material examined.—China: Guangdong: 2, Hainan Island (Jianfengling), 30.VI.1981, 7.IV.1983 (IEZU).
Distribution.—Original locality unknown, China.

Agniini Thomson

6. *Monochamus tonkinensis* Breuning, 1935
Material examined.—China: Guangdong: 1, Foshan, 20.V.1981 (GIF).
Distribution.—Vietnam and China.

Acanthocini Lacordaire

7. *Exocentrus guttulatus alboguttata* Fisher, 1925
Material examined.—China: Guangxi: 1, Lungzhou, 18.V.1982 (AAG).
Distribution.—Philippines and China.

Saperdini Mulsant

8. *Oberea hebescens* Bates, 1873
Material examined.—China: Jiangsu: 1, Xiashu, 30.V.1936 (IEZU).
Distribution.—U.S.A. and China.

ACKNOWLEDGMENTS

I am indebted to many persons for their help with this work. Prof. Zhang Shimei (JAU) and Mr. Li Jun (AG) loaned the respective holotypes described in this paper. I am grateful to Dr. John A. Chemsak of the University of California, Berkeley; Dr. Wojciech J. Pulawski, Dr. David H. Kavanaugh, Dr. Norman D. Penny, Mr. Vincent F. Lee, Mr. Thomas W. Davies, Ms. Susan M. Middleton and Mrs. L. Gail Freihofer of the California Academy of Sciences, San Francisco; Dr. Lee H. Herman and Mr. Sarfraz Lodhi of the American Museum of Natural History, New York; and Dr. Terry L. Erwin, Dr. Richard E. White, Dr. Theodore J. Spilman and Mr. Gary F. Hevel of the National Museum of Natural History, Washington, D.C. for their hospitality and help during my visits to their museums.

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Two New Species of *Priocnemis* from the Nearctic Region (Hymenoptera: Pompilidae)

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Abstract.—Two new species in the primarily Holarctic subgenus *Priocnemis* are described from the Nearctic region, *Priocnemis* (*Priocnemis*) *lasiura* from California and *Priocnemis* (*Priocnemis*) *kevini* from Idaho and Michigan. Both descriptions are based on the males.

The subgenus *Priocnemis* is primarily Holarctic in distribution with extensions into Asia, Africa and South America. The extent of the fauna in Central and South America has yet to be determined. The Nearctic fauna, including the ones described here, consists of 11 species.

Priocnemis (*Priocnemis*) *lasiura*, NEW SPECIES

Holotype male.—Black, metasoma with vague blue reflections. Length 8.74 mm. Anterior wing length 6.74 mm. Wings hyaline, anterior wing darkened from base of marginal, first submarginal and third discoidal cells to apex, with narrow band of faint infuscation over basal and transverse median veins. Posterior wing darkened from just beyond transverse cubital vein to apex. Erect hair long and moderately abundant on head, proepisternum, sixth metasomal sternum and subgenital plate, long, scattered on metasomal sterna two to five, elsewhere short and sparse. Hairs of sixth sternum forming loose brush, longest anteriorly, becoming progressively shorter toward posterior margin. Appressed pubescence dilute, white on head and mesosoma, longer and more noticeable on corners of lower face and posterior slope of propodeum, dark on metasoma. Head and mesosoma densely punctate, punctures very small, contiguous, those on frons separated by average of 0.25 times puncture diameter. Head rounded, slightly wider than long, FD/TFD 0.90. Temples narrow. Ocelli forming right triangle, POL/OOL 0.78. Front narrow, MID/TFD 0.53. Compound eyes diverging above, LID/UID 0.81. Clypeus narrow, 2.31 times as wide as long, apical margin slightly convex. Length of third antennal segment 0.92 times fourth and 1.09 times ultimate segment. Pronotum short, broadly angled to declivous anterior portion, posterior margin broadly angulate. Postnotum 1.18 times as long as metanotum. Propodeum in profile low, nearly flat anteriorly with slightly steepened posterior slope. Anterior wing with marginal cell 3.28 times as long as high, removed from wing apex by 0.75 times its length. Third submarginal cell 1.52 times as long as second submarginal measured on cubitus, third transverse cubital vein meeting cubitus at right angle. Posterior tibial spur 0.78 times length of basitarsus. Subgenital plate (Fig. 3) broad, ligulate, widest at base, sides more or less evenly convergent toward rounded apex, uniformly covered with stout, straight, erect hairs which are as long as half width of plate. Genitalia in ventral view (Fig. 1) with aedeagus widest at, or slightly beyond, middle, tapering to subacute apex. Digitus stout, widest at apex, ventral surface with numerous short setae. Gonostylus slender, shorter than parapenial lobes, in lateral view (Fig. 2), with ventral margin arcuate and set with dense, long, straight hairs, dorsal margin with few long hairs.

Type.—Holotype male (CAS): California: Tulare County: Ash Mountain, Kaweah Power Station #3, VII-17-1983 (R. D. Haines). The genitalia are in glycerine in a microvial pinned with the specimen. Paratypes: Five males with same data as holotype except VI-3 to IX-8 in CAS and author's collection.

Female.—Unknown.

Variation ($n = 6$).—Length 7.16–8.42 mm. Anterior wing length 6.52–7.05 mm. FD/TFD 0.89–0.91. POL/OOL 0.73–0.86. MID/TFD 0.50–0.55. LID/UID 0.79–0.84. Clypeus 2.00–2.34 times as wide as long. Third antennal segment 0.91–1.03 times length of fourth. Postnotum 1.00–1.31 times as long as metanotum. Anterior wing marginal cell 3.28–3.76 times as long as high. Third submarginal cell 1.20–1.74 times as long as second. Posterior tibial spur 0.69–0.78 times length of basitarsus. Apex of subgenital plate broadly rounded, subtruncate or slightly indented.

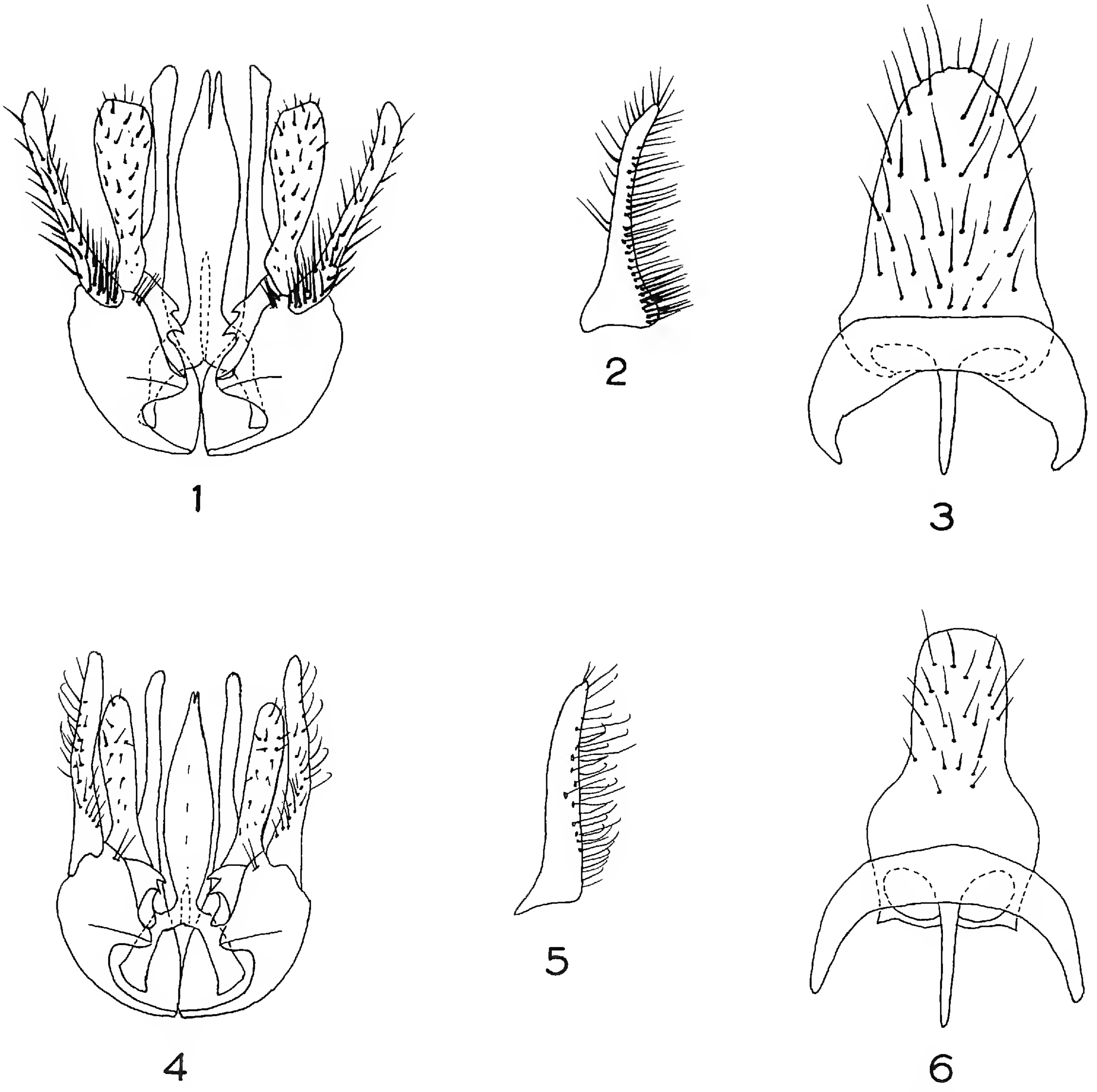
Discussion.—The type series of *Priocnemis lasiura* consists of specimens larger than males of any described North American species in the nominate subgenus. Although somewhat more slender, they are comparable in size to males of *oregona* Banks and *minorata* Banks in the subgenus *Priocnemissus.*

This species will run to couplet 3 of Townes' (1957) key but will fit neither alternate. The subgenital plate is very broad, its long erect hairs are not recurved and the frons is distinctly punctate.

Morphologically *P. lasiura* does not appear closely related to any species described previously from the Nearctic region. In general size and pattern of punctation, it is similar to *germana* (Say) and *notha* (Cresson) but the compound eyes are more strongly convergent below, the clypeus is longer in relation to its width, the wings are hyaline, distinctly darkened at the tips and the third submarginal cell is noticeably longer than the second. Additionally, the apical margin of the clypeus is thin and lamellate (variously thickened in males of *germana*), the gonostylus is long, slender and arched (short, lobed and expanded at apex in *germana*) and the subgenital plate is broad, nearly flat and uniformly covered with long, erect hairs (narrow, toothed and with hairs restricted to basal areas in *notha*).

Priocnemis (*Priocnemis*) *kevini*, NEW SPECIES

Holotype male.—Black, metasoma and femora dark brown, anterior tibia medium brown. Length 6.41 mm. Anterior wing length 4.41 mm. Wings faintly infuscate, slightly darker at apex but without distinct marginal band. Erect hairs sparse, longest on frons, proepisterna, anterior coxae, metasomal sterna two to six and subgenital plate, elsewhere very short. Hairs of sixth sternum more numerous than on preceding sterna but not forming a brush. Appressed pubescence very dilute, pale brown to white on head and mesosoma, darker on metasoma, slightly longer on lower corners of face and clypeus. Head densely punctate, punctures small, shallow, regular, those on frons separated by average of 0.30



Figures 1–3. *Priocnemis lasiura*. 4–6. *Priocnemis kevini*. 1, 4. Genitalia, ventral view. 2, 5. Left gonostylus, lateral view. 3, 6. Subgenital plate, ventral view.

times puncture diameter. Mesosoma densely punctate dorsally, punctures very small, shallow, irregular. Head noticeably wider than long, FD/TFD 0.83. Temples moderately well developed. Ocelli forming acute triangle, POL/OOL 0.60. Frons relatively wide, MID/TFD 0.59. Compound eyes scarcely divergent above, LID/UID 0.96. Clypeus 2.52 times as wide as long, apical margin truncate. Length of third antennal segment 0.97 times fourth and 1.07 times ultimate segment. Pronotum long, evenly curved anteriorly, posterior margin sharply angulate. Postnotum 1.00 times as long as metanotum. Propodeum in profile low, slightly steepened posteriorly. Anterior wing with marginal cell 4.35 times as long as high, removed from wing apex by 0.97 times its length. Third submarginal cell 0.90 times as long as second, measured on cubitus, third transverse cubital vein meeting cubitus at obtuse angle. Posterior tibial spur 0.85 times length of basitarsus. Subgenital plate (Fig. 6) widest at base, constricted to subrectangular apical portion, apex somewhat convex, apical half uniformly covered with stout, erect, straight hairs, decurved at apices and about as long as width of plate. Genitalia (Fig. 4) with aedeagus widest about middle, tapering to acute apex. Digitus nearly parallel-sided, not expanded toward apex, outer surface uniformly clothed with short setae. Gonostylus blade-like, slightly longer than parapenial lobes, in lateral view (Fig. 5) with ventral margin slightly concave and set with long, somewhat decurved hairs, dorsal margin with few apically directed hairs near apex.

Type.—Holotype male (CAS): Idaho: Gooding County: Wood River, 1 mi NE Gooding, Malaise Trap 8A-6P, VII-6/7-1980 (M. S. and K. M. Wasbauer). The genitalia are in glycerine in a microvial pinned with the specimen. Paratypes: Three males with same data as holotype in CAS and author's collection; one male, Michigan: Ann Arbor, IX-3/16-1975 (M. G. Fitton) in BM.

Female.—Unknown.

Variation ($n = 5$).—Length 4.10–6.41 mm. Anterior wing length 3.54–4.67 mm. FD/TFD 0.83–0.93. POL/OOL 0.45–0.60. MID/TFD 0.52–0.62. UID/LID 0.89–0.96. Clypeus 2.48–2.92 times as wide as long. Third antennal segment 1.03–1.10 times as long as fourth. Postnotum 1.00–1.12 times as long as metanotum. Anterior wing marginal cell 3.60–4.35 times as long as high. Third submarginal cell 0.82–1.18 times as long as second. Posterior tibial spur 0.62–0.85 times length of basitarsus.

Discussion.—As in the preceding species males of *Priocnemis kevini* will not run beyond couplet 3 of Townes' key. The frons is punctate and the exposed portion of the subgenital plate is not over 1.5 times as long as wide. The hairs on the plate are long, suberect and straight, recurved only at their tips. In this feature, the species resembles *P. hestia* (Banks) but lacks the pair of longitudinal parallel carinae of the sixth metasomal sternum.

This species is affectionately dedicated to my son, Kevin, a good collector and companion on many field trips.

ACKNOWLEDGMENTS

I thank Mr. M. C. Day, British Museum (Natural History), London for sending material and for his comments and suggestions. I thank Mr. R. D. Haines, Tulare County Agricultural Commissioner/Sealer's Office, Visalia for providing material of one of the species here described.

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Robert Cunningham Miller (1899–1984)

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Dr. Robert Cunningham Miller was born at Blairsville, Pennsylvania, on July 3, 1899. He died at Herrick Hospital in Berkeley, California, on June 11, 1984, in his eighty-fourth year, after several years of declining health. Robert C. Miller was one of three sons and two daughters of Coursen Herbert Miller and Alma (née Gilmore) Miller. Both of his parents were ordained ministers in the Free Methodist Church.

According to the Membership Record on file with the Pacific Coast Entomological Society, Robert C. Miller became interested in insects "In the backyard, at age of 4 years; received encouragement from many entomologists, including T. N. Brown of Uniontown, Penna., and E. C. Van Dyke (a correspondent of T. N. Brown)." As Director of the California Academy of Sciences, from 1938 to 1963, Dr. Miller strongly supported the association of the Pacific Coast Entomological Society with the Academy and served as Treasurer of this society for twenty-one years.

Robert C. Miller attended Public Schools and Greenville College, a Methodist College in Greenville, Illinois, where he received an A.B. degree in 1920. Majoring in Marine Biology, he received his A.M. (in 1921) and Ph.D. (in 1923) degrees from the University of California, Berkeley, with Joseph Grinnell as his major professor. While a graduate student, Miller studied marine boring organisms that were threatening the piers in San Francisco Bay.

Robert C. Miller was successively Assistant Professor (1924–1930), Associate Professor (1930–1936), and Professor (1936–1938) of Zoology and Oceanography at the University of Washington. In 1929–1932 he received a leave of absence to serve as Visiting Professor at Lingnan University (now Zhongshan University) in Canton, China. On September 15, 1937, he married a lovely fellow faculty member, Lea Van Puymbroeck. Their marriage took place in Ghent, Belgium, the native country of his wife.

In 1938, the California Academy of Sciences was searching for a Director, and Joseph Grinnell, a Trustee, recommended his former student. Robert C. Miller accepted the Director's position even though he did not apply for it, and during his quarter century of guidance the institution prospered and advanced. During his directorship, the Alexander F. Morrison Planetarium was built, with its unique star projection system designed and built under the direction of the Academy's Albert S. Getten and Dr. G Dallas Hanna. This was followed by the Lovell White Hall of Man and Nature, the Dean Witter African Hall, the Alice Eastwood Hall of Botany, the John Ward Mailliard, Jr. Library, the May Treat Morrison Auditorium, and new quarters for the expanded Botany and Birds and Mammals departments, as well as a one and one-half million dollar renovation of Steinhart Aquarium. Dr. Miller founded *Pacific Discovery,* a journal of nature and culture

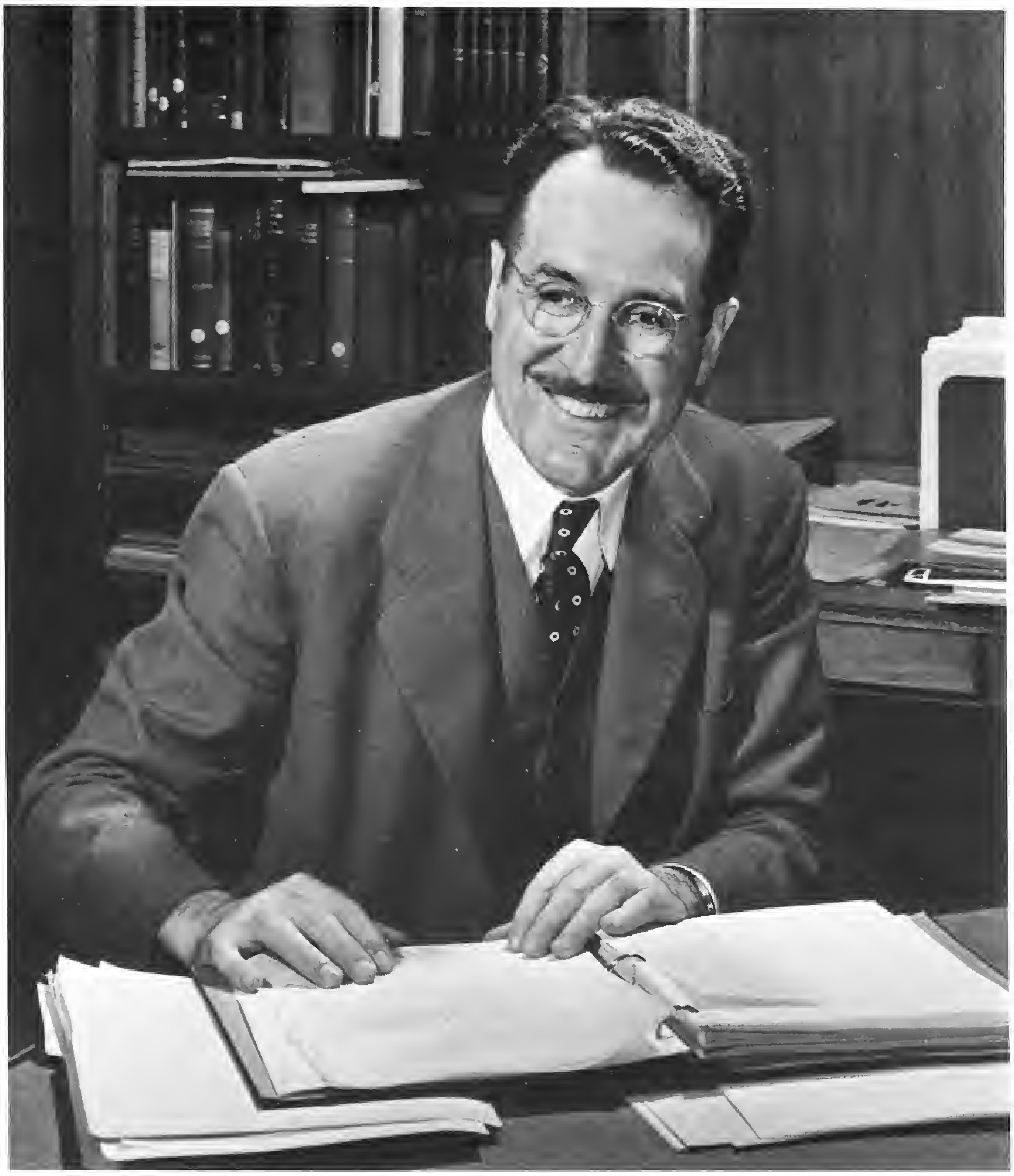

Figure 1. Robert Cunningham Miller. Photograph taken at California Academy of Sciences (Courtesy Academy Archives).

in the Pacific World (serving as managing editor 1948–1963), and the popular television show, *Science in Action,* so well narrated by Drs. Tom Groody and Earl S. Herald.

Robert C. Miller chose to provide headquarters for and served as officer of at least two organizations during his association with the Academy—as Secretary to the Pacific Division of the American Association for the Advancement of Science for twenty-eight years, and as Treasurer of the Pacific Coast Entomological Society for twenty-one years. The Academy also contracted for the California State Marine Research Commission in the coordination of the California Cooperative Oceanic Fisheries Investigations (CALCOFI), including studies of the Pacific Sardine, Northern Anchovy, and Herring.

In 1943, Robert C. Miller succeeded Edwin R. Leach as Treasurer of the Pacific Coast Entomological Society and served in this office until his retirement in 1963. For most of this time, Mrs. Vashti Hawley Getten, Dr. Miller's administrative secretary, handled all the accounts and billings for the Society. Fortunately she continued as a volunteer for the eighteen years that I served as Treasurer of the Society, some of the latter years, after her own retirement from the Academy. Nearly forty years of support to the Pacific Coast Entomological Society was initiated by Dr. Miller and continued by his successor as Director, Dr. George E. Lindsay. On November 15, 1968 Dr. Miller was elected an Honored Member of the Pacific Coast Entomological Society.

Robert C. Miller's earlier association and friendship with Drs. Don L. Frizzell and Harriet Exline Frizzell at the University of Washington, was supportive in the establishment, in 1972, of the Frizzell Arachnological Fund at the California Academy of Sciences, a fund with a principal of over $100,000.

Robert C. Miller published over 220 articles in a broad spectrum of biological topics—on conservation, on fishes, on birds both of the Pacific Coast of North America and China, on insects, on botany, on mollusks, on biographies, on reviews, etc. His first paper, published in 1916, treated the Dayflower (*Commelina communis*), while his book, *The Sea,* first published by Random House, Inc. in 1966, was translated and published in four additional languages.

Some early papers published in the field of Entomology by Dr. Miller include:

1917. Tenacity to life in insects. Scientific American Supplement, 83(2148):133.
1917. Seventy-five thousand insects. The Guide to Nature, 10(10):153–155.
1917. The story of the dragon. American Motherhood, 45(2):111–113.
1929. Subcutaneous parasitism of a young warbler by fly larvae. Murrelet, 10(1): 13–14.
1930. Thomas Nesmith Brown, Entomological News, 41(1):29–30.
1931. The Brenthidae and Lycidae of China (translated from the German of Kleine). Lingnan Science Journal, 7:491–496.

Robert C. Miller was a man of keen wit, and he enjoyed telling stories that were always sophisticated and pertinent. He delighted in a play on words and his pleasure in using the correct word is well shown in his vice-presidential address presented at the 32nd meeting of the AAAS.

The Pacific Coast Entomological Society, the Academy, and Science in general are fortunate to have had Dr. Miller's strong interest, support, and guidance.

Robert C. Miller's wife preceded him in death in 1979. Dr. Miller is survived by two brothers, Mendal Miller, of Seattle, Washington, and Donald Miller, of Gaithersburg, Maryland, and by two sisters, Lois Winslow, of Stanton, California, and Jean Bowman of Santa Ana, California, and many nieces and nephews.

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A Simple Humidity Chamber for Maintaining Subterranean Termites (Isoptera: Rhinotermitidae) in the Laboratory

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Abstract.—A simple and inexpensive apparatus for establishing the high humidity necessary to rear *Reticulitermes hesperus* Banks in the laboratory is described. This humidity chamber permits soil-free culture and could be used with other subterranean termite species. This technique could also be modified for use with other insects requiring specific humidity conditions.

Various techniques have been described for maintaining cultures of *Reticulitermes* species (Isoptera: Rhinotermitidae) in the laboratory. Most of these techniques require soil or some other tunneling substrate to retain moisture (Hendee, 1937; Adamson, 1941; Strickland, 1950; Haverty, 1979; Smith, 1979). However, soil-free culture is advantageous when individual termites must be removed from rearing containers frequently for biological assays, and also facilitates observations of group behavior. Pence (1957) describes a method using plaster in place of soil to retain moisture. This permits ready observation, but the apparatus is designed for long-term maintenance and individual termites are not easily removed.

I describe here a simple and inexpensive method of maintaining western subterranean termites, *Reticulitermes hesperus* Banks, in the laboratory. This technique satisfies their high moisture requirement (Williams, 1934; Pence, 1957) in soil-free culture. Individuals can easily be removed from rearing boxes with a hand aspirator.

MATERIALS AND METHODS

Subterranean termites can be collected either in traps (La Fage et al., 1983) or by dissecting infested wood. In our laboratory, infested wood is cut into small blocks and termites dislodged from their galleries by tapping the wood. Dislodged individuals and those removed from infested soil with an aspirator attached to a small vaccum pump are placed in clear plastic boxes (ca. 30 × 19 × 10 cm). These boxes were originally sold for storing shoes. Each box is provided with a small piece of the wood from which the termites were collected, Whatman No. 1 filter paper, and a small piece of damp cotton. The damp cotton is a source of moisture while the box is open during the collection process. These boxes, each containing a maximum of ca. 3000 termites, are then placed open (without lids) in a humidity chamber.

The humidity chamber is a rectangular (ca. 36 × 30 × 80 cm) 32-gallon polyethylene refuse container containing 10–15 liters of water. Refuse containers such as Sears Permanex 6 in which the lid slides down over the rim (friction-fit) provide a better seal than those in which the handles move to lock the lid in place. Termite rearing boxes are placed on stackable plastic storage shelves (such as Rubbermaid No. 2340). Approximately 7 cm must be sawn off one end of each shelf for it to fit into the refuse container. Each refuse container easily holds four stacked shelves, thus housing up to four rearing boxes (ca. 12,000 termites).

Results and Discussion

Humidity within the chamber can be monitored with a small hygrothermograph or with a direct-reading membrane hygrometer such as those manufactured by Bacharach, Inc. With our laboratory temperatures of 21–25°C, a nearly saturated atmosphere (94 ± 5% RH) is maintained within the chamber. Although high humidity is desirable for subterranean termite survival, lower humidity regimes could also be established with salt solutions (cf. Peterson, 1964; Winston and Bates, 1960).

Whatman No. 1 filter paper is our standard feeding substrate and is added as needed to the rearing boxes. No decline in activity or survival has been noted in groups kept in the laboratory for over three years. A diet such as that described by Mauldin and Rich (1975) could also be used in lieu of filter paper.

In addition to its use as a rearing container, this humidity chamber is also appropriate for use in feeding assays, since it eliminates the need to add water periodically to the experimental units (petri dishes, etc.). As noted by Haverty (1979) opening these containers to replenish the water is disturbing and can cause some termite mortality. In our laboratory, petri dishes or 30 ml plastic cups containing termites and the substrate of interest are placed in the humidity chamber and left undisturbed for the duration of the test. This technique has been employed to assess termite survival in alpha-cellulose and various sawdusts (unpublished), and to assay feeding on rice papers suspected of antifeedant activity (Grace et al., 1986).

Although designed for subterranean termite maintenance, this method of humidity control has also been successfully adapted in our laboratory to rear bark beetles and may prove useful with other insects as well.

Acknowledgments

I am grateful for the cooperation of G. W. Frankie, I. Kubo and D. L. Wood (U.C., Berkeley). I thank D. L. Wood for manuscript review and A. G. Appel (Auburn University) for encouraging publication.

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Scientific Note

Arthropod Visitors at *Washingtonia filifera* (Wendl) Flowers[1]

Although some species of palm are wind-pollinated, others are known to rely upon insects for pollination (Tomlinson, 1979, Ann. Rev. Ecol. Syst., 10:85–107; Blombery and Rodd, 1982, Palms, Angus and Robertson, London). It has not yet been determined which of these two systems is operative for the desert fan palm, *Washingtonia filifera,* of the Sonoran Desert. McClenaghan and Beauchamp (1986, Evolution, 40:315–322) speculated that the lack of genetic differentiation among *W. filifera* populations might be the result of insect, rather than wind, pollination. Lepesme (1947, Les insectes des palmiers, Rue de Tournon, Paris) listed 20 insect species associated with *W. filifera* but, with the exception of *Dinapate wrightii,* did not describe the relationship between the insects and the palms. A first step in ascertaining the mechanism of pollination is to determine which, if any, insects visit *W. filifera* flowers.

On 20 and 21 July 1984, insects and other arthropods were observed or collected at inflorescences of three desert fan palms located in Palm Canyon, Riverside Co., Ca. Identifications of arthropods were made by the author, and Saul Frommer and Robert Wagner of the University of California at Riverside. These taxa are listed in Table 1 in decreasing frequency of occurrence. None of the species collected appeared in Lepesme's (1947) list.

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[1] Supported by a grant from the Richard King Mellon Foundation to the Palm Springs Desert Museum.

Table 1. Arthropods observed or collected on inflorescences of the desert fan palm, *Washingtonia filifera.* Listed in decreasing frequency of occurrence.

Scientific name	Common name	Order
Apis mellifera	Honey bee	Hymenoptera
*Polistes** *P. major* *P. apachus* *P. dorsalis*	Paper wasps	Hymenoptera
Xylocopa californica	California carpenter bee	Hymenoptera
Dermestidae†	Hide beetles	Coleoptera
Forelius foetidus	ant—no common name	Hymenoptera
Stratiomyidae†	Soldier flies	Diptera
Pepsis sp.	Tarantula hawks	Hymenoptera
Tripoxylon xantianum	Mud dauber wasp	Hymenoptera
Alleculidae†	Comb-clawed beetles	Coleoptera
Litoprosopus coachella	Palm moth	Lepidoptera
Tachytes sp.	Sand wasps	Hymenoptera
Prionyx parkeri	Sand wasp	Hymenoptera
Megachile sp.	Leafcutter bees	Hymenoptera
Salticidae†	Jumping spiders	Araneae

* As a genus, the second most frequent visitor.

† Arthropod could only be identified to the family level.

The desert fan palm inflorescences observed in this study were visited by over 75 insects per hour. The most frequent visitor was the introduced honey bee (*Apis mellifera*) followed by paper wasps (*Polistes*), and the California carpenter bee (*Xylocopa californica*). The latter insect often destroys the flower as it feeds (Cornett, 1985, Pan-Pacific Entomologist, 61:251–252). Most insects would visit 5 or more flowers on a single inflorescence and then fly from the palm. It could not be determined if they immediately visited a second palm. Many of these species may be pollinators of *W. filifera* and the diversity and abundance of insects in general suggest that the flowers of this palm species are insect pollinated.

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Scientific Note

Sleeping Habits of *Steniolia tibialis* Handlirsch (Hymenoptera: Sphecidae) in Sierra County, California

Sleeping clusters of *Steniolia tibialis* Handlirsch were observed between July 9 and August 15, 1981 at the San Francisco State University Sierra Nevada Field Campus (SNFC) (120°34′W, 39°37′N), 1500 m south of Bassett's Station, Sierra County, California.

Eleven sleeping clusters with between 2 and 5 individual wasps were counted. Twelve sleeping individuals not associated with other wasps were found. Sleeping wasps were individually numbered with acrylic paints. Four sleeping cluster sites used by the wasps were found. Three of these sites were in a moist wooded meadow, dominated by red fir (*Abies magnifica* A. Murr.), and grasses (*Poa bolanderi* Vasey, *Glyceria elata* (Nash) Hitchc., *Dactylis glomerata* L. and *Elymus glaucus* Buckl.), extending 300 m north of the SNFC entrance road. The fourth site was in a sandy open area 1500 m NW of SNFC, with sparse vegetation dominated by *Monardella odoratissima* Benth. and *Penstemon gracilentus* Gray.

Most of the sleeping *Steniolia tibialis* individuals were found on *Dactylis glomerata* (37); with a few on *Veratrum californicum* Durand. (Liliaceae) (4), and one on *Glyceria elata.* One sleeping individual was found in the fourth site, on *Monardella odoratissima.*

Several individuals were found in clusters on the same plant each night, suggesting that the cluster locations were persistent. New individuals were found nightly in each cluster; all individuals switched to other clusters within three days, suggesting that cluster composition was transient. The sex ratio in the clusters did not differ significantly from 1:1 (paired t-test, $t_{.05}$ [10 df] = 1.16, $P = 0.270$), and the numbers of males and females were normally distributed (Wilk-Shapiro test of normality, $W = 0.9089$, $P \geq 0.1$).

This is the first record of preference for grasses as sleeping cluster sites by *Steniolia.* Evans and Gillaspy (1964, Amer. Midl. Nat., 72:257–280) listed many plants where sleeping clusters of *Steniolia* have been found, including Composites, Gymnosperms and a variety of herbaceous weedy species. They studied large (500 individual) seasonally recurring clusters of *Steniolia obliqua* (Cresson) on branches of lodgepole pine near Moran, Wyoming. Their study suggested the sleeping clusters were largest in June.

Perhaps the location of the sleeping clusters at the SNFC may be explained by the physiognomy of the dominant low herbaceous vegetation. Interspecific differences in sleeping behavior in the genus *Steniolia* could explain the absence of sleeping clusters of *Steniolia tibialis* on *Abies* in the present study.

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PUBLICATION RECEIVED

The Cerambycidae of North America, Part VII, No. 1: Taxonomy and Classification of the Subfamily Lamiinae, Tribes Parmenini through Acanthoderini. By E. Gorton Linsley and John A. Chemsak. University of California Publications in Entomology, vol. 102, ix + 258, 57 figs. Date of publication: 28 February 1985 (vide John Chemsak). Published by University of California Press, 2223 Fulton Street, Berkeley, CA 94720, telephone (415) 642-4562. Price $21.00 paperbound. ISBN 0-520-09690-8.

This is the eighth volume of this series to be issued since the commencement of publication, in 1961, with Part I, of a monograph of the Cerambycidae of America north of Mexico. With two additional planned volumes, the first as Part VII, No. 2, will complete the Lamiinae, tribes Acanthocini through Hemilophini, and the tenth and last volume will present a final bibliography and index. The present volume, in monographing the subfamily Lamiinae, discusses 16 tribes, 38 genera, and 113 valid species group taxa. The 57 figures include excellent habitus illustrations prepared by Celeste Green and Carolyn Tibbetts.

The following nomenclatorial and taxonomic changes are published:

In the tribe Parmenini Mulsant—*Ipochus hispidus* Casey, 1913, *I. parvulus* Casey, 1913, *I. globicollis* Casey, 1913, *I. pinicola* Casey, 1913, and *I. catalinae* Casey, 1913, new synonyms of *I. fasciatus* LeConte, 1852 (pp. 11–12).

In the tribe Moneilemini Thomson—*Monoplesa armigera* Motschulsky designated type species of *Monoplesa* Motschulsky, 1875 (=*Moneilema* Say, 1824) (p. 19); *Moneilema* (*M.*) *annulatum montanum* Psota, 1930, *M.* (*M.*) *puncticollis* Psota, 1930, *M.* (*M.*) *angulatum* Psota, 1930, *M.* (*M.*) *hybrida* Psota, 1930, new synonyms of *M. annulatum* Say, 1824 (pp. 22–23); *Moneilema* (*M.*) *corrugans* Casey, 1913, *M.* (*M.*) *corrugans ovipennis* Casey, 1913, *M.* (*M.*) *corrugans* var. *arizonicum* Psota, 1930, *M. corpulenta* Knaus, 1925, *M.* (*M.*) *nigriventris* Fisher, 1926, *M.* (*M.*) *vittata* Fisher, 1928, *M.* (*M.*) *duncani* Psota, 1930, *M.* (*M.*) *rinconi* Psota, 1930, *M.* (*M.*) *apressum* var. *scabrum* Psota, 1930, *M.* (*M.*) *alpinum* Psota, 1930, *M.* (*M.*) *parahybrida* Psota, 1930, and *M.* (*M.*) *texanum* Psota, 1930, new synonyms of *M. appressum* LeConte, 1852 (pp. 24–25); *Moneilema giganteum* Craighead, 1923, new synonym of *M. gigas* LeConte, 1873 (p. 28); *Moneilema obtusum* Leconte, 1873 and *M.* (*Collapteryx*) *spoliatum* Horn, 1885, new synonyms of *M. semipunctatum* LeConte, 1852 (pp. 29–30); *Moneilema crassum* LeConte, 1853, *M. laevigatum* Bland, 1862, *M.* (*Collapteryx*) *simplicicornis* Casey, 1913, *M.* (*C.*) *rugosipennis* Fisher, 1928, *M.* (*C.*) *isolatum* Psota, 1930, *M.* (*C.*) *punctatum* Psota, 1930, and *M.* (*C.*) *walsenburgi* Psota, 1930, new synonyms of *M. armatum* LeConte, 1853 (pp. 33–35); and *M.* (*Collapteryx*) *mundelli* Fisher, 1931, new synonym of *M. blapsides ulkei* Horn, 1885 (p. 37).

In the tribe Monochamini Thomson—*Cacoplia nebulosa albata* Knull, 1960, new synonym of *Hebestola nebulosa* Haldeman, 1847 (p. 45); *Monochamus obtusus fulvomaculatus* Linsley, 1933, new status (p. 60); *Monochamus clamator rubigineus* (Bates, 1880), new status (p. 68); *Monochamus clamator linsleyi* Dillon and Dillon, 1941, new status (p. 71); *Goes variegatus,* new species, Florida, South Carolina, Georgia, and Mississippi (p. 86); and *Goes tumifrons,* new species, Missouri, Florida, Georgia, and Texas (p. 91).

In the tribe Dorcaschematini Thomson—*Hetoemis* Haldeman, 1847, new synonym of *Dorcaschema* Haldeman, 1847 (p. 103); *Dorcaschema cinereum* (Olivier, 1795), new combination (p. 105); *Hetoemis cinerea bimaculata* Dillon and Dillon, 1948, new synonym of *Dorcaschema cinereum* (Olivier, 1795) (p. 105); and *Dorcaschema octovittata* Knull, 1937, new synonym of *D. alternatum* (Say, 1824) (p. 110).

In the tribe Adetini Lacordaire—*Parmenonta thomasi,* new species, Florida (p. 114); *Tautoclines binotata* Thomson designated type species of *Tautoclines* Thomson, 1868 (=*Adetus* LeConte, 1852) (p. 115); *Adetus lewisi,* new species, Arizona (p. 116).

In the tribe Ataxiini Lacordaire—*Parysatis collaris* Thomson = *Ataxia obscura* [Fabricius] designated type species of *Parysatis* Thomson, 1868 (=*Ataxia* Haldeman, 1847) (p. 124).

In the tribe Desmiphorini Thomson—*Pyrracita apicata* Thomson designated type species of *Pyrracita* Thomson, 1868 (=*Desmiphora* Audinet-Serville, 1835) (p. 136).

In the tribe Estolini Lacordaire—*Estoloides aquilonius,* new species, Arizona (p. 159).

In the tribe Pogonocherini Mulsant—*Estoloderces navarroi* Melzer designated type species of *Estoloderces* Melzer, 1928 (=*Lypsimena* Haldeman, 1847) (p. 166); *Poliaenus obscurus schaefferi* Linsley, 1933, new status (p. 181); *Poliaenus obscurus albidus* Linsley, 1933, new status (p. 181); *Ecyrus dasycerus* var. *texanus* Schaeffer, 1908, new synonym of *E. arcuatus* Gahan, 1892 (p. 190); and *Cerambyx ovatus* Goeze, designated type species of *Pogonocherus* (*Pityphilus*) Mulsant, 1862–3 (=*Pogonocherus* (*Pogonocherus*) Megerle, 1821) (p. 196).

In the tribe Acanthoderini Thomson—*Aegomorphus quadrigibbus* (Say, 1835), new combination (p. 246); *Psapharochrus quadrigibbus lucidus* Knull, 1958, new synonym of *Aegomorphus quadrigibbus* (Say, 1835) (p. 247); *Aegomorphus modestus* (Gyllenhal, 1817), new combination (p. 250); *Aegomorphus arizonicus,* new species, Arizona (p. 253); and *Aegomorphus peninsularis* (Horn, 1880), new combination (p. 254).—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

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Synonymic Species List of Euglossini

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Abstract.—A detailed checklist of all the species in the apid tribe Euglossini is given, including synonymy, complete type data and complete references.

SYNONYMIC SPECIES LIST OF EUGLOSSINI

The biology of the euglossine orchid bees has attracted increasing interest since Dodson, et al. (1969) discovered how to attract large numbers of males to chemical baits. There has also been considerable taxonomic work on this group since 1969, with a 50% increase in the number of described species.

In 1967b Moure published a checklist of the Euglossini. This checklist was invaluable at the time but now requires considerable revision. Moure listed 5 species of *Euglossa,* including *coruscans, cyanosoma, macropsectra, orichalcea* and *spinigaleis,* which have never been published. In addition, *Euglossa augaspis, iopyrrha, platymera, pleosticta* and *stilbonata* were given as Moure species. However, they were not published by Moure but were later published by Dressler (1982a, 1982b, 1982c).

As a result of this confusion, some new synonymy and many additional species, we give below a complete synonymic list of euglossine species. Subspecies are indicated by ssp. Type repositories are given in capital letters and correspond with the city of the particular museum given below.

Type repositories are as follow: BELEM—Museu Paraense Emilio Goeldi, Belem, Pará, Brazil; BERLIN—Zoologisches Museum, Humboldt-Universität, Berlin, E. Germany; BUDAPEST—Hungarian Natural History Museum, Budapest; BUENOS AIRES—Museo Nacional de Buenos Aires, Argentina; CAMBRIDGE—Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA; COPENHAGEN—Universitetes Zoologiske Museum, Copenhagen, Denmark; CUREPE—Commonwealth Institute of Biological Control, Curepe, Trinidad; CURITIBA—Universidade Federal do Parana, Curitiba, Brazil; DAVIS—Bohart Museum of Entomology, University of California, Davis, USA; GAINESVILLE—Florida State Museum, University of Florida, Gainesville, USA; GENEVA—Museum of Natural History, Geneva, Switzerland; GENOA—Museo Civico di Storia Naturale, Genoa, Italy; LAWRENCE—Snow Museum, University of Kansas, Lawrence, USA; LONDON—British Museum (Natural History), London, England; MUNICH—Zoologische Sammlung des Bayerischen Staates, Munich, W. Germany; NEW YORK—American Museum of Natural History, New York, USA; OXFORD—Hope Entomological Collections, Oxford University Museum, England; PARIS—Museum National d'Histoire Naturelle, Laboratoire d'Entomologie, Paris, France; SAN JOSE—Department of Entomology, University of Costa Rica, San Jose; SAO PAULO—Museu de Zoologia, Universidade de São Paulo, Brazil; STOCKHOLM—Naturhistoriska Riksmuseet, Stockholm, Sweden; TURIN—Instituto e Museo di Zoologia, Universita di Torino, Turin, Italy; UPPSALA—Zoological Institute, University of Uppsala, Sweden; VIENNA—Zweite Zoologische Abteilung, Naturhistorisches Museum, Vienna, Austria; WASHINGTON—U.S. National Museum of Natural History, Washington, D.C.

Aglae Lepeletier and Serville

Aglae caerulea Lepeletier and Serville, 1825:105. Lectotype female; French Guiana: Cayenne (TURIN).

Eufriesea Cockerell

aeniventris (Mocsáry), 1896:5. (*Euglossa*). Lectotype female; Brazil: Espirito Santo (TURIN).
anisochlora (Kimsey), 1977:8. (*Euplusia*). Holotype male; Panama: Panama Prov., Cerro Jefe (DAVIS).
auripes (Gribodo), 1882:226. (*Euglossa*). Holotype male; French Guiana: Cayenne (GENOA).
boharti (Kimsey), 1977:10. (*Euplusia*). Holotype male; Venezuela: Aragua, Rancho Grande (DAVIS).
brasilanorum Friese, 1899:147. (*Euglossa combinata* ssp.). Holotype male; Brazil: Espirito Santo (BERLIN).
caerulescens (Lepeletier), 1841:1. (*Euglossa*). Holotype male; "Mexico" (PARIS).
  simillima (Moure and Michener *in* Moure), 1965:275. (*Euplusia*). Holotype male; Mexico: Chihuahua, Maguarichic (LAWRENCE).
chalybaea (Friese), 1923:27. (*Euglossa*). Holotype male; Bolivia: Tarata (NEW YORK).
chrysopyga (Mocsáry), 1898:497. (*Euglossa*). Lectotype female; Bolivia: "Songo" (BUDAPEST).
combinata (Mocsáry), 1897:446. (*Euglossa*). Lectotype female; Bolivia: Antonio (BUDAPEST).
concava (Friese), 1899:151. (*Euglossa mexicana* ssp.). Lectotype male; Nicaragua (BERLIN).
convexa (Friese), 1899:151. (*Euglossa mexicana* ssp.). Holotype female; "Brasilia" (BUDAPEST).
corusca (Kimsey), 1977:10. (*Euplusia*). Holotype male; Panama: Zona del Canal, Barro Colorado Island (DAVIS).
distinguenda (Gribodo), 1882:267. (*Euglossa*). Holotype male; French Guiana: Cayenne (GENOA).
  dentilabris (Mocsáry), 1897:443. (*Euglossa*). Holotype male; Brazil: Espirito Santo (BUDAPEST).
dressleri (Kimsey), 1977:12. (*Euplusia*). Holotype male; Panama: Zona del Canal, Piña area (DAVIS).
duckei (Friese), 1923:28. (*Euglossa*). Holotype female; Brazil: Para, Macapa (NEW YORK).
eburneocincta (Kimsey), 1977:12. (*Euplusia*). Holotype male; Guyana: Dawa (WASHINGTON).
elegans (Lepeletier), 1841:13. (*Eulaema*). Holotype female; French Guiana: Cayenne (TURIN).
excellens (Friese), 1925:27. (*Euglossa*). Holotype male; Ecuador: Guayaquil (BERLIN).
fallax (F. Smith), 1854:381. (*Euglossa*). Lectotype male; Brazil: Pará (LONDON).
flaviventris (Friese), 1899:152. (*Euglossa mexicana* ssp.). Lectotype female; Brazil (BUDAPEST).
formosa (Mocsáry), 1908:581. (*Euglossa*). Holotype female; Brazil: Amazonas, Tefe (BUDAPEST).
fragrocara Kimsey, 1977:13. (*Euplusia*). Holotype male; Peru: Huanuco, Rio Pachitea (DAVIS).
laniventris (Ducke), 1902b:573. (*Euglossa*). Lectotype male; Brazil: Pará, Belem (BELEM).
limbata (Mocsáry), 1897:442. (*Euglossa*). Holotype female; Brazil: Piauí (BUDAPEST).
  basalis (Friese), 1898:203. (*Euglossa*). Lectotype female; Surinam (BERLIN).
lucida (Kimsey), 1977:13. (*Euplusia*). Holotype male; Colombia: Valle, Anchicaya (DAVIS).
lucifiera Kimsey, 1977:18. Holotype male; Panama: Panama, El Llano-Carti Rd., 19 km N El Llano (DAVIS).
macroglossa (Moure), 1965:274. (*Euglossa*). Holotype male; Costa Rica: Turrialba (LAWRENCE).
magrettii (Friese), 1899:148. (*Euglossa*). Lectotype male; Venezuela (GENOA).
  magrettii fulvohirta (Friese), 1899:148. (*Euglossa*). Lectotype male; Venezuela (GENOA).
  andina (Friese), 1925:27. (*Euglossa*). Lectotype female; Peru: Vilcanota (BERLIN).
mariana (Mocsáry), 1896:4. (*Euglossa*). Holotype female; Bolivia: Bueyes (BUDAPEST).
  superba (Mocsáry), 1898:498. (*Euglossa*). Holotype male; Bolivia: "Songo" (BUDAPEST).
  pulcherrima (Friese), 1923:27. (*Euglossa*). N. name for *superba* Mocsáry, 1898, nec Hoffmannsegg, 1817.
  mariae (Friese), 1940:158. (*Euglossa*). Lapsus for *mariana* Mocsáry, 1898.
mexicana (Mocsáry), 1897:444. (*Euglossa*). Lectotype female; Mexico: Presidio (BUDAPEST).

mussitans (Fabricius), 1787:301. (*Apis*). Holotype female; French Guiana (COPENHAGEN).
  mexicana inermis (Friese), 1899:151. (*Euglossa*). Lectotype male; Venezuela (NEW YORK).
nigrescens (Friese), 1925: 27. (*Euglossa*). N. name for *magretti nigrita* Friese, 1903.
  magrettii nigrita (Friese), 1903:574. (*Euglossa*). Lectotype female; Ecuador: Balzapampa (WASHINGTON). Nec Lepeletier.
  longipennis (Friese), 1925:28. (*Euglossa*). Holotype female; Ecuador: Guayaquil (BERLIN).
nigrohirta (Friese), 1899:142. (*Euglossa*). Holotype female; Brazil: Pará (BERLIN).
opulenta (Mocsáry), 1908:582. (*Euglossa*). Holotype male; Peru: Chanchamayo (BUDAPEST).
ornata (Mocsáry), 1896:3. (*Euglossa*). Holotype male; Brazil: Pará (BUDAPEST).
pallida (Kimsey), 1977:15. (*Euplusia*). Holotype male; Mexico: Chiapas, Tuxtla Gutierrez (GAINESVILLE).
pretiosa (Friese), 1903:575. (*Euglossa*). Holotype female; Ecuador: Santa Inez (NEW YORK).
pulchra (F. Smith), 1854:381. (*Euglossa*). Holotype female; Brazil: Pará, Tapajos (LONDON).
purpurata (Mocsáry), 1896:127. (*Euglossa*). Lectotype female; Peru: Iquitos (BUDAPEST).
rufocauda (Kimsey), 1977:15. (*Euplusia*). Holotype male; Panama: Panama, Cerro Campana (DAVIS).
rugosa (Friese), 1899:152. (*Euglossa*). Lectotype female; Mexico (BERLIN).
schmidtiana (Friese), 1925:26. (*Euglossa*). Lectotype male; Costa Rica: Sarapiqui (BERLIN).
superba (Hoffmannsegg), 1817:52. (*Plusia*). Holotype male; Brazil: Pará (WASHINGTON).
  manni (Cockerell), 1912:41. (*Eulaema*). Holotype male; Brazil: Rondônia, Abuna (WASHINGTON).
surinamensis (Linnaeus), 1758:578. (*Apis*). Holotype female; Surinam (STOCKHOLM).
  tropica (Linnaeus), 1758:579. (*Apis*). Holotype female; "in calidus regionibus" (UPPSALA).
  abdomenoflavum (DeGeer), 1773:574. (*Apis*). Holotype male; Surinam (STOCKHOLM).
  smaragdina (Perty), 1833:150. (*Centris*). Holotype male; Brazil: Minas Gerais (MUNICH).
  angulata (Mocsáry), 1897:443. (*Euglossa*). Lectotype female; Brazil: Piauí (BUDAPEST).
  bruesi (Cockerell), 1914:307. (*Eulaema*). Holotype female; Ecuador: Guayaquil (WASHINGTON).
  amabilis (Cockerell), 1917:16. (*Eulaema*). Holotype male; Brazil: Amazonas, Manaus (WASHINGTON).
  tectora (Kimsey), 1977:16. (*Euplusia*). Holotype male; Panama: Zona del Canal, Frijoles (DAVIS).
theresiae (Mocsáry), 1908:581. (*Euglossa*). Holotype female; Brazil: Amazonas, Tefe (BUDAPEST).
tucumana (Schrottky), 1902:117. (*Euglossa*). Holotype female; Argentina: Tucuman (BUENOS AIRES).
venezolana (Schrottky), 1913:708. (*Centris*). Holotype male; Venezuela (SAO PAULO).
  buchwaldi (Friese), 1923:27. (*Euglossa*). Lectotype female; Peru (BERLIN).
venusta (Moure), 1965:273. (*Euplusia*). Holotype female; Panama: Panama, Cerro Campana (LAWRENCE).
vidua (Moure), 1976:277. (*Euplusia*). Holotype female; Surinam (repository unknown).
violacea (Blanchard), 1840:405. (*Euglossa*). Holotype female; Brazil (type lost).
  danielis (Schrottky), 1907:56. (*Eumorpha*). Holotype female; Paraguay: Asuncion (type lost).
violascens (Mocsáry), 1898:497. (*Euglossa*). Lectotype female; Bolivia: "Songo" (BUDAPEST).
  auriceps (Friese), 1899:156. (*Euglossa*). Holotype male; Paraguay: Asuncion (WASHINGTON).
xantha (Kimsey), 1977:17. (*Euplusia*). Holotype male; Guyana: Rockstone, Mazaruni-Potaro (DAVIS).

***Euglossa* Latreille**

alleni Moure, 1968:35. Holotype male; Costa Rica: Puntarenas, Palmar (WASHINGTON).
allosticta Moure, 1969:242. Holotype male; Panama: Zona del Canal, Gamboa (WASHINGTON).
amazonica Dressler, 1982c:146. Holotype male; Brazil: Pará, Belem, IPEAN (WASHINGTON).
analis Westwood, 1840:262. Lectotype male; Brazil: Amazonas (OXFORD).
  bicolor Ducke, 1902b:565. Lectotype male; Brazil, Pará, Belem (BELEM).
annectans Dressler, 1982c:127. Holotype male; Brazil: Guanabarra, Floresta de Tijuca (WASHINGTON).
asarophora Moure, 1969:239. Holotype male; Peru: Iquitos (LONDON).
atroveneta Dressler, 1978a:177. Holotype male; Guatemala: Santa Rosa (WASHINGTON).
augaspis Dressler, 1982b:133. Holotype male; Brazil: Amazonas, Manaus (WASHINGTON).
aureiventris Friese, 1899:135. Lectotype female; Brazil (VIENNA).
auriventris Friese, 1925:29. Syntype females; Brazil: Rio Branco, Ecuador: Guayaquil (BERLIN).

avicula Dressler, 1982c:146. Holotype male; Brazil: Espirito Santo, Conceiçao da Barra (WASHINGTON).

azureoviridis Friese, 1930:137. Lectotype male; Costa Rica: San Jose (BERLIN).

nigrescens Friese, 1930:137. Lectotype female; Costa Rica: San Jose (BERLIN).

bidentata Dressler, 1982a:122. Holotype male; Peru: Huanuco, Llullapichis, Rio Pachitea (WASHINGTON).

bigibba Dressler, 1982a:128. Holotype male; Peru: Tebas (=Pebas) (BUDAPEST).

bursigera Moure, 1970:151. Holotype male; Panama: Zona del Canal, Barro Colorado Is. (CURITIBA).

ssp. *bursigera cupreicolor* Moure, 1970:152. Holotype male; Costa Rica: Pozo Azul, San Jose (CURITIBA).

carinilabris Dressler, 1982b:134. Holotype male; Brazil: Bahia, Itabuña (WASHINGTON).

chalybeata Friese, 1925:29. Lectotype male; Brazil: Pará, Belem (BERLIN).

ssp. *chalybeata iopoecila* Dressler, 1982a:126. Holotype male; Brazil: Paraná, Alexandra (WASHINGTON).

championi Cheesman, 1929:148. Lectotype male; Panama: Chiriquí (LONDON).

charapensis Cockerell, 1917:146. Holotype female; Peru: Rio Charape (WASHINGTON).

chlorina Dressler, 1982c:141. Holotype male; Venezuela: Caracas (WASHINGTON).

cognata Moure, 1970:156. Holotype male; Brazil: Mocajuba (Mangabeira) (CURITIBA).

cordata (Linnaeus), 1758:572. Holotype male; "Guianas" (STOCKHOLM).

crassipunctata Moure, 1968:40. Holotype male; Panama: Zona del Canal, Gamboa (WASHINGTON).

crininota Dressler, 1978a:176. Holotype male; Mexico: Veracruz, Cordoba (WASHINGTON).

cyanaspis Moure, 1968:46. Holotype male; Panama: Zona del Canal, Diablo Heights (WASHINGTON).

cyanea Friese, 1899:135. Lectotype female; Bolivia: San Antonio (BUDAPEST).

cyanura Cockerell, 1917:146. Holotype male; Panama: Colón, Porto Bello (WASHINGTON).

cybelia Moure, 1968:26. Holotype male; Panama: Panama Prov., Cerro Campana (WASHINGTON).

deceptrix Moure, 1968:58. Holotype male; Panama: Panama, Cerro Campana (WASHINGTON).

decorata F. Smith, 1874:444. Holotype female; Brazil: Amazonas, São Paulo de Olivenca (LONDON).

ruficauda Cockerell, 1918:688. Holotype female; Guyana: Kalacoon (NEW YORK).

despecta Moure, 1968:55. Holotype male; Panama: Zona del Canal, Barro Colorado Is. (WASHINGTON).

dissimula Dressler, 1978a:173. Holotype male; Panama: Panama, Cerro Campana (WASHINGTON).

dodsoni Moure, 1965:266. Holotype female; Costa Rica: Turrialba (LAWRENCE).

dressleri Moure, 1968:29. Holotype male; Panama: Zona del Canal, Gamboa (WASHINGTON).

erythrochlora Moure, 1968:32. Holotype male; Costa Rica: Puntarenas, San Vito (WASHINGTON).

flammea Moure, 1969:231. Holotype male; Panama: Zona del Canal, Gamboa (WASHINGTON).

fuscifrons Dressler, 1982b:134. Holotype male; Ecuador, Napo, Veracruz (WASHINGTON).

gaianii Dressler, 1982c:142. Holotype male; French Guiana: 12 km SW Kourou (WASHINGTON).

gibbosa Dressler, 1982c:147. Holotype male; Ecuador: Pichincha, Santo Domingo (WASHINGTON).

gorgonensis Cheesman, 1929:146. Holotype male; Costa Rica (LONDON).

ssp. *gorgonensis erythrophana* Dressler, 1978a:170. Holotype male; Costa Rica: Puntarenas, Golfito (WASHINGTON).

granti Cheesman, 1929:147. Holotype female; Colombia: Gorgona Is. (LONDON).

hansoni Moure, 1965:269. Holotype female; Panama: Colón, Piña area (LAWRENCE).

hemichlora Cockerell, 1917:146. Holotype female; Ecuador: Paramba (WASHINGTON).

auricollis Friese, 1923:26. Lectotype female; Ecuador: Guayaquil (BERLIN).

heterosticta Moure, 1968:52. Holotype male; Panama: Panama, Cerro Campana (WASHINGTON).

hyacinthina Dressler, 1982b:135. Holotype male; Panama: Chiriquí, Fortuna Dam (WASHINGTON).

ignita F. Smith, 1874:444. Holotype male; Jamaica (LONDON).

chlorosoma Cockerell, 1918:688. Holotype female; Guyana: Bartica Dist. (NEW YORK). NEW SYNONYMY.

igniventris Friese, 1925:29. Holotype female; Costa Rica: San Jose, La Caja (WASHINGTON).

cupreiventris Cheesman, 1929:146. Holotype female; Panama (LONDON).

imperialis Cockerell, 1922:6. Holotype female; Panama: Rio Trinidad (WASHINGTON).

intersecta Latreille, 1938:273. Holotype ?; French Guiana: Cayenne (Lost).

brullei Lepeletier, 1841:10. Holotype female; "Senegal" (Error—Amazon Region) (PARIS).

romandii Guérin, 1845:458. Lectotype male; locality unknown (GENEVA ?).

ioprosopa Dressler, 1982a:124. Holotype male; Peru: Huanuco, Llullapichis, Rio Pachitea (WASHINGTON).

iopyrrha Dressler, 1982a:123. Holotype male; Brazil: Pará, Obidos (WASHINGTON).

jamaicensis Moure, 1968:43. Holotype male; Jamaica (CURITIBA).

laevicincta Dressler, 1982b:136. Holotype male; French Guiana: 19 km SW Kourou (WASHINGTON).

lazulina Friese, 1923:26. Holotype female; Brazil: Pará, Obidos (BERLIN).

liopoda Dressler, 1982c:143. Holotype male; Venezuela: Bolivar, Rio Chicanan (WASHINGTON).

macrorhyncha Dressler, 1982b:136. Holotype male; Ecuador: Pichincha, Santo Domingo (WASHINGTON).

maculilabris Moure, 1968:23. Holotype male; Panama: Panama, Cerro Campana (WASHINGTON).

magnipes Dressler, 1982c:148. Holotype male; Peru: Huanuco, Llullapichis, Rio Pachitea (WASHINGTON).

mandibularis Friese, 1899:137. Lectotype female; Brazil: Rio Grande do Sul, Santa Cruz do Sul (BERLIN).

   bernardina Cockerell, 1917:144. Holotype male; Paraguay: San Bernardino (WASHINGTON).

   aenescens Friese, 1925:28. Lectotype male; Brazil: Mato Grosso, Passa Quatro (BERLIN).

melanotricha Moure, 1967 (*In* Sakagami et al.):47. Holotype male; Brazil: Mato Grosso, Araxa (CURITIBA).

micans Dressler, 1978a:175. Holotype male; Costa Rica: Heredia, Puerto Viejo, La Selva (WASHINGTON).

mixta Friese, 1899:135. Lectotype male; Panama: Chiriquí (BUDAPEST).

modestior Dressler, 1982c:143. Holotype male; Peru: Loreto, Iquitos (WASHINGTON).

mourei Dressler, 1982c:148. Holotype male; Colombia: Amazonas, Leticia (WASHINGTON).

nigropilosa Moure, 1965:270. Holotype female: Ecuador: Tungurahua, Topo (LAWRENCE).

nigrosignata Moure, 1969:234. Holotype male; Panama: Coclé, El Valle de Anton (WASHINGTON).

obtusa Dressler, 1978a:171. Holotype male; Mexico: Veracruz, Los Tuxtlas near Montepio (WASHINGTON).

oleolucens Dressler, 1978a:169. Holotype male; Costa Rica: Puntarenas, Las Cruces S San Vito (WASHINGTON).

parvula Dressler, 1982b:137. Holotype male; Colombia: Amazonas, Leticia (WASHINGTON).

perfulgens Moure, 1967a:388. Holotype female; Brazil: Amazonas, Tefe (CURITIBA).

perviridis Dressler, 1985:78. Holotype male; Peru: Madre de Dios, 30 km SW Puerto Maldonado (WASHINGTON).

pictipennis Moure, 1943:191. Holotype female; Brazil: São Paulo, Batatais (CURITIBA).

piliventris Guérin, 1845:458. Syntype male, female; Brazil: Pará (GENOA).

platymera Dressler, 1982c:144. Holotype male; Brazil: Amazonas, Manaus (WASHINGTON).

pleosticta Dressler, 1982c:150. Holotype male; Brazil: Espirito Santo, N Linhares (WASHINGTON).

polita Ducke, 1902b:571. Lectotype male; Brazil: Pará, Belem (BELEM).

prasina Dressler, 1982b:138. Holotype male; Colombia: Amazonas, Leticia (WASHINGTON).

purpurea Friese, 1899:135. Lectotype male; Panama: Chiriquí (BUDAPEST).

retroviridis Dressler, 1982a:123. Holotype male; Colombia: Amazonas, Leticia (WASHINGTON).

rugilabris Moure, 1967a:391. Holotype female; Brazil: Amazonas, Tabatinga (CURITIBA).

sapphirina Moure, 1968:38. Holotype male; Panama: Zona del Canal, Gamboa (WASHINGTON).

securigera Dressler, 1982c:145. Holotype male; Brazil: Espirito Santo, Conceiçao da Barra (WASHINGTON).

singularis Mocsáry, 1899:169. Holotype female; Surinam (BUDAPEST).

   meliponides Ducke, 1902b:569. Lectotype female; Brazil: Pará, Itaituba (BELEM).

   apiformis Schrottky, 1911:39. Holotype female; Peru: Cuzco (Lost ?).

stellfeldi Moure, 1947:11. Holotype female; Brazil: Pará, Caioba (CURITIBA).

stilbonata Dressler, 1982b:138. Holotype male; French Guiana: 19 km SW Kourou (WASHINGTON).

townsendi Cockerell, 1904:24. Lectotype female; Mexico: Vera Cruz, San Rafael (NEW YORK).

tridentata Moure, 1970:152. Holotype male; Panama: Zona del Canal, Summit Gardens (WASHINGTON).

trinotata Dressler, 1982b:139. Holotype male; Colombia: El Valle, Buenaventura, Campamento de Pulpapel (WASHINGTON).

turbinifex Dressler, 1978a:168. Holotype male; Panama: Colón, Santa Rita ridge (WASHINGTON).

ultima Moure, 1968:61. Holotype male; Venezuela: Merida (BUDAPEST).
variabilis Friese, 1899:135. Lectotype male; French Guiana: Cayenne (BERLIN).
villosa Moure, 1968:17. Holotype male; Panama: Coclé, El Valle de Anton (WASHINGTON).
villosiventris Moure, 1968:20. Holotype male; Panama: Panama, Cerro Jefe (WASHINGTON).
viridifrons Dressler, 1982b:140. Holotype male; Brazil: Pará, Belem, IPEAN (WASHINGTON).
viridis (Perty), 1833:148. (*Cnemidium*). Holotype male; Brazil: Amazonas (MUNICH).
  azurea Ducke, 1902b:570. Lectotype male; Brazil: Amapa, Macapa (BELEM).
viridissima Friese, 1899:136. Lectotype male; Mexico (VIENNA).

Eulaema Lepeletier

boliviensis (Friese), 1898:205. (*Eulema*). Lectotype female; Bolivia (BERLIN).
bombiformis (Packard), 1869:57. (*Euglossa*). Holotype female; Ecuador: Napo, Quito (CAMBRIDGE).
  niveofasciata (Friese), 1899:165. (*Euglossa*). Lectotype female; Brazil: Pernambuco (VIENNA).
bomboides (Friese), 1923:28. (*Euglossa*). Lectotype female; Ecuador: Balzapamba (NEW YORK).
cingulata (Fabricius), 1804:355. (*Centris*). Lectotype female; Guyana (?) (COPENHAGEN).
  fasciata Lepeletier, 1841:12. Lectotype female; French Guiana: Cayenne (PARIS).
  cajennensis Lepeletier, 1841:14. Holotype female; French Guiana: Cayenne (TURIN).
leucopyga (Friese), 1898:203. (*Eulema*). Holotype female; Colombia (BERLIN).
meriana (Olivier), 1789:65. (*Apis*). Holotype male; Surinam (Lost ?).
  dimidiata (Fabricius), 1793:316. (*Apis*). Holotype male; Surinam (PARIS). Nec Olivier, 1789.
  quadrifasciata (Friese), 1903:575. (*Euglossa*). Lectotype male; Costa Rica: San Carlos (BERLIN).
  tenuifasciata (Friese), 1925:30. (*Euglossa*). Holotype female; Bolivia: Tarata (NEW YORK).
 ssp. *meriana flavescens* (Friese), 1899:165. (*Euglossa dimidiata* ssp.). Lectotype female; Colombia (VIENNA).
 ssp. *meriana terminata* (F. Smith), 1874:442. (*Eulema*). Holotype male; Trinidad (LONDON).
mocsaryi (Friese), 1899:161. (*Euglossa*). Holotype female; Brazil (OXFORD).
nigrita Lepeletier, 1841:14. Lectotype female; French Guiana: Cayenne (TURIN).
  analis Lepeletier, 1841:14. Holotype male; Brazil (PARIS).
  raymondi (Schrottky), 1907:65. (*Centris*). Lectotype female; Venezuela: Caracas (SAO PAULO).
  nigriceps (Friese), 1923:27. (*Euglossa*). Lectotype male; Colombia: Cauca-Tal (BERLIN).
  willei Moure, 1963:213. Holotype male; Costa Rica: Guanacaste, Rio Blanco (SAN JOSE).
peruviana (Friese), 1903:575. (*Euglossa*). Lectotype female; Peru: Cuzco, Marcapata (BUDAPEST).
polychroma (Mocsáry), 1899:170 (*Euglossa*). Holotype male; Peru: Callanga (BUDAPEST).
polyzona (Mocsáry), 1897:442. (*Euglossa*). Lectotype female; Surinam (BUDAPEST).
  difficilis (Friese), 1898:206. (*Eulema*). Lectotype female; Brazil: Pará (BERLIN).
seabrai Moure, 1960:19. Holotype female; Brazil: Rio de Janeiro (CURITIBA).
 ssp. *seabrai bennetti* Moure, 1967a:384. Holotype male; Trinidad: Aripo (CUREPE).
 ssp. *seabrai luteola* Moure, 1967a:375. Holotype female; Colombia: Monte Redondo (CURITIBA).
 ssp. *seabrai mimetica* Moure, 1967a:379. Holotype male; Brazil: Pará, Obidos, Curusumba (CURITIBA).
speciosa (Mocsáry), 1897:445. (*Euglossa*). Holotype female; Panama: Chiriquí (BUDAPEST).
  semirufa (Friese), 1898:204. (*Eulema*). Holotype male; Panama: Chiriquí (BERLIN).
  nigrifacies (Friese), 1899:205. (*Eulema*). Holotype male; Venezuela: Santa Parima (BERLIN).
  panamensis (Mocsáry), 1899:169. (*Euglossa*). Holotype female; Panama: Chirquí (BUDAPEST).
  sarapiquiensis (Friese), 1925:30. (*Euglossa*). Holotype female; Costa Rica: Sarapiqui (BERLIN).

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azteca Moure, 1966:15. Holotype male; Mexico: Hidalgo, Jacala (LAWRENCE).
dentata (Linnaeus), 1758:657. (*Apis*). Holotype female; Trinidad (UPPSALA).
  nitida (Perty), 1833:148. (*Chrysantheda*). Holotype female; Brazil: Piauí (MUNICH).
  subcornuta (Romand), 1849:xxxvi. (*Chrysantheda*). Holotype male; Venezuela: Caracas (Repository ?).
frontalis (Guérin), 1845:458. (*Euglossa*). Type ?; French Guiana: Cayenne (Repository ?).
smaragdina (Guérin), 1845:458. (*Euglossa*). Lectotype female; Mexico: Yucatan (GENOA).
  aurata Erichson, 1848:592. Holotype female; Guyana (Repository ?).
  cyanescens Cockerell, 1926:657. Lectotype female; Trinidad (NEW YORK).
trochanterica (Friese), 1900:66. (*Chrysantheda*). Holotype female; Brazil: Pará (BERLIN).

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Revision of the Plant Bug Genus *Noctuocoris* Knight (Heteroptera: Miridae: Orthotylinae)

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Abstract.—The orthotyline genus *Noctuocoris* Knight is diagnosed and redescribed. The type species, *fumidus* (Van Duzee), is redescribed and a male dorsal habitus is provided. Two new species, *autlan* and *conspurcatus* are described from central Mexico and the western United States, respectively. The male genitalia of all species are described and illustrated. Scanning electron micrographs of the scale-like setae and pretarsus of *fumidus* are presented.

Knight (1923) described the genus *Noctuocoris* to receive a single species, *Orthotylus fumidus* Van Duzee, 1916, from Colorado. This species was subsequently reported from Massachusetts, Michigan, Minnesota, New York, Pennsylvania, South Dakota, and Utah (Knight, 1923, 1941, 1968), and from Manitoba, Ontario, and Quebec, Canada (Kelton, 1980). Our study has revealed additional records of *fumidus* from Iowa, North Dakota, Oklahoma, and British Columbia, as well as two new species, *autlan* from Jalisco, Mexico and *conspurcatus* from Arizona and Colorado.

All measurements are in millimeters. Abbreviations for specimen depositories correspond to institutions listed in the acknowledgments.

Noctuocoris Knight

Noctuocoris Knight, 1923:510, 523 (new genus); 1941:82, 105; 1968:94, 109, fig. 141. Kelton, 1980:197, 246, 247, map 79.

Diagnosis.—Recognized by the elongate, parallel-sided hemelytra and uniformly dark rufous brown to nearly black general coloration (Fig. 1); dorsal vestiture possessing both black and white scale-like setae with broad converging ridges (Fig. 2); lorum strongly swollen; and male genitalia with the following characteristics: right paramere short, 'T' shaped (Figs. 9–11, 20–22, 33–35); posterodorsal margin of genital capsule between right paramere socket and apex with solitary spine-like process (Figs. 4, 6, 16, 17, 27, 28); phallotheca with deep circular notch on right basal margin (Figs. 31, 32); and vesica with two distally flattened, strongly serrate spiculae (Figs. 7, 8, 18, 19, 29, 30); left spicula bifurcate, dextral branch with strong basal spine.

Description of male.—GENERAL ASPECT. Macropterous. Length 5.20–6.98. Fuscous brown to grayish black; surface shagreened and slightly shining; dorsal vestiture with short appressed scale-like white and black setae intermixed with longer, suberect black simple setae. HEAD. Elliptical with frons very slightly projecting beyond anterior margin of eyes; posterior margin of head ecarinate or

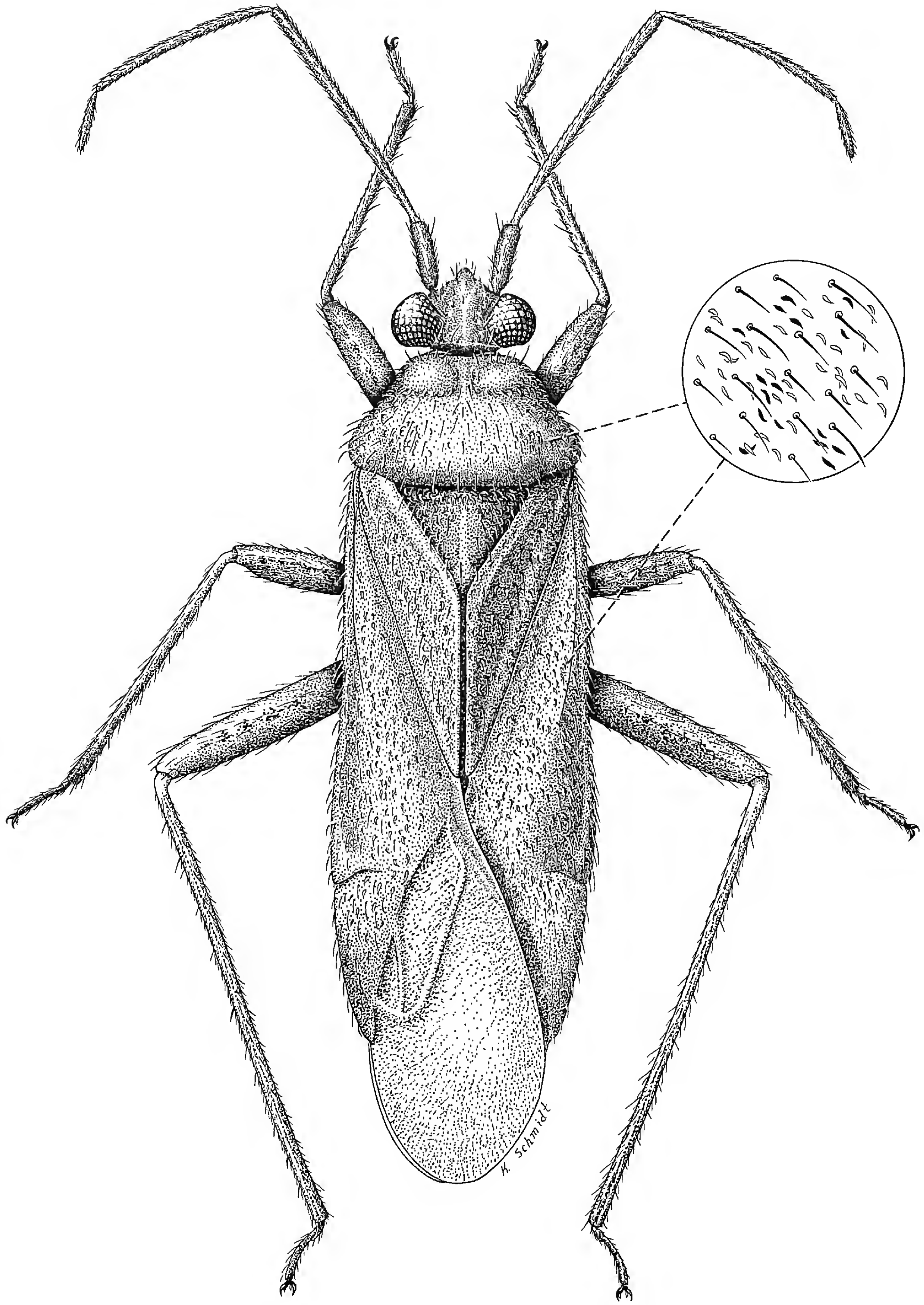


Figure 1. *Noctuocoris fumidus*, dorsal habitus of male.

Figures 2, 3. *Noctuocoris fumidus.* 2. Scale-like setae on dorsum. 3. Pretarsal structures.

with very slightly elevated carina, and with transverse row of erect black bristle-like setae; temporal areas glabrous; frons flattened or slightly convex anteriorly, tylus prominent, junction with frons shallowly or very shallowly depressed; eyes large occupying more than half of head height; posterior margin of eye straight, narrowly removed from anterior margin of pronotum; antennal fossa nearly contiguous with anterior margin of eye, lower margin of fossa situated above ventral margin of eye; eye emarginate near fossa; juga weakly protruding, lora more strongly so; width of genae less than or equal to diameter of antennal segment I; bucculae sometimes extending posteriad of margin of antennal fossa in lateral view; gula obsolete; antennae brown or black; segment I with densely distributed suberect black simple setae and several large erect black bristle-like setae; segment II with densely distributed suberect pale setae, sometimes also with black setae; labium reaching apex of mesosternum or base of mesocoxae. PRONOTUM. Lateral margins slightly concave, posterior margin broadly rounded, anterior margin concave medially, calli weakly differentiated, attaining anterolateral margins of pronotum; mesoscutum narrowly exposed; scutellum weakly arched, anteromedial region transversely flattened. HEMELYTRA. Elongate, parallel-sided, broadest anterior to cuneal fracture; claval, cubital and radial veins weakly elevated; embolium uniformly narrow; cuneal incisure sharp; cuneal fracture distinct, angled anteriad; cuneus longer than broad; membrane uniformly fuscous or conspurcate, veins pale at apex and brachium. LEGS. Black or brown; tibiae with several longitudinal rows of minute black spinules, tibial spines black, without dark spots at bases. GENITALIA. *Genital capsule:* Large, subtriangular, length subequal to width in ventral view; slightly produced posteriad of paramere sockets, apex broadly rounded; posterodorsal margin between right paramere socket and apex with solitary spine-like process; posteroventral surface sometimes with erect black bristles set in large sockets; aperture of moderate size, 'U' shaped, lateral margin dorsad of left paramere with very small spine-like process, or tubercle. *Left paramere:* Sensory lobe prominent, rounded and set with bristle-like setae; lateral lobe or arm laterally flattened, slightly curved, abruptly tapered and recurved distally; apex narrow and rounded. *Right paramere:* Somewhat 'T' shaped in lateral view; shaft narrow in comparison to expanded distal end, dorsal lobe of distal end more produced than ventral lobe; interodistal surface minutely wrinkled; apex broadly sunken. *Phallotheca:* Conical in ventral view; dorsal edge of opening broad, sinuate and narrowing to posterior end, and with deep circular notch basally on right side. *Vesica:* Ductus seminis simple, cylindrical, flexible, with ribs; secondary gonopore horseshoe-shaped, with long well sclerotized base; two posteriorly directed vesical spiculae, broadly attached right and left of midline of ductus adjoining base of gonopore and ductus, curving laterad even with opening of gonopore; right spicula smaller than left spicula, broad basally, flattened and strongly serrate distally, sometimes with large spine at base of flattened portion; left spicula broad basally, tapering to flattened, bifurcate, strongly serrate distal half, dextral branch with variously shaped large basal spine.

Female.—Macropterous. Similar to male in color, vestiture, and structure, except usually slightly larger with smaller eyes and much broader vertex. GENITALIA. Following the terminology of Slater, 1950. *Sclerotized rings:* Small, widely separated; lateral margin of ring strongly folded dorsomesad, extending across ring to mesal margin. *Posterior wall:* K structures very large, subquadrate, concealing J structures, narrowly separated basomedially, inner margin moderately concave; L structure narrowly visible in anterior view.

Type species.—*Orthotylus fumidus* Van Duzee, 1916:127, designated by Knight, 1923:523.

Distribution.—Widely distributed in the northern United States and southern Canada from New York and Quebec, west to British Columbia, and south in the Intermountain Region to Colorado and Arizona (Fig. 39). A single specimen of the new species, *autlan,* is known from the state of Jalisco in Mexico.

Discussion.—Stonedahl and Schuh (1986) recognized *Noctuocoris* as belonging to a complex of six genera that share the following defining characters: (1) antennal segment I longer than width of vertex; (2) very prominent tylus; (3) large antennal fossae; (4) phallotheca broadly opened dorsally; (5) posterodorsal margin of genital capsule between right paramere socket and apex with sclerotized ridge and/or 1–3 spine-like process(es); and (6) vesica with two, distally branched, recurved, and usually strongly serrate spiculae. *Noctuocoris* can be distinguished from the other members of this group by the characters given in the generic diagnosis.

The host plant associations of *Noctuocoris* species are not well known. In Canada, *fumidus* has been collected on *Quercus* and *Carya.* Kelton (1980) gave *Quercus macrocarpa* Michx. as the habitat for this species in easern Canada. A single female of *conspurcatus* was taken on *Pinus contorta* Dougl. in north-central Colorado. All three species of this genus have been collected at light.

***Noctuocoris autlan,* New Species**

(Figs. 4–14, 39)

Diagnosis.—Distinguished from *conspurcatus* and *fumidus* by the following characteristics of the male genitalia: posteroventral region of genital capsule with long black setae but lacking stout bristles (Fig. 6); dorsal lobe of right paramere strongly produced, subtruncate apically (Figs. 9, 10); sunken region between dorsal and ventral lobes of right paramere deeply angulate (Fig. 11); base of flattened portion of right spicula of vesica without strong, solitary spine (Figs. 7, 8); dextral branch of left spicula with large, bifurcate, basal spine (Figs. 7, 8). Further differentiated from *fumidus* by the conspurcate hemelytral membrane, and from *conspurcatus* by antennal segment II only slightly longer than posterior width of pronotum.

Description of male.—GENERAL ASPECT. Total length 5.78; grayish black with frons, anterior portion of pronotal disk, and cuneus dark rufus brown; antennae, posterolateral region of pronotum, pair of patches either side of midline of mesoscutum, lateral portion of scutellum, corium near commissure, anteromedial region of cuneus, mesosternum, epimeron, and legs black; posteromedial patch of pronotum, lateral corners of mesoscutum, and apex of scutellum faintly white; mesosternum with broad polished patches; black scale-like setae densely distributed above blacker portions of dorsal aspect. HEAD. Width across eyes 1.00, width of vertex 0.29; length of antennal segment I 0.56, segment II 1.77; posterior margin of head ecarinate; frons slightly convex, junction with tylus very shallow; eyes large occupying three-quarters of head height; lora protruding; width of genae equal to diameter of antennal segment I, bucculae small, extending slightly posteriad of posterior margin of antennal fossa; gula obsolete; length of labium 1.41, reaching apex of mesosternum; antennae black, segment II with densely distributed pale and black suberect setae. PRONOTUM. Posterior width 1.68. HEMELYTRA. Cuneus 1.5 times as long as broad; membrane conspurcate. LEGS. Uniformly black. GENITALIA. *Genital capsule:* Tubercle dorsad of left paramere; ventral surface without black bristles. *Right paramere:* Somewhat elongated in distal view; dorsal lobe greatly produced; sunken region between dorsal and ventral lobes deep; ventral lobe produced and wrinkled. *Vesica:* Right spicula. Strongly serrate, without large solitary spine at base of flattened portion; surface without serrations; apex truncate. Left spicula. Sinistral branch with flattened portion strongly serrate and wide medially, tapering to pointed apex. Dextral branch with large bifurcate basal spine, narrowed distally and with truncate apex.

Female.—Unknown.

Etymology.—Named for the type locality; a noun in apposition.

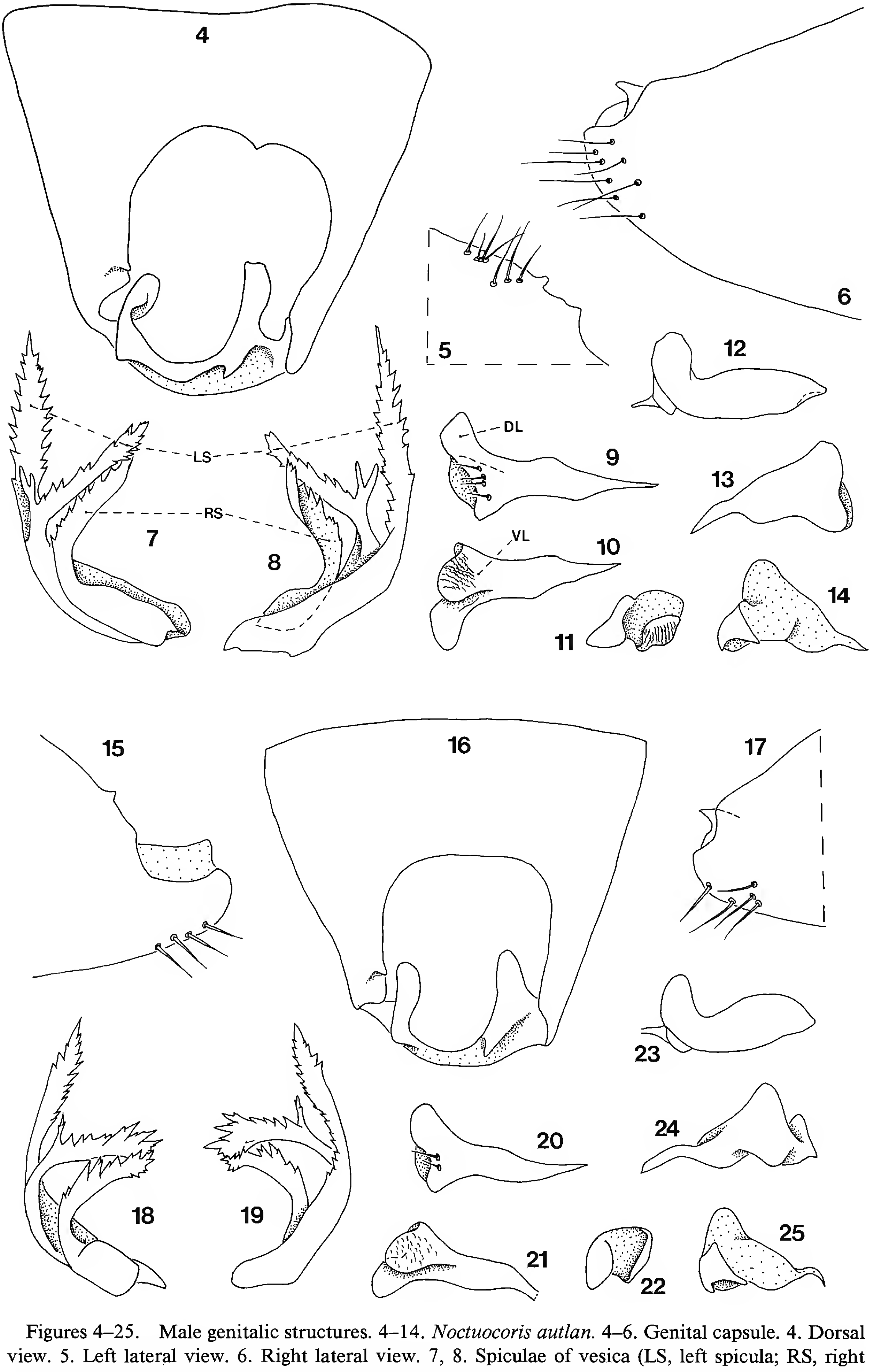
Holotype ♂.—MEXICO: *Jalisco.* 16 km N of Autlan, July 12–14, 1983, at black light, Kovarik, Harrison, and Schaffner (TAM), deposited at American Museum of Natural History.

Distribution.—Jalisco, Mexico (Fig. 39).

Noctuocoris conspurcatus, NEW SPECIES
(Figs. 15–25, 39)

Diagnosis.—Recognized by the conspurcate hemelytral membrane, length of antennal segment II much greater than posterior width of pronotum, and by these characteristics of the male genitalia: posteroventral region of genital capsule with very stout, dark bristles (Figs. 15, 17); dorsal lobe of right paramere less strongly produced, rounded apically (Figs. 20, 21); sunken region between dorsal and ventral lobes of right paramere shallowly rounded (Fig. 22); base of flattened portion of right spicula of vesica without strong, solitary spine (Figs. 18, 19); dextral branch of left spicula with solitary, finely serrate, basal process (Figs. 18, 19).

Description of male.—GENERAL ASPECT. Total length 6.98; dark brown; juga, anterior margin of pronotum, and diffuse patches of frons, pronotal disk, clavus, corium and cuneus lighter brown; pair of patches either side of midline of mesoscutum, faint midline of scutellum, and apex of scutellum almost white; mesosternum with broad polished patches. HEAD. Width across eyes 0.98, width of vertex 0.31; length of antennal segment I 0.59, segment II 2.00; posterior margin ecarinate; frons slightly convex, junction with tylus shallow; eyes large, occupying slightly more than two-thirds of head height; lora prominent; width of genae greater than diameter of antennal segment I; bucculae large, extending slightly



Figures 4–25. Male genitalic structures. 4–14. *Noctuocoris autlan.* 4–6. Genital capsule. 4. Dorsal view. 5. Left lateral view. 6. Right lateral view. 7, 8. Spiculae of vesica (LS, left spicula; RS, right spicula). 7. Right lateral view. 8. Left lateral view. 9–11. Right paramere. 9. Outside lateral view (DL,

posteriad of posterior margin of antennal fossa; gula obsolete; length of labium 1.54, reaching slightly beyond apex of mesosternum; antennae black, segment II with densely distributed pale recumbent and black suberect setae. PRONOTUM. Posterior width 1.48. HEMELYTRA. Cuneus 2.2 times as long as broad; membrane conspurcate. LEGS. Uniformly black. GENITALIA. *Genital capsule:* Very small pointed process dorsad of left paramere; ventral surface with several black bristles. *Right paramere:* Somewhat rounded in distal view; dorsal lobe not greatly produced; sunken region between dorsal and ventral lobes shallow. *Vesica:* Right spicula. Without large solitary spine at base of flattened portion, but with pair of large serrations; surface with several serrations; apex truncate. Left spicula. Sinistral branch with flattened portion somewhat wide medially, tapering to pointed apex. Dextral branch with finely serrate basal spine, expanded distally and with truncate apex.

Female.—Length 6.12; width of head across eyes 0.97, width of vertex 0.41; length of antennal segment I 0.62, segment II 2.01; length of labium 1.49; posterior width of pronotum 1.50. Measurements from Colorado specimen.

Etymology.—Named for its conspurcate hemelytral membrane.

Holotype ♂.—ARIZONA. *Coconino Co.,* 2 mi SW of Jacob Lake, August 16, 1958, at light, W. L. Nutting (UAZ), deposited at American Museum of Natural History.

Paratypes.—ARIZONA. *Cochise Co.,* Chiricahua Mts., Tex Canyon, September 16, 1927, J. A. Kusche, collector, ♀ (CAS) [head missing]. COLORADO. *Grand Co.,* St. Louis Creek Campground, 3.4 mi W of Fraser, August 16, 1980, 9000 ft, G. M. Stonedahl, ex *Pinus contorta* Dougl., ♀ (AMNH).

Distribution.—Colorado and Arizona (Fig. 39).

***Noctuocoris fumidus* (Van Duzee)**

(Figs. 26–39)

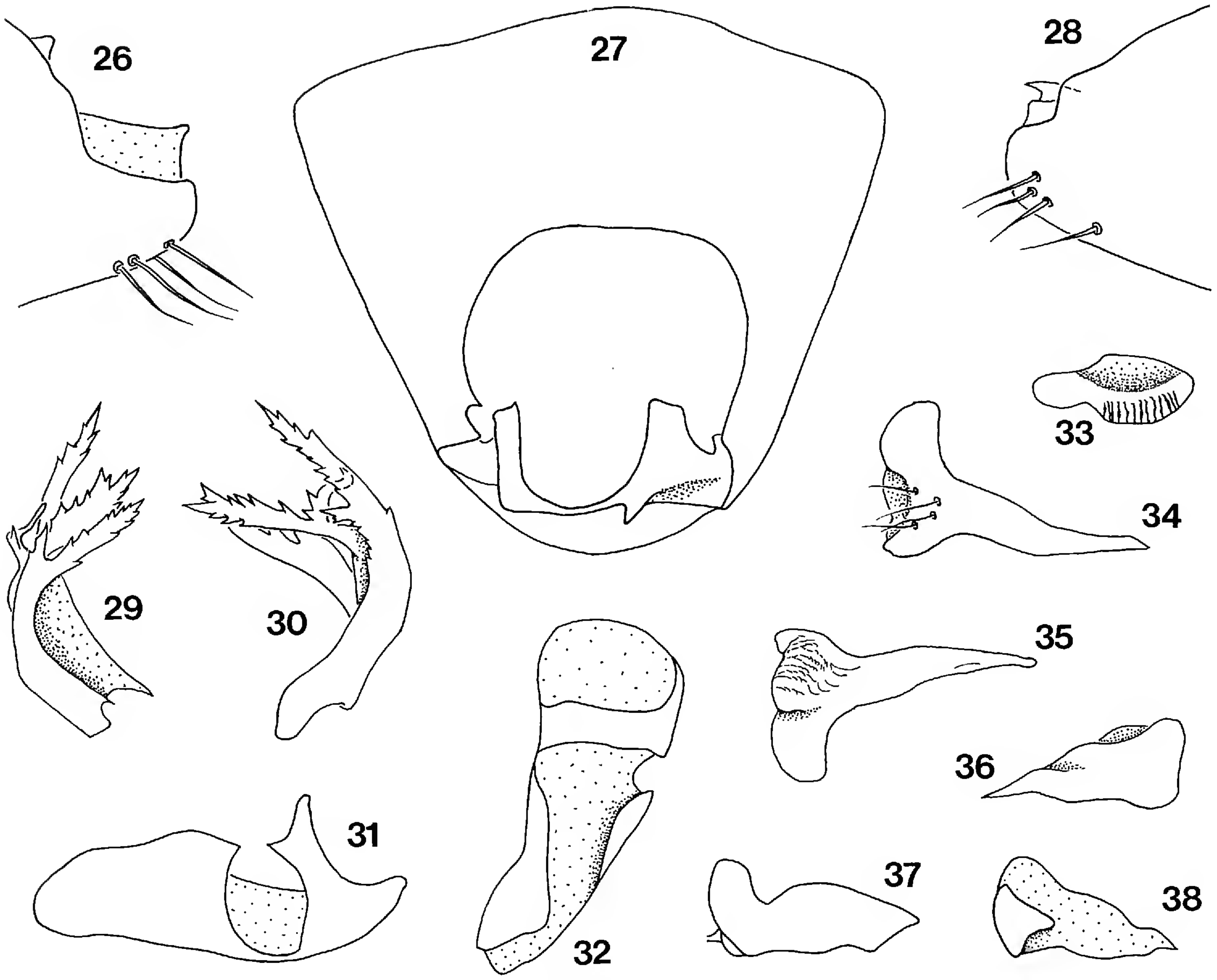
Orthotylus fumidus Van Duzee, 1916:127 (new species).

Noctuocoris fumidus, Knight, 1923:523, 524, fig. 96 (new combination); 1941: 105 (distribution); 1968:109, fig. 141 (distribution). Kelton, 1980:246, 247, map 79 (description, distribution).

Diagnosis.—Differs from *autlan* and *conspurcatus* by the uniformly fumose hemelytral membrane (Fig. 1), and smaller spiculae of the vesica with large spine or strong serration at base of flattened portion of right spicula (Figs. 29, 30). Further differentiated from *autlan* by the stout bristles on the posteroventral region of the genital capsule (Figs. 26, 28), shallowly rounded sunken region between dorsal and ventral lobes of right paramere (Fig. 33), and the undivided single spine at base of dextral branch of left spicula (Figs. 29, 30). The length of antennal segment II of *fumidus* is equal to or considerably greater than the posterior width of the pronotum.

←

dorsal lobe). 10. Inside lateral view (VL, ventral lobe). 11. Distal view. 12–14. Left paramere. 12. Lateral lobe, lateral view. 13. Sensory lobe, lateral view. 14. Inside posterolateral view. 15–25. *Noctuocoris conspurcatus.* 15–17. Genital capsule. 15. Left lateral view. 16. Dorsal view. 17. Right lateral view. 18, 19. Spiculae of vesica. 18. Right lateral view. 19. Left lateral view. 20–22. Right paramere. 20. Outside lateral view. 21. Inside lateral view. 22. Distal view. 23–25. Left paramere. 23. Lateral lobe, lateral view. 24. Sensory lobe, lateral view. 25. Inside posterolateral view.



Figures 26–38. Male genitalic structures of *Noctuocoris fumidus*. 26–28. Genital capsule. 26. Left lateral view. 27. Dorsal view. 28. Right lateral view. 29, 30. Spiculae of vesica. 29. Right lateral view. 30. Left lateral view. 31, 32. Phallotheca. 31. Right lateral view. 32. Dorsal view. 33–35. Right paramere. 33. Distal view. 34. Outside lateral view. 35. Inside lateral view. 36–38. Left paramere. 36. Sensory lobe, lateral view. 37. Lateral lobe, lateral view. 38. Inside posterolateral view.

Description of male.—GENERAL ASPECT. Male. Total length 5.20–6.65; fuscous brown with frons, anterior portion of pronotal disk, mesoscutum, scutellum, cuneus, epimeron, coxae, tarsi, apex of tibiae, and venter dark rufus brown; apex of scutellum faintly white. HEAD. Width across eyes 0.96–1.03, width of vertex 0.29–0.33; length of antennal segment I 0.46–0.54, segment II 1.50–1.91; posterior margin of head with very slightly elevated carina; frons flattened, weakly convex anteriorly, junction with tylus shallow; eyes large, occupying four-fifths of head height; juga and lora weakly protruding; genae narrower than diameter of antennal segment I; bucculae very small, not extending posteriad of margin of antennal fossa; length of labium 1.29–1.40, reaching apex of mesosternum or slightly beyond; antennae fuscous brown, segment II with densely distributed suberect pale setae. PRONOTUM. Posterior width 1.41–1.62. HEMELYTRA. Cuneus almost twice as long as broad; membrane uniformly fuscous. LEGS. Fuscous brown, femora of some specimens with lighter ground color and with row of variously shaped fuscous patches. GENITALIA. *Genital capsule:* Pointed process dorsad of left paramere; ventral surface with several or many black bristles. *Right paramere:* Somewhat elongated in distal view; dorsal lobe produced; sunken region between dorsal and ventral lobes shallow. *Vesica:* Right spicula. Long and narrow,

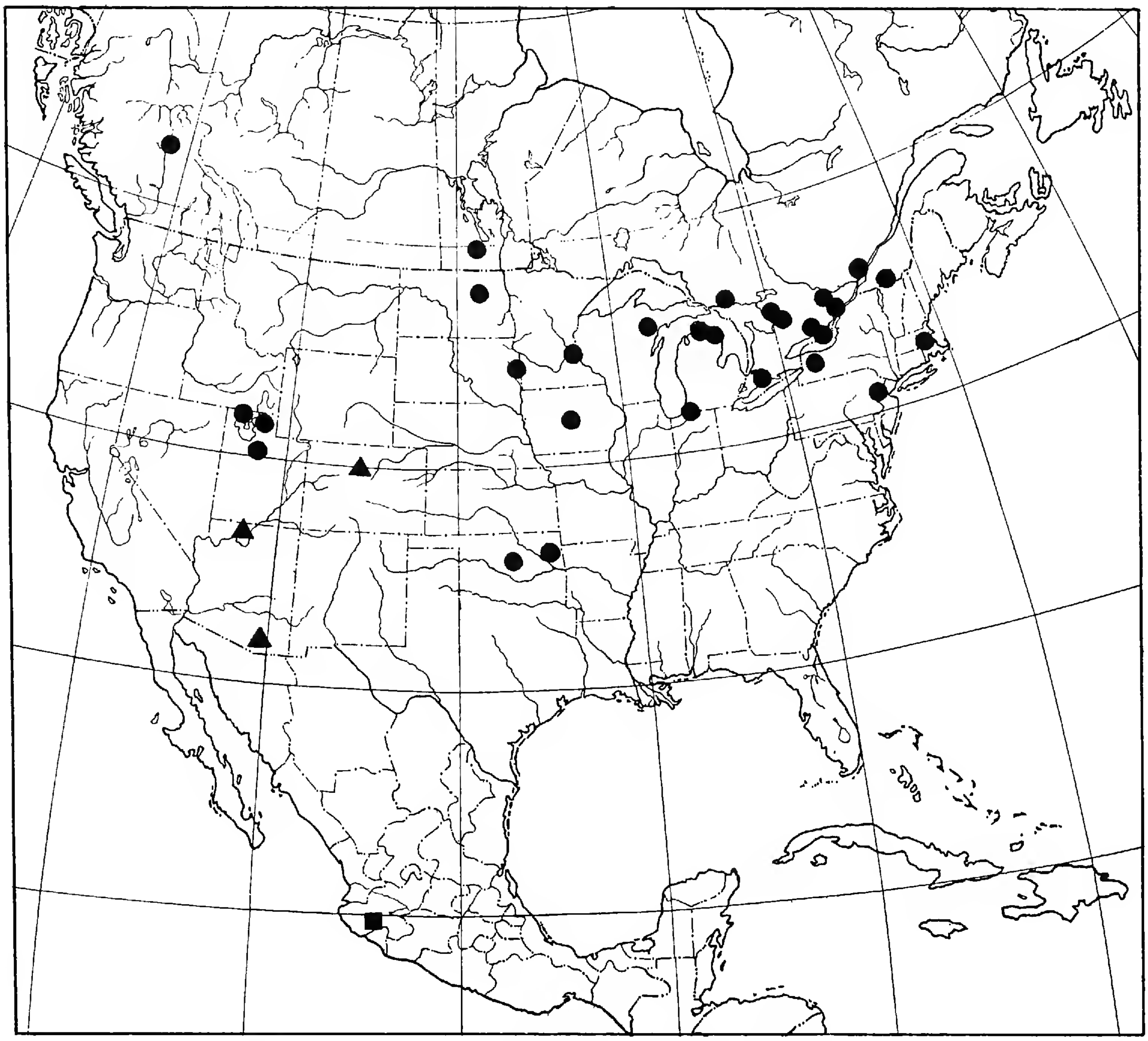


Figure 39. Distribution of *Noctuocoris autlan,* ■; *Noctuocoris conspurcatus,* ▲; *Noctuocoris fumidus,* ●.

or shorter and finely serrate, with spine at base of flattened portion, sometimes only weakly differentiated from marginal serrations; surface with several serrations; apex pointed. Left spicula. Sinistral branch with flattened portion narrow over entire length, apex pointed. Dextral branch with long narrow spine at base of flattened portion, spine sometimes finely serrate, or recurved; expanded or tapered distally, with apex truncate or pointed.

Female.—Length 5.20–6.62; width of head across eyes 0.95–1.01, width of vertex 0.39–0.41; length of antennal segment I 0.55–0.61, segment II 1.58–1.93; length of labium 1.32–1.52; posterior width of pronotum 1.33–1.63.

Type.—HOLOTYPE ♀ [head missing]: COLORADO. *Larimer Co.,* Ft. Collins, July 28, 1898, E. P. Van Duzee (CAS).

Distribution.—Widely distributed in the northern United States and southern Canada; south to Utah, Colorado, and Oklahoma (Fig. 39).

Discussion.—This species was described from a single female specimen and placed in the genus *Orthotylus* by Van Duzee (1916). Knight (1923) correctly recognized it as distinct from other North American species of that genus and moved it to the new genus, *Noctuocoris,* at the same time designating a male allotype from Batavia, New York, July 7, 1913 (USNM). Although slight differences in external morphology and male genitalia are found between populations east and west of the Rocky Mountains, we agree with Knight that both of these populations are conspecific.

Material examined.—Fifty specimens with collection dates from June 5 to September 1. CANADA: BRITISH COLUMBIA: *Caribou,* Soda Creek (UBC). MANITOBA: *Prairie Const.,* Carberry (CNC). ONTARIO: *Algoma District,* Biscotasing. *Carleton Co.,* Ottawa. *Elgin Co.,* St. Thomas (all CNC). *Genville Co.,* Ventor (TAM). *Hastings Co.,* Marmora, and Hastings Co. (CNC). *Muskoka District,* Muskoka (USNM). *Parry Sound District,* Otter Lake. *Prince Edward Co.,* Palmer Rapids. QUEBEC: *Brome Co.,* Knowlton. *Champlain Co.,* Lac Mondor, Ste. Flore (all CNC). UNITED STATES: IOWA: *Story Co.,* Ames (TAM). MASSACHUSETTS: *Middlesex Co.,* Framingham (USNM). MICHIGAN: *Berrien Co.,* Three Oaks (CNC). *Cheboygan Co.* (USNM). *Dickinson Co.* (USNM). *Alpena Co.,* Alpena (USNM). MINNESOTA: *Ramsy Co.,* and St. Anthony Park (USNM). NEW YORK: *Genesee Co.,* Batavia (USNM). NORTH DAKOTA: *Ramsey Co.,* Devil's Lake (USNM). OKLAHOMA: *Payne Co.,* Stillwater (USNM). *Rogers Co.,* Claremore (CNC, USNM). PENNSYLVANIA: *Monroe Co.,* Delaware Water Gap (USNM). SOUTH DAKOTA: *Brookings Co.,* Brookings (USNM). UTAH: *Box Elder Co.,* Snowville (USU). *Cache Co.,* Logan (USU, USNM). *Utah Co.,* Provo (USNM).

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A Review of the Genus *Coptocatus* Montandon (Hemiptera: Naucoridae)

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The genus *Coptocatus* has remained obscure since its original description by Montandon (1909). The type species, *C. oblongulus,* was based on three specimens from Borneo, a brachypterous male and macropterous female from "Kina Balu," and another macropterous specimen from Brunei. The two former specimens, which constitute the types, are now housed in the Riksmuseet, Stockholm; the location of the Brunei specimen is unknown to me. Recent collections in Borneo by the author and J. T. Polhemus, working under a grant from the National Geographic Society, have provided many additional specimens of this genus, including examples of two new species, *C. kinabalu* and *C. tebedu,* described herein. Further material was kindly provided by Gary Hevel from the Smithsonian Institution's Sabah Project and by George F. Edmunds, Jr. of the University of Utah. The discovery of *C. tebedu* in Sarawak extends considerably the known range of the genus to include the entire mountainous western portion of Borneo.

Coptocatus is closely allied to the Indochinese genera *Cheirochela* and *Gestroiella,* the three forming a tight monophyletic unit sharing many synapomorphies. These include antennae recessed into special grooves in the undersides of the eyes, an extremely reduced labrum set in a deep cavity at the base of the rostrum below a greatly produced anteclypeus (see Fig. 8), the apparent fusion of several abdominal sternites and paratergites, and dense hair pads at the apices of the hind and middle tibiae. Montandon established the subfamily Cheirochelinae to hold *Cheirochela* and *Gestroiella* on the basis of material sent to him from Burma by M. L. Fea which he noted "permits the establishment of a new division well characterized by the form of the head and mouthparts and the absence of the labrum, and which tends to draw nearer the Belostomatidae," and subsequently included *Coptocatus* in the same subgroup (Montandon, 1909). These genera were treated as the tribe Cheirochelini by La Rivers (1971), and are clearly separate as a group from their closest putative relative, the Philippine genus *Asthenocoris* (Usinger, 1938). In fact, considerable morphological evidence exists to suggest that the subfamily Cheirochelinae is polyphyletic, and that the Cheirochelini may have evolved from a laccocorine ancestor far removed from the naucorine lineage that gave rise to the endemic faunas of New Guinea and the Philippines. Montandon's observation on the similarity of the Cheirochelini to belostomatids is based on superficial aspects of external appearance, but these naucorids are among the largest hemipteran predators in the streams of tropical Asia, frequently exceeding in size species of the belostomatid genus *Diplonychus* with which they are geographically sympatric, and as such represent the largest Naucoridae extant.

Members of the Cheirochelini frequent rushing waters, and may employ some form of plastron respiration, a hypothesis supported by morphological evidence. In *Coptocatus* the majority of individuals are brachypterous, a condition which precludes the maintenance of a subalar air stores like that employed by many other naucorid genera. In addition, the venter lacks a thick hydrofuge pile, bearing instead a very fine, short, closely appressed layer of silvery hairs, interrupted along the lateral portions of the paratergites by glabrous areas bearing complex structures of an apparently sensory nature (see Fig. 7). These "sense organs" consist of roughly ovate to circular depressions set with numerous minute shining foveae, and are similar to structures observed in the New Guinea genus *Idiocarus* Montandon. In the latter taxon the venter is set with a thick, recumbent gold hair pile, and the "sense organs" are visible as ovate depressions of different reflectivity present laterally on the abdominal paratergites and on the prothorax. Structures of this type and location in the Neotropical genus *Cryphocricos* were judged by Parsons and Hewson (1974) to represent static sense organs, helping to keep the insects correctly oriented in the stream in the absence of a dorsal air store; a similar function would also appear likely in the case of *Coptocatus* and *Idiocarus.* The structure and function of such sense organs has been extensively documented for the genus *Aphelocheirus,* species of which employ sophisticated plastron respiration (Thorpe and Crisp, 1947a, 1947b, 1947c).

I thank Gary Hevel of the Smithsonian Institution for the opportunity to examine specimens collected by that institution's Sabah Project and George F. Edmunds, Jr. of the University of Utah for the gift of *Coptocatus* collected by himself, C. H. Edmunds, W. G. Peters and J. L. Peters in the course of mayfly research supported by the National Science Foundation and the National Geographic Society. Also special thanks to P. Lindskog of the Riksmuseet, Stockholm for the loan of the types of *C. oblongulus.* All specimens treated herein are held in the following collections: United States National Museum, Washington, D.C. (USNM); Naturhistoriska Riksmuseet, Stockholm (NHRM); J. T. Polhemus Collection, Englewood, Colo. (JTPC). Types are deposited in the USNM. All measurements are given in millimeters. This research was supported in part by a grant from the National Geographic Society, Washington, D.C.

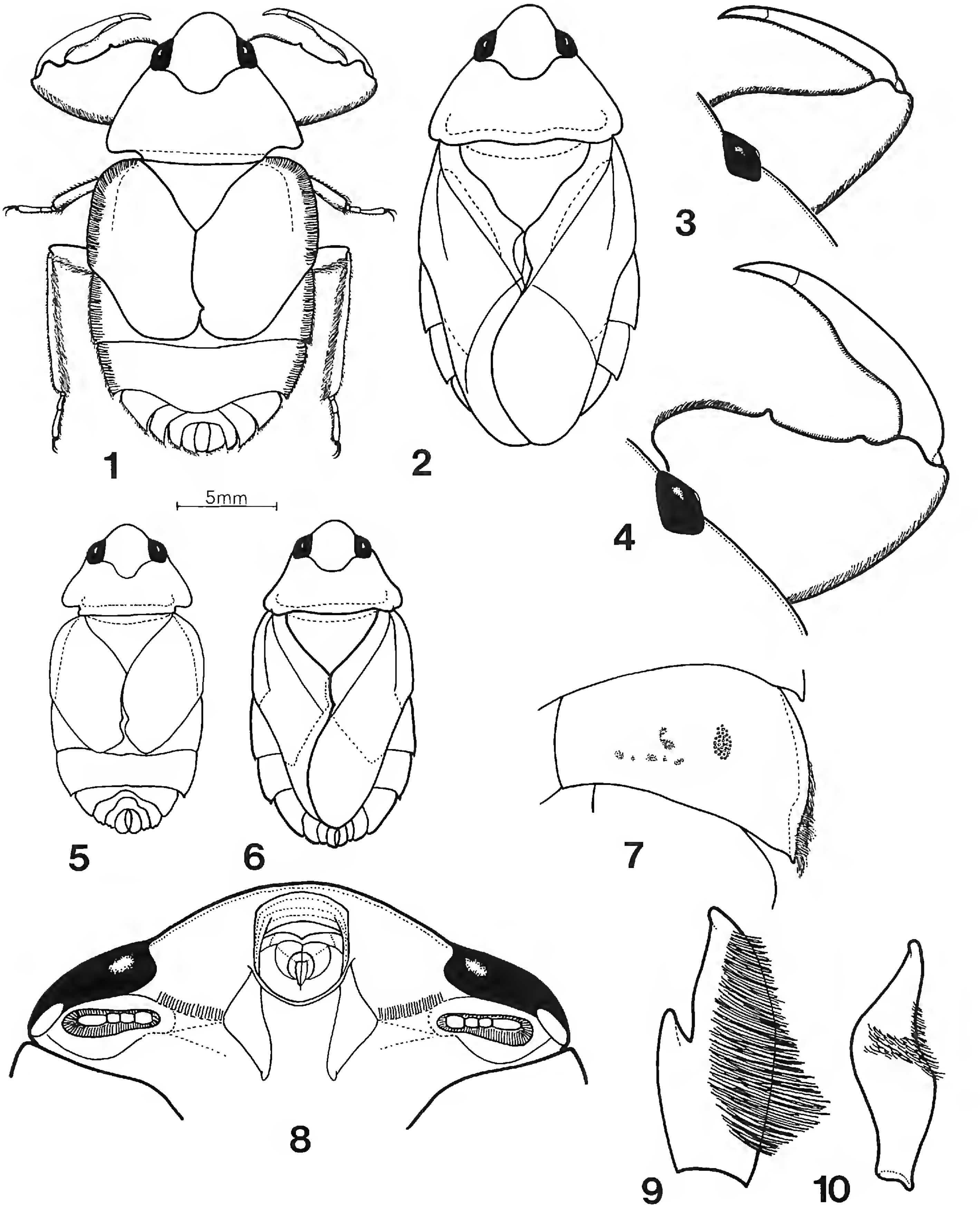
KEY TO THE SPECIES OF *COPTOCATUS* MONTANDON

1a. Overall length 17 mm or greater (see Figs. 1, 2); male fore femur frequently bearing one or two toothlike projections on anterior face adjoining tibia (see Fig. 4); male parameres bidentate (see Fig. 9) . . . *C. kinabalu,* n. sp.

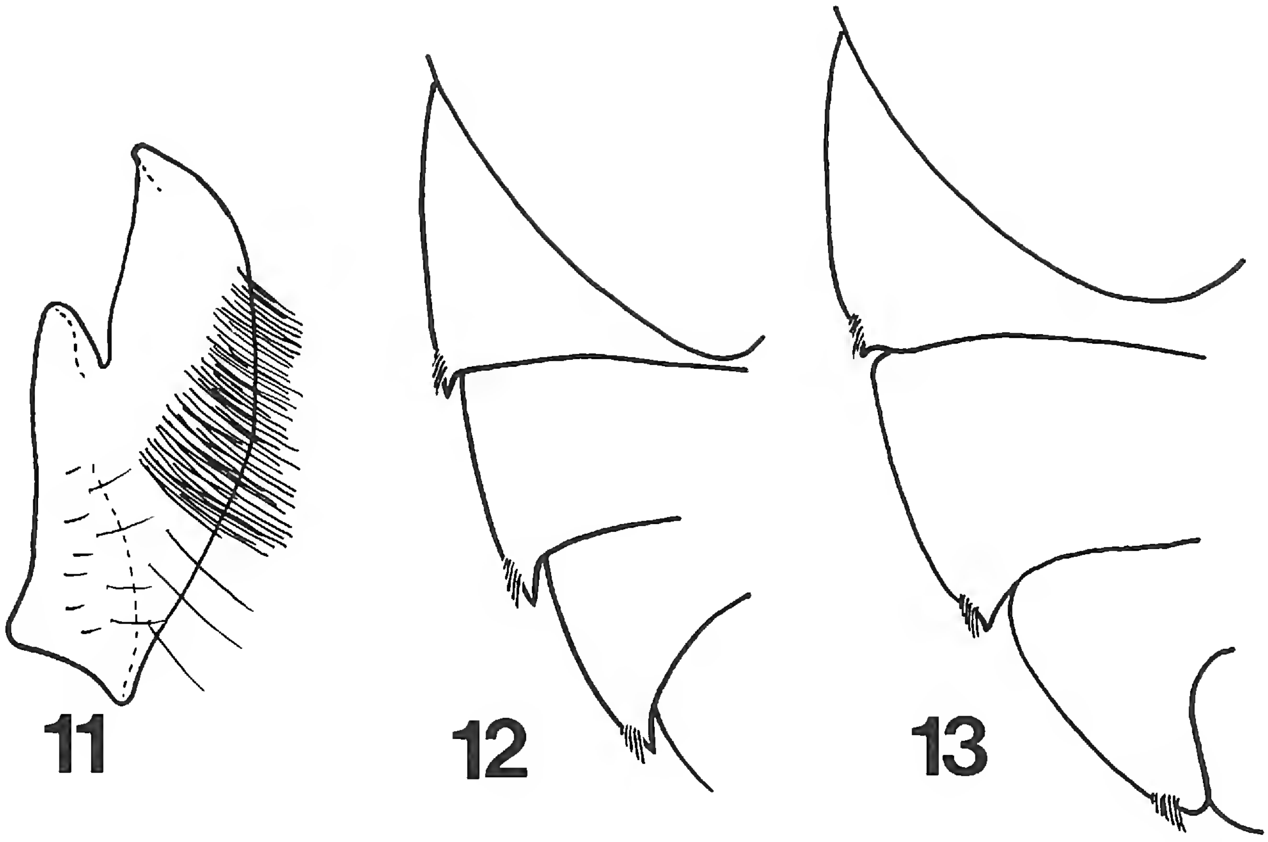
b. Overall length 15 mm or less (see Figs. 5, 6); male fore femur lacking toothlike projections; male parameres either bidentate or tapering . . 2

2a. Posterolateral angles of abdominal segments II and III (at least) strongly produced and spinose (see Fig. 12); male parameres bidentate (see Fig. 11) . . . . *C. tebedu,* n. sp.

b. Posterolateral angles of abdominal segments II and III not strongly produced, at most weakly spinose (see Fig. 13); male parameres not bidentate, tapering to rounded tips (see Fig. 10) . . . . *C. oblongulus* Montandon



Figures 1–10. *Coptocatus* sp. Scale bar provided for habitus figures only. 1. *Coptocatus kinabalu,* n. sp., habitus, brachypterous male. 2. *Coptocatus kinabalu,* n. sp., habitus, macropterous male, legs and setiferation omitted. 3. *Coptocatus kinabalu,* n. sp., detail of female foreleg. 4. *Coptocatus kinabalu,* n. sp., detail of male foreleg. 5. *Coptocatus oblongulus* Montandon, habitus, brachypterous male type specimen, legs and setiferation omitted. 6. *Coptocatus oblongulus* Montandon, habitus, macropterous female, legs and setiferation omitted. 7. *Coptocatus kinabalu,* n. sp., detail of ventral surface of abdominal paratergite V showing locations of sensory organs and spiracle. 8. *Coptocatus oblongulus* Montandon, ventral view of head showing location of maxillary plates, recessed antennae, and rostral cavity. 9. *Coptocatus kinabalu,* n. sp., male left paramere. 10. *Coptocatus oblongulus* Montandon, male left paramere.



Figures 11–13. *Coptocatus* sp. 11. *Coptocatus tebedu,* n. sp., male left paramere. 12. *Coptocatus tebedu,* n. sp., detail of abdominal margin showing tergites II–IV. 13. *Coptocatus oblongulus* Montandon, detail of abdominal margin showing tergites II–IV.

Coptocatus oblongulus Montandon

Coptocatus oblongulus Montandon, 1909, Bull. Soc. Sci. Buch., 18:45.

This species may be recognized by its small size (see Figs. 5, 6), by its nonspinose posterolateral abdominal angles (see Fig. 13), and by its distinctively shaped male parameres (see Fig. 10) which, as in all the Cheirochelini, are symmetrical. I have examined the two type specimens housed in the Riksmuseet, Stockholm, a macropterous female and a brachypterous male. Both specimens are in excellent condition, and bear the following labels; "Borneo, Kina Balu" (printed); "Coptocatus oblongulus Montandon, type 1908" (in Montandon's writing, with type designation in red and note "brachyptr." or "macroptr." on appropriate specimen); "Typus" (printed label on red paper); "441 64" (on red paper, first number printed, second number written); "1 85" (on brachypterous specimen) or "2 85" (on macropterous specimen; both labels on red paper, with first number printed and second number written); "Riksmuseum, Stockholm" (on green paper). Since no single type is indicated, these specimens represent cotypes, and the brachypterous male is hereby designated lectotype.

Specimens taken by the author and by the Edmunds and Peters group on the Liwagu River near Mt. Kinabalu match the type specimens very well, including the particulars of the male genitalia. On the types the legs are dull brown, while those of the more recent specimens are pallid to white, but this is likely an artifact due to preservation method or aging. This species has been taken through a considerable range of elevations, from the low forests at Ranau where the river was over 50 meters wide to the headwaters near Liwagu Cave where the width was barely 5 meters. In all cases the insects preferred a rocky bed with a moderate but not rushing current and were most often taken from among substrates of coarse gravels overlain by moderate sized rocks.

Material examined.—BORNEO, Malaysia, Sabah: 2 macropterous males, 3 brachypterous males, 2 macropterous females, 3 macropterous females, 11 nymphs, Liwagu River at bridge, Ranau, S4e, 335 m, VIII-16-72, G. F. and C. H. Edmunds, W. L. and J. G. Peters (JTPC); 4 macropterous males, 2 macropterous females, Liwagu River N of Kundassan, S8, 915 m, VIII-16-72, W. L. and J. G. Peters (JTPC); 1 macropterous male, Liwagu River at Liwagu Cave, SE of Headquarters, S7e, 1525 m, VIII-14-72, G. F. and C. H. Edmunds (JTPC); 2 brachypterous females, 2 nymphs, Mantukungan River, S of Poring Hot Springs, S6, 365 m, VIII-12-72, W. L. and J. G. Peters (JTPC); 1 macropterous female, 16 km E of Ranau, VIII-14-83, G. F. Hevel and W. E. Steiner (USNM); 11 macropterous males, 6 macropterous females, 1 brachypterous female, 17 nymphs, Liwagu River at Kundassan, VIII-1-85, CL 2021, D. A. and J. T. Polhemus (JTPC); 1 macropterous male, 13 brachypterous males, 13 brachypterous females, 16 nymphs, stream 1 km S of Poring Hot Springs, VIII-2-85, CL 2023, D. A. and J. T. Polhemus (JTPC); 1 macropterous male, 1 brachypterous male, 2 macropterous females, 1 brachypterous female, 1 nymph, Sungai Samalang, 7 km S of Ranau, VIII-3-85, CL 2026, D. A. and J. T. Polhemus (JTPC); 3 brachypterous males, Sungai Nukakatan trib., 26 km S of Ranau, VIII-3-85, CL 2028, D. A. and J. T. Polhemus (JTPC).

Coptocatus kinabalu D. Polhemus, New Species

Brachypterous male.—Large, robust, highly streamlined and dorsoventrally flattened (see Fig. 1), general coloration dark brown. Overall length 19–21 mm; maximum width (across base of abdomen) 10–11 mm.

Head brown, shining, anterior margin along anteclypeus infuscated, width/length = 5.3/4.5; anteclypeus greatly produced, apex evenly rounded, projecting beyond rostrum for a distance greater than exposed rostral length when viewed laterally; eyes black, convex, roughly quadrate, width/length = 1.0/1.8, raised above level of vertex and separated from it by wide, shallow sulci, lateral margins bearing a weakly developed flange; anterior/posterior interocular 3.3/3.5; vertex greatly produced posteriorly, extending rearward for over 0.5 the length of an eye. *Pronotum* brown, shining, width/length (midline) = 10/3.4; lateral margins with narrow raised black ridge, posterolateral angles acute, rounded. *Scutellum* yellowish brown, shining, width/length = 6.0/3.0, anterior margin strongly reflexed downward. *Hemelytra* dark brown, brachypterous, extending only to posterior margin of abdominal tergite II, tips broadly rounded, surface set with fine pale granular microstructure, embolium weakly defined, explanate, set with long recumbent black setae; hemelytral commissure with small projecting tooth on left hemelytron distally, fitting into corresponding indentation on right hemelytron. *Abdomen* with tergites II–VIII exposed, dark brown, lighter laterally, surface set with closely appressed black setae; posterolateral angles of segments III–VII acutely spinose, angles on segments III–VIII with long rearwardly projecting hair tufts. *Ventral surface* reddish brown, covered with very fine, closely appressed silvery hairs, head glabrous, yellowish to greenish; rostrum set into deep well behind projecting anteclypeus, tip brown, glabrous; labrum greatly reduced, barely evident, set into roof of rostral cavity; maxillary plates oriented horizontally, flush with bottom of head capsule; two (1 + 1) rows of raised brown setae present running from bases of maxillary plates to bases of antennae; antennae thick, four segmented, segment I larger in diameter than segments II–IV, segment IV longest, set into deep groove below eyes lined with fine gold setae; head behind eye weakly carinate medially. Prosternum with distinct carina anteromedially between fore coxae, proepisternal plates clearly visible, triangular, posterior margins reflexed downward to form hair lined pits adjoining mesosternum, proepimeron with tiny shining pit-like structures present below fore coxal cavity; mesosternal plate gently raised with a weak furrow medially, tip produced to an acute point caudad; metasternal plate barely visible, acarinate; undersurface of wing embolium with tiny shining pit-like structures present near anterior angles. Abdominal venter with extremely fine covering of short recumbent silvery hairs, paratergites on segments III and IV (second and third visible, respectively) fused to sternites, sutures lacking; paratergites II–VII with ovate areas of tiny shining pit-like structures laterally; spiracles present as semicircular depressions; rows of irregular glabrous depressions present behind spiracles, running roughly parallel to posterior paratergal margins (see Fig. 7); sternites IV and VII with posteriorly directed gold hair tufts present medially on posterior margins; sternites V and VI fringed with gold setae on posterior margins; genital segment glabrous, bearing gold setae distad; entire abdominal venter microscopically roughened and pruinose, lateral margins narrowly glabrous. *Legs* yellowish brown, fore tibiae and coxae reddened; fore coxae, trochanters and femora massive, fore femur bearing up to two stout protruding teeth along anterior margin (see Fig. 4), posterior margin bearing fringe of long gold setae; anterior face of fore trochanter and femur and adjoining face of fore tibia set with short stiff gold setae; fore tibia weakly curved, inner margin frequently sinuate in larger individuals, fore tarsus barely delineated, claw single, blunt, obscure. Middle and hind coxae yellowish, recessed into ventral body surface, ventral faces concave; middle and hind trochanters glabrous, middle femur slender, bearing longitudinal row of fine raised gold setae along posterior margin; middle tibia with about thirty transverse rows of four to six stout reddish spines present along anterior margin, posterior margin with about fifteen similar but smaller transverse spine rows and a thick margin of long gold setae; posterior femur set with long black swimming hairs along posterior margin; posterior tibiae thickly set with short reddish spines along anterior margin, posterior margin with long black swimming hairs; middle and posterior tibiae bearing thick pads of posteriorly directed gold hairs apically on ventral face and a transverse row of short reddish spines apically along inner margin; middle and hind tarsi three segmented, distal segment as along as basal two combined, all segments set with short spines ventrally, hind tarsi also with gold setae on ventral face; parempodia setiform; claws bent sharply apically, tips infuscated, blunt. *Male parameres* symmetrical, bidentate shape as in Figure 9, set with a comb of long setae. Vessica lightly and symmetrically sclerotized, terminal lobe large, membranous, bluntly rounded.

Brachypterous female.—Similar to male in general structure, but not nearly so massive, form narrower, length 20.0–17.5 mm; maximum width 10.0–9.0 mm. Fore femora not armed with teeth on anterior margins (see Fig. 3), fore tibiae slender, inner margins not sinuate. Subgenital plate roughly trapezoidal, widened basally, tip rounded.

Macropterous male.—Form more elongate than brachypter, with wings fully developed and extending beyond tip of abdomen (see Fig. 2). Length 20.0 mm; maximum width (across wing embolia) 9.50 mm. Pronotum more massive, posterolateral angles more rounded, less acute, a weak sulcus present adjoining posterior margin; scutellum raised, bearing a transverse carinate ridge behind anterior margin; wings with clavus, embolium, and membrane well defined, brown, membrane dark brown to blackish; entire dorsal surface set with pale granular microstructure; small sclerotized plate present at anterolateral margin of clavus.

Material examined.—Holotype, male, and allotype: BORNEO, Malaysia, Sabah, 17 km S of Keningau, VIII-31-83, G. F. Hevel and W. E. Steiner (USNM). Paratypes as follows: BORNEO, Malaysia, Sabah: 2 brachypterous males, 4 brachypterous females, same data as types (USNM, JTPC); 1 brachypterous female, 11 km E of Donggongon, IX-3-83, G. F. Hevel and W. E. Steiner (USNM); 1 brachypterous male, Apin Apin, IX-2-83, G. F. Hevel and W. G. Steiner (USNM); 2 brachypterous males, 17 km E of Donggongon, IX-4-83, G. F. Hevel and W. G. Steiner (USNM); 3 brachypterous males, 2 brachypterous females, 3 nymphs, 10 km SW of Tambunan, IX-2-83, G. F. Hevel and W. G. Steiner (USNM, JTPC); 1 macropterous male, 2 nymphs, Paginatan, VIII-18-83, G. F. Hevel and W. E. Steiner (USNM); 1 macropterous male, 1 brachypterous female, 11 nymphs, tributary of Sungai Moyog, 3 mi E of Penampung, X-2-78, G. F. and C. H. Edmunds (JTPC); 1 nymph, Mansuncun River, NE of Kota Kinabalu, 300 m, VIII-18-72, G. F. and C. H. Edmunds (JTPC); 1 macropterous male, 1 brachypterous male, 1 brachypterous female, 12 nymphs, Sungai Nukakatan, 26 km S of Ranau, VIII-3-85, CL 2028, D. A. and J. T. Polhemus (JTPC).

Remarks.—*C. kinabalu* may be easily recognized by its large size, massively developed male forelegs, and male genital structures. By far the biggest naucorid in Borneo, and one of the largest in the world, this species frequents open rocky mountain rivers where it is found in areas of swift smooth current amid fist to head sized rocks. Although its range is sympatric with that of *C. oblongulus* Montandon, the two species appear to segregate habitats on the basis of stream size. At the Sungai Nukakatan, for instance, *C. kinabalu* was present in the large main river but not in a small side tributary, where *C. oblongulus* occurred instead. The habitat partitioning beween these two species would provide an interesting study for aquatic ecologists.

Etymology.—The name "kinabalu" is a noun in apposition and refers to Mt. Kinabalu, the highest mountain in Borneo, from the vicinity of which all known examples of this species have come.

Coptocatus tebedu **D. Polhemus, NEW SPECIES**

Brachypterous male.—Small for genus, general coloration dull brown, becoming yellowish on head, pronotum, and scutellum. Overall length 13–14 mm; maximum width (across base of abdomen) 7 mm. *Head* yellowish brown, anterior margin black, width/length = 3.33/2.63, anteclypeus highly produced, apex evenly rounded, projecting far beyond base of rostrum; eyes black, convex, width/length = 0.76/1.06, separated from vertex by shallow sulci, lateral flange barely evident; anterior/posterior interocular = 1.87/2.02; vertex greatly produced posteriorly, extending back for over 0.7 the length of an eye. *Pronotum* yellowish brown, darker behind eyes, width/length = 5.56/1.72, lateral margins with narrow raised lip, posterolateral angles acute, rounded, posterior margin infuscated, delineated by distinct transverse sulcus. *Scutellum* yellowish brown, with darker muscle attachment scars to either side of midline, width/length = 3.69/2.12, strongly depressed along anterior margin, lateral margins weakly sinuate. *Hemelytra* dark brown, brachypterous, not attaining posterior margin of abdominal tergite II, tips broadly rounded, surface minutely roughened, embolium weakly defined, explanate, lateral margin raised, black, set with long recumbent pale setae; hemelytral commissure with small projecting tooth on left hemelytron distally, fitting into corresponding indentation on right hemelytron. *Abdomen* with tergites II–VIII exposed, brown, yellowish laterally, set with closely appressed fine black setae except on areas adjoining lateral margins, posterolateral angles of segments II–IV sharply produced, spinose, those of segments V–VII rounded, all segments bearing fringe of long pale recumbent setae along lateral margins and tufts of stout setae at posterolateral angles. *Ventral surface* reddish brown, covered with very fine closely appressed silvery setae on abdomen, head yellowish; rostrum set into deep cavity below anteclypeus, yellowish, tip infuscated, glabrous; labrum extremely reduced, set anteriorly into roof of rostral cavity, brown; maxillary plates horizontal, triangular, pale; two (1 + 1) rows of raised brown setae running from bases of maxillary plates to bases of antennae; antennae thick, four segmented, pale, set into grooves beneath eyes, segment IV as long as segments II and III combined. Prosternum lightly pruinose, with distinct raised black carina anteromedially between forelegs, proepisternal plates well exposed, triangular, dipping posteriorly to form two pits adjoining mesosternal plate set with tufts of gold setae; mesosternal plate pruinose, with numerous irregular ovate glabrous areas scattered along anterior margin, weak longitudinal sulcus present medially, anterior margin weakly reflexed medially, posterior margin produced to an acute point; mesosternal plate small, acarinate, posterior margin with gold setae. Abdominal venter with typical sense organs and spiracular modifications as described in previous species, paratergites on segments III and IV (second and third visible) fused to sternites, sutures lacking; lateral margins of paratergites glabrous, infuscated, bearing tufts of gold setae at posterolateral angles; sternites IV and VI–VII with tufts of setae medially; genital segment brown, glabrous, set with gold setae. *Legs* pallid to yellowish, fore femur with row of long recumbent gold setae on posterior margin and pad of thick short gold setae on anterior margin; fore tibia brown, gently curved, inner margin occasionally sinuate, fore tarsus with single segment bearing single blunt claw; middle and hind coxae pale, concave on ventral faces; middle and hind trochanters pale, glabrous; middle femur slender, with longitudinal row of gold setae along hind margin; middle tibia with transverse rows of spines on anterior and posterior margins, long gold setae present along posterior margin; hind femur and tibia with long gold setae along posterior margins, tibia with reddish spines on anterior face; middle and hind tibiae bearing thick gold hair pads and transverse rows of reddish spines apically; middle and hind tarsi three segmented, distal segment longest, all segments with short spines ventrally, hind tarsi with gold setae on ventral face; parempodia setiform; claws black, sharply bent, blunt. *Male parameres* symmetrical, bidentate, shape as in Figure 11, bearing a comb of long setae; vessica lightly and symmetrically sclerotized, terminal lobe squared off apically.

Brachypterous female.—Similar to male in general structure and coloration, but form slightly more elongate, length 14.0–14.5 mm; maximum width 6.9–7.0 mm. Posterolateral angles of abdominal segments II–V produced and spinose, raised patches of setae present medially on abdominal sternites IV–VI. Subgenital plate trapezoidal, widened basally, bearing transverse rows of fine setae, a tuft of longer setae present medially near tip, posterior margin evenly rounded, fringed with long gold setae.

Macropterous form.—Unknown.

Material examined.—Holotype, male, and allotype: BORNEO, Malaysia, Sarawak, Tebedu, SE of Kuching, shallow rocky river, VIII-9-85, CL 2048, D. A. and J. T. Polhemus (USNM). Paratypes: 25 brachypterous males, 23 brachypterous females, 17 nymphs, same data as types (JTPC).

Remarks.—*C. tebedu,* n. sp. may be recognized by its small size, spinose posterolateral abdominal angles (see Fig. 12), and bidentate male parameres (see Fig. 11). Although the parameres are quite similar to those of *C. kinabalu,* that species is much larger and more robust, so that its size and habitus alone are sufficient to prevent confusion. The type series of *C. tebedu* was taken in a swift, shallow, unshaded river flowing in a bed of sand and cobbles. The type locality is less than ten kilometers from the Indonesian frontier, and this species undoubtedly occurs in the biologically unexplored mountains of Kalimantan.

Etymology.—The name "tebedu" is a noun in apposition and refers to the name of the type locality.

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Scientific Note

A New Distribution Record for *Megalodacne fasciata* (Coleoptera: Erotylidae)

On 5 July 1983 one specimen of *M. fasciata* was collected in an ultraviolet trap used to monitor almond insect pests. The location was an almond orchard approximately 1 mile E of Hamilton City, CA adjacent to the Glenn-Butte County line but in Butte County, in an almond orchard. On 13 August 1983 ten specimens were collected in the same orchard mining bracket fungi (*Fomes* sp.) on almonds; several larvae were also collected. On 12 December 1983 ten more specimens were collected approximately 3 miles W of Durham, CA, also mining bracket fungi on almonds but no larvae were collected. On 10 June 1984 one specimen was collected approximately 5 miles SE of Red Bluff, Tehama County, in an ultraviolet light trap. The specimens were all collected by the author.

Since the collection data are separated by both geographical space and calendar time it would appear that *M. fasciata* is well established in Butte and probably Glenn and Tehama Counties.

Previous distribution records for *M. fasciata* are Eastern North America from Florida to Connecticut, New York, and Ontario, westward to Minnesota, Iowa, Colorado, and Texas, down to Mexico. These new records now extend its range from the Atlantic coast to the Pacific coast.

The best explanation for the new distribution record of *M. fasciata* is due to an accidental introduction. One hypothesis (L. G. Bezark, pers. comm.) is accidental transportation of firewood upon which there was some species of fungi to host the adults and/or larvae.

Voucher specimens are deposited in the collection of the California Academy of Sciences and the California Insect Survey.

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Nest Provisioning and Related Activities of the Sand Wasp, *Bembix americana comata* (Hymenoptera: Sphecidae)

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With the exception of *Bembix stenebdoma* Parker, which feeds upon Chrysopidae, North American *Bembix* are predators of flies (Evans, 1966, 1978). In California, meaningful biological data are available for 6 (55%) of the 11 species of *Bembix* that reportedly occur there (Bohart and Horning, Jr., 1971). Of these, *B. americana comata* Parker is the most abundant and perhaps the most widespread member of the genus in the state. Biological information for *B. americana comata,* some of it conflicting (see below), is contained in the works of Parker (1925), Essig (1926), and Evans (1957, 1966). During a recent investigation of the non-hematophagous pangoniine horse fly, *Brennania hera* (Osten Sacken) (Lane and Anderson, 1985), *B. americana comata* females were occasionally observed attacking hovering *B. hera* males. Subsequently, a study of this wasp was initiated at a nearby colony to evaluate its nest provisioning behavior with respect to *B. hera* and other flies, to characterize its burrows, and to elucidate the relationship between prey size and survival after onset of paralysis.

METHODS

The study area.—This study was conducted in a coastal sand dune ecosystem at North Beach, Point Reyes National Seashore, Marin County, California during the summers of 1982 and 1983. North Beach abuts the Pacific Ocean ca. 52.5 km NW of San Francisco. Characteristics of the dunes at the Point Reyes peninsula have been presented previously (Cooper, 1967). Coastal strand is the plant community typical of the dunes, and plants commonly observed there include *Mesembryanthemum chilense* Molina, *Artemisia pycnocephala* Candolle, *Grindelia stricta* Candolle, and *Lupinus arboreus* Sims (Munz, 1968). Temperatures average ca. 11.7°C in summer and 10.0°C in winter. Precipitation falls mainly between October and April and averages 610 mm annually. Fog and wind occur often, especially in summer.

Predatory behavior and onset of *Bembix* diurnal flight activities were associated with several meteorological factors. Ambient and soil surface temperatures were recorded either with a model BAT-4 thermometer (Bailey Instruments, Inc., Saddle Brook, N.J.) or a Taylor pocket thermometer (Taylor Instruments, Arden, N.C.), relative humidity with a hygrothermograph (Julien P. Friez and Sons, Inc., Baltimore, Md.), illumination with a Weston model 756 sunlight illumination meter (Weston Instruments, Inc., Newark, N.J.), and wind velocity with an Alnor Thermo-anemometer (type 8500, Illinois Testing Laboratories, Inc., Chicago, Ill.) or a wind meter (Dwyer Instruments, Inc., Michigan City, Ind.).

Information on nest-provisioning activities was obtained by observing wasps returning to their burrows with prey. Immediately after a wasp entered its burrow, an insect net was placed over the entrance and the time spent inside recorded. In 1982, all wasps were collected for species determination, whereas in 1983 they were released to avoid depleting the local population.

After measuring the diameter of the entrance, a long, flexible plant stem was inserted into the burrow to trace its course and to facilitate digging it. Dimensions of the burrows and cells, and the shapes of the former, were recorded. The larval wasp, if present, and all associated intact prey were collected. In 1982, all fragments from partially eaten specimens were also collected and preserved in 70% ethanol, and an attempt was made to identify all flies to the generic or specific level. A few paralyzed *B. hera* females found in nests were dissected to determine their reproductive status by previously described methods (Lane and Anderson, 1982). The terms nulliparous and uniparous refer to flies that have not oviposited previously and those that have laid a single egg mass, respectively.

In 1983, dipterous prey were taken from 20 female wasps returning to their burrows from foraging trips. Flies were held individually in plastic vials at 19.4–25.0°C and 54–93% RH and examined daily until they died. Afterwards, flies were oven dried (105°C) for 48 hr, weighed on a Mettler H20T balance, and the dry weights of flies regressed against time to death following envenomization.

RESULTS

The *Bembix americana comata* colony was located in a denuded, slightly elevated (ca. 25–35°) expanse of dune roughly 400 m^2 having a western exposure. It was situated on and near the edge of a bluff top overlooking a sandy ocean beach. The soil was a dark yellow brown sand that was aridic for at least six months yearly. Most burrows occurred in an area of ≤ 30 m^2, and the size of the adult wasp population on any given date in late July or August was estimated to have been no more than 30 individuals. No other colonies of *B. americana comata* were found along the bluff top up to 91 m distant. A ridge used as a hovering/mating site by *B. hera* adults was located ca. 55 m from the colony.

Adult wasps flew during heavy, low-lying fog and at temperatures as low as 12°C while they foraged on the ridge where *B. hera* adults hovered and mated (Table 1). On six foggy or overcast days, wasps were first seen on this ridge when ambient temperatures averaged 15.0 ± 2.0°C (range = 12.0–17.2°C). In 1983, diurnal weather conditions when the first wasps were seen flying in the colony area were likewise variable (Table 2). On average, morning flight activities began over a 2 hr period on different days as air and soil surface temperatures reached ca. 18.5°C and 30.1°C, respectively. The maximum air temperature recorded during flight periods was 23°C. However, wasp activity was not seen in the colony area between 1000 and 1500 hr on a damp (i.e., intermittent drizzle), foggy day when ambient and soil surface temperatures ranged from 14.4–17.8°C and 17.2–26.7°C, respectively.

Foraging wasps usually flew within 2.5–5.0 cm of the dune surface in an apparently random, searching mode. Occasionally they alighted on bare sandy spots for brief periods up to 1 or 2 min; rarely did they remain in an area for more than a few minutes before flying away. We observed three female wasps as they attacked *B. hera* males hovering ca. 10–20 cm above ground along a ridge between

Table 1. Relationship of *Bembix americana comata* foraging activity to *Brennania hera* (♂) hovering and weather conditions at a coastal sand dune, North Beach, Pt. Reyes National Seashore, California, 1982–1983.

				Temp. (°C)					
Date	Time[1] (hr)	Observation	*B. hera* ♂ hovering period (hr)[2]	Air	Sand surface	RH (%)	Illumination (Ft-c)	Wind (km/hr)	Cloud cover (%)
1982									
20 July	1015	wasp on ground with *hera* ♂ as prey	0923–1031	—	—	—	—	—	100
22 July	0923	1st wasp seen in *hera* hovering area	0914–1051	16.0	24.0	92	4200	5.6	100F[3]
	0947	wasp hovering		16.5	25.5	75	4300	4.8	100F
23 July	0928	1st wasp seen flying close to ground	0932–1102	14.0	21.0	82	4200	9.7	100F
	0932	wasp foraging close to ground		14.0	20.5	80	—	9.7	100F
	1000	wasp caught hovering *hera* ♂ and flew off with it		14.0	23.3	72	4900	—	100F
28 July	1012	1st wasp seen on ridge	0909–1034	12.0	22.5	93	5300	11.3	100F
	1013	wasp attacked hovering *hera* ♂ but fly escaped		12.0	22.5	93	5300	11.3	100F
	1022	wasp on ground with *hera* ♂ as prey		12.6	24.3	91	—	—	100F
31 August	0857	1st wasp seen flying close to ground	0847–0903	14.0	22.3	86	3850	8.0	100
	0903	wasp flew off ridge with *hera* as prey		14.5	23.3	78	4450	8.9	100
	0904	wasp hunting within 2.5–5.0 cm of ground		14.5	23.3	78	4450	8.9	100
	0912–0954	6 wasps seen foraging, landing, or flying over ridge		15.5–21.5	25.0–40.5	54–79	3850–8500	7.2–12.1	0–100
1983									
27 July	0809	wasp caught hovering *hera* ♂	<0737–0845	16.7	27.2	—	—	—	50–100
2 August	0918	wasp foraging within 15 cm of ground	0826–0947	17.2	25.0	100	—	8.8	100F

[1] Converted from Pacific Daylight Time to Pacific Standard Time.

[2] Hovering by 1 or more ♂ occurred sporadically during hovering periods, not continuously.

[3] F = foggy.

Table 2. Weather conditions at onset of *Bembix americana comata* daily flight activity, North Beach, Pt. Reyes National Seashore, California, 1983.

Date	Time[1]	Temperature (°C)		RH (%)	Wind (km/hr)	Cloud cover
		Air	Soil surface			
26 July	0945	19.4	33.3	N/A	N/A	sunny
27 July	0927	17.8	31.1	N/A	N/A	sunny
3 August	1031	17.2	29.4	89	9.7	fog burning off
10 August	0833	15.0	22.8	94	5.6	sunny
19 August	1005	20.5	30.5	90	9.7	70%
24 August	0930	21.1	33.3	77	4.0	sunny
Mean ± SD	0938 ± 40	18.5 ± 2.3	30.1 ± 3.9	87.5 ± 7.3	7.3 ± 2.9	

[1] Converted from Pacific Daylight Time to Pacific Standard Time.

0809 and 1013 hr (Pacific Standard time) during late July (Table 1). One male had been hovering for 19 sec when a wasp collided with it, but the fly escaped. The other flies were captured and stung immediately, presumably in flight, since both individuals were paralyzed when collected moments later as the wasps alighted on the ridge. Also, five wasps were seen with *B. hera* adults as prey either on the ground in the tabanid hovering area or in the midst of the wasp colony as they returned to their nests, and three paralyzed *B. hera* adults were found lying unattended among the nests.

On six occasions when *B. hera* hovering/mating periods were observed in their entirety, the first *Bembix* females were seen hunting in the hovering area from 4 min before to 63 min ($\bar{x}$ = 30.3 ± 28.5 min) after tabanid flight activity began (Table 1). A mean of 1.8 ± 0.8 wasps was seen foraging during these hovering/mating periods. One day when hovering lasted for 16 min, wasps were observed 9 times as they foraged on the ridge over a 57 min period, but seven of the sightings were made after hovering had ended.

Wasps observed (n = 11) returning from successful foraging trips held the prey with their middle pair of legs as they relocated and uncovered their burrow entrances. They were quite efficient in finding their burrows. Most (64%) hovered over or scanned the colony before landing, and more than ½ found their burrow entrance at the first spot they dug. The mean number of landings prior to successful burrow relocation was 1.5 ± 0.7, and the mean time spent digging before the burrow was reopened was just 9 sec. After entering the burrow, the wasp invariably covered the entrance with sand (n = 39). The mean time wasps spent inside their burrows was 66.5 ± 28.9 sec (range = 18–130 sec, n = 29). Upon exiting the burrow, 90.5% (n = 21) of the wasps covered the entrance.

The nests of female *B. americana comata* consisted of a narrowly elongate burrow with a single terminal brood cell. Dimensions of the burrows and cells are given in Table 3. Year-to-year variations in the various parameters were not significant at the 5% level (Mann-Whitney test) except for the widths of the cells. A significantly higher percentage of burrows were curved (65.4%) rather than straight (34.6%) for their length ($\chi^2_{\mathrm{Adj}} = 4.33$, $0.025 < P < 0.05$).

Six wasp cocoons found in 1982 and 1983 were predominantly brown in color, 18.0 ± 1.4 (range = 16.0–19.5) mm long, 6.5 ± 0.4 (range = 6.0–7.0) mm wide, and somewhat bullet-shaped. A male *B. americana comata* emerged on or about

Table 3. Physical characteristics of *Bembix americana comata* burrows and brood cells in a coastal sand dune, North Beach, Pt. Reyes National Seashore, California, 1982–1983.

Parameter	Mean ± SD (*n*)[1] 1982	Mean ± SD (*n*)[1] 1983
Burrows		
Length (cm)[2]	17.34 ± 3.20 (34)	18.95 ± 4.56 (28)
Diam. (mm)	9.95 ± 2.92 (21)	8.86 ± 0.96 (28)
Cells		
Length (cm)	3.27 ± 1.90 (6)	3.51 ± 0.77 (26)
Width (cm)	1.60[3] ± 0.20 (6)	1.36[3] ± 0.43 (26)
Height (cm)	1.70 ± 0.71 (6)	1.22 ± 0.31 (26)
Volume (cm^3)	9.23 ± 8.06 (6)	6.22 ± 3.81 (26)
Depth (cm)[4]	9.94 ± 2.76 (8)	11.40 ± 3.46 (28)

[1] *n* = sample size.

[2] Includes length of cell.

[3] Significantly different from each other ($P < 0.05$, Mann-Whitney test); all other parameters measured did not differ significantly between years at the 5% level.

[4] Depth below ground surface.

14 July 1983 from a cocoon collected 31 August 1982. None of the other cocoons yielded an adult wasp within 1 to 2 years of observation.

In total, 311 flies or remnants of flies were removed from 26 brood cells in 1982. The number of flies per cell averaged 12.0 ± 9.6 and ranged from 1 to 48. Of these, 113 (36%) representing 32 taxa in 11 families were determined to genus or species, and a twelfth family, Tephritidae, was represented by a single undetermined species (Table 4). All flies belonged to the suborder Brachycera, and 75% of the determined taxa were members of the infraorder Muscomorpha (terminology after McAlpine et al., 1981). In descending rank, the three most abundant flies were the muscid, *Orthellia caesarion* (Meigen), the tabanid, *Brennania hera,* and the asilid, *Nicocles aemulator* (Loew). Both *O. caesarion* and *B. hera* were present in at least 35% of the brood cells; the tachinid, *Reinhardiana* sp., was found in 27%.

Brennania hera adults were present in 35% and 46% of the nests examined in 1982 and 1983, respectively (i.e., exclusive of nests unoccupied by larval wasps). The difference in the percentages of burrows yielding *B. hera* between years was not significant ($\chi^2_{\mathrm{Adj}} = 0.32$, $0.50 < P < 0.75$). A mean of 1.9 horse flies was found in *B. hera*-positive nests in both years. The distribution of *B. hera* adults in burrows was adequately fitted by a Poisson distribution in 1982 ($\chi^2 = 2.60$, $0.10 < P < 0.25$) and in 1983 ($\chi^2 = 1.75$, $0.10 < P < 0.25$). More males than females were found in brood cells both years, and these differences were significant in 1983 ($\chi^2_{\mathrm{Adj}} = 5.88$, $0.01 < P < 0.025$) and when data from both years were pooled ($\chi^2_{\mathrm{Adj}} = 6.62$, $0.01 < P < 0.025$).

One of two paralyzed *B. hera* adults removed from separate burrows on 18 August 1982 was largely nulliparous and partly uniparous, the other uniparous. Ovarioles of the uniparous fly were in the sac-stage (i.e., dilated) and contained no residual eggs, whereas the nulliparous/uniparous specimen was partly gravid and partly in the sac-stage (e.g., one of her ovaries contained 83 mature eggs and

Table 4. Partial list and relative abundance of Diptera taken as prey by *Bembix americana comata* females at North Beach, Point Reyes National Seashore, 20 July to 31 August 1982.[1] New familial, generic or specific prey records are indicated by †. The number of questionable determinations for a few taxa are given in parentheses in column 2.

Taxon	No. individuals
Tabanidae	
Brennania hera (Osten Sacken)	17
Asilidae†	
Asilus sp.†	1
Nicocles aemulator (Loew)†	11 (2)
Bombyliidae†	
Hemipenthes sp.†	2
Villa sp. 1†	1
Villa sp. 2†	1
Dolichopodidae	
Dolichopus sp.†	1
Hercostomus sp.†	1
Syrphidae	
Allograpta sp.†	2 (1)
Carposcalis sp.†	1
Eristalis arbustorum (L.)	1
Eristalis sp.[3]	4
Melanostoma sp.†	1
Tephritidae†	
Undet. sp.†	1
Sciomyzidae†	
Limnia inopa (Adams)†	1
Anthomyiidae†	
Fucellia sp.†	1
Hylemya (*Delia*) *deviata* Huckett†	1
Scatophaga stercoraria (L.)†	1
Muscidae	
Coenosia tigrina (Fabricius)	5
Helina ?multiseriata Malloch†	1
Musca autumnalis De Geer†	4
Muscina assimilis (Fallen)	4
Orthellia caesarion (Meigen)†	20
Calliphoridae	
Paralucilia wheeleri (Hough)†	1
Phormia regina (Meigen)	3
Sarcophagidae	
Sarcophaga sp.	1
Tachinidae	
Blondelia sp.†	2
Gymnosoma filiola Loew†	1
Madremyia saundersi (Williston)†	5 (2)
Protodejeania sp.†	8
Ptilodexia conjuncta (Wulp)†	2
Reinhardiana sp.†	8 (1)

[1] 26 burrows were examined on 7 dates.

[2] More than one species may be represented.

more than 30 sac-stage ovarioles). A third *B. hera* female taken from a wasp returning to its nest also was nulliparous and gravid; her ovaries each contained 62 mature eggs. All three flies were inseminated and contained a moderate quantity of fat body in their hemocoelic cavities. None had hematin granules in their rectal papillae or blood in their digestive tracts, but all three had a dark green to nearly blackish substance in their alimentary canals, particularly in the midgut region.

Twenty paralyzed flies taken from wasps comprised 11 species and 7 families of Brachycera. These included five *B. hera,* three *M. autumnalis,* two each of *O. caesarion, Pollenia rudis* (Fabricius) (Calliphoridae), and *Sarcophaga* sp., and single specimens of *Eristalis* sp., *Melanostoma* sp., *Pegomya duplicata* (Malloch) (Anthomyiidae), *S. stercoraria, Helina obscurata* (Meigen) (Muscidae), and *Arctophyto* sp. (Tachinidae). Of these, *H. obscurata* and *Arctophyto* sp. represent new prey records for *B. americana comata.* They lived a mean of 4.1 ± 2.5 (range = 1–10) days after onset of paralysis. Signs of life detected among paralyzed flies included occasional isolated or quivering movements of the abdominal tip, tarsi, antennae, mouthparts, and, in one instance, a wing. There was a highly significant positive correlation between time to death and dry weight of flies when all species were lumped ($0.005 < P < 0.01$, Fig. 1). By contrast, the correlation between these variables for the five *B. hera,* all of which were males, was not significant ($r = -0.553$, $0.20 < P < 0.50$).

DISCUSSION

Females of *B. americana comata* inhabiting the North Beach area forage over widely varying weather conditions including foggy or overcast to sunny days and temperatures ranging from ca. 12 to 23°C. On the other hand, populations of this wasp (reported as *B. comata*) from two other localities in the San Francisco Bay region (i.e., Alameda and San Francisco) were inactive on overcast days and, at one location, at temperatures below 19 to 20°C (Parker, 1925; Evans, 1957). According to Evans (1957), the minimum flight temperature-threshold of 19 to 20°C that he recorded for *B. americana comata* is unusually low for a member of the genus. Thus it appears that different populations of this wasp, even those from the same region, possess the genetic capacity to adjust their diel activity patterns to various local meteorological conditions. At North Beach, flight activity in the colony area was first noted when soil surface temperatures reached ca. 30°C, irrespective of cloud cover. Flight did not occur on rainy days, presumably because precipitation either affected it directly or indirectly by cooling soil to temperatures below those eliciting adult activity. Light was not involved because flight occurred on both heavily overcast and clear days when illumination ranged between 3850 and 8500 foot-candles.

Bembix americana comata is the most important predator of *B. hera* adults at North Beach. Ants and Barn Swallows, *Hirundo rustica* L., occasionally prey on this horse fly, but their combined impact on the population is substantially less than that of the sand wasp. However, Barn Swallows are significant predators of adults of *Apatolestes actites* Philip and Steffan, another psammophilous horse fly that breeds along the Point Reyes National Seashore (Lane et al., 1983). In apparently the only other North American report of predation of hovering horse flies by a *Bembix* wasp, Blickle (1959) observed five captures of *Tabanus bishoppi* Stone males by *B. belfragei* Cresson. In every case, the wasp approached the

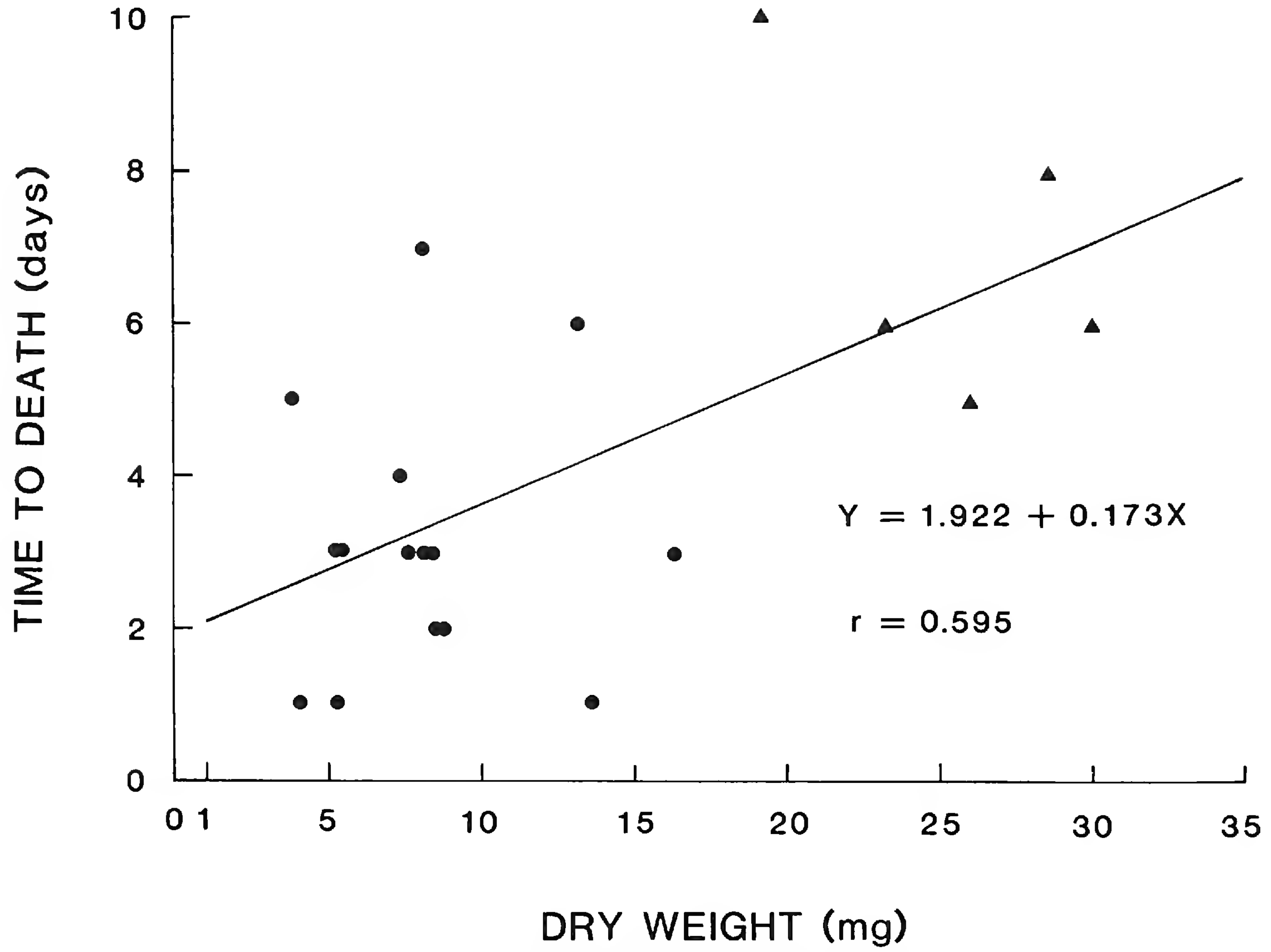

Figure 1. Relationship between survival of paralyzed flies (11 species) and their dry weights. Data points for five *Brennania hera* males are represented by solid triangles.

hovering fly from the rear, captured it, and then flew away. As the tabanid flight season progressed, the appearance of *Bembix* wasps in the hovering area seemed to evoke increased wariness by *T. bishoppi* males. Similar behavior was not shown by *B. hera* males, but the sporadic occurrence and short duration of hovering by *B. hera* males may be behaviors that evolved specifically to reduce their exposure to potential natural enemies (Lane and Anderson, 1985).

That female wasps returning to the colony area with prey spent, on average, only 9 sec digging at 1.5 spots before entering their nests demonstrates that they have a highly efficient mechanism for nest relocation. Experimental evidence shows that other species of *Bembix,* such as *B. niponica* Smith and *B. rostrata* Fabricius use prominent landmarks in the general vicinity of the nest for orientation (Tsuneki, 1956; Iersel and Assem, 1964). Such landmarks seem to be learned by *B. niponica* females during a special "orientation flight" undertaken directly after the nest has been constructed. It is not known whether *B. americana comata* engages in a similar flight following nest construction.

The duration of foraging trips for *B. americana comata* in San Francisco was determined by Parker (1925), who observed four wasps for nearly two hours; the mean duration of these trips was 13 min per fly. After returning to their nests, wasps remained inside for approximately 1 min (range: ½–1½ min), which agrees closely with our findings ($\bar{x}$ = 66.5 sec) as well as those of Evans (1957).

In general, nest dimensions and other characteristics of the colony at North

Beach are in remarkable accord with those reported for this species by Evans (1957) and disagree in several respects from data presented by Parker (1925) and Essig (1926). Burrow lengths given by Parker are slightly greater than our measurements, whereas those recorded by Essig (i.e., "16 to 20 inches") appear to be grossly in error. Further, unless *B. americana comata* displays an inordinate amount of variation in nest construction, the latter authors misinterpreted the shapes of the burrows; they are neither equipped with three brood chambers (Parker) or shaped like an inverted Y (Essig). As noted by Evans (1957) and reconfirmed by us, the burrows are usually slightly to strongly curved or sometimes straight, and they are invariably unicellular.

To the list of 28 determined species of flies in 9 families recorded as prey of *B. americana comata* previously (Parker, 1925; Evans, 1957), we added 25 genera or species and five families of Diptera representing at least 27 specific taxa. Only seven (25%) of the flies determined in the former investigations were also found during the present study. Thus, *B. americana comata,* like nearly all North American *Bembix* species, is a catholic predator of Diptera. The greater numbers of some flies in the nests of *B. americana comata* during July and August 1982, notably *O. caesarion* and *B. hera,* may reflect their greater abundance locally and/or their relative accessibility to foraging wasps. It would be of considerable interest to compare the population levels of potential dipterous prey and the numbers of prey actually found inside nests in future *Bembix* studies.

Although analyses of nest contents revealed that *B. hera* is a significant dietary item of wasp larvae, an even better indication of its importance would have been obtained had we recorded biomass as well. The mean dry weight of *B. hera* adults (25.44 ± 4.33 mg) exceeded that for each of the other flies (4.06–14.89 mg) used in the prey-longevity experiment by nearly two to several-fold. In Alameda and San Francisco, *B. hera* was of comparatively minor or no importance in the diet of *B. americana comata* larvae when collections were made (Parker, 1925; Evans, 1957), but prey abundance was not systematically quantified in either study.

The random distribution of *B. hera* adults in *B. americana comata* burrows indicates that wasps do not selectively prey on horse flies despite the proximity of a major *B. hera* hovering/mating site. These findings lend additional weight to our speculative opinion that the sporadic and brief hovering episodes of *B. hera* males are effective anti-predator behaviors. On the other hand, the nearness of the male tabanid hovering site may account for the observed sex-biased predation by *Bembix* females. *Brennania hera* females are less vulnerable to wasp predation because they do not swarm and they appear to be dispersed more evenly throughout the sand dune ecosystem. Sex-biased predation resulting from increased risk-taking reproductive activities by the competitive sex has been documented in several orders of insects, and it generally involves males (Gwynne and Dodson, 1983).

That the ovaries of one of the dissected tabanid females captured by *Bembix* females contained many mature eggs plus ovarioles in the sac-stage reveals that the fly had probably been caught while ovipositing. An alternative explanation, namely, that *B. hera* females can lay two or more partial egg masses per gonotrophic cycle seems less likely since most gravid *B. hera* females lay a single, autogenously-produced egg mass during the first gonotrophic cycle (R. S. Lane and J. R. Anderson, unpubl. data). Females presumably oviposit deep in dense vegetation since repeated efforts to locate egg masses or observe oviposition on the periphery of dune plants were fruitless.

In discussing paralysis of *Bembix* prey, Evans (1966) recommended that future students of these wasps pay attention to the effects of the sting since specific differences seem to exist. Dipterous prey of *B. americana comata* lived on the average about as long as those of *B. niponica,* i.e., 4.1 vs. 4.5 days, respectively, though the value for *B. niponica* is an underestimate because Tsuneki (1956) did not know how long flies had been in the nests he dug. Additionally, the regression analysis revealed that there is a significant positive correlation between size of prey and survival after onset of paralysis when all species are lumped. There was no association between dry weights of the five *B. hera* males and survival, but this may merely reflect the small sample size ($n = 5$) involved. The observed association between size and longevity may not be dose-dependent but due instead to the fact that smaller flies may desiccate sooner because the ratio of surface area to volume increases with decreasing size. If this is so, then larger flies would be expected to live longer because they would lose body water more gradually.

Finally, in contradistinction to Parker (1925) and in agreement with Evans (1957), all flies captured by *B. americana comata* at North Beach were stung immediately and suffered permanent paralysis. Several wasps observed by Parker (1925) did not sting their prey immediately with the result that the flies escaped while the wasps were entering their nests. These disparate findings demonstrate that there can be significant intraspecific differences in the predatory behavior of *B. americana comata* within a fairly restricted geographical region.

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FOUR HUNDRED AND THIRTY-SIXTH MEETING

The 436th meeting was held Friday, 18 January 1985, at 8:10 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 14 December 1984 were read and accepted. Two persons were proposed and elected as new members: Mr. Kevin M. Spollen as a student member and Dr. Norman D. Penny as a regular member.

Dr. Edwards announced that the latest issue of *Pacific Discovery* contains an article on monarch butterflies. Mr. Vincent F. Lee read the names of three additional members who elected to be sponsoring members for 1985: Dr. Richard K. Allen, Dr. and Mrs. William E. Ferguson, and Mr. David G. Marqua. Dr. Cornelius B. Philip presented a scientific note, "A Collection of Four Species of Tabanid Flies Taken from an Anaconda Snake in Peru in May, 1984." He also announced that the latest newsletter of the Pacific Division of the American Association for the Advancement of Science mentioned the Society's participation in the Montana meetings this year.

The featured speaker Dr. Edward S. Ross, California Academy of Sciences, presented the lecture entitled "Entomological Highlights of a Recent Journey to Turkey, North Africa, and Europe." His well-illustrated slide lecture recounts part of a 26,000 mile trip taken in seven months of 1984, with emphasis on embiid collecting, *Ophrys* orchids and their pollination by scoliid wasps, and archeological sites of Tunisia, Morocco, Spain, Greece, Sicily, and Turkey.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 83 persons was present, of which 35 signed as members and 35 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND THIRTY-SEVENTH MEETING

The 437th meeting was held Friday, 15 February 1985, at 8:10 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 18 January 1985 were read and accepted. Mr. Vincent F. Lee announced that another member Dr. E. Eric Grissell had elected to be a sponsoring member for 1985. Four persons were proposed and elected as new members: Mr. Michael S. Arduser as a student member, and Mr. Tadese Gebre-Hawariat, Dr. Lee R. Johnson, and Dr. Barry M. Wilk as regular members.

Dr. Edwards announced that Mr. David L. Wagner, who gave an excellent talk on hepialids to our Society in 1984, recently won the Snodgrass Memorial Research Award from the Entomological Society of America. Mr. Jett S. Chinn presented slides showing infection of the raphidophorids *Pristoceuthophilus pacificus* (Thomas), *Pristoceuthophilus* sp., and *Ceuthophilus* sp. by the fungus *Entomophthora* sp. in Pacifica. Dr. D. Dee Wilder presented slides showing exposed combs of a honeybee colony. Dr. Edward L. Smith presented slides of sawfly (*Euura scoulerianae* E. L. Smith) and cecidomyiid (*Mayetiola* sp.) galls on willows (*Salix* sp.) and commented on the remarkable survivorship of last instar larva or prepupa of the cecidomyiid to submersion in the fixative FAA. Dr. Harvey I. Scudder announced that the Bureau of Land Management has set aside the areas in the Stewart Valley, Nevada where he had been studying insect fossils.

The featured speaker Dr. Edward S. Ross, California Academy of Sciences, presented the lecture entitled "Entomological Highlights of a Recent Journey to Turkey, North Africa, and Europe." This lecture was a continuation of the talk given in January of his trip taken in 1984, with emphasis on the Alps portion of the trip. Excellent slides on the entomology, general natural history, geology, and human culture of Europe and England were shown.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 85 persons was present, of which 38 signed as members and 33 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND THIRTY-EIGHTH MEETING

The 438th meeting was held Friday, 15 March 1985, at 8:15 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 15 February 1985 were read, corrected, and accepted. Mr. Vincent F. Lee announced that two additional members Dr. John E. Hafernik Jr. and Mr. Benjamin Keh elected to be sponsoring members for 1985. Six persons were proposed and elected as new members: Mr. Steven H. Dreistadt and Mr. David H. Jensen as student members, and Dr. Gordon Gordh, Dr. Tohko Y. Kaufman, Dr. Peter G. Mason, and Dr. Richard C. Wilkerson as regular members.

Dr. Edwards announced that the annual meeting of the Pacific Slope Section of the Lepidopterists' Society will be held in June this year at Camp Norris, San Bernardino Mountains. Mr. Dean Jamieson presented a recent collection of unusual Lepidoptera belonging to the family Alucitidae. Dr. Stanley C. Williams announced a course on beekeeping, offered by the San Francisco Community College District. Dr. Edward L. Smith announced the recent monograph on fossil scorpions by the late Dr. E. N. Kjellesvig-Waering.

The featured speaker Ms. Valerie Brown, staff entomologist, California Department of Food and Agriculture, Sacramento, presented a lecture entitled "The Status of Gypsy Moth Program in California and the Northwest." She presented information on the general biology of the gypsy moth and the current control measures taken against it, showed a movie produced in Canada on the gypsy moth, and traced the history of gypsy moth infestations in the Pacific Coast states, with special reference to California.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 34 persons was present, of which 20 signed as members and 13 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND THIRTY-NINTH MEETING

The 439th meeting was held Friday, 19 April 1985, at 8:15 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with Past President Dr. Harvey I. Scudder presiding.

The minutes of the meeting held 15 March 1985 were read, corrected, and accepted. Mr. Vincent F. Lee announced that an additional member Mr. Eric M. Fisher elected to be a sponsoring member for 1985. Five persons were proposed and elected as new members: Mr. John J. Dayton, Mr. Arthur V. Evans, and Mr. Nathan Schiff as student members, and Mr. Edmund F. Giesbert and Dr. William F. Kraus as regular members.

Dr. Edward L. Smith showed slides of a primitive crustacean and some interesting primitive insects. Dr. Kirby W. Brown showed slides of the fern and magnolia white scales.

The featured speaker Dr. Reg F. Chapman, Visiting Professor, University of California, Albany, lectured on "The Paradoxical Biology of an African Grasshopper." He presented some ingenious experiments to some interesting paradoxes in the biology of the variegated grasshopper, *Zonocerus variegatus* (Linnaeus), a native pest of the cassava plant in the rain forest belt of Nigeria.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 35 persons was present, of which 27 signed as members and 8 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTIETH MEETING

The 440th meeting was held Friday, 17 May 1985, at 8:10 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 19 April 1985 were read and accepted. Mr. Vincent F. Lee announced that Mr. Arthur L. Chan elected to be a sponsoring member for 1985. Four persons were proposed and elected as new members: Mr. Craig C. Allison, Ms. Sharon S. Mead, and Mr. Curtis Y. Takahashi as student members, and Mr. William T. Pyles as a regular member.

Dr. Edwards reminded the audience about the Pacific Division of the American Association for the Advancement of Science meeting in Montana in June. Dr. Kirby W. Brown showed slides of the eggs of *Prionus californicus* Motschulsky. Mr. Larry G. Bezark showed several slides of *Cyrtopogon princeps* Osten Sacken and *C. montanus* Loew and their microhabitats near Placerville. Dr. Norman D. Penny talked about a three day trip in which he was able to collect all three species of bittacid Mecoptera of California.

The featured speaker Mr. Dean W. Jamieson, entomologist at Instar Pest Consultants, Inc., San Jose, presented a lecture entitled "Entomology, Public Health, and Pest Control." He talked about his experiences with arthropod infestations of human and human habitation when he was employed by the Santa Clara County Department of Health. Slides of human myiasis, house dust mite and other mites causing dermatitis, and other arthropod vectors and pests were shown, and case histories were discussed. Sampling procedures and control measures were briefly described. He stressed how much misinformation and incorrect arthropod identification abound among public health workers.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 29 persons was present, of which 23 signed as members and 6 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-FIRST MEETING

The 441st meeting was held Friday, 25 October 1985, at 8:20 p.m., in the Goethe Room, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 17 May 1985 were read and accepted. Fifteen persons were proposed and elected as new members for 1985 (those for 1986 indicated in parentheses): Mr. David A. Carmean, Mr. David L. Wagner, and Ms. Marianne A. Wong (1986) as student members; and Mr. Robert L. Allen (1986), Dr. Ranit K. Bhattacharjee (1986), Dr. John F. Burger, Mr. James W. Cornett, Mr. Parker V. Gambino, Dr. Joseph R. Holomuzki, Mr. Clive D. Jorgensen (1986), Dr. Robert W. Longair (1986), Mr. Jay W. Nelson, Dr. Laurence Packer (1986), Dr. Kenneth W. Stewart, and Dr. Leonard S. Vincent as regular members.

Mr. Larry G. Bezark announced the 1986 annual meeting of the Pacific Division of the American Association for the Advancement of Science at the University of British Columbia, Vancouver, Canada, in 8–13 June 1986, in which the Society will be a participant. Dr. Edwards reported on this year's meeting in Missoula where there was a get-together of entomologists and a field trip to Glacier National Park, led by him. Dr. Norman D. Penny reported that the eggs of two of the three species of bittacid Mecoptera of California he collected in May have not hatched yet. Dr. Ronald E. Stecker reported that Dr. William E. Ferguson wrote a long letter from South Africa. Mr. Vincent F. Lee announced three books published in 1985: J. D. Polhemus. Shore bugs (Heteroptera-Hemiptera; Saldidae); A. S. Menke and D. R. Miller (editors). Entomology of the California Channel Islands; and International Code of Zoological Nomenclature. Third edition.

The featured speaker Dr. Marjorie A. Hoy, University of California, Berkeley, presented a lecture entitled "Genetic Improvement of Biological Control Agents: Status and Prospect for Biotechnology." She gave a brief history of insects used in biological control and her own experiences with the braconid *Apanteles melanoscelus* (Ratzeburg) as a control agent for the gypsy moth, *Lymantria dispar* (Linnaeus). She talked about laboratory cross-breeding experiments to produce a heterotic strain which theoretically improves the effectiveness of the parasitoid on the moth. However, field efficacy of the heterotic strain has not yet been demonstrated. Improved resistance of the western predatory mite, *Metaseiulus occidentalis* (Nesbitt), a predator of eriophyid and tetranychid mites on almonds, grapes, and other citrus crops, to carbaryl, sulfur, and organophosphate pesticides by artificial selection techniques, showed high promises and cost effectiveness. Similar experiments have been done on the common green lacewing, *Chrysoperla carnea* (Stephens), the first insect predator selected for pesticide resistance. New biotechnological techniques with potential promise for improving the genetic stock of biological control agents, such as recombinant DNA, cell culture transformation, virus vector, and minichromosomes, were briefly discussed.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 42 persons was present, of which 23 signed as members and 19 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-SECOND MEETING

The 442nd meeting was held Friday, 15 November 1985, at 8:20 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 25 October 1985 were read and accepted. Four persons were proposed and elected as new members for 1986: Mr. Patrick A. Luft and Mr. Michael P. Kennedy as student members, and Mr. Joe E. Clopton and Mr. Robert C. Wilson as regular members.

Dr. Edwards announced the formation of two ad hoc committees: the nominating committee, consisting of Dr. Marius S. Wasbauer as chairperson, and Dr. Jerry A. Powell and Dr. Ronald E. Stecker as members, and the auditing committee, with Mr. H. Vannoy Davis as chairperson, and Dr. Paul H. Arnaud Jr. and Mrs. Helen K. Court as members. Mr. Vincent F. Lee suggested that the Society purchase an automatic coffee maker and provide freshly ground coffee for the social hour. Mr.

Larry G. Bezark announced that, starting in 1986, the Society will send out newsletters, instead of postcards, to announce the upcoming Society meetings and also other entomological or related meetings, notices, etc. Dr. Edwards showed slides of beautiful butterfly art objects crafted by artisans of the Haus der Schmetterlinge in Koblenz, Federal Republic of Germany and of the Matterhorn and surrounding areas.

The featured speaker Dr. Edward J. Rogers, medical entomologist at the Disease Vector Ecology and Control Center, Naval Air Station, Alameda, presented a lecture entitled "Natural History of Dance Flies." He summarized the known information on the predatory, swarming, ballooning, dance, and mating behavior of the Empididae, with special reference to his own observations of some Californian species of *Hilara, Rhamphomyia,* and *Empis.* His field experiments on swarming patterns of several species of empidids demonstrated the environmental conditions under which these flies swarmed.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 45 persons was present, of which 29 signed as members and 16 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-THIRD MEETING

The 443rd meeting was held Friday, 13 December 1985, at 8:10 p.m., in the Goethe Room, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. J. Gordon Edwards presiding.

The minutes of the meeting held 15 November 1985 were read and accepted. Two persons were proposed and elected as student members for 1986: Mr. Arash Agah and Mr. Michael D. Schwartz.

Dr. Edwards asked for committee reports. Mr. Vincent F. Lee reported that in 1985 the Society had 46 sponsoring members and added 11 regular and 17 student members to its membership roll. Dr. Edwards announced that Dr. John A. Chemsak will remain as editor of the journal through 1986. Dr. Jerry A. Powell announced the slate of candidates for 1986: Mr. Larry G. Bezark as president, Dr. Stanley C. Williams as president-elect, Dr. Wojciech J. Pulawski as treasurer, and Mr. Vincent F. Lee as secretary. The members present elected these candidates to their respective offices. Dr. Edwards then passed the gavel to the new president. Mr. Bezark.

Mr. Lee announced that an automatic coffee maker was purchased for use during the social hour. Dr. Edward L. Smith announced that Dr. Jarmila Kukalova-Peck will be speaking on fossil insects at the February 1986 meeting. Mr. Lee announced that the Entomology Department of the Academy is offering used U.S. National Museum and Cornell insect trays for sale. He suggested that a local member might set up a small business of evaluating insect collections donated to museums.

Mr. Benjamin Keh showed slides taken from a world reknowned insect zoo near Tokyo. Mr. Michael P. Kennedy showed slides of processionary caterpillars in the Vatican. Mr. Bezark reported collecting the first specimens of a European syrphid fly *Eristalinus* sp. for North America, when he attended the Entomological Society of America meetings in Hollywood, Florida. Dr. Williams announced that the Association of Biologists for Computing will be hosting a series of seminars in January 1986 at San Francisco State University. Mr. Bezark mentioned some anecdotes from Dr. Edwards's former students and himself.

The featured speaker Dr. J. Gordon Edwards, professor at San Jose State University, gave the presidential address entitled "Natural History of Costa Rica." He lectured on the geological, physiographic, and topographic features and showed slides of the interesting insects and flowers from his several trips to this biologist's paradise.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 54 persons was present, of which 38 signed as members and 16 as guests.—V. F. Lee, Secretary.

THE PAN-PACIFIC ENTOMOLOGIST

Information for Contributors

Members are invited to submit manuscripts on the systematic and biological phases of entomology, including short notes or articles on insect taxonomy, morphology, ecology, behavior, life history, and distribution. Non-members may submit manuscripts for publication, but they should read the information below regarding editing and administrative charges. Manuscripts of less than a printed page will be published as space is available, in Scientific Notes. All manuscripts will be reviewed before acceptance. Manuscripts for publication, proofs, and all editorial matters should be addressed to the editor.

General. — The metric system is to be used exclusively in manuscripts, except when citing label data on type material, or in direct quotations when cited as such. Equivalents in other systems may be placed in parentheses following the metric, *i.e.* "1370 m (4500 ft) elevation".

Typing. — **Two copies** of each manuscript must be submitted (original and one xerox copy or two xerox copies are suitable). All manuscripts must be **typewritten, double-spaced** throughout, with ample margins, and be on bond paper or an equivalent weight. **Carbon copies** or copies on paper larger than 8½ × 11 inches are not acceptable.

Underscore only where *italics* are intended in the body of the text. **Number all pages** consecutively and put authors name on each sheet. References to **footnotes** in text should be numbered consecutively. Footnotes **must** be typed on a separate sheet.

Manuscripts with extensive corrections or revisions will be returned to the author for retyping.

First Page. — The page preceding the text of the manuscript must include (1) the complete title, (2) the order and family in parentheses, (3) the author's name or names, (4) the institution with city and state or the author's home city and state if not affiliated (5) the complete name and address to which proof is to be sent.

Names and descriptions of organisms. — The first mention of a plant or animal should include the full scientific name with the author of a zoological name *not* abbreviated. Do not abbreviate generic names. Descriptions of taxa should be in telegraphic style. The International Code of Zoological Nomenclature must be followed.

Tables. — Tables are expensive and should be kept to a minimum. Each table should be prepared as a line drawing *or* typed on a separate page with heading at top and footnotes below. Number tables with Arabic numerals. Number footnotes consecutively for each table. Use only horizontal rules. Extensive use of tabular material requiring typesetting may result in increased charges to the author.

Illustrations. — No extra charge is made for line drawings or halftones. Submit only photographs on glossy paper and original drawings. Authors *must* plan their illustrations for reduction to the dimension of the printed page (117 × 181 mm; 4⅝ × 7⅛ inches). If possible, allowance should be made for the legend to be placed beneath the illustration. Photographs should not be less than the width of the printed page. Photographs should be mounted on stiff card stock, and bear the illustration number on the face.

Loose photographs or drawings which need mounting and/or numbering are not acceptable. Photographs to be placed together should be trimmed and abut when mounted. Drawings should be in India Ink, or equivalent, and at least twice as large as the printed illustration. Excessively large illustrations are awkward to handle and may be damaged in transit. It is recommended that a metric scale be placed on the drawing or the magnification of the *printed* illustration be stated in the legend where applicable. Arrange figures to use space efficiently. Lettering should reduce to no less than 1 mm. *On the back of each illustration* should be stated (1) the title of the paper, (2) the author's complete name and address, and (3) whether he wishes the illustration returned to him. Illustrations not specifically requested will be destroyed. **Improperly prepared illustrations will be returned to the author for correction prior to acceptance of the manuscript.**

Figure legends. — Legends should be typewritten double-spaced on separate pages headed EXPLANATION OF FIGURES and placed following LITERATURE CITED. Do not attach legends to illustrations.

References. — All citations in text, e.g., Essig (1926) or (Essig 1958), must be listed alphabetically under LITERATURE CITED in the following format:

Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2:211–212.
Essig, E. O. 1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York, 1050 pp.

Abbreviations for titles of journals should follow a recent volume of *Serial Sources for the Biosis Data Base,* BioSciences Information Service. For **Scientific Notes** the citations to articles will appear within the text, i.e. . . . "Essig (1926, Pan-Pac. Entomol., 2:211–212) noted . . .".

Proofs, reprints, and abstracts. — Proofs and forms for the abstract and reprint order will be sent to authors. Changes in proof will be charged to the author.

Editing and administrative charges. — Papers by members of the Pacific Coast Entomological Society are charged at the rate of $30.00 per page. Members without institutional or grant funds may apply for a society grant to cover a maximum of one-half of these charges. Non-members will be charged at the rate of $60.00 per page. Editing and administrative charges are in addition to the charge for reprints and do not include the possible charges for author's changes after the manuscript has been sent to the printer.

Announcement

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PROCEEDINGS OF THE PACIFIC COAST ENTOMOLOGICAL SOCIETY.
Vol. 1 (16 numbers, 179 pages) and vol. 2 (9 numbers, 131 pages). 1901–1930. Price $5.00 per volume.

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Vol. 1 (1924) to vol. 51 (1975), price $10.00 per volume of 4 numbers, or $2.50 per single issue. Vol. 52 (1976) to vol. 57 (1981), price $15.00 per volume, or $3.75 per single issue, except for vol. 57, no. 1, $10.00. Vol. 58 (1982) and subsequent issues, $20.00 per volume or $5.00 per single issue.

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Volume 1. *The Sucking Lice* by G. F. Ferris. 320 pages. Published October 1951. Price $10.00 (plus $1.00 postage and handling).*

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Volume 3. *Revisionary Studies in the Nearctic Decticinae* by David C. Rentz and James D. Birchim. 173 pages. Published July 1968. Price $4.00 (plus $0.75 postage and handling).*

Volume 4. *Autobiography of an Entomologist* by Robert L. Usinger. 343 pages. Published August 1972. SPECIAL PRICE $5.00 (plus $1.00 tax, postage, and handling for California orders, $0.70 postage and handling for non-California U.S. orders, or $1.70 for foreign orders). No members discount at this special price.

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Application for membership in the Society and changes of address should be addressed to the Secretary, Vincent F. Lee, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118-9961.

Manuscripts, proofs, and all correspondence concerning editorial matters should be addressed to Editor, Pacific Coast Entomological Society, 201 Wellman Hall, University of California, Berkeley, CA 94720. See back cover for instructions.

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Pacific Coast Entomological Society

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Revision of the New World Genus *Lotisma* (Lepidoptera: Copromorphidae)[1]

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Abstract.—*Lotisma* Busck is revised for the two included species: *L. trigonana* (Walsingham), from western North America and *L. vulcanicola* Meyrick, from Costa Rica. A new subspecies, *L. trigonana durangoensis,* is described for a disjunct population from Durango, Mexico. The larva of *L. trigonana* is described and illustrated, showing relationships closest to *Ellabella* Busck.

The genus *Lotisma* is a small western North American genus encompassing one very widespread species, *Lotisma trigonana* (Walsingham), and one species from Costa Rica, *Lotisma vulcanicola* Meyrick. The genus has had a history of varying family placement. Walsingham (1879) described the first species in Tortricidae, inasmuch as they resemble some species of *Decodes.* Busck (1909, 1925) and Meyrick (1932) placed the genus in Glyphipterigidae and Yponomeutidae. More recently, following a study of world genera of Glyphipterigidae, this amorphous family was segregated into several families, with a number of odd genera being transferred to other families, among these *Lotisma* (Heppner, 1978) to Copromorphidae. *Lotisma* clearly is not a glyphipterigid, but head morphology, wing venation, genitalia characters, and characters of the immature stages point to a placement in Copromorphidae. MacKay (1972) was the first recent scientist to note that the genus had some relationship to Carposinidae, a family related to Copromorphidae, by comparison of larval characters.

Lotisma is here characterized morphologically in detail, along with the adults and immature stages of *L. trigonana,* plus redescription of *L. vulcanicola. Lotisma trigonana* is known from Alaska to Costa Rica, but the disjunct nature of the Mexican and Costa Rican populations has prompted the naming of this segregate as a separate subspecies.

Lotisma Busck

Lotisma Busck, 1925:98 (Type-species: *Sciaphila trigonana* Walsingham, 1879, orig. design).

Adult.—Small moths, 6.5–11.0 mm forewing lengths. *Head* (Figs. 1, 3): vertex somewhat roughened; frons similar; labial palpus slightly upcurved, with long median segment (2× basal or apical segments); maxillary palpus (Figs. 2, 4) relatively large, 3-segmented; haustellum well-developed, long, unscaled; pilifer

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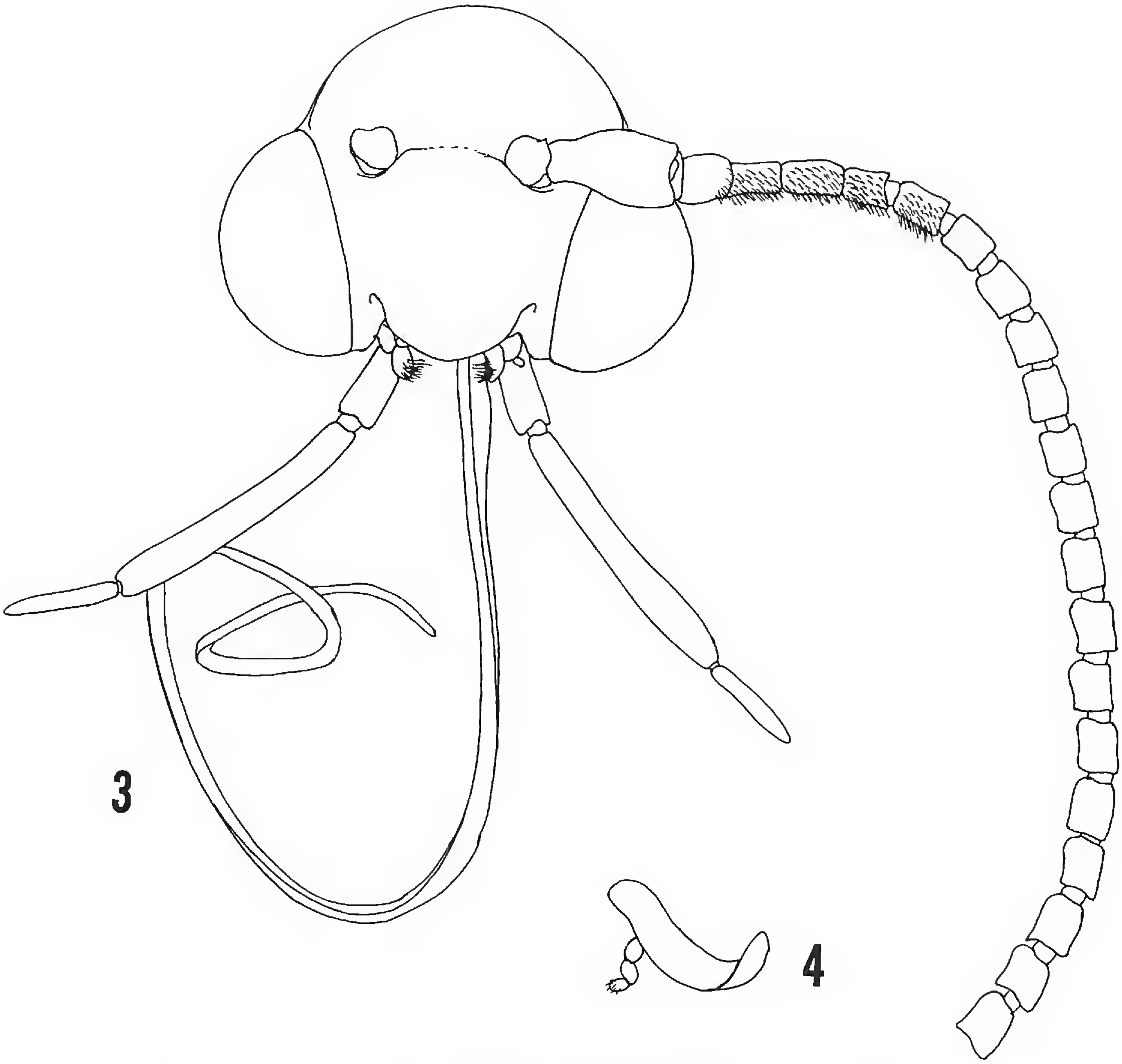
[1] Contribution No. 613, Bureau of Entomology, Fla. Dept. Agric. & Consumer Serv.

Figures 1, 2. Head morphology of *Lotisma trigonana* (Walsingham). 1. Head profile (USNM 77335, California). 2. Same, detail of haustellum base, maxillary palpus, and pilifer.

large; compound eye large (⅔ of head height); ocellus absent; antenna (Fig. 3) filiform, with ventral setae, and normal length (½ forewing length), not noticeably sexually dimorphic; antennal scape without pecten. *Thorax:* normal; legs 0-2-4 spur formula, with small foreleg epiphysis. *Forewing* (Fig. 5): subelongate (ca. 3× long as wide); apex slightly pointed, termen somewhat oblique to rounded tornus; all veins present and separate; R_5 to termen near apex; chorda absent; cell closed, with slight vestigial median vein evident; M_1–M_3 nearly equidistant, with M_3 very near to CuA_1; cubital veins curved near end of cell, becoming parallel toward termen; CuP present near tornus; A_{1+2} with basal fork; A_3 very small. *Hindwing* (Fig. 5): subovate-elongate (ca. 2× long as wide); apex distinct but rounded; termen a broad oblique curve to rounded tornus; all veins present; Rs separate from Sc; median veins with M_1 close to M_2 at base and M_3 stalked with CuA_1; cell with vestigial median vein evident; CuA_2 becoming parallel to CuA_1 at termen; CuP evident along most of wing to tornus; A_{1+2} with small basal fork; A_3 long; A_4 small. *Abdomen:* normal; ♂ with pair of external coremata on sternite 7. *Male genitalia:* uncus a well-developed, narrow projection; gnathos undeveloped; socius absent (but many setae on uncus); transtilla absent; valva elongate, setaceous, with an overlapping sacculus with separate appendages; anellus a U-shaped plate; tegumen rounded; vinculum small, half-hexagonal; saccus absent; aedeagus short, with phallobase and single rugose cornutus. *Female genitalia:* ovipositor short (1.5× length of segment 7), setaceous papilla analis; apophyses average, with posterior pair twice length of anterior pair; ostium a simple funnel (sclerotized) on intersegmental membrane between sternites 7 and 8; ductus bursae membranous after sclerotized area, merging into ostium, subequal in length to bursa length or short; corpus bursae a simple oval or with elongate extension; ductus seminalis emergent from sclerotized part of ductus bursae; signum absent.

Immature stages.—Larvae bisetose (prothoracic L-group); crochets uniordinal mesal penellipse (or incomplete circles); D1 absent on A9. Pupae unspined.



Figures 3, 4. Head morphology of *Lotisma trigonana* (Walsingham). 3. Head frontal view (USNM slide 77711), Washington. 4. Same, detail of maxillary palpus and haustellum.

Hosts.—Borers of Ericaceae fruits.

Distribution.—Southern Alaska to southern California, along the Pacific Coast; disjunct records in Durango, Mexico, and Costa Rica.

Species.—Two known species.

Remarks.—*Lotisma* appears nearest to *Ellabella* Busck, although each genus is relatively isolated in Copromorphidae (Heppner, 1984). Characters of the adult head and wing venation, together with the morphology of the immature stages, support this conclusion. The larval and pupal similarities have been pointed out by DeBenedictis (1984), in that most of the larval chaetotaxy is the same for both genera, likewise for the pupae. Head characters vary more in the two genera, since *Lotisma* lacks ocelli and has only 3 maxillary palpi segments evident, but pilifers are equally large as in *Ellabella,* as is the relative length of the 2nd labial palpus segment; antennal setae are also similar. Wing venation is similar in each genus, with *Lotisma* having M3 more distant from M2 in the forewing and M1 more

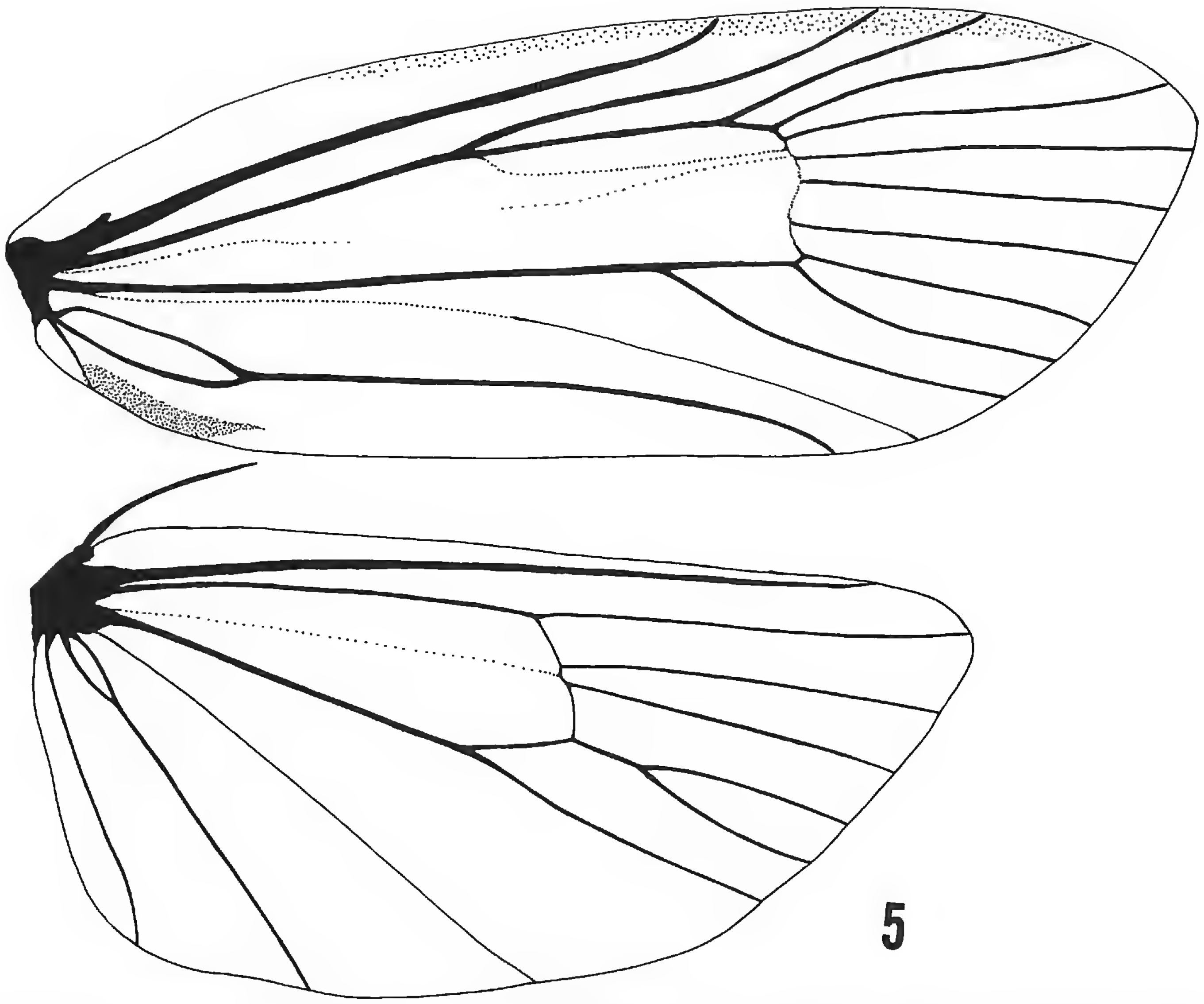


Figure 5. Wing venation of *Lotisma trigonana* (Walsingham), British Columbia (USNM 77070).

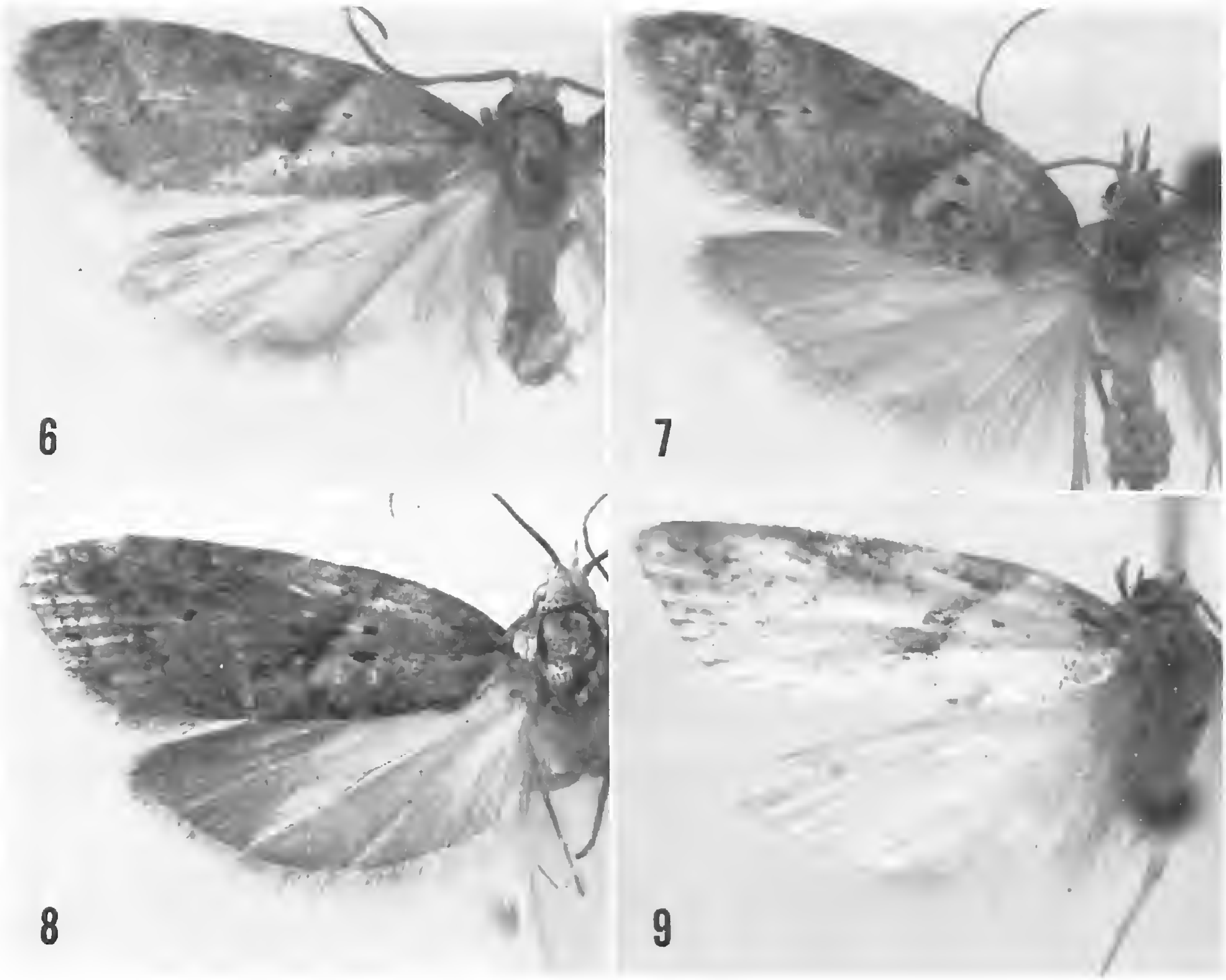
approximate to M2 in the hindwing than in *Ellabella,* and with the hindwing M3 connate with CuA_1 near the cell end; the pterostigma seems absent in *Ellabella. Lotisma* lacks the anterior and posterior corematal hairs of the abdomen of *Ellabella.*

***Lotisma trigonana* (Walsingham)**

Sciaphila trigonana Walsingham, 1879:22.
Hemerophila kincaidiella Busck, 1904:747.
Lotisma trigonana.—Busck, 1909:98.

This species is here divided into two subspecies, the nominate subspecies occurring from south Alaska to southern California and the new subspecies occurring in western Mexico.

Male.—Head: gray with white on frons and laterally from vertex; antenna gray with white on anterior side of scape; labial palpus brown and gray with apical segment white and white on mesal side of palpus. *Thorax:* gray with white on posterior ends of patagia; venter white; legs dark gray and brown, with white bands on distal ends of each segment. *Forewing* (Fig. 6): white mixed with gray near anal and costal margins, with dark brown at base near costa and as a large median triangular patch having a sharp diagonal border from costa diagonally directed toward mid-wing; usually more diffuse border distally; large dark patch with white midway on costal margin, two small dark brown spots, one at ⅓ from



Figures 6–9. Adults of *Lotisma*. 6. *L. trigonana trigonana* (Walsingham), ♂ California (UCB). 7. ♀, California (CAS). 8. *L. t. durangoensis,* n. subsp., ♀ holotype (UCB), Durango, Mexico. 9. *L. vulcanicola* Meyrick, ♂ holotype (NHMV), Costa Rica.

base (sometimes two small spots at this point) and one at ⅔ from wing base; apical quarter with two more or less distinct subterminal dark brown lines, with the more distant from termen being more broken into irregular spots; apical border dark brown; fringe gray; venter gray-brown. *Hindwing:* uniform pale gray-brown, becoming more white centrally; fringe gray and white; venter pale gray and white. *Abdomen:* gray-brown or tan and white.

Female.—Similar to male (Fig. 7).

Immature stages.—*Larva* white, head capsule amber; pinacula distinct but little sclerotized (not amber). Head (Figs. 22, 23) hypognathous; frontoclypeus ⅔ distance to epicranial notch; stemmata in oval, 6 in number; labrum as illustrated (Figs. 21, 23); submentum as illustrated (Fig. 24), with posterior sclerotized arms bifurcate and with tuberculate central setae; mandible with 5 teeth (Fig. 25). Prothorax with sclerotized dorsal shield; L-group bisetose on single pinaculum; D1 close to D2; SD1 distant from SD2; SV setae approximate on single pinaculum. Meso- and metathorax with D1 approximate to D2 and SD1 approximate to SD2, each group on a single pinaculum; L1 approximate to L2 on one pinaculum but together distant from L3. Abdominal segments with prolegs on A3–6; crochets uniordinal in mesal penellipse (or incomplete circle); setae D1 closer together dorsally than D2 on A1–8; SD2 minute; L1 approximate to L2 on single pinaculum, distant from L3; SV group trisetose except on A8 and A9; segment A9 with D1 absent; segment A10 with 6 terminal setae and 2 dorsal setae.

Pupa unspined but with simple setae on abdominal tergites.

Hosts.—The following host data is available from specimen labels or literature references:

Arbutus menziesii Pursh (Ericaceae) (Berkeley Hills, California; British Columbia).
Arctostaphylos sp. (Ericaceae) (Marin County, California).
Gaultheria shallon Pursh (Ericaceae) (Steelhead, British Columbia).
Oxycoccus sp. (Ericaceae) (Sea View, Oregon).
Vaccinium sp. (Ericaceae) (Olympia, Washington; Baudon, Oregon).
Vaccinium sp. (Ericaceae) (Sierra Morena, San Mateo Co.).
Vacinium ovatum Pursh (Ericaceae) (Jig Harbor & Rosedale, Washington (James, 1955)).

Distribution.—Alaska to southern California, along the Pacific Coast; disjunct populations near Durango, Mexico, and Costa Rica.

Lotisma trigonana trigonana **(Walsingham)**

The nominate subspecies occurs along the Pacific Coast, Alaska to southern California.

Forewing length.—6.5–11.0 mm (♂); 6.5–10.8 mm (♀).

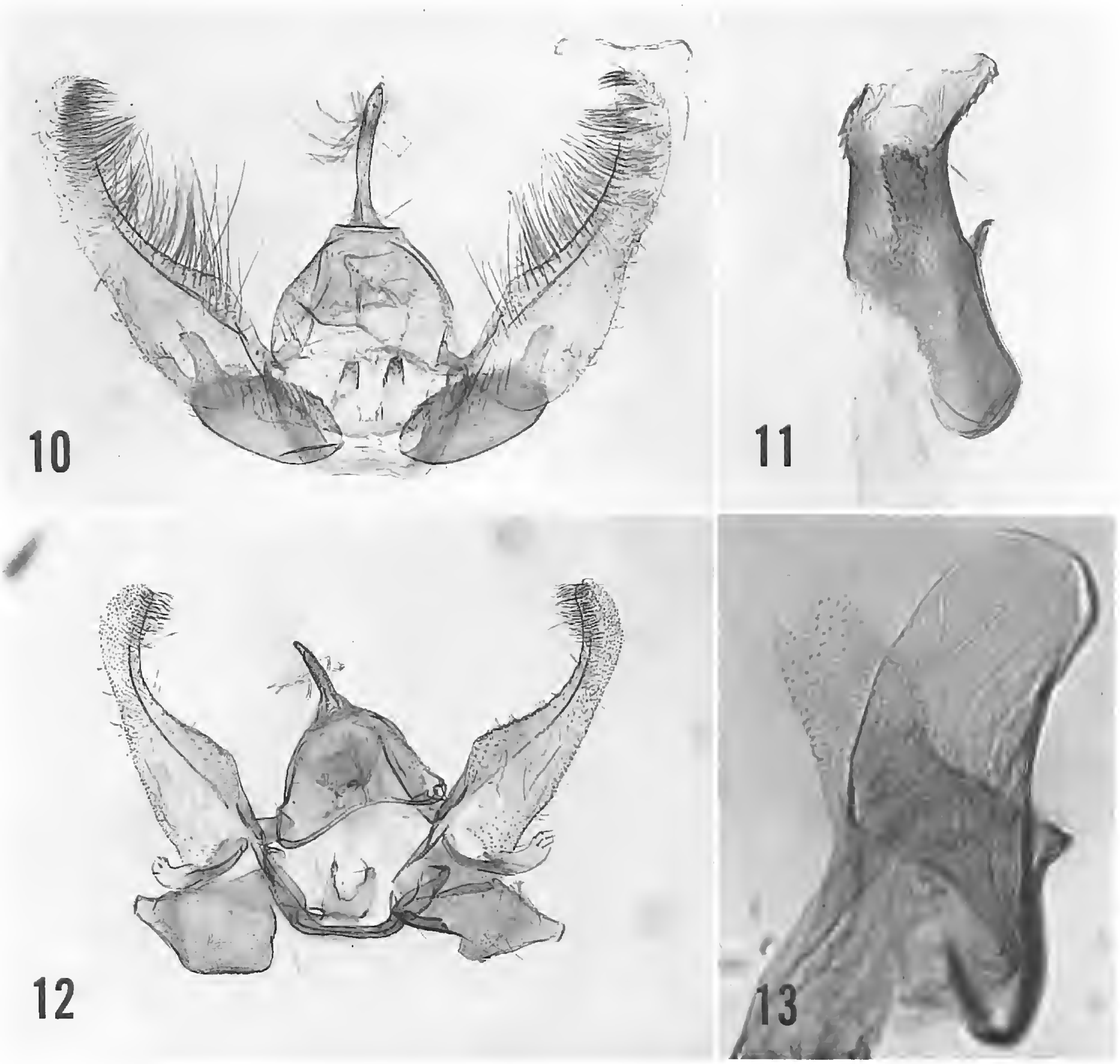
Male (Fig. 6).—As described for the species. *Male genitalia* (Fig. 10): as described for the genus but with the following particulars: uncus long (ca. 2× anellus height); valva evenly narrow to apex after basal width; anellus with basal invagination; aedeagus (Fig. 11) with apical spines.

Female (Fig. 7).—Not significantly different in coloration from the male. *Female genitalia* (Figs. 14, 15): as described for the genus but with the following particulars: papilla anales subequal to anterior apophyses; ductus bursae sclerotized area about 2× length of ostial funnel (Fig. 16), overall length subequal to bursa; corpus bursae ovate without extension.

Flight period.—Feb.–Apr., June (Alaska); May–early Sept. and Oct.–Dec. (Wash.–B.C.); Jan.–Dec. (Calif.).

Types.—Lectotype ♂ (BMNH) (*Sciaphila trigonana* Walsingham): nr. Mendocino City (Mendocino Co.), Calif. 3-5-1871, Walsingham (desig. by Heppner, 1982:279); 1 ♂, 4 ♀ paralectotypes, (same data) (BMNH). Lectotype ♂ (USNM) (*Hemerophila kincaidiella* Busck): Seattle [King Co.], Washington, [no date], Kincaid (hereby designated); 2 ♂ paralectotypes, (same data), 1-III-1896, "Type No. 7809" (USNM); 1 ♂ paralectotype, (same data), 16-VI-1901 (LACM). [Lectotypes are chosen from the best specimen among the syntypes.]

Additional specimens.—(243 ♂, 163 ♀): CANADA. British Columbia.—Fitzgerald, 17-IV-1922 (2 ♂), W. R. Carter (USNM). Fraser Mills, 10-IV-1921 (3 ♂), 24-VII-1921 (1 ♀), [no date] (1 ♂), L. E. Marmont (USNM). Goldstream, 18-IV-1921 (3 ♀), E. H. Blackmore (USNM). Maple Bay, Vancouver Id., 13-VII-1933 (3 ♀), J. H. McDunnough (CNC). New Westminister, 5-VII-1900 (2 ♀), 6-VII-1900 (1 ♂, 1 ♀), 11-VII-1900 (1 ♂), 15-VII-1900 (1 ♂), 22-VII-1900 (2 ♀), C. Durrant (BMNH). Saanich Dist., 1-III-1922 (5 ♂), W. Downes (CNC); 4-XII-1953 (4 ♂, 1 ♀—CNC; 2 ♂, 1 ♀—USNM), O. Peck, "*Arbutus menziesii* berries." Steelhead, VIII-1933 (2 ♂, 1 ♀), H. B. Leech, em. 21-XI-1933 "berries of *Gaultheria shallon*"

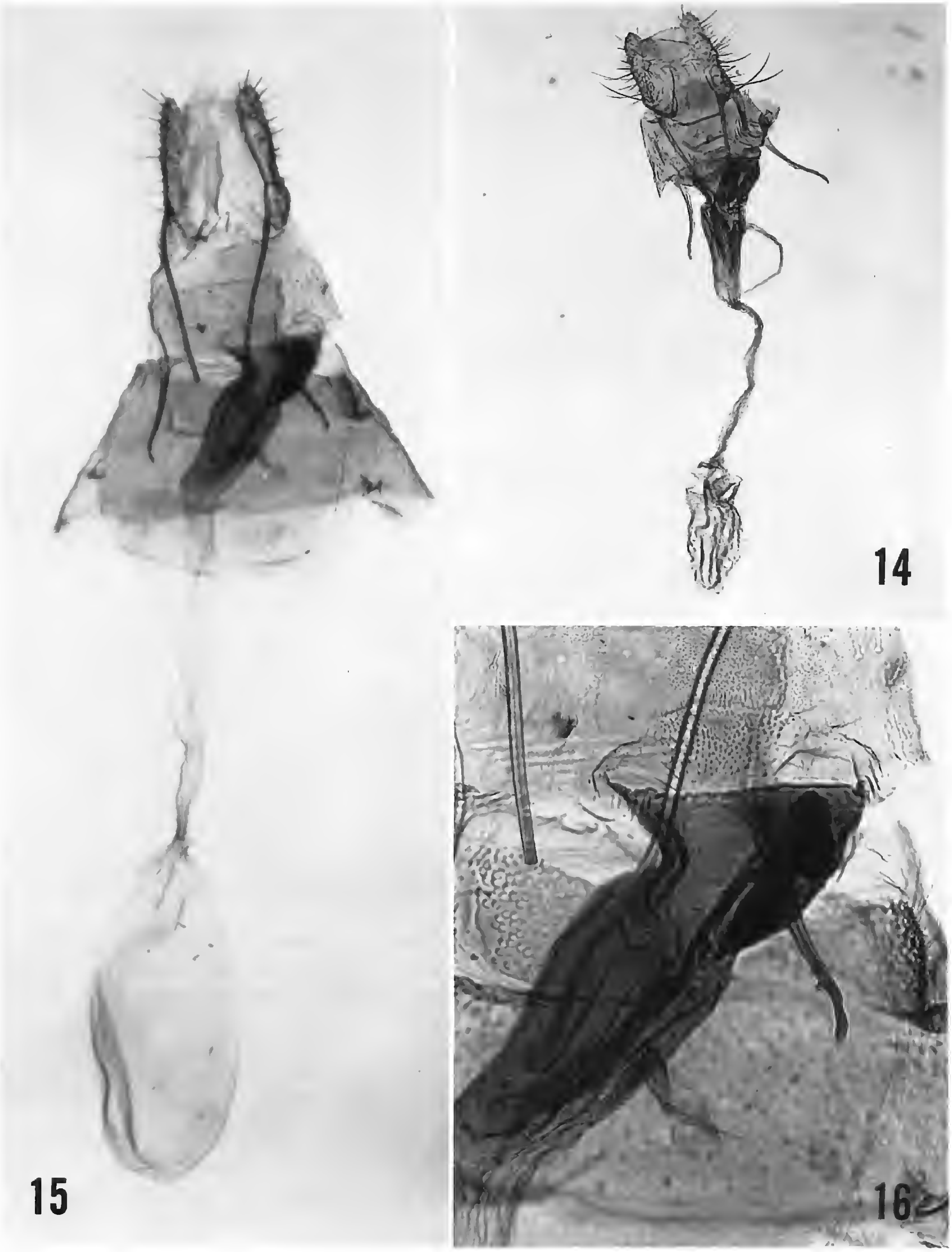


Figures 10–13. Male genitalia of *Lotisma.* 10. *L. trigonana trigonana* (Walsingham), ♂, California (JBH 290, CAS). 11. Same, detail of aedeagus [enlarged]. 12. *L. vulcanicola* Meyrick, ♂ holotype (NHMV), Costa Rica (JBH 912) [sacculus pushed down]. 13. Same, detail of aedeagus [enlarged].

(CNC). Uctuetet, 11-VII-1909 (2 ♂, 1 ♀), (CNC). Vancouver, 4-III-1905 (1 ♂), 4-III-1906 (1 ♂), 13-III-1905 (1 ♀), 24-III-1906 (1 ♂), 29-III-1903 (1 ♂), 5-IV-1903 (1 ♂), W. Downes (CNC). Victoria, 18-VII-1921 (1 ♀), (USNM); 23-II-1921 (4 ♂), 24-II-1921 (8 ♂), 10-X-1922 (1 ♂), W. Downes (CNC). Wellington, 25-III-1899 (1 ♀), [W. G. Dietz] (MCZ); 1-IV-1904 (2 ♂), 3-IV-1904 (2 ♂), (INHS); 7-IV-1902 (1 ♀), (USNM); 8-IV-1903 (1 ♀), G.W. Taylor (USNM); 10-IV-1902 (1 ♀), (ANSP); 14-IV-1902 (1 ♀), (ANSP); 14-IV-1903 (1 ♂), (INHS); 16-IV-1903 (1 ♂), 18-IV-1902 (1 ♂), 20-IV-1903 (1 ♂), (USNM); IV-[1903] (3 ♂, 3 ♀—ANSP; 2 ♂—LACM; 4 ♂, 2 ♀—USNM), G. W. Taylor; VI-1902 (1 ♂), W. G. Dietz (MCZ); 10-XI-1956 (1 ♂), R. Guppy (CPK).

UNITED STATES. Alaska.—Orca, 27-VI-1899 (1 ♀), T. Kincaid, "Harriman Expedition '99" (USNM).

California.—*Alameda Co.:* Berkeley, 23-I-1965 (1 ♀), 24-I-1966 (1 ♂), 4-II-1966 (1 ♀), 20-II-1966 (1 ♂), 11-III-1963 (1 ♂), 10-V-1965 (1 ♀), 23-V-1965 (1 ♂), 19-IX-1965 (1 ♂), R. L. Langston (UCB); 22-V-1960 (1 ♀), V. Bert (UCB); 14-XII-



Figures 14–16. Female genitalia of *Lotisma*. 14. *L. trigonana* (Walsingham), ♀ lectotype (BMNH slide 20212), California. 15. *L. trigonana* (Walsingham), ♀ (CAS), California (JBH 911). 16. Same, detail of ostium.

1960 (1 ♀), J. A. Powell (UCB). Moraga Ridge, 11-VI-1926 (1 ♂), H. H. Keifer (CAS). Strawberry Cyn., Berkeley, 15-I-1963 (1 ♀), J. A. Powell (UCB). *Contra Costa Co.:* Berkeley Hills, 14-IV-1966 (1 ♀), r. f. *Arbutus menziesii* (9-V-1966), J. A. Powell (UCB). El Cerrito, 19-VI-1960 (1 ♂), C. D. MacNeill (CAS); 23-X-

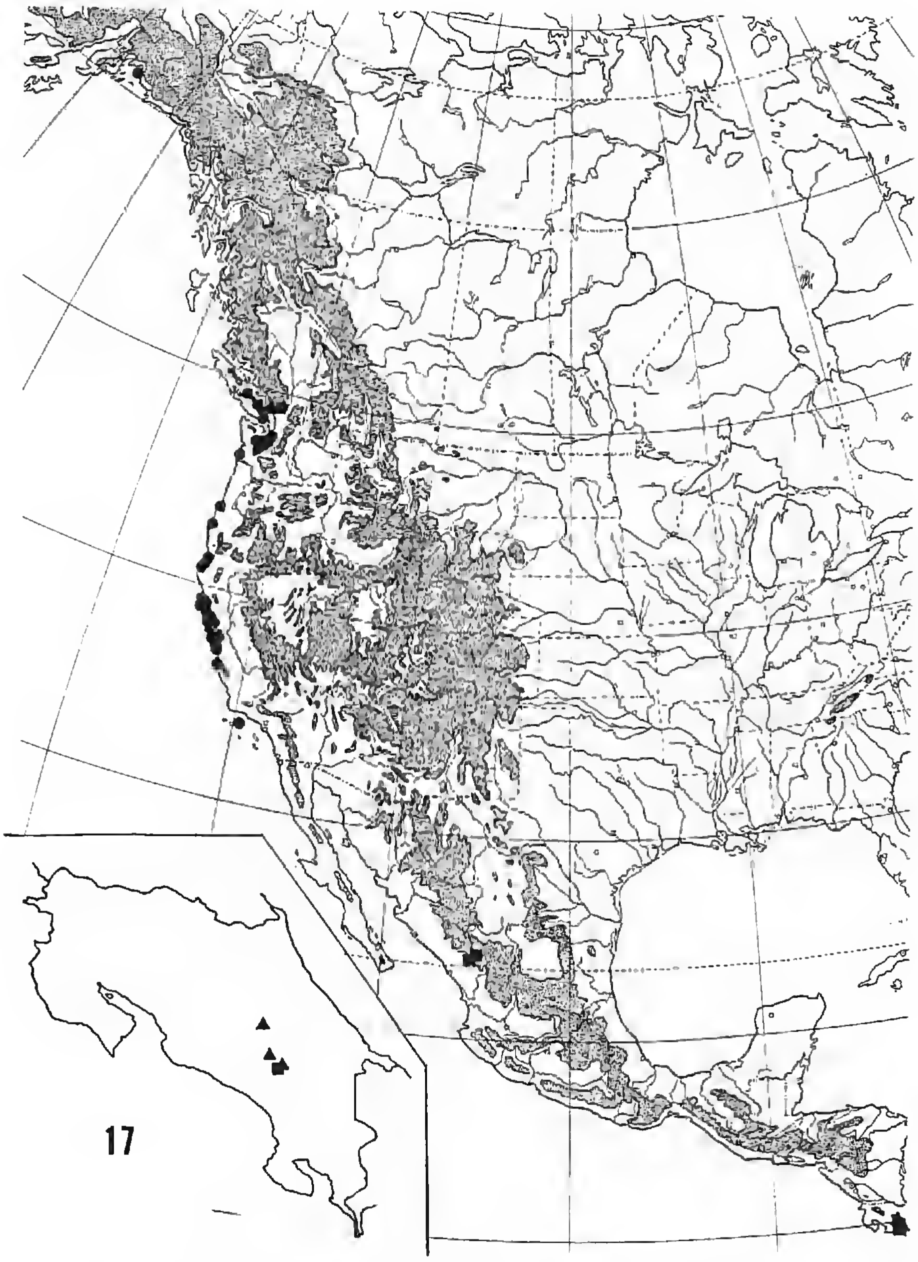


Figure 17. Distribution map of *Lotisma* (with inset of Costa Rica): *L. t. trigonana* (Walsingham) (●); *L. t. durangoensis,* n. subsp. (■); *L. vulcanicola* Meyrick (▲). [1500 m elev. shaded]

1960 (1 ♀), T. R. Haig (CAS). Orinda Village, 25-V-1970 (1 ♀), E. I. Schlinger (UCB). Richmond, 9-IV-1966 (1 ♀), J. Slater (UCB); 23-V-1959 (1 ♀), 28-V-1959 (♀), C. D. MacNeill (CAS). *Humboldt Co.:* Arcata, 15-VII-1969 (2 ♂), 16-VII-1969 (1 ♂), J. A. Powell (UCB). Briceland (5 mi NW), 2–3-IX-1973 (1 ♀), J. A. Powell (UCB). Myers Flat, 23-VIII-1960 (1 ♂, 1 ♀), J. A. Powell (UCB); nr. Myers Flat, 31-VIII-1960 (1 ♂), 2-IX-1960 (1 ♂), C. D. MacNeill (CAS). *Los Angeles Co.:* Chinese Harbor (ridge), Santa Cruz Id., 9-VI-1966 (1 ♀), J. A. Powell (UCB). *Marin Co.:* Inverness, I-10-1964) (2 ♂, 1 ♀), P. H. Arnaud (CAS); 3-II-1963 (1 ♂), 6-VII-1963 (3 ♂, 1 ♀), 7-VII-1963 (1 ♂), 20-VII-1962 (1 ♂), 8-VIII-1962 (1 ♂, 1 ♀), 19-VIII-1962 (1 ♂), 2-IX-1962 (1 ♀), 8-IX-1962 (4 ♂), C. A. Toschi (UCB). Inverness Ridge, 15-V-1970 (2 ♂), J. A. Powell (UCB). Mill Valley, 17-I-1926 (1 ♀), 4-II-1926 (1 ♂, 3 ♀), E. P. Van Duzee (CAS); 11-II-1910 (1 ♀), F. X. Williams (CAS); 11-II-1926 (2 ♂, 1 ♀), M. C. Van Duzee (CAS); 14-II-1926 (1 ♀), 25-II-1926 (2 ♀), 28-II-1926 (2 ♀), E. P. Van Duzee (CAS); 1–6-III-1966 (7 ♂), 7-11-III-1966 (1 ♂, 2 ♀), R. H. Arnaud (CAS); 5-III-1926 (1 ♀), E. P. Van Duzee (CAS); 7-III-1926 (1 ♀), M. C. Van Duzee (CAS); 12-III-1920 (1 ♀), E. P. Van Duzee (CAS); 12-III-1926 (3 ♂, 5 ♀), M. C. Van Duzee (CAS); 16-III-1926 (1 ♂), W. Wild (CU); 17-III-1926 (1 ♀), 18-III-1924 (1 ♀), E. P. Van Duzee (CAS); 19–22-III-

1965 (1 ♀), P. H. Arnaud (CAS); 21-III-1926 (1 ♂, 1 ♀), M. C. Van Duzee (CAS); 30-III-1966 (2 ♂), P. H. Arnaud (CAS); 3–4-IV-1966 (2 ♂, 1 ♀), 5–7-IV-1966 (2 ♂), P. H. Arnaud (CAS); 7-IV-1926 (1 ♂), 9-IV-1926 (1 ♀), M. C. Van Duzee (CAS); 8–12-IV-1966 (4 ♂, 3 ♀), 19–23-IV-1966 (22 ♂, 5 ♀), 25-IV-1965 (4 ♂), 26-IV-1965 (4 ♂, 1 ♀), P. H. Arnaud (CAS); 28-IV-1958 (1 ♂), C. W. O'Brien (UCB); 29-IV-1958 (1 ♂), H. B. Leech (UCB); 1-V-1958 (1 ♀), H. B. Leech (UCB); 3-V-1924 (1 ♂), E. P. Van Duzee (CAS); 6-V-1926 (1 ♀), M. C. Van Duzee (CAS); 6–10-V-1965 (11 ♂, 13 ♀), P. H. Arnaud (CAS); 14-V-1924 (1 ♀), E. P. Van Duzee (CAS); 18–20-V-1965 (4 ♂, 3 ♀), 21–23-V-1965 (4 ♂, 6 ♀), P. H. Arnaud (CAS); 25-V-1924 (1 ♂, 2 ♀), E. P. Van Duzee (CAS); 4-VI-1957 (1 ♂), J. A. Powell (UCB); 4–5-VI-1965 (1 ♂), P. H. Arnaud (CAS); 12–13-V-1965 (6 ♂, 1 ♀), P. H. Arnaud (CAS); 27-VI-1925 (2 ♂), E. P. Van Duzee (CAS); 1–2-VII-1965 (1 ♂, 3 ♀), 3–6-VII-1965 (6 ♂, 1 ♀), 7–8-VII-1965 (1 ♂), P. H. Arnaud (CAS); 8-VII-1925 (1 ♂), E. P. Van Duzee (CAS); 9–12-VII-1965 (4 ♂, 1 ♀), 13–15-VII-1965 (5 ♂), P. H. Arnaud (CAS); 13-VII-1924 (1 ♂), E. P. Van Duzee (CAS); 19-VII-1925 (6 ♂, 2 ♀), 8-VIII-1925 (2 ♂, 2 ♀), H. H. Keifer (CAS); 6-X-1958 (1 ♂), H. B. Leech (UCB); 7-XI-1925 (1 ♂), E. P. Van Duzee (CAS); 5-XII-1925 (1 ♂, 4 ♀), E. P. Van Duzee (CAS). Phoenix Lake, 8-VI-1936 (2 ♀), r. f. manzanita berries (4-VII, 12-VII-1936), H. H. Keifer (USNM). Mt. Tamalpais, 15-VI-1960 (1 ♀), "on stem *Eriophyllum,*" J. A. Powell (UCB). Tomales Bay St. Park, 1-VIII-1969 (1 ♂, 2 ♀), ex manzanita berries (11-VIII, 22-VIII, 2-IX), J. A. Powell (UCB). *Mendocino Co.:* Mendocino, 19-V-1957 (1 ♀), J. R. Helfer (UCB). Novarro River, 29-V-1871 (1 ♂, 6 ♀—BMNM; 2 ♀—USNM), T. Walsingham [undesignated syntypes]. "Cal. Wlsm." (1 ♂) (USNM). Ukiah, 18-V-1966 (1 ♀), J. A. Powell (UCB). *Monterrey Co.:* Carmel, 1-I-1926 (1 ♀), 14-X-1933 (1 ♂), L. S. Slevin (CAS); IV (1 ♀—CU; 3 ♂, 2 ♀—USNM), VI (1 ♂—CU; 6 ♂, 7 ♀—USNM), A. H. Vachell. *San Francisco Co.:* San Francisco, 24-I-1920 (1 ♀), E. P. Van Duzee (CAS); 9-V-1909 (1 ♀), F. X. Williams (CAS). *San Mateo Co.:* Sierra Morena, 22-IV-1947 (1 ♀), r. f. *Vaccinium,* J. W. Tilden (ANSP). *Santa Cruz Co.:* Santa Cruz, 11-X-1932 (1 ♂), 24-X-1932 (1 ♂), (USNM). *Sonoma Co.:* Guerneville, I [no year] (1 ♀), (CAS).

Oregon.—*Coos Co.:* Bandon, 16-X-1946 (1 ♀), 18-X-1946 (1 ♂), (USNM). Tugman St. Park, nr. Lakeside, 10-VIII-1976 (1 ♂), J. A. Powell (UCB). *Douglas Co.:* Glide, 24-VIII-1954 (1 ♀), D. R. Davis (USNM). Tiller, 30-VI-1954, D. R. Davis (USNM). *Lane Co.:* Honeyman St. Park, 6 mi S Florence, 18-VIII-1962 (1 ♂), W. E. Ferguson (UCB).

Washington.—*Baker Co.:* Crosby, 11-VI-1934 (1 ♀), r. f. huckleberry, W. W. Baker (USNM). *King Co.:* Factoria, 9-IV-1949 (3 ♂, 3 ♀), E. C. Johnston (CNC). Seattle, 1-III-1896 (1 ♂), (USNM). *Mason Co.:* Shelton, 16-IV-1949 (2 ♀), E. C. Johnston (CNC). *Pacific Co.:* Sea View, 6-IV-1919 (1 ♀), 12-X-1918 (1 ♀), H. K. Plank (USNM). *Pierce Co.:* Jig Harbor, XI-1935 (5 ♂, 1 ♀), ex *Vaccinium ovatum* fruits, Baker & Wilcox (USNM). Rosedale, 20-IX-1963, ex *Vaccinium ovatum* fruits (em. II-1964), E. P. Breakey & E. G. Tinius (USNM). *Thurston Co.:* Olympia, 3-IV-1893 (2 ♂), T. Kincaid (CU); 1-XI-1944 (1 ♂), 20-XII-1944 (1 ♀), ex huckleberry (USNM). Tenino, 23-IV-1949 (1 ♂), E. C. Johnston (CNC). *Whatcom Co.:* Morovitz R. S., 10-VIII-1931 (1 ♂), J. F. G. Clarke (USNM).

Remarks.—The great distance between the Pacific Coast populations and the Mexican populations, has prompted the use of subspecies for *L. trigonana.* There appear to be no differences between the two races that are not within the range of variation from the different localities. Northern specimens of the nominate subspecies (British Columbia) tend to be larger and darker than specimens from central or southern California. The Mexican specimens, however, tend to be as large and dark as the specimens from British Columbia. There are no records of typical *L. trigonana* from localities very far inland from the Pacific Coast. Records are lacking south of Monterrey and Carmel, California, except for a unique specimen from Santa Cruz Id., Los Angeles Co. The ericaceous hosts, such as *Arbutus* and *Arctostaphylos*, range south into northern Baja California, but thus far no moths have been found from these southern areas. The extreme northern record, in Alaska, indicates that *L. trigonana* should be found all along the Pacific Coast: there is a possibility, however, that the Alaska locality ("Orca") refers to the Oras Islands of Puget Sound, Washington, since the 1899 Harriman Alaska Expedition, which collected the single specimen, may have started collecting in Puget Sound.

Lotisma trigonana and *L. vulcanicola* show no major differences in the female genitalia except in the bursa, but the male genitalia have significant differences in the uncus, the shape of the valvae, and the aedeagus. Likewise, the adult maculation shows some differences, although it is obvious that the species are very closely related.

***Lotisma trigonana durangoensis*, NEW SUBSPECIES**

A Mexican and Central American race of *L. trigonana*, not of significant difference morphologically but generally darker or more gray.

Forewing length.—7.5–7.8 mm (♂); 8.5–10.0 mm (♀).

Male (see Fig. 8).—As in *L. trigonana* but with forewing subterminal lines usually more distinct; overall wing pattern darker, a higher frequency of adults having the forewing basal dark spot at ⅓ from wing base as a dual spot (this is less frequent in the nominate subspecies). Male genital characters as in the typical subspecies.

Female (Fig. 8).—Same as male in wing pattern. *Female genitalia:* same as in the typical subspecies but apophyses tending to be slightly longer.

Immature stages.—Unknown.

Host.—Unknown (presumably Ericaceae as in the nominate subspecies).

Distribution.—Mexico (Durango and nearby border area of Sinaloa); Costa Rica.

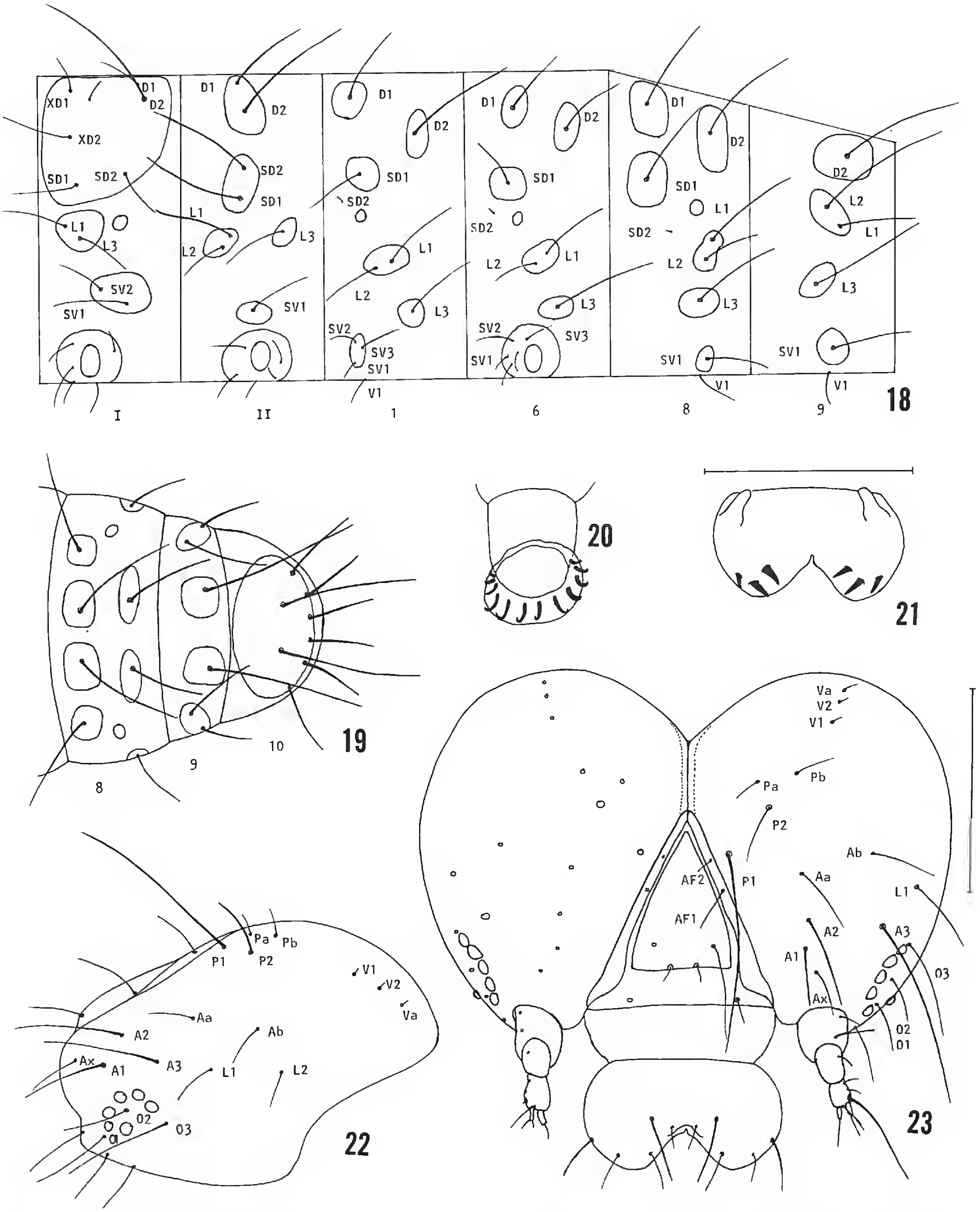
Flight period.—July–August; May (Costa Rica).

Types.—Holotype ♀ (UCB): Mexico: 10 mi W El Salto, Durango, 21-VII-1964, 8800 ft, Chemsak & Powell (Slide JBH 294).

Paratypes (12 ♂, 12 ♀).—MEXICO. *Durango:* 30 mi W Durango, 8400 ft [2554 m], 3–7-VIII-1972 (2 ♀), Powell, Veirs & MacNeill (UCB). El Salto (9 mi W), 8800 ft [2675 m], 2-VII-1964 (2 ♀), Chemsak & Powell (UCB). Las Rusias, 12 mi E La Ciudad, 9200 ft [2797 m], 14–18-VIII-1972 (2 ♂), Powell, Veirs & MacNeill (UCB). La Ciudad (24 mi W) 7500 ft [2280 m], 19-VII-1964 (10 ♂, 3 ♀), J. A. Powell (UCB). *Sinaloa:* El Palmito (4 mi W), 20-VI-1964 (1 ♂, 1 ♀), J. A. Powell (UCB); (8 mi W), 6400 ft [1945 m], 8–12-VIII-1972 (4 ♀), Powell, Veirs & MacNeill (UCB).

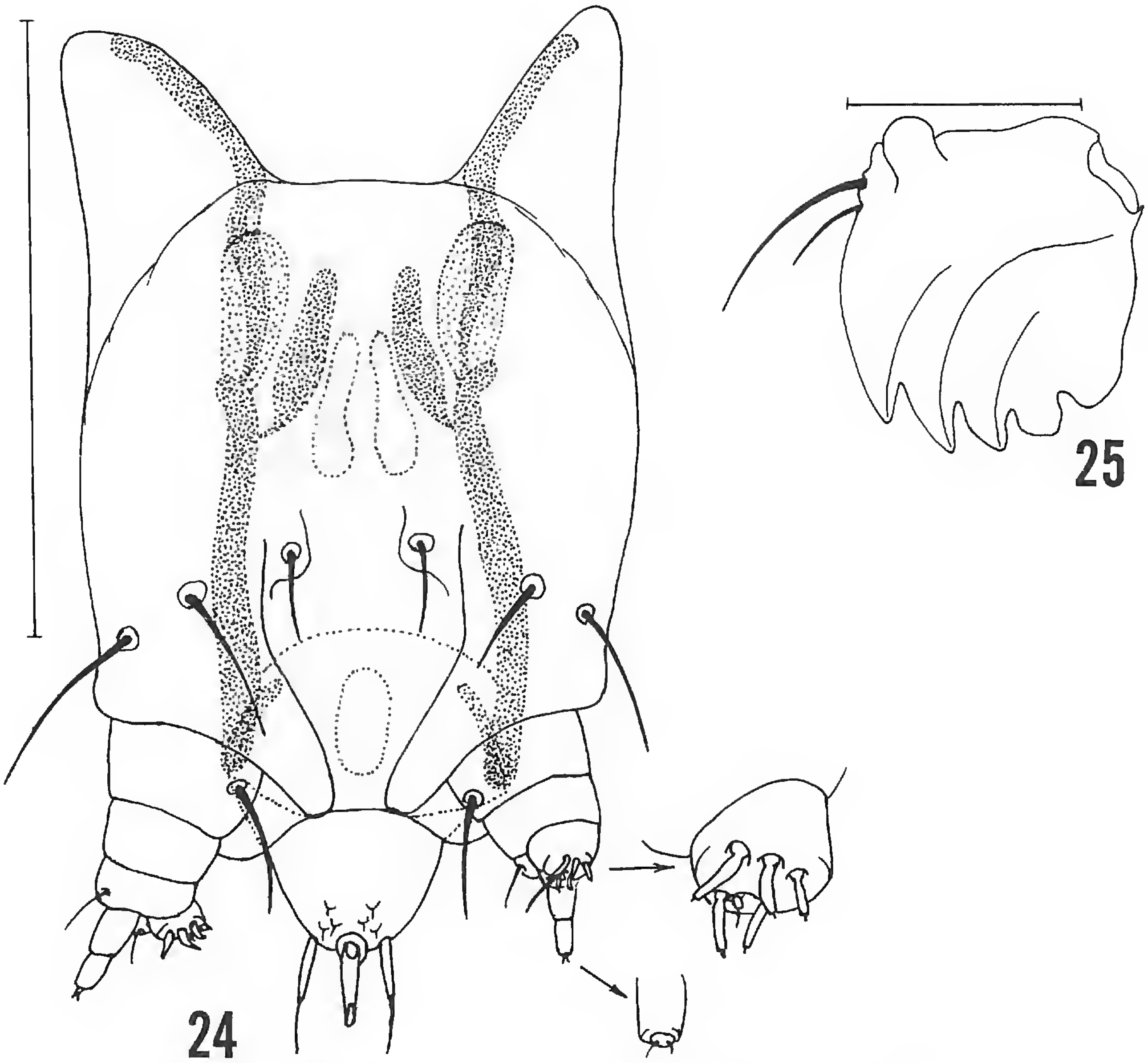
Additional specimens.—COSTA RICA. *Cartago:* Cerro de la Muerte, Pension La Georgina, 3000 m, 23/25-V-1985 (2 ♀), J. A. Powell & P. A. Opler (UCB).

Remarks.—As noted for the typical populations of *L. trigonana*, there are no significant differences between the Mexican and Costa Rican segregates and the



Figures 18–23. Larval characters of *Lotisma trigonana* (Walsingham). 18. Larval chaetotaxy. 19. Caudal segments (dorsal view). 20. Proleg and crochets. 21. Labrum (ventral view) (scale line = 0.5 mm). 22. Head (lateral view). 23. Head (front view, with labrum attached) (scale line = 0.5 mm).

Pacific Coast populations. The two subspecies are extremely disjunct, especially so when one notes that typical *L. trigonana* is found only along the Pacific Coast, with no interior records south or in Arizona or the Great Basin. *L. trigonana durangoensis* may well range over much of the Sierra Madre Occidental south to Costa Rica where more recent collections have located another segregate population.



Figures 24, 25. Details of *Lotisma trigonana* (Walsingham) larva. 24. Submentum (ventral view) (scale line = 0.5 mm), with details (at arrows) enlarged. 25. Mandible (ventral side) (scale line = 0.2 mm).

Lotisma vulcanicola Meyrick

Lotisma vulcanicola Meyrick, 1932:285.

A Central American species superficially very similar to *L. trigonana.* Diagnostic characters are in the male genitalia, where the valvae have a distinct narrowed area near the apex and the uncus is short.

Forewing length.—7.8–8.3 mm (♂); 8.0–9.1 mm (♀).

Male (Fig. 9).—*Head:* tan, with white on frons; antenna tan, with long central cilia; labial palpus dark brown with white on apical segment and on mesal side. *Thorax:* tan, with some white posteriorly; patagia dark brown anteriorly and white on posterium; venter white; legs tan and white. *Forewing* (Fig. 9): lustrous white, with dark brown patch at base along costal margin; a mid-wing diagonal dark brown bar from costa at CuP fold, directed toward tornus; another dark brown patch on costal margin at ⅔ from base; a small dark brown spot at end of discal call; apical quarter with various dark brown marks forming an indistinct subterminal line; apex with dark brown bar near end and tan along costal margin; fringe white, brown with white on anal field. *Hindwing:* lustrous white, somewhat translucent centrally; fringe white, venter white. *Abdomen:* white and tan; venter white.

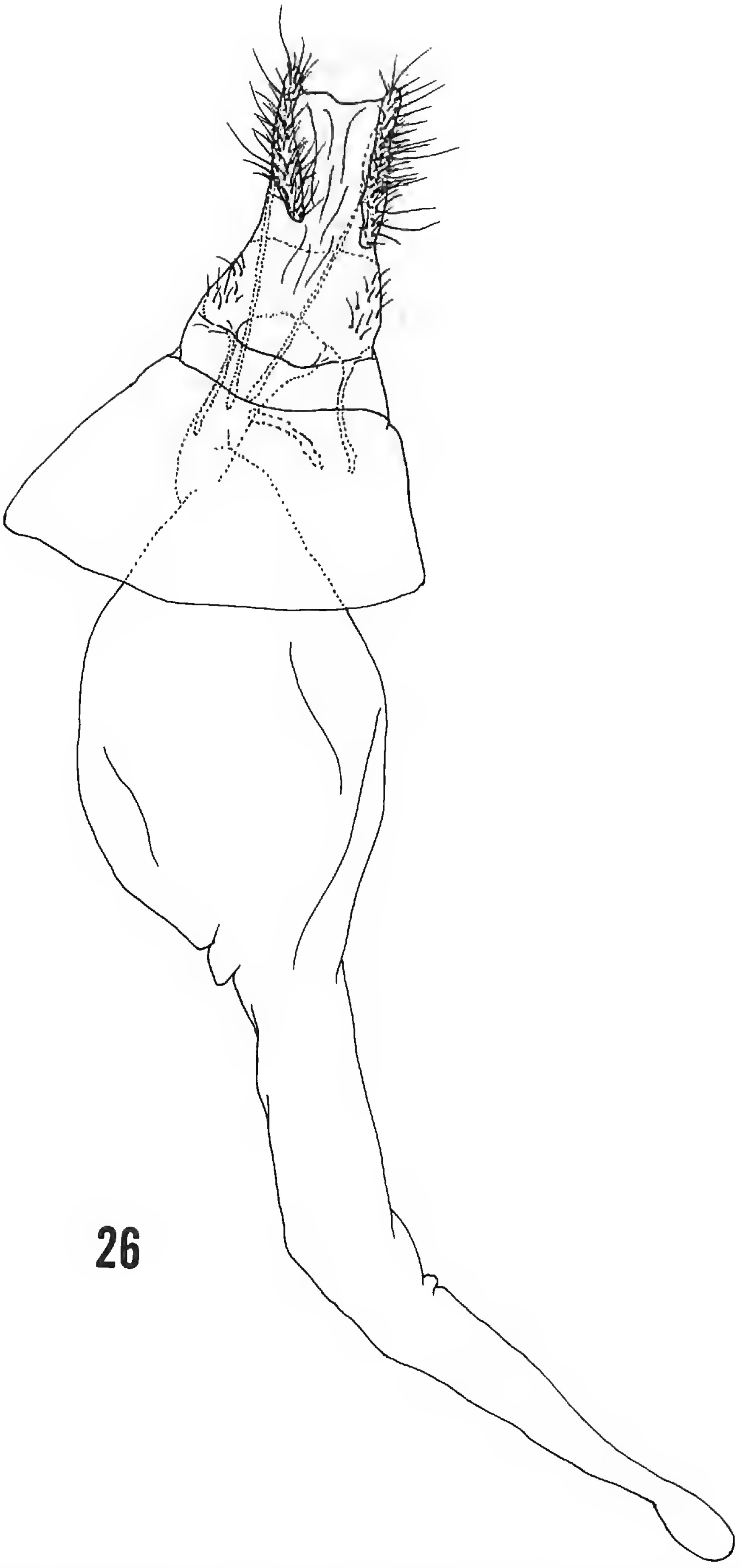


Figure 26. Female genitalia of *Lotisma vulcanicola* Meyrick plesiotype, Costa Rica (JBH 1855, UCB).

Male genitalia (Fig. 12): as described for the genus but with the uncus short (ca. 1¼ × anellus height); valva with narrow distal end having distinct "neck" following the basal width; anellus basally straight and without an invagination; aedeagus without distal spines (Fig. 13).

Female.—As in the male. *Female genitalia* (Fig. 26): as for the genus but with papilla anales slightly longer than anterior apophyses; ductus bursae little sclerotized and short, merging into large corpus bursae having a narrow extension twice bursa length.

Immature stages.—Unknown.

Host.—Unknown (conceivably Ericaceae hosts as in *L. trigonana*).

Distribution.—Costa Rica (2200–3000 m).

Flight period.—May.

Types.—Holotype ♂ (NHMV): Costa Rica: Irazu, 21–28-V-1930, Reimoser, 2200–2500 m. Plesiotype ♀ (UCB): Costa Rica: Cartago Prov., Cerro de la Muerte, Pension La Georgina, 3000 m, 23/25-V-1985, J. A. Powell & P. A. Opler (UCB).

Additional specimens.—COSTA RICA. Cartago: Cerro de la Muerte, Pension La Georgina, 3000 m, 23/25-V-1985 (5 ♂, 2 ♀), J. A. Powell & P. A. Opler (UCB). 7 km SE El Canon, 2500 m, 28-V-1985 (1 ♂), J. A. Powell & J. T. Doyen (UCB).

Remarks.—*Lotisma vulcanicola* has been found again only recently, since the unique male was originally collected in 1930. It is conceivable that the distribution of this species may be much wider in Central America but this will require more extensive collections of microlepidoptera in the region to determine. Various Ericaceae should be searched as the possible host of this species at appropriate elevations. Fresh adult specimens have the dark forewing markings more pronounced than shown for the somewhat worn holotype (Fig. 9) but the species retains the more extensive silvery white areas of the forewings that distinguish it markedly from *L. trigonana*. At Cerro de la Muerte recent collections have also for the first time found both *L. vulcanicola* and *L trigonana* flying at the same time, with *L. trigonana* being noticeably darker and gray in coloration compared to *L. vulcanicola*.

ACKNOWLEDGMENTS

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The Relationship Between Cocoon Weight and Prepupal Weight in *Megachile rotundata* (Hymenoptera: Megachilidae)[1]

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The utilization of energy and nutrients by organisms can be viewed as a problem in the efficient allocation of limited resources to the various processes and characteristics necessary for survival and reproduction. In a broad sense, a trade-off exists between survival and reproduction (Calow, 1977) such that requisites directed to one process are generally unavailable to, and prevent the maximization of, the other. Among some species of bees, one characteristic linked to survival is the cocoon. Cocoons are thought to improve the chances of survival to the adult stage by maintaining a favorable environment for continued development, and by affording protection from enemies (Stephen et al., 1969). Yet, cocoon construction must reduce adult size and/or the requisites available for reproduction when the adult stage is reached. Despite this interesting interaction, little information exists on the amount of energy or biomass that immature stages direct to cocoon synthesis.

This note supplements the detailed energy and nitrogen budgets presented by Wightman and Rogers (1978) for unsexed, immature alfalfa leafcutting bees (*Megachile rotundata* (F.) (Megachilidae)) and provides data on 1) cocoon and prepupal wet weights and 2) overwintering weight loss from the prepupal to the adult stage. The following questions are considered: 1) Is cocoon size related to prepupal size and, if so, what is the form of the relationship? Wightman and Rogers (1978) reported that the cocoon averaged 12.4% of cocoon and prepupal dry weight. However, Stephen and Torchio (1961) noted that small individuals frequently spin incomplete cocoons. Thus, the relationship between the weights may be sigmoidal rather than parabolic or linear as might be predicted. 2) Do the sexes differ in the proportion of body weight used in cocoon construction? If the relationship between cocoon and prepupal weight is parabolic, then males might be expected to use a greater proportion of body weight in cocoon construction. 3) How much weight is lost during the transition from pupa to adult and is weight loss related to size or sex of the immature, or to the time during the flight season when an individual is produced?

MATERIALS AND METHODS

Nests were obtained from paper soda straws (5 mm diameter, 6.7 cm depth) from artificial wooden domiciles at two sites in northern Utah. Data comparing cocoon and prepupal weights were obtained from Greenville Farm, North Logan,

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[1] Contribution from Utah Agricultural Experiment Station, Utah State University, UMC 48, Logan, Utah 84322, Journal Paper No. 3187, and USDA, ARS, Bee Biology & Systematics Laboratory, Utah State University, Logan, Utah 84322-5310.

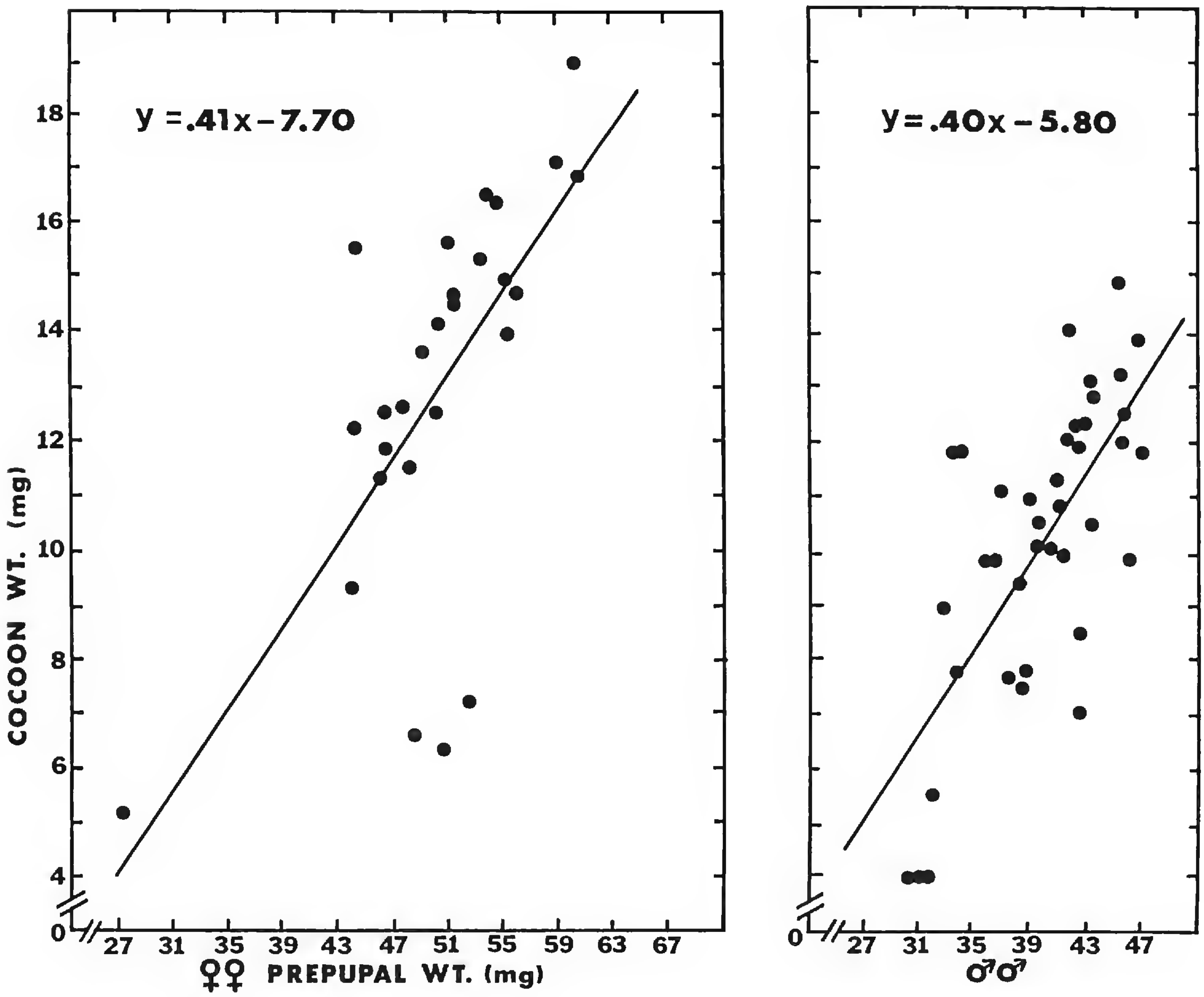

Figure 1. The relationship between weight of cocoon and weight of prepupae for female (a) and male (b) *M. rotundata.*

Utah (see Tepedino, 1983 for details). After collection in September, nests were maintained at room temperature (24–28°C) until mid-October when they were opened and separated into their component cells. Leaf pieces and feces were carefully removed from the cocoons of 100 randomly selected cells and cocoon and resident prepupa were weighed on an electronic balance (mg^{-1}). Prepupae were stored in individual gelatin capsules at 4–5°C for the overwintering period. They were incubated at 29°C the following June and sex and mortality were recorded. Nests for the study of overwintering weight loss were obtained from a population housed adjacent to a commercial alfalfa field in Clarkston, Utah. Completed nests were collected weekly from mid-July through September and maintained in the laboratory at room temperature. In mid-October, 100 randomly selected cells from each collection date were opened and the prepupae weighed (mg^{-1}). Subsequent treatment was as described above except individuals were weighed again upon emergence the following June.

RESULTS

The correlation between cocoon and prepupal weights was highly significant for both sexes ($r(♂) = 0.71$, $n = 39$, $P < 0.001$; $r(♀) = 0.67$, $n = 27$, $P < 0.001$), and was best described by linear equations (Fig. 1). There was no significant

Table 1. Overwintering weight loss of male and female alfalfa leafcutting bees by week of collection. n = sample size, SD = standard deviation.

	Male			Female		
Week	n	% loss	SD	n	% loss	SD
1 (7/14)	23	4.1	2.5	10	5.4	4.4
2 (7/21)	67	3.4	2.4	35	4.2	3.7
3 (7/29)	80	5.2	2.8	25	5.4	3.5
4 (8/5)	34	5.0	4.4	11	4.0	3.6
5 (8/18)	60	3.3	1.1	14	3.6	1.2
6 (8/25)	56	4.5	3.7	18	3.4	1.4
7 (9/2)	57	5.6	1.7	18	5.9	4.1
8 (9/9)	69	4.2	2.2	20	3.6	0.9
9 (10/1)	21	1.9	1.4	10	3.1	3.8
ξ	467	4.3	2.8	161	4.4	3.2

difference between the sexes in the slopes of the regression lines ($P > 0.05$). Combining data for both males and females yielded the equation: $y = 0.33x - 3.10$ where y and x are cocoon and prepupal weights, respectively ($r = 0.74$, $P < 0.001$). In addition, there was no significant difference between the sexes in the ratio of cocoon weight to cocoon plus prepupal weight (x(♂) = 0.201, SD = 0.038; x (♀) = 0.202, SD = 0.037; $P > 0.05$).

Data on overwintering weight loss were subjected to arcsin transformation and analyzed by two-way unbalanced factorial ANOVA with sex and week of production as factors (Table 1). There was no significant difference between the sexes ($P > 0.05$) nor was there a significant interaction between sex and weeks ($P > 0.05$). There was, however, a significant difference among weeks ($P < 0.001$); the only clear pattern was that prepupae produced during the last collection week lost less weight over winter than did those from other collection dates.

DISCUSSION

The estimate of cocoon weight as a percentage of cocoon and prepupal weight (20.1%) is substantially higher than that calculated from the data of Wightman and Rogers (1978) (12.4%). Their data are probably more accurate because dry weights rather than wet weights were used. It was impossible to use dry weight in this study because of the need to determine the sex of the specimens. Nevertheless, it is unlikely that the differences between the studies are due to the accuracy of measurement. Rather, populations of *M. rotundata* may differ in the energy and nutrients they invest in cocoons. In some species of bees, cocoon spinning appears to be facultative rather than obligatory, while in others, some individuals in a population spin cocoons but others do not (Rozen, 1984; Torchio and Trostle, 1986).

The only comparable data on cocoon and immature weights in non-social bees appears to be that of Parker (1984) for the megachilid bees, *Osmia latisulcata* Michener and its parasite, *Stelis depressa* Timberlake. In *S. depressa,* the cocoon represents 19.1% of cocoon and prepupal weight. For *O. latisulcata,* it was necessary to adjust Parker's (1984) measurements because he weighed adults rather than post-spinning prepupae. We used the overwintering weight loss estimate of

4.3% for *M. rotundata* to increase the adult weights reported by Parker (1984). After this adjustment, the estimate of cocoon weight as a percentage of cocoon and prepupal weights is 27.5% for males and 21.3% for females. The estimates for *O. latisulcata* are actually somewhat lower than those presented here because the cocoon weight includes weight of the feces. Thus, in both species, cocoon weight as a percentage of immature weight appears to be similar to that of *M. rotundata.* It would be instructive to know the relative amounts of calories or biomass that other species channel to cocoon construction and to relate this to other parameters such as incidence of parasitism, overwintering mortality and fecundity. Such comparisons await additional studies.

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Reproductive Soldiers in the Termopsidae (Isoptera)

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Abstract.—In addition to nonreproductive soldiers, reproductive soldiers are reported to occur in six of the 17 species of primitive, rotten-wood termites in the world. All three species in the genus *Zootermopsis* from the western United States occasionally produce reproductive soldiers in colonies that are orphaned from the primary reproductives. New records of reproductive soldiers of both sexes are reported from *Zootermopsis laticeps* (Banks). It is suggested that if reproduction by termite soldiers is primitive, then soldiers may have originally evolved by individual-level selection under intracolonial competition among replacement reproductives, rather than by group selection for colony defense.

Polymorphism has evolved in at least 20 different orders of insects (Richards, 1961). Most polymorphism involves color or wing development. But, examples in which one of the morphs is soldier-like are more common than is generally recognized. These include virtually all termites (soldiers lost in Apicotermitinae) in which soldiers are monophyletic (Hare, 1937), about 17% of ant genera in which the soldiers are polyphyletic (Wilson, 1979), some thrips, assassin bugs, bark beetles, fig wasps, and others (Hamilton, 1979), one bee (Houston, 1970), some aphids (Aoki, 1982, 1983), and lammellicorn beetles (Otte and Stayman, 1979). In many of these cases behavioral studies have shown that the primary function of the hypertrophied mandibles of the soldier-like morph is not colony defense but intracolony combat (Hamilton, 1979). Thus it appears that these morphs have evolved by selection pressures resulting from reproductive competition, i.e., social selection, or more specifically intrasexual selection (West-Eberhard, 1981). In view of this it seems significant that the most socially primitive termites have occasional reproductive soldiers. In this paper records of reproductive soldiers in the family Termopsidae are assembled for the first time along with new records in *Zootermopsis laticeps* from Arizona.

Review of Reproductive Soldiers in Termopsidae

Records of reproductive soldiers are widely scattered through the literature, interspersed among mostly old descriptions of natural history. Consequently these records have never before been assembled. The earliest observations were on *Zootermopsis angusticollis* and *Z. nevadensis* by Heath (1903). He observed three such "monstrosities" and noted that they occurred only when the primary reproductives were absent. All three laid eggs in captivity and these hatched into normal nymphs and workers. Heath later (1907) stated that reproductive soldiers "appeared in small fragments of wood, which have broken off from the main trunk inhabited by an extensive colony . . . ." He regarded them as developmental abnormalities possibly induced by an abnormal "mode of feeding" associated with the disturbed conditions.

Imms (1919) made numerous references to reproductively functional soldiers in his monograph on *Archotermopsis wroughtoni.* He observed that the testes and ovaries of soldiers were normally developed to the same extent as those of the alates before flight and showed no signs of "degeneration or arrestation of development." He found five females with ovaries more developed than those of preflight alates. He stated that "it is likely that all the individuals of that caste [soldiers] are potentially capable of reproduction." He also referred to studies by Müller (1873) on *Calotermes* [=*Kalotermes*] *canellae* and observations on *C. nodulosus* and *C. rugosus* that soldier ovaries are developed almost to the same extent as in the winged caste but have the spermathecae undeveloped. Thus he felt that a general trend existed from primitive termite soldiers with well developed and sometimes functional gonads, through more advanced soldiers with gonads reduced "primarily by an arrestation of development," to the most advanced soldiers with a "variable amount of atrophy or degeneration."

Heath (1927) added an additional observation of a "fertile soldier," bringing to four the number of specimens he had observed. He also made actual observations of copulation between the female fertile soldier and a male neotenic reproductive and again observed ovipositing of eggs and hatching of normal progeny. Heath (1928) reported observation of 14 additional fertile soldiers of *Z. nevadensis* all of which had been collected from fragments of a broken limb of *Pinus radiata.* He illustrated the fertile soldiers' relatively small heads compared to normal soldiers and described their tendency to congregate with neotenics rather than to "move about from place to place" in the manner of typical soldiers.

Castle (1934) also observed fertile soldiers of both sexes of *Z. nevadensis* from colonies collected in the field and in isolated groups in the laboratory. He stated that they developed in groups having neither soldiers nor functional reproductives. Light (1943) stated that in *Zootermopsis angusticollis* "Intercastes such as wing-padded soldiers, and various soldier-nymphal-neotenic or alate-soldier-nymphal-neotenic intergrades indicate that several of these influences may affect the terminal characteristics of a single individual." Light (1944) reported experiments in which typical soldiers when isolated were found incapable of transformation to reproductive soldiers, an indication that reproductive soldiers do not develop through the transformation of typical soldiers.

Zootermopsis and *Archotermopsis* belong to the termopsid subfamily Termopsinae, in many respects the most primitive of living termites (Emerson, 1933, 1955). Reproductive soldiers have also been reported from the monogeneric subfamily Stolotermitinae. Morgan (1959) referred to small-headed "emergency soldiers" which develop under disturbed conditions in *Stolotermes ruficeps.* It seems likely that these are reproductive soldiers. Gay and Calaby (1970) reported that "soldiers with obvious wing pads, and functional gonads have been demonstrated in male soldiers . . ." of *Stolotermes brunneicornis.* This has been confirmed by J. A. L. Watson (pers. comm.) who observed "soldiers that on histological grounds appear to be fertile in *Stolotermes brunneicornis* (Hagen) from Tasmania . . . ." Emerson and Krishna (1975) state that "In the most primitive termites [presumably termopsids] soldiers occasionally lay unfertilized eggs which may hatch into parthenogenetic nymphs."

NEW RECORDS OF REPRODUCTIVE SOLDIERS IN *Z. LATICEPS*

Recently I have made observations of reproductive soldiers in *Zootermopsis laticeps* from Arizona. The first individual was found in a 1.5 meter section of willow about 30 cm in diameter which had been sawn from a standing tree near Tumacacori, Arizona, in July, 1982 and stored at ambient conditions in Tucson until extracted on November 29, 1982. The log fragment, which contained only a portion of the original colony and was orphaned from the primary reproductives, had the following population at the time of extraction: 779 immatures of various instars, 8 normal soldiers, 3 neotenic females, and 1 small-headed male reproductive soldier (see Fig. 1). Because the small-headed soldier resembled Heath's (1928) illustration of a fertile soldier in *Z. nevadensis,* it was dissected to ascertain the condition of its reproductive system. The reproductive tract proved to be well developed and apparently functional on the basis of size. In contrast, the reproductive tracts of the normal soldiers from the same colony were completely undeveloped. In comparison to the reproductive tract of a mature primary king, from another colony with a population of 913 individuals, the width and length of the vasa deferentia and the width, length, and number of accessory gland tubules were comparable. The testicular diameter of the reproductive soldier was even greater than that of the primary king (Fig. 2). Unfortunately, no attempt was made to find sperm.

Another colony of *Z. laticeps* was collected from a willow branch near Rio Rico, Arizona, on March 4, 1984. From this colony four groups were set up in petri dishes: (Group #1: 11 nymphs with wing pad abscission scars; Group #2: 57 short-wing-padded (N1 and N2) nymphs; Group #3: 52 long-wing-padded (N3) nymphs; Group #4: 66 workers and 5 soldiers). A total of 3, 12, 2, and 8 neotenics developed within these groups, respectively. Over an observation period of 160+ days, first eggs appeared from 72–91 days and first larvae after 131 days. Presoldiers appeared only in Group #2. Four presoldiers developed between day 16 and 20 and transformed to soldiers between day 34 and 46. All four were dissected on day 103. The smaller two were females, whose ovary development was comparable to neotenics of the same age. The other two soldiers were a male and a female and had underdeveloped gonads. As with the field-collected specimen the two reproductive soldiers had noticeably smaller heads than typical soldiers.

SUMMARY

The Termopsidae contains 17 species in 5 genera and 3 subfamilies. Six species in 3 genera and in 2 subfamilies have been reported to have reproductive soldiers or at least soldiers with apparently functional gonads. Table 1 gives a full listing of the family Termopsidae with all references to reproductive soldiers. Three species whose biologies have been moderately investigated and yet are unknown to possess reproductive soldiers are *Porotermes adamsoni* (Mensa-Bonsu, 1976; Lenz, 1985), *P. planiceps* (Coaton and Sheasby, 1976), and *Stolotermes africanus* (Coaton and Sheasby, 1978). The remaining species without reports of reproductive soldiers have not been well studied. Reproductive soldiers may be expected in additional termopsid species when their biologies are more closely examined.

The possible relevance of reproductive soldiers to theories on the origin to

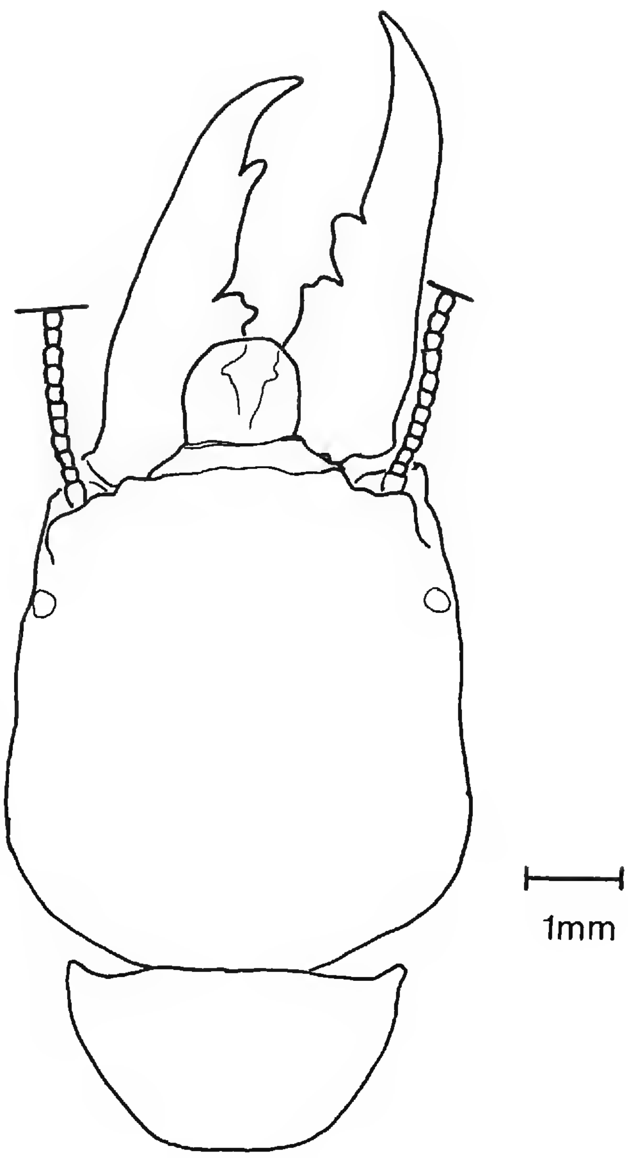

Fig. 1A

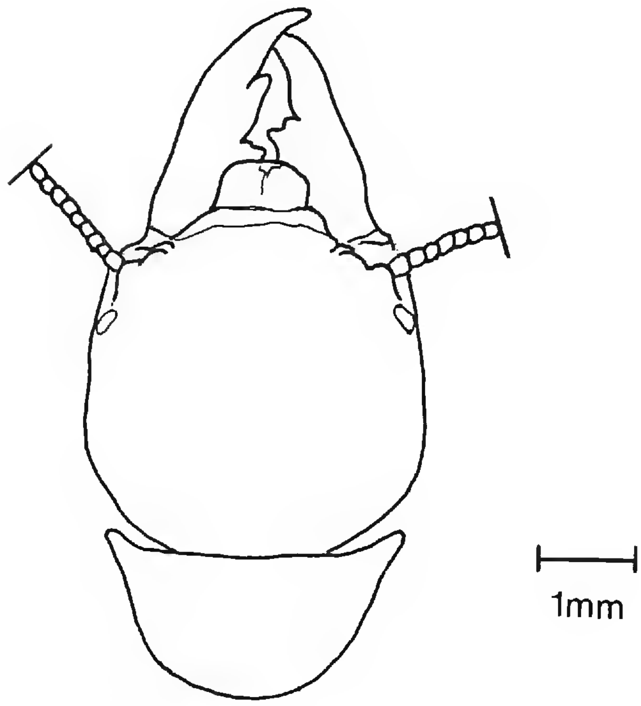

Fig. 1B

Figure 1. A. Head and pronotum of a typical non-reproductive soldier of *Zootermopsis laticeps* from Colony #3 (right mandible slightly disjointed). B. Head and pronotum of male reproductive soldier of *Zootermopsis laticeps* from Colony #3 collected near Tumacacori, Arizona (see text).

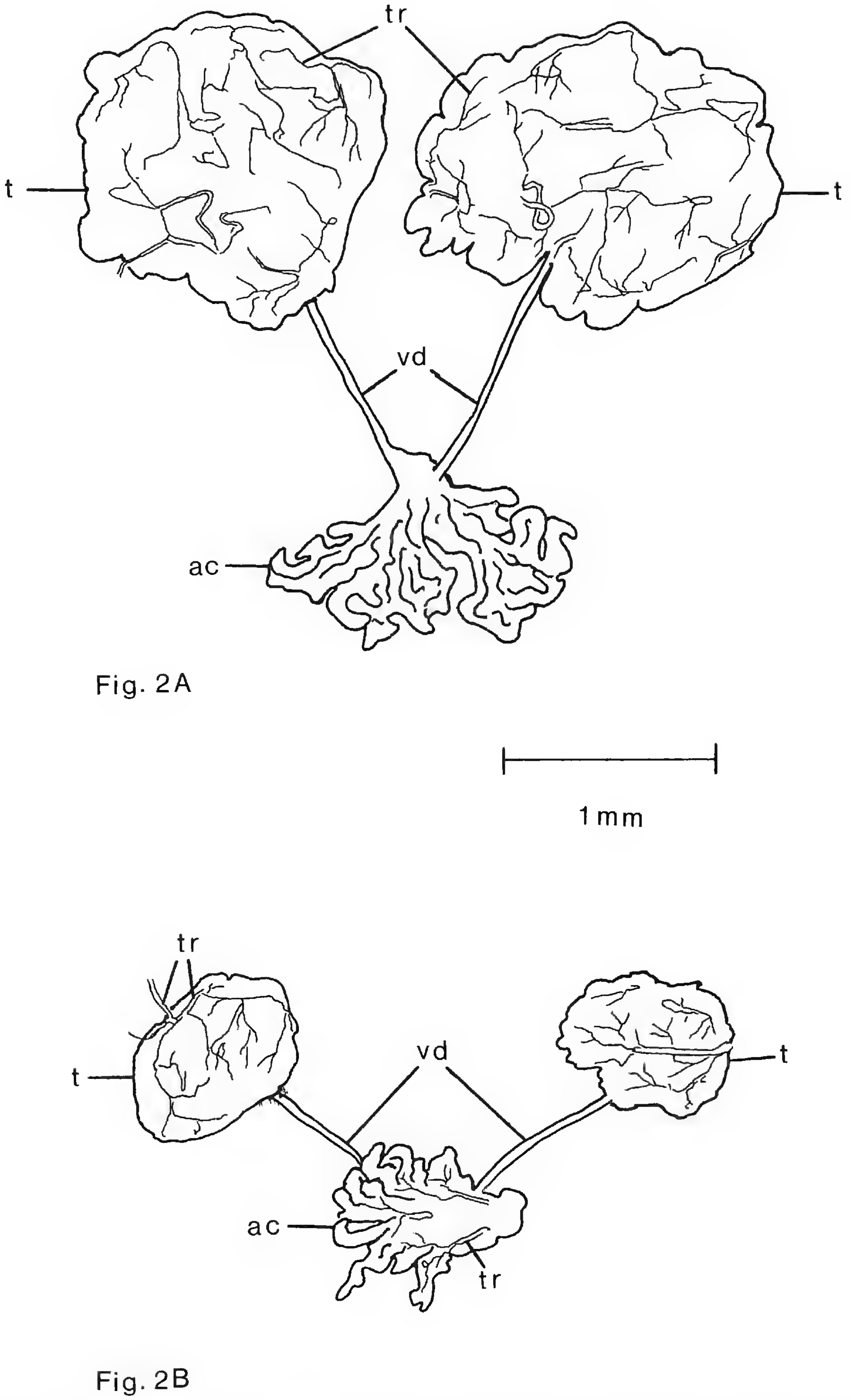

Figure 2. A. Testes (t), vasa deferentia (vd), and accessory glands (ac) of reproductive soldier of *Zootermopsis laticeps* from Colony #3 (see Fig. 1B), trachea (tr). B. Testes, vasa deferentia, and accessory glands of king of *Zootermopsis laticeps* from Colony #4 with population in excess of 900 individuals (diagrams A and B to same scale).

Table 1. Synopsis of Termopsidae with notes and references to species having records of probable reproductive soldiers.

Termopsidae
- Termopsinae
  1. *Archotermopsis wroughtoni* soldiers with functional gonads. Imms (1919)
  2. *Archotermopsis deodare* (=*A. wroughtoni*?) no information
  3. *Hodotermopsis japonicus* no information
  4. *Hodotermopsis sjostedti* no information
  5. *Zootermopsis angusticollis* fertile soldiers. Heath (1903, 1907, 1927); Castle (1934); Light (1943, 1944); S. L. W. Greenberg (pers. comm.)
  6. *Zootermopsis nevadensis* fertile soldiers. Heath (1903, 1907, 1927, 1928); Castle (1934); Light (1943, 1944); one apparent example (not dissected), M. I. Haverty (pers. comm.)
  7. *Zootermopsis laticeps* reproductive soldiers
- Stolotermitinae
  8. *Stolotermes africanus* no information
  9. *Stolotermes australiensis* no information
  10. *Stolotermes brunneicornis* soldiers with functional gonads. Gay and Calaby (1970); J. A. L. Watson (pers. comm.)
  11. *Stolotermes inopinatus* no information
  12. *Stolotermes queenslandicus* no information
  13. *Stolotermes ruficeps* emergency soldiers. Morgan (1959)
  14. *Stolotermes victoriensis* no information
- Porotermitinae
  15. *Porotermes adamsoni* reproductive soldiers not reported
  16. *Porotermes planiceps* no information
  17. *Porotermes quadricollis* no information

termite soldiers must await a better understanding of the conditions under which they develop and behavioral studies to determine whether they engage in combat with other replacement reproductives. There is reason to believe that reproductive soldiers do fight since lethal siblicidal fighting is known to occur between replacement reproductives of several lower termites (see references in Myles and Chang, 1984).

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PAN-PACIFIC ENTOMOLOGIST
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Scientific Note

A Note on Predation of Caddisflies (*Cheumatopsyche logani* and *Hydropsyche wineman,* Trichoptera: Hydropsychidae) by the Wolf Spider, *Pardosa steva* (Lycosidae)

On 4 June 1975 (1045–1145 hr) a large emergence of caddisflies (Trichoptera: Hydropsychidae) *Cheumatopsyche logani* Gordon & Smith and *Hydropsyche wineman* Denning) was observed along the banks of the Snake River below C. J. Strike Dam, Owyhee County, Idaho, elevation 750 m. As the adult caddisflies fluttered around the large rocks on the river bank individuals of the wolf spider, *Pardosa steva* Lowrie & Gertsch (Lycosidae) were observed feeding on some of them. The spiders were common on the rock surfaces (ca. 5/m^2). As the adult caddisflies fluttered along the shore and landed on the rocks many would be approached by *P. steva.* The success of the predators was about 12 percent. The day was warm (20°C) and windy and the water temperature was 10°C.

H. wineman has not previously been reported from Idaho (Anderson, 1976, Tech. Bull. 134, Agr. Expt. Sta., OR State Univ., Corvallis, 152 pp.; Newell and Minshall, 1977, Great Basin Natur., 37:253–257; and Newell and Minshall, 1979, Jour. ID Acad. Sci., 15:33–51). The record for *H. wineman* represents a range extension of approximately 260 km to the west and southwest of previous Oregon records (Anderson, 1976, Tech. Bull 134, Agr. Expt. Sta., OR State Univ., Corvallis, 152 pp.). *C. logani* has been previously reported for Idaho (Roemhild, 1982, NW Sci., 56:8–13) with no specific locality given. *P. steva* has previously been reported for Idaho (Barnes, 1959, Amer. Mus. Nov., 1960:1–20, Fig. 4 [what appears to be Valley County]). No feeding records were presented. There are apparently no published prey records for *P. steva* (C. D. Dondale, pers. comm., 1986). These also appear to be the first records of predation on *C. logani* and *H. wineman.*

Voucher specimens of *P. steva* have been deposited in the American Museum of Natural History (AMNH), New York, and of all species involved in the College of Idaho Museum of Natural History (CIDA), Caldwell.

N. Platnick identified *Pardosa steva* and D. G. Denning determined the caddisfly species. C. D. Dondale, J. McCaffrey and P. E. Blom assisted with the spider literature.

William H. Clark, *Idaho Department of Health & Welfare, Division of Environment, 450 West State Street, Boise, Idaho 83720* and *Museum of Natural History, College of Idaho, Caldwell, Idaho 83605.*

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Mayflies of Vietnam: *Acerella* and *Drunella* (Ephemeroptera: Ephemerellidae)

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Mayfly nymphs of the family Ephemerellidae collected in Vietnam by Dr. Tomas Soldan, Czechoslovak Academy of Sciences, included species of *Acerella* Allen and *Drunella* (*Drunella*) Needham.

Drunella (*Drunella*) Needham

Drunella s.s. now contains three Asian species, *D. gilliesi* Allen & Edmunds, described from Nepal, *D. perculta* Allen, new combination, described from Vietnam, and *D. soldani,* new species.

Drunella (*Drunella*) *perculta* Allen, NEW COMBINATION

Ephemerella (*Acerella*) *perculta* Allen, 1971:520.
Acerella perculta Allen, 1980:82.

Type locality.—Stream 6 km S Delat, Vietnam.

New record.—Stream nr. Duc Trong, Lam Dong Prov., Vietnam, 30-X-84, T. Soldan.

Diagnosis.—Head with paired submedian occipital tubercles. Pronotum with an anterior median and paired posterior submedian tubercles; mesonotum with paired anterior submedian tubercles, paired middle submedian tubercles, a median tubercle near posterior margin, and paired submedian tubercles near posterior margin; middle coxae with short tubercle on lateral margin; hind femora without distinct apical projections; claws with 5–7 denticles. Abdominal terga 1–9 with paired submedian tubercles, tubercles short and narrowly separated tergum 1, tubercles longer and more widely separated terga 2–3, tubercles longest and more widely separated terga 4–9; posterolateral projections 8–9 well developed, projection segment 9 long, extending beyond posterior margin segment 10 (see Allen, 1971, fig. 28).

Remarks.—This species was described from nymphs collected in Vietnam, and the nymphs from Duc Trong are unquestionably this species. They possess all of the morphological characters of the type series except for a mesonotal spine. A careful examination of nymphs described as *Acerella perculta* reveals that the lateral mesonotal spine that was described as being possessed by this species, and is a primary character of nymphs of *Acerella,* is attached to the coxae of the middle legs and not to the mesonotum. The absence of a mesonotal spine, the absence of spines or tubercles on the anterior margin of the fore femora, and the presence of tubercles on the head, thoracic nota and abdominal terga suggest that the correct placement of this species is with *Drunella* s.s.

***Drunella* (*Drunella*) *soldani* Allen, New Species**

Nymph.—Length: body 7.0–8.0 mm; caudal filaments 4.0–5.0 mm. General color light brown without distinctive markings. Head light brown; head with paired suboccipital tubercles between compound eyes; maxillary palpi 3-segmented, third segment rudimentary. Thorax light brown; mesonotum with a median posterior tubercle between bases wing pads; legs light brown; claws with 8–9 denticles. Abdominal terga light brown; terga 2–9 with paired submedian tubercles, tubercles small segment 2 and increasing in size to segment 8, spines on segment 9 smaller than 8; posterolateral projections segments 8–9 small, 9 not projecting beyond posterior margin segment 10; abdominal sterna pale. Caudal filaments brown with whorls small spines at apex each segment, without intersegmental spines.

Types.—Holotype. Mature female nymph, San Binh nr. Ba Vi, Vietnam, 15-XI-82, T. Soldan, in collection Czechoslovak Academy of Sciences, Praha.

Remarks.—This species is distinguished from the other two Asian species by the following combination of characters: (1) pronotum without tubercles; (2) hind femora without apical projection; (3) abdomen with paired submedian tubercles on terga 2–9; and (4) posterolateral projection on segment 9 not extending to nor beyond posterior margin segment 10.

***Acerella* Allen**

The genus *Acerella* now includes only three species, *A. longicaudata* (Ueno), *A. commodema* Allen and *A. uenoi* Allen & Edmunds (=*undatella* Allen).

***Acerella longicaudata* (Ueno)**

This species was described from Honshu, Japan, and the following record extends its known range to Vietnam.

New record.—Stream at Ba Vi, Wa Son Binh, Vietnam, 15-XI-84, T. Soldan, in collection California Academy of Sciences, San Francisco.

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Notes on American Macrocephalinae with Descriptions of Two New Species (Hemiptera: Phymatidae)

Nicholas A. Kormilev[1]

Abstract.—The author proposes two new taxa: *Lophoscutus schaffneri,* n. sp. (Mexico), and *L. virginensis,* n. sp. (Virgin Is.). *Macrocephalus* (*Lophoscutus*) *spiculiger* Kormilev, 1968, was put into synonymy with *Lophoscutus spiculosus* (Champion), 1898, and *Macrocephalus similis* Kormilev, 1972, was put into synonymy with *Macrocephalus dorannae* Evans, 1931, as their junior synonyms. List of species belonging to *Macrocephalus* Swederus, 1787, and *Lophoscutus* Kormilev, 1951, is given.

American Macrocephalinae have thus far 69 species distributed within 3 genera: *Extraneza* Barber, 1939, *Lophoscutus* Kormilev, 1951, and *Macrocephalus* Swederus, 1787. *Extraneza* Barber with a single species, *E. nasuta* Barber, 1939, is the most primitive, having an archaic character of three segmented fore tarsi (Macrocephalinae generally have no fore tarsi). Of the other two genera, *Lophoscutus* Kormilev is more primitive than *Macrocephalus* Swederus, having a simple, straight scutellar carina, some times slightly enlarged at base, and parameres in the shape of a simple hook. *Macrocephalus* Swederus is more advanced having the scutellar carina enlarged at basal half in the shape of a lancet, some times truncate, or even tricuspidate posteriorly, and parameres with a subapical branch.

Until 1951 all American Macrocephalinae, with the exception of *Extraneza* Barber, were assigned to *Macrocephalus.* In 1951 I separated *Lophoscutus* from *Macrocephalus* as a subgenus and in 1956 Maa and Lin elevated it to the generic rank. In 1966 Zayas again assigned all Cuban species to *Macrocephalus,* though some of them belong to *Lophoscutus.* There is still some confusion about which species belong to *Macrocephalus* and which to *Lophoscutus.* To correct this situation I give a list of species belonging to each of these genera. There is still some doubt about a few species, which I could not examine, which are indicated in the lists.

Having received more material, I could see that *Macrocephalus* (*Lophoscutus*) *spiculiger* Kormilev, 1968, is identical with *Lophoscutus spiculosus* (Champion), 1898, and should go into synonymy. The same also with *Macrocephalus similis* Kormilev, 1972, which is identical with *Macrocephalus dorannae* Evans, 1931.

In continuation two new species are described: *Lophoscutus schaffneri,* n. sp., and *L. virginensis,* n. sp.

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Species Belonging to *Lophoscutus*

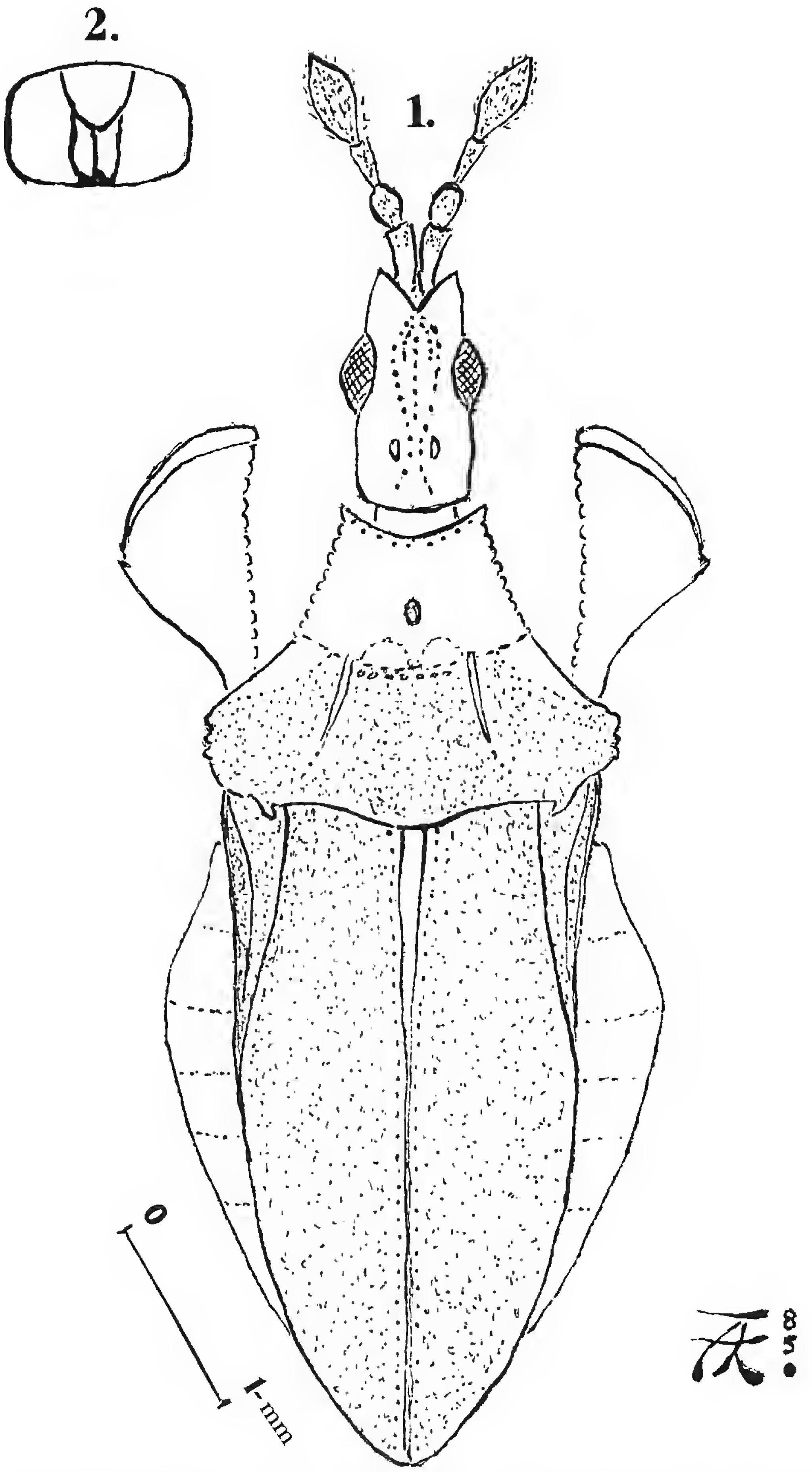
acuñai (Bruner), 1946
affinis (Guérin), 1843
alayoi (Zayas), 1966
angustatus (Champion), 1898
asper (Stal), 1876
aterrimus Kormilev, 1981
attenuatus (Champion), 1898
balloui (Bruner), 1926
bergrothi (Handlirsch), 1897
chemsaki Kormilev, 1984
crassimanus (Fabricius), 1803
dominicanus Kormilev, 1963
dudichi (Kormilev), 1949 (=*M. obscurus* Dudich, 1922, preoccupied)
falleni (Stal), 1862
gracilis (Handlirsch), 1897
granulatus (Champion), 1898
inaequalis (Champion), 1898
israeli (Zayas), 1966
julianus (Bruner), 1951 (=*L. drakei* Kormilev, 1962)
kormilevi (Zayas), 1966
lepidus (Stal), 1862
leucographus (Westwood), 1843
macilentus (Westwood), 1843
margaritis Kormilev, 1962
marmoratus Kormilev, 1966
michelbacheri Kormilev, 1984
mopsus (Handlirsch), 1897
paraspiculosus (Kormilev), 1953
parvulus (Handlirsch), 1897
patriciae (Zayas), 1966
prehensilis (Fabricius), 1803
productus (Barber), 1939
pulchellus (Westwood), 1843
pulcher Kormilev, 1981
rugosipes (Guérin), 1857
schaffneri Kormilev, new species
spiculissimus (Barber), 1939
spiculosus (Champion), 1898 (=*L. spiculiger* Kormilev, 1968, new synonymy)
stali (Handlirsch), 1897
subproductus Kormilev, 1962
subsimilis (Dudich), 1922
testaceus Kormilev, 1963
uhleri (Handlirsch), 1898
virginensis Kormilev, new species
viridis Kormilev, 1984
wygodzynskyi (Kormilev), 1949
To *Lophoscutus* also probably belong: *insignis* Kormilev, 1957; *insularis* Dudich, 1922; *thoracicus* Valdés, 1910

Species Belonging to *Macrocephalus*

argentinus Kormilev, 1951
arizonicus Cockerell, 1900
aspersus Champion, 1898
barberi Evans, 1931
cimicoides Swederus, 1787
crassus Handlirsch, 1897
dissolutus Kormilev, 1984
dollingi Kormilev, 1984
dorannae Evans, 1931 (=*M. similis* Kormilev, 1972, new syn.)
incisus Stal, 1862
manicatus (Fabricius), 1803
notatus Westwood, 1843
panamensis Champion, 1898
peruvianus Dudich, 1922
reuteri Handlirsch, 1897
tuberosus Westwood, 1843
vorax Hussey, 1953
To *Macrocephalus* also probably belong: *vesiculosus* Handlirsch, 1897; *westwoodi* Guérin, 1857

Lophoscutus schaffneri **Kormilev, New Species**
(Figs. 1, 2)

Female.—Head, pronotum, pleurae, abdomen and femora with concolorous granulation; scutellum with setigerous granulation, which is lighter than background, setae very short and incumbent.



Figures 1, 2. *Lophoscutus schaffneri*, n. sp., ♀. 1. Dorsal aspect. 2. Genital segments from behind.

Head longer than its width across eyes (30:22); clypeus with a row of brown granules; similar rows flanking clypeus and extending backward between ocelli, reaching hind border of head; other granulation is concolorous. Antennae short, only 1½× as long as width of head across eyes; relative length and width (in parentheses) of antennal segments I to IV are: 9(5):5(3):6(3):11(6). Relative length of labial segments I to III are: 15:12:10.

Pronotum shorter than its maximum width across lateral angles (45:57); anterior angles acute and slightly diverging; anterior border with a row of spiculoid granulation; antero-lateral-anterior borders straight, crenulate; antero-lateral-posterior borders straight then slightly rounded; lateral angles truncate, their exterior border with three small granules; postero-lateral borders rounded than sinuate; hind border rounded. Fore disk convex and granulate; interlobal depression deep. Hind disk 3 × longitudinally depressed; carinae conspicuous on fore ⅔, then evanescent; along fore border of hind lobe extends a transverse row of white granules; rest of granules are concolorous. Hind disk roughly punctured and with dispersed granulation; in some specimens granules are placed inside punctures.

Scutellum long and narrow (85:46), slightly constricted at base; median carina slightly enlarged at basal ¼, then thin, reaching tip of scutellum. Disk roughly punctured at base, finely punctured elsewhere; between punctures are dispersed fine, whitish, setigerous granules with very short, incumbent hairs.

Hemelytra mostly covered by scutellum; corium sparsely granulate.

Abdomen ovate, longer than its maximum width across segment III (80:66); lateral borders evenly rounded; postero-exterior angles of connexiva not protruding. Connexiva and venter granulate.

Pleurae: Fore border of propleuron sinuate and denticulate, disk densely granulate; other pleurae less granulate.

Legs: Fore femora longer than their maximum width (33:16).

Color.—Orange-yellow; hind lobe of pronotum, scutellum and corium red brown; pale yellow strip along scutellar carina.

Measurements.—Total length 6.52 mm; width of pronotum 2.28 mm; width of abdomen 2.64 mm. One paratype is smaller: 5.52, 2.00 & 2.48 mm.

Holotype.—♀, MEXICO, Oaxaca, 11.3 mi SE Totalapan, 21.VII.74; Clark, Murray, Ashe and Schaffner, coll.; deposited at the Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Paratypes.—1 ♀, MEXICO, Puebla, 11.8 mi NW Irucar, 15.VII.74; Clark, Murray, Ashe and Schaffner, coll.; 2 ♀, MEXICO, 13.3 mi NE Tehuitzingo, 13–14.VII.74; same collectors; 1 ♀, MEXICO, Morelos, 10 mi E Cuernavaca, 8.VII.74; same collectors; deposited at the Department of Entomology, Texas A&M University, College Station, Texas and Kormilev collection.

It is a pleasure to dedicate this species to one of its collectors Dr. Joseph C. Schaffner.

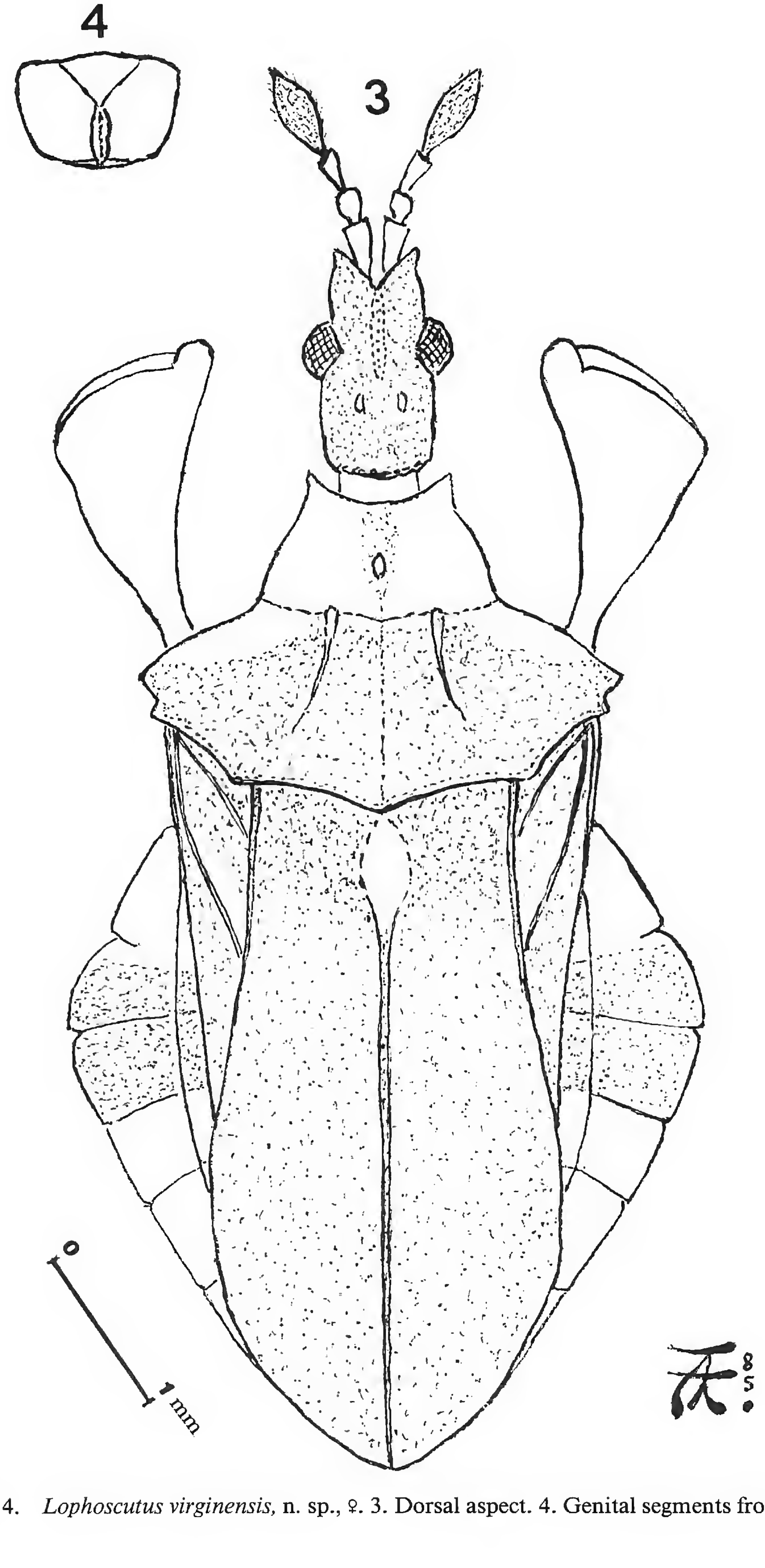
Lophoscutus schaffneri, n. sp. is related to *L. margaritis* Kormilev, 1962, also from Mexico, but is smaller, the scutellum more constricted at base and with setigerous granulation; the antennae relatively shorter and the color is different.

***Lophoscutus virginensis* Kormilev, New Species**

(Figs. 3, 4)

Female.—Elongate ovate; head posteriorly and laterally, fore lobe of pronotum anteriorly, laterally and at the base of carinae, with fine, white granulation; a few fine, white scattered granules on connexivum, pro- and mesopleuron. Mesosternal cross granulate on fore branch. Hind lobe of pronotum and base of scutellum roughly punctured, rest of scutellum finely punctured.

Head longer than its width across eyes (33:22); ocelli placed nearer to eyes than to hind border of head; genae rounded anteriorly; bucculae with two flaps. An-



Figures 3, 4. *Lophoscutus virginensis,* n. sp., ♀. 3. Dorsal aspect. 4. Genital segments from behind.

tennae thin, 1½× as long as width of head across eyes (34.5:22); relative length and width of antennal segments I to IV are: 8(5):5(3):7(3):15(6). Relative length of labial segments I to III are: 18:12:7.

Pronotum short and wide (48:72); fore border sinuate and with white granulation; anterior angles spiculoid and slightly diverging; antero-lateral-anterior borders slightly convex and finely granulate; antero-lateral-posterior borders slightly convex; lateral angles incised, forming two teeth; postero-lateral borders sinuate; posterior border convex medially, sinuate laterally. Fore lobe convex, interlobal depression clearly visible; carinae raised and granulate at base, then diverging in an arc, evanescent posteriorly.

Scutellum tongue-shaped, longer than its maximum width at ⅔ of its length (95:50); median carina raised and enlarged at base, then depressed, forming an ovate, yellow callosity and produced backward as a narrow, straight carina, reaching tip of scutellum. At base of median carina a few white granules; rest of scutellum with dispersed, light granulation. Disk roughly punctured at base, finer elsewhere.

Hemelytra mostly covered by scutellum; corium with a few scattered granules.

Abdomen cordate, shorter than its maximum width across segment III (90:92); connexiva II and III semifused; lateral borders straight at II, convex at III, straight from IV to VII; hind border (VIII) rounded; postero-exterior angles of connexiva slightly protruding on II and III, not protruding from IV to VII.

Legs: Fore femora longer than their maximum width (45:22); disk granulate on upper border.

Color.—Head, hind lobe of pronotum, corium and transverse band of abdomen testaceous; base of scutellum red brown laterad of median yellow spot; fore lobe of pronotum, connexivum before and behind transverse band and ventral side of the body, yellow; legs and labium yellow with greenish tinge; antennal segments I to III yellow, IV dark brown.

Measurements.—Total length 7.20 mm; width of pronotum 2.98 mm; width of abdomen 3.68 mm.

Holotype.—♀, VIRGIN ISLANDS, St. Thomas, Frenchman's Bay, 2 mi (3 km) E Charlotte-Amalia, 16.VII.1979; C. B. Marsha, coll., deposited at the California Academy of Sciences, San Francisco; Type No. 15181.

Lophoscutus virginensis, n. sp. is closely related to *L. subproductus* Kormilev, 1962, from Puerto Rico, but is larger, the abdomen wider than long, granulation very scarce, the color is different, and the transverse band of the abdomen is testaceous, not orange with a carmine tinge.

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Scientific Note

Early Seasonal Records for Three Halictine Bees on *Isomeris arborea* in Southern California (Hymenoptera: Apoidea)

On December 25, 1985, between 0930 and 1000 PST, my wife and I collected 12 native bees visiting *Isomeris arborea* (sometimes known as "bladder pod"), near Desert Hot Springs, Riverside County, California, on the mountain slopes opposite Palm Springs. This was the only plant species in bloom at the time and the flowers were densely populated with honeybees, making the native species, all small halictines, very difficult to see and capture.

Isomeris is an attractive nectar plant which, in the desert, presumably blooms whenever it rains. However, published records of bees taking pollen from it are lacking. Of 23 species recorded by Hurd (1979) as visitors to this plant (9 andrenids, 1 halictid, 3 megachilids, 7 anthophorids), all are polylectic or oligoleges of some other plant (Hurd does not include the sex of the bees in his records) (additional data are presented by Moldenke and Neff (1974)). It may be of interest, therefore that the three species of halictines making up our sample (kindly identified by George C. Eickwort), included two that were gathering pollen. Of six females of *Dialictus microlepoides* (Ellis), each was carrying substantial loads of pollen, and the single female of *Evylaeus amicus* (Cockerell) had just begun to pack pollen near the bases of the hind legs. The five females of *Evylaeus pulveris* (Cockerell) were taking only nectar and had no evidence of pollen on the body.

As far as known, these are the earliest seasonal records for these presumably polylectic species of bees, as well as verified pollen sources for two.

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Two New Species of *Jappa* from Australia (Ephemeroptera: Leptophlebiidae)

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Abstract.—Two new species of horned *Jappa, J. edmundsi* and *J. serrata* are described from North Queensland on the basis of larval characters. Comparisons are made with the only other known horned *Jappa, J. kutera* Harker. Illustrations of head characters and notes on biology are provided.

The burrowing mayfly genus *Jappa* was erected by Harker (1954) to hold *J. kutera* Harker (type species) and *J. tristis* Harker. The original description of the larvae of this genus (Harker, 1950) was based only on *J. kutera* in which the larvae possess frontal horns on the head that are superficially similar to the mandibular tusks present in most Ephemeroidea. Riek (1970) reports that there are 7 species of *Jappa,* of which several are without frontal horns. The two species originally assigned to the genus remain the only named species in the genus.

Two new species of *Jappa* bearing frontal horns are described herein; they were collected by the junior author in the Cape Tribulation area of northern Queensland. This extends the known range of the burrowing species with frontal horns, which were previously reported by Riek (1970) to occur from central Queensland to southern New South Wales. Numerous adults of *Jappa* were also taken by the junior author as far north as Cape York, but without associated larvae.

The descriptions and discussions below are based on larvae only, preserved in 80% ethanol. CL numbers following locality data refer to codes used by the junior author to reference ecological notes. Types are deposited in the Australian National Insect Collection, Canberra (ANIC).

Jappa edmundsi, NEW SPECIES

Nymph.—Length: body 14.5 mm (including horns), caudal filaments 7.2 mm.

Head.—Frontal horns approximately 2× head capsule length, bifurcate into dorsal and ventral prongs, dorsal prongs small and divergent laterally, ventral prongs 4× longer than dorsal prongs and curving strongly toward each other (Fig. 1); two clumps of fine setae present basally on each horn to either side of dorsal surface, third setal clump present at median horn base on head dorsum; small protruberance present at base of each horn on dorsal surface; antennae long, bearing whorls of short setae at apex of each segment, setae 1–1.5× diameter of antennae.

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Thorax.—Pronotum roughly quadrate, broader anteriorly, lateral margins explanate, bearing long pale setae; legs with femora, tibia and tarsi covered with very long fine pale setae; fore femur broad, flattened; fore tibia cylindrical, longer than femur.

Abdomen.—Abdominal terga 4–9 bearing many long fine setae; posterolateral spines on segments 8 and 9 small; 3 caudal filaments present posteriorly, bearing long pale setae.

Coloration.—Dorsum generally with brown markings on yellowish white background; venter pale, unmarked; dorsum of head light, area bordered by ocelli and frontal suture slightly darker, distinct dark brown markings present posterior to lateral ocelli and medial to eyes (Fig. 1); pronotum with laterally placed, longitudinal dark brown markings at same distance from midline as eyes; mesonotum with dark brown markings just lateral to midline; abdominal terga bearing distinct, paired brown longitudinal stripes on segments 1–7, segment 8 with longitudinal stripes closer to midline and faint, segments 9 and 10 unmarked.

Material examined.—Holotype, immature larva: AUSTRALIA, Queensland, Hutchinson Creek at Cape Tribulation road, north of Daintree Landing, CL 1733, VIII-17-83, D. A. and T. J. Polhemus (ANIC). Paratypes: 8 immatures, same data as types, 2 in ANIC, remainder in University of Utah.

Etymology.—The name "edmundsi" is in honor of George F. Edmunds, Jr.

***Jappa serrata*, New Species**

Nymph.—Length: body 10 mm (includes horns), caudal filaments 5.5 mm.

Head.—Frontal horns approximately 1 × head capsule length; dorsal horn margins serrate distally (Fig. 3), serration number typically 4, excluding horn tip, occasionally 3 on smaller specimens; 2 clumps of fine setae present basally on each horn to either side of dorsal surface; small protruberance present between setal clumps on dorsal surface of horn base; antennae long, bearing whorls of long setae at apex of each segment, setae 2–2.5 × antennal diameter.

Thorax.—Pronotum roughly quadrate, broader anteriorly, lateral margins explanate, bearing long pale setae; legs with femora, tibiae and tarsi covered with very long fine pale setae; fore femur broad, flattened; fore tibia cylindrical, longer than femur.

Abdomen.—Posterior halves of abdominal tergites bearing many long fine setae; posterolateral spines on segments 8 and 9 small; 3 caudal filaments present posteriorly, bearing long pale setae.

Coloration.—Dorsum generally with brown markings on yellowish white background; venter yellowish white with some dark brown markings on thorax; prosternum with two longitudinal dark brown markings medial to coxae on either side of midline, small horizontal dark brown marking on posterior aspect; mesosternum with two pairs of longitudinal dark brown markings, first pair anterior, larger and closer to midline, second pair posterior, just medial to coxae; head mostly light with darker area between ocelli, eyes, and posterior margin of head capsule; pronotum yellow, with four brown bilaterally arranged markings, lateral markings longer and darker than more medial ones; mesonotum yellow with distinct curving horizontal brown line near posterior margin, apex of curve oriented towards abdomen; metanotum yellow with irregular brown line near posterior margin; abdomen yellowish white, tergites 4–9 marked with single longi-

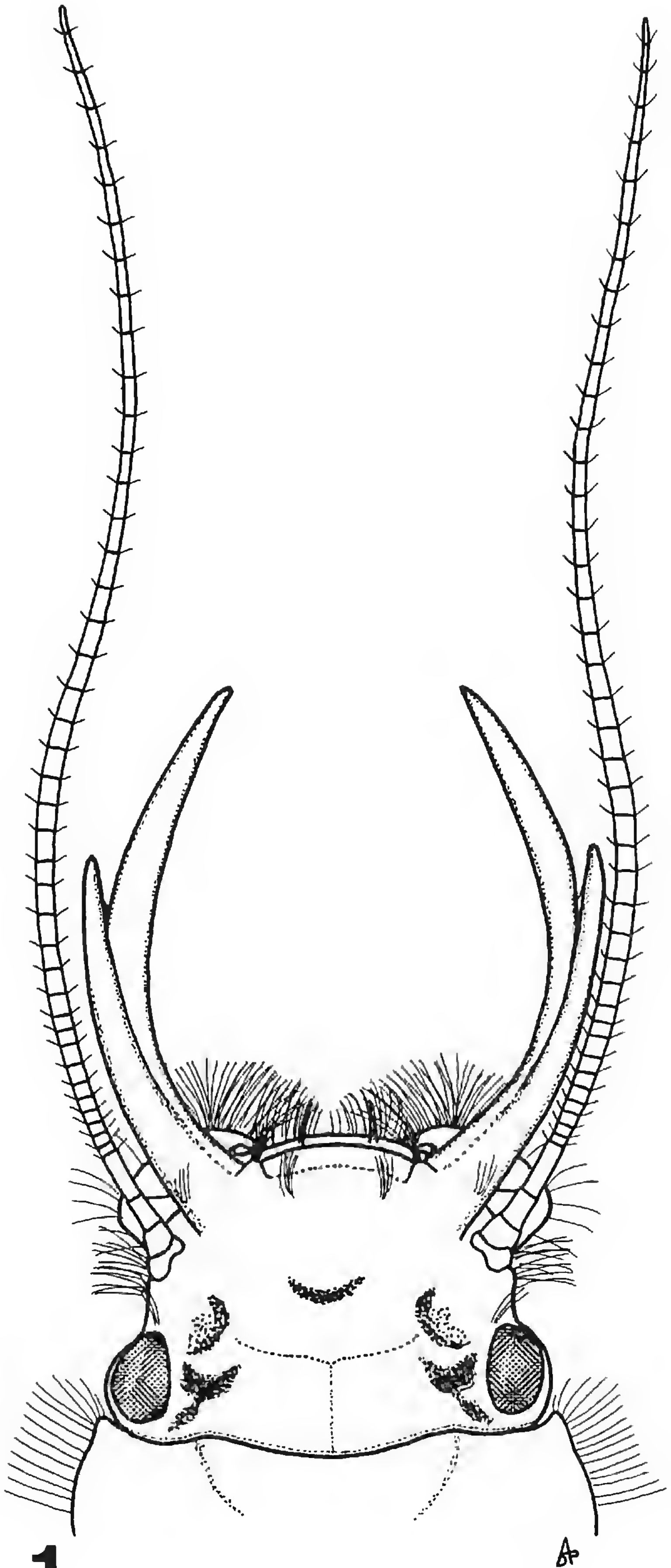
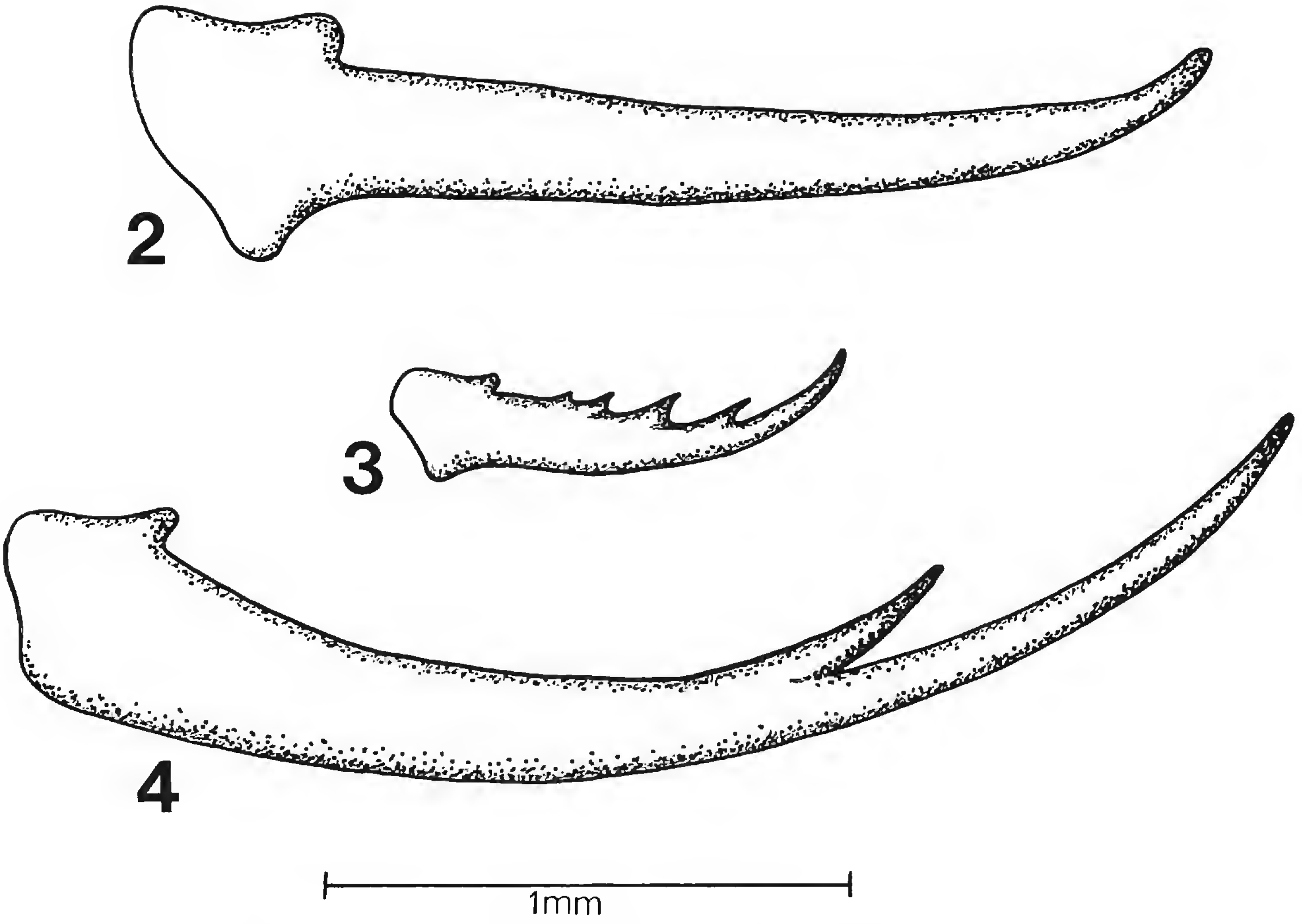


Figure 1. *Jappa edmundsi,* n. sp., dorsal view of head.

tudinal light brown stripe, stripe slightly divided on segment 8, inconspicuous on segment 9.

Material examined.—Holotype, immature larva: AUSTRALIA, Queensland, Hutchinson Creek at Cape Tribulation road, north of Daintree Landing, CL 1733, VIII-17-83, D. A. and T. J. Polhemus (ANIC). Paratypes: 4 immatures, same data as types, 1 in ANIC, 3 at University of Utah.



Figures 2–4. Frontal horns of *Jappa* spp., lateral view. 2. *J. kutera* Harker. 3. *J. serrata,* n. sp. 4. *J. edmundsi,* n. sp.

Etymology.—The name "serrata" refers to the distinctive frontal horns of this species.

DISCUSSION

J. edmundsi may be distinguished from the other known larvae of *Jappa* by the strongly bifurcate frontal horns (Figs. 1, 4). Additional distinctive features include the three fine setal clumps basally on the horns and adjacent head dorsum, the length of the setae on the antennae, the length of the front tibiae and the dorsal coloration.

J. serrata may be distinguished from the other known larvae of *Jappa* by the serrate dorsal margins of the frontal horns (Fig. 3). Additional distinctive features include the two fine setal clumps present basally on the horns, the length of the setae on the antennae and the dorsal coloration.

J. serrata and its sympatric congener *J. edmundsi* can also be distinguished from each other by size (*J. edmundsi* 7–12 mm and *J. serrata* 6–8 mm) and by the difference in horn versus head length. Because of the paucity of available specimens and the lack of mature nymphs, caution should be used when considering such characteristics as color for identification.

J. kutera Harker, the other known horned species of *Jappa,* differs from *J. edmundsi* and *J. serrata* by the frontal horns, which in *J. kutera* are without serrations or bifurcations (Fig. 2). These horns are generally 1–1.5× the head capsule length, with a small setal clump present on the dorsum of each horn tip. Setal clumps at the horn bases appear to be variable, with either 2 or 3 present on the specimens examined. The setae on the antennae of *J. kutera* are also distinctive, with the basal ¼ of the antenna bearing long setae (2–2.5 × diameter of antenna) while the distal ¾ bears short setae (1–1.5 × diameter of antenna). The abdominal dorsum is usually more heavily setiferous than in the other species, with segments 3–9 bearing many long fine setae. Posterolateral spines on abdominal segments 8 and 9 are larger than in *J. edmundsi* and *J. serrata.* Dorsal coloration varies between different localities but in general differs from *J. edmundsi* and *J. serrata* in that the abdominal terga have paired brown markings that are larger than those in the preceding two species.

BIOLOGY

The type series of *J. edmundsi* and *J. serrata* were both taken at the same locality in the same section of Hutchinson Creek just upstream of the Cape Tribulation road crossing. Specimens were collected from a coarse sandy substrate overlain by a layer of heavy, black, rounded stones in swiftly flowing water approximately 0.6 meters deep. The stream at the type locality was heavily shaded by rain forest.

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Ecological Notes on Male *Mydas xanthopterus* (Loew) (Diptera: Mydidae) and Their Interactions with *Hemipepsis ustulata* Dahlbohm (Hymenoptera: Pompilidae)

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Abstract.—Observations of the hilltopping male *Mydas xanthopterus* (Loew) were made on a ridge near Portal, Arizona during June–August 1978. Male flies were active from sunrise until late morning, defending portions of hilltop bushes and small trees. Territories were defended prior to study initiation in late June until about 18 July after which only scattered individuals remained on the hilltop. Territorial aggressiveness was directed toward all nearby flying objects. The co-occurring wasps *Hemipepsis ustulata* Dahlbohm and *Polistes canadensis* (Cresson) also defended sites on the hilltop. *H. ustulata* males more aggressively defended their territories against *Mydas* males than against *Polistes* males, possibly due to mimetic similarity of *Mydas* to *Hemipepsis.*

The biology of flies of the family Mydidae is little known (Borrer et al., 1976), although this uncommon group is widespread in the warmer areas of the world. Biological information in taxonomic works by Wilcox and Papavero (1971) and Papavero and Wilcox (1974) and scattered descriptions of larval forms make up the bulk of the recent literature on this group (e.g., Genung, 1959; Krivosheina, 1977).

Male territorial behavior was discussed by Norris (1938), and Zikan (1942), both of whose published accounts of mydids included mention of mating systems resembling leks. Meyers et al. (1984) recently noted the superficial similarity of *Mydas xanthopterus* (Loew) and tarantula hawk wasps, specifically *Pepsis formosa* Say. This paper describes seasonal and daily activity patterns of *Mydas xanthopterus* (det. by J. Wilcox) males and relates that to the male's reproductive role. In addition the interactions and possible mimicry between *M. xanthopterus* and the tarantula hawk wasp, *Hemipepsis ustulata* Dahlbohm, are discussed.

METHODS

The study site consisted of three hills along the backbone of an 1800 meter mountaintop, 1.5 km south of Portal, Arizona in the Coronado National Forest. To the east, west and north, the terrain dropped steeply away to a dry plain of 1100 to 1500 meters in elevation. From the study site the ridgeline rose gently to the south culminating in 2600 m Portal Peak, 3.5 km to the south. Vegetation at the hilltop site consisted of scattered trees and shrubs with a sparse ground cover of annuals and perennial grasses characteristic of the upper Chihuahuan desert (Lowe, 1964; Linsley and Cazier, 1972).

Observations of *Mydas* activity were made between 30 June and 23 August 1978, incidental to and coincident with studies of the behavior of *Hemipepsis* males (Nelson, 1986). Each male *Mydas* defended a territory consisting of a small bush or portion of a shrubby tree along the hilltop study site. Daily and seasonal activity patterns of *Mydas* males were obtained from records of interspecific encounters between *Mydas* and color-marked *Hemipepsis* males during behavioral studies of the latter species. None of the 20 to 30 *Mydas* males present on the one hectare study site were marked. Observations were made primarily between sunrise and noon when study animals were most active.

RESULTS

Mydas xanthopterus were found only near the tops of three hills along the ridge at the study site (n = 20–30). Ten *Mydas* were collected and sexed; eight were males. Males exhibited evidence of hilltopping behavior (Shields, 1967; Downes, 1969; McFarland, 1976) by perching on the tops of chihuahua pines (*Pinus leiophylla*), one-seed juniper (*Juniperus monosperma*), and several species of scrub oak (*Quercus* spp.), and aggressively investigating flying objects such as other insects, birds, or even small stones. Exclusive use of these perches and territory sites by resident males was taken as further evidence of "classic" hilltopping behavior (McFarland, 1976).

H. ustulata are known to use hilltopping as a reproductive strategy (Alcock, 1981). Each *Hemipepsis* male at the study defended a small bush or tree against intruders much as did *M. xanthopterus.* However *Mydas* territories were smaller and thus several *Mydas* males were frequently present within the territory of one *Hemipepsis* male. *M. xanthopterus* bear a strong resemblance to *Hemipepsis ustulata* in terms of body color (black), wing color (orange), and body size. *M. xanthopterus* antenna are long and wasplike, further accentuating the similarities. There was evidence that *H. ustulata* males were fooled by this superficial resemblance.

Encounters between *Mydas* and *H. ustulata* males often involved chases of long distance and duration as well as mid-air clashes. Male encounters usually began when the male of one species flew out from its perch, either spontaneously or aggressively towards another flying object. Adjacent males then flew out in response, following the first male. Upon close approach and investigation one male then typically broke off the encounter, soon returning to its territory. However the length of each pairwise encounter in both time and distance varied between various species pairs. Both *Hemipepsis* males and *Polistes canadensis* (Cresson) males were involved in two-way and three-way conflicts with *Mydas.* A record of intra- and interspecific clashes between *Hemipepsis-Hemipepsis, Hemipepsis-Mydas,* and *Hemipepsis-Polistes* (Table 1) showed that the intensity of the territorial encounters as measured by the length in distance of each territorial chase was distinctly different for each couplet of combatants. As one might expect, the intraspecific *Hemipepsis* encounters were of longer distance than similar encounters with the other two species (ANOVA, $P < 0.05$). However, encounters between *Hemipepsis* and *Mydas* males were also significantly greater in distance than *Hemipepsis-Polistes* encounters.

Table 1. Number and percentage of male-male territorial chases (>4 m) between *Hemipepsis* and three species of flying insects. Territorial flights are summarized from June–July 1978.

Species	Total territorial flights	No. flights >4 m in length	% flights >4 m in length
Hemipepsis-Hemipepsis	140	75	53.6
Hemipepsis-Mydas	59	15	25.4
Hemipepsis-Polistes	1164	69	5.9

I recorded the number of territorial defense flights/hour by *Hemipepsis* and the reasons for those flights. Fewer than 10% of those flights were in response to *Mydas*. We can infer seasonality of *Mydas* males from this data (Fig. 1). Peak numbers of territorial defense encounters occurred between *Mydas* and *Hemipepsis* between 9 and 17 July, dropping to almost nil after 18 July. Data for one 9 day period prior to the peak activity indicate fewer territorial encounters. No data were collected prior to 30 June but *Mydas* males were observed on the study site at least as early as 23 June.

Daily numbers of territorial encounters between *Hemipepsis* and *Mydas* peaked between 0700 and 0800 Mountain Standard Time (MST) even though territorial defense flights by *Hemipepsis* males did not reach a maximum until 0900–1000 MST (Fig. 2). It can be reasonably inferred that the rate of *Hemipepsis-Mydas* encounters reflected the *Mydas* territorial activity with a 3 hour period in the morning as well as a period of activity beginning after 1200 MST. *Mydas* males (and *Hemipepsis* males) are only active on afternoons characterized by cooler temperatures following morning thundershowers or heavy clouds. In general, fewer *Mydas* were active during the afternoon period.

Discussion

Hilltopping.—Males of *Mydas xanthopterus* may employ hilltopping as a strategy to secure mates. Shields (1967) clearly shows the reproductive nature of hilltop sites for butterflies, the main advantage being to facilitate encounters between the sexes. Downes (1969) viewed hilltopping as merely a special case of the well known tendency of many insects to be attracted to "optical markers" for the purposes of breeding. Competition for dominance within a reproductive assemblage of males, and greatly skewed sex ratios are identifying characteristics of such lek territoriality (Emlen and Oring, 1977). Hilltopping exhibits these key characteristics. However, the development of hilltopping in *M. xanthopterus* represents only one solution to the problem of acquiring mates. Numerous other species of at least 4 genera of Mydidae inhabit the locality of the study site; only this species and one other were observed in the vicinity of hilltops.

Another possible meeting place for rare and/or widely scattered species of Mydidae would be at food sources. Not much is known of the feeding habits of adults, although Genung (1959) stated that adult Mydidae are known predators of insects. Meyers et al. (1984) collected specimens of *Mydas xanthopterus* on food plants in the Chiricahua Mountains 25 km E of my study site. It is possible that site was also used for mating. Zikan (1942) found *Mydas* spp. males but never females feeding on flowers, a situation which suggests the skewed sex ratios typical of mating arenas. This apparently was not true for *M. xanthopterus* since

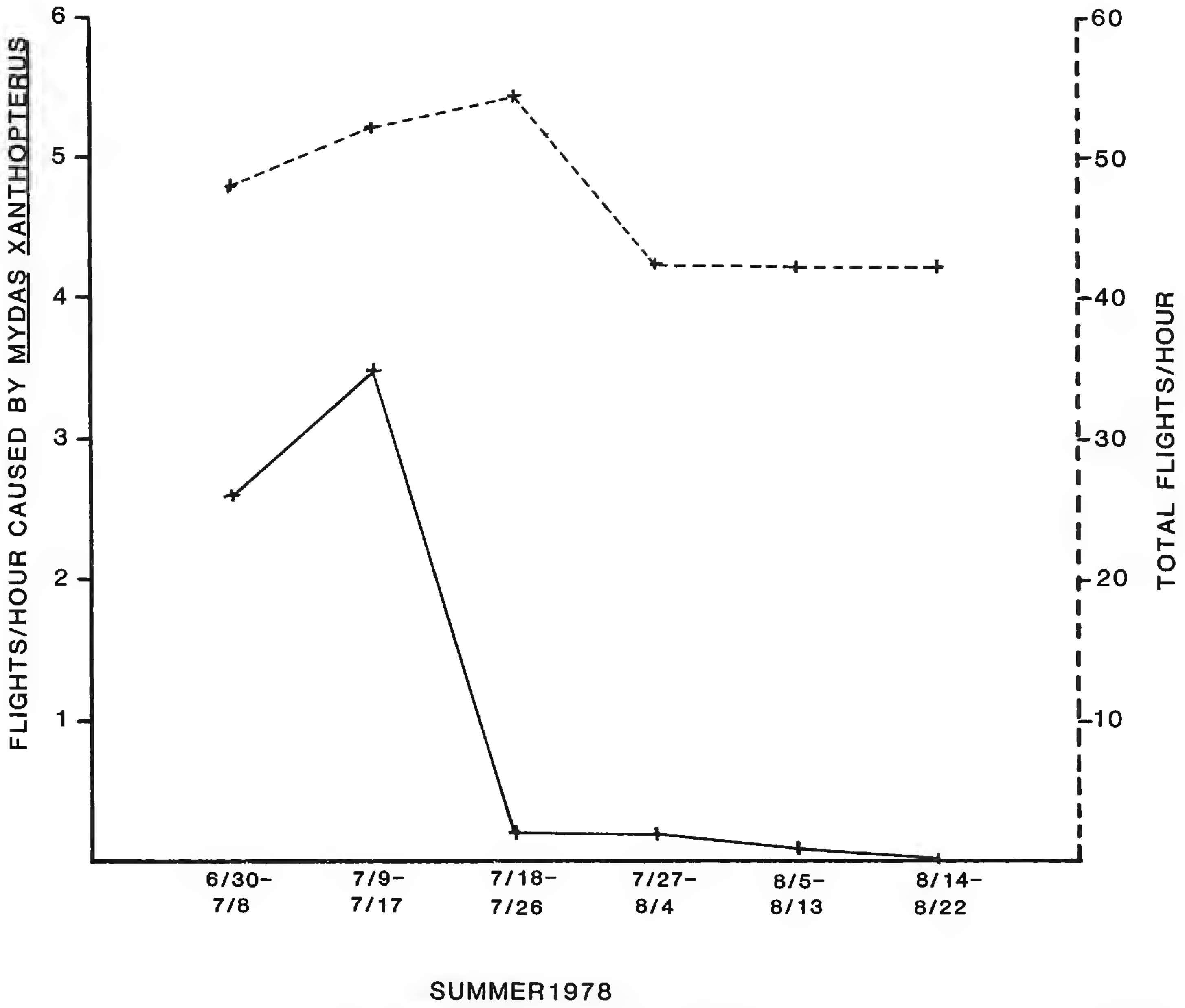

Figure 1. Seasonal variation in the total number of *Hemipepsis ustulata* territorial defense flights/hour (dashed line), and the number of *Hemipepsis* territorial defense flights/hour caused by *Mydas xanthopterus* (solid line).

Meyer et al. (1984) reported approximately equal numbers of male (5) and female (4) flies collected at the feeding site. If the flower patch were used as a mating site one might expect a skewed sex ratio. However in the megachilid bee *Anthidium maculosum* males defend patches of flowers and both sexes mate promiscuously (Alcock et al., 1977). Sex ratios in that case are closer to unity.

One advantage hilltopping may confer is a means of avoiding confusion among males and females of closely related species all trying to mate at the same location. Hilltopping could be viewed as one workable, alternative mating system with the principle advantage of spacial separation from the mating aggregations of related species that may use different mechanisms for mating. Seasonality and diurnal periodicity may further reproductively isolate *M. xanthopterus*. Figure 1 suggests that most reproductive activity is completed by late July; daily activity of males seems to be restricted to the cooler parts of the day (Fig. 2). Hilltopping as a reproductive strategy is also useful for those species whose larval forms are widely scattered, as mydid larva probably are. Nothing has been published on the larval foods of *M. xanthopterus*; however other species of Mydidae are suspected of having juvenile forms which are predatory of coleopterous larva (Genung, 1959; Krivosheina, 1977). Such a mode of existence which would necessitate a wide

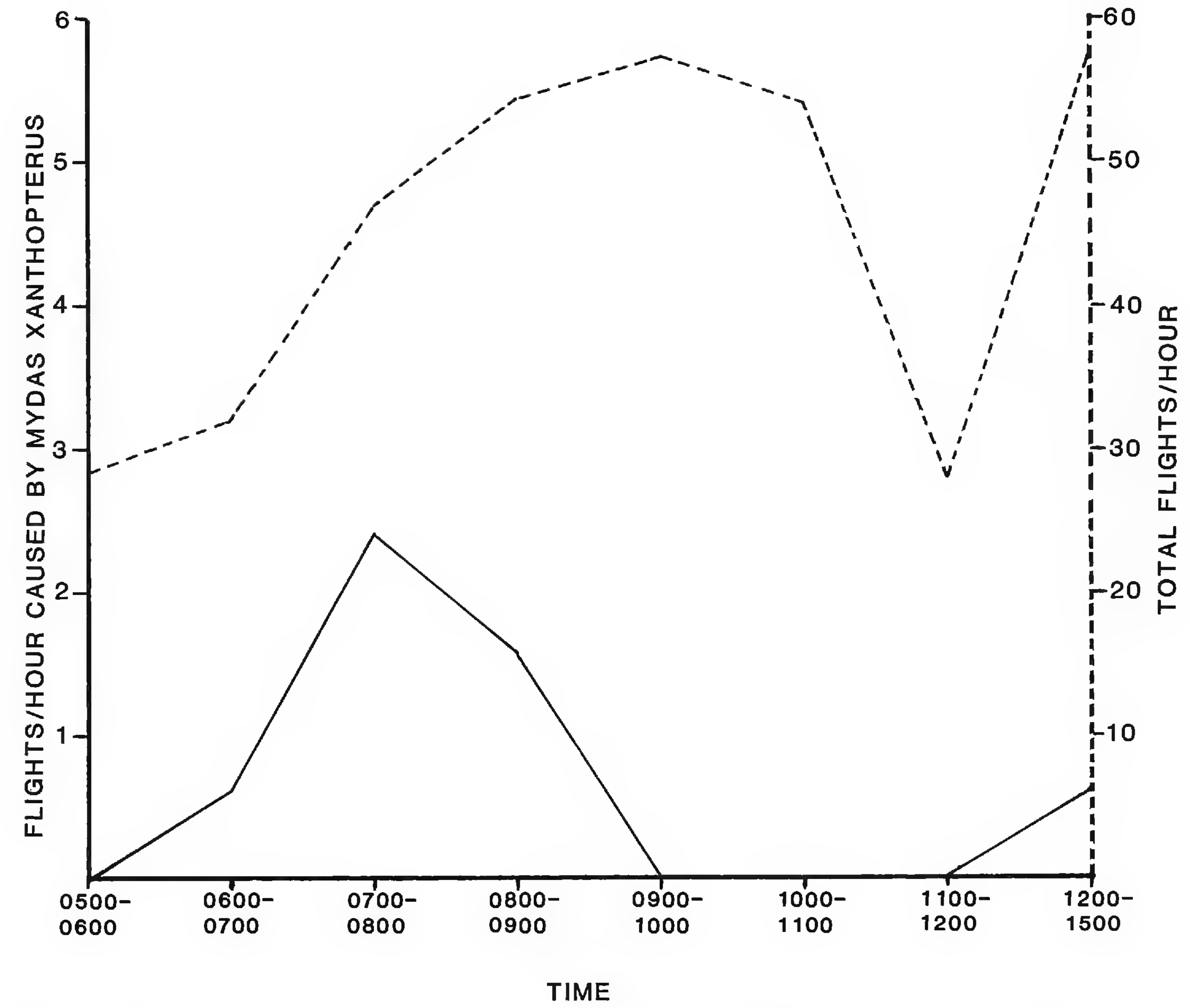

Figure 2. Daily variation in the total number of *Hemipepsis ustulata* territorial defense flights/hour (dashed line), and the number of *Hemipepsis* territorial defense flights/hour caused by *Mydas xanthopterus* (solid line).

dispersion of larva. Particular preference by Mydidae larvae has been shown for sandy soils (Steyskal, 1956; Genung, 1959; Wilcox and Papavero, 1971), an abundance of which occurs in the vicinity of the study site. Thus, when adult *Mydas* emerge, probably asynchronously, finding mates may involve a difficult and time-consuming search without some reproductive mechanism such as hilltopping. For relatively rare species such as *Mydas xanthopterus,* such a strategy becomes even more important.

Mimicry.—Mydidae have previously been noted as mimics of pompilid and other species of wasps (Howard, 1907; Zikan, 1942, 1944). Meyer et al. (1984) noted the marked resemblance of *M. xanthopterus* to the co-occurring *Pepsis formosa.* Zikan (1942) recorded *Mydas* spp. males trying to mate with large black Pompilidae, which they seem to mimic. J. Wilcox (in litt.) examined a *M. xanthopterus* specimen on which a note stated that the fly closely resembled *Pepsis thisbe* (Lucas), a pompilid similar in appearance to *Hemipepsis.*

Polistes-Hemipepsis encounters rarely (5.9%) resulted in long chases. One might reasonably expect that territorial defense flights between these two pugnacious species would involve encounters more aggressive than those between the distantly related *Hemipepsis* and *Mydas* (Nelson, 1986). This suggests that *Hemipepsis* males reacted to the superficial similarity between themselves and *Mydas* males with the resulting intense (longer in time and distance) territorial defense encounters. However, other possibilities exist that could adequately explain the levels of aggression (as defined by territorial defense chases greater than 4 meters): 1) Because of the large number of *Hemipepsis-Polistes* encounters (Table 1), the combatants may have become habituated to each other and as a result, engaged in more passive territorial defense, or 2) *Mydas* may be a stronger flier than *Polistes,* thereby drawing *Hemipepsis* into longer pursuits. In the first case, however, encounters between *Polistes* males and *Hemipepsis* males were not longer early in the morning before habituation presumably would have occurred (Nelson, 1986). Flights between those two species were invariably short in distance. For the second possibility, both *Polistes* and *Mydas* are relatively strong and aggressive fliers. Casual observations did not reveal any behavioral traits that would account for the relative lengths of territorial defense flights except that *Hemipepsis* males appeared to exhibit more interest in the visually more similar *Mydas* flies.

Female *Hemipepsis* defend themselves with a powerful sting; at least some predators probably avoid them as a result. Therefore, successful mimicry of pompilid wasps by *M. xanthopterus* would presumably increase their adult survival. The close associations of pompilids and *M. xanthopterus* noted in at least two situations (Meyers et al., 1984; present study) might help maximize the many advantages conferred by mimicry by providing a larger number of appropriate mimics for predators to see. And in this case the male *Hemipepsis* could themselves be considered mimics of conspecific females, part of the large number of insects that use presumed mimetic advantage of black and orange. Whatever selective advantages accrue to *Mydas* males through pompilid mimicry could well be similar to advantages that accrue to *Hemipepsis* males from their resemblance to *Hemipepsis* females.

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Ceratosmicra campoplegicus Burks, Male Description and New Distribution Records (Hymenoptera: Chalcididae)

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Abstract.—The male of *Ceratosmicra campoplegicus* Burks is described from material collected in California, United States. The petiole of the male plesioallotype and the male of *C. meteori* Burks, a closely related species, are illustrated. The range of *C. campoplegicus* was California (Burks, 1979) though should also include Oregon and Arizona (Burks, 1968). New distribution data extends this range into Baja California Norte, Morelos, and Puebla (Mexico). Additional locality data for Oregon and Arizona are presented.

Recently, while conducting studies on the family Chalcididae, the undescribed male of *Ceratosmicra campoplegicus* Burks was discovered in several collections. *Ceratosmicra campoplegicus* was described from females in Burks' (1968) second treatment of the genus *Ceratosmicra* Ashmead in America north of Mexico. At present, males of two (*C. campoplegicus* and *C. provancheri* Burks) of the six species of *Ceratosmicra* in America north of Mexico are not described. I therefore take this opportunity to describe one of these, *C. campoplegicus.*

In Burks' (1968) key to species, the male of *C. campoplegicus* keys to the female of *C. campoplegicus.* Males of *C. campoplegicus* and *C. meteori* Burks, a closely related species, are sometimes difficult to distinguish from each other because the key character identifying *C. meteori* (middle area of the petiole enlarged—see Fig. 2) is not prominant in some individuals. These two species can be separated by the shape of the flange at the base of their petiole. The flange of *campoplegicus* is broad (Fig. 1); the flange of *meteori* is narrow (Fig. 2).

Ceratosmicra campoplegicus Burks

Plesioallotype male.—Length 4.0 mm. Black with yellow and white markings. The following areas are yellow: ventral surface of scape, pedicel, flagella, and club; antennal sockets, genae, frons, clypeus, labrum, mandibles except teeth, thin band along posterior margin of compound eye extending from gena to lateral ocelli; dorsal submedial area of pronotum; lateral, outer margin of mesopraescutum; lateral, outer margin of mesoscutellum; tegulae, anterior half of fore coxae, fore and middle legs except middle coxae and tarsal claws; anterior, dorso-anterior, and ventro-posterior areas of outerside of hind femora, hind tibiae except in middle, hind tarsus except claws, dorso-basal half of hind coxae, median triangular area of tergite 1 (T1), T2 dorso-laterally, submedial spot on T6, and ventral margin of tergites. Basal ⅓ of petiole white.

Scape reaching level of anterior ocellus, widened apically; flagella of equal length,

Figures 1, 2. Lateral view of petiole of male (1) *Ceratosmicra campoplegicus,* male plesioallotype and (2) *Ceratosmicra meteori.*

all slightly longer than wide; ring segment ¼ as long as flagella, club 2.5× flagellar length, pedicel slightly longer than flagella, scrobe cavity shallow, margins acarinate, coriaceous. Frons, genae, and clypeus coriacious. Clypeus triangular, labrum 3× as wide as long. Distance between antennal sockets equal to antennal socket diameter. Anterior ocellus round, lateral ocelli oval. Anterior ocelli separated from lateral ocelli by anterior ocellar diameter. Lateral ocelli separated from margin of compound eye by ½ lateral ocellar diameter. Remainder of head and thorax dorsally with shallow setigerous umbilicate punctation, integument aciculate. Head in dorsal view wider than width of thorax. Anterior margin of pronotum acarinate though squared off. Lateral sides of pronotum coriaceous. Mesopleural acetabulum shallow, transversely carinate. Petiole in lateral view linear, 7× as long as widest point, anterior flange angled dorsally, prominant (Fig. 1). Petiole in dorsal view slightly wider in posterior half than anterior half, integument coriaceous. Length of petiole equal to length of mesopraescutum and pronotum together. Propodeum with a strong inverted "Y" shaped carina, remainder coriaceous, without ventral or lateral teeth. Outer dorsal area of hind coxae centrally glabrous and heavily coriaceous. Hind coxae 1.2× as long as petiole. Hind femora with a distinct, sharp tooth on inner side near base. Ventral margin with 17 teeth.

Type locality.—California, Tulare County, Ash Mountain, Kaweah Powerhouse #3, X-29-1982, J. A. Halstead, R. D. Haines, and D. J. Burdick. This specimen is in the collection of the United States Museum of Natural History, Washington, D.C.

The recorded range for *C. campoplegicus* is California (Burks, 1979) but should also include Oregon and Arizona (Burks, 1968). New distribution data extends the range of this wasp into Baja California Norte, Morelos, and Puebla (Mexico). Additional locality data for Oregon and Arizona and the new records for Mexico include:

UNITED STATES. OREGON, Yamhill Co.: 27-I-1934, E. S. Ross (1 ♀). ARIZONA, Pima Co.: Santa Catalina Mts., 15-VIII-1938, Bryant (1 ♀); Cochise Co.: Chiricahua Mts., E. Turkey Creek, 6.5 mi W Portal, 6400 ft, 20-VII-1981, on *Quercus,* H. A. Hespenheide (1 ♀); Chiricahua Mts., Sunny Flat, 5700 ft, 26-V-1980, on *Quercus,* H. A. Hespenheide (1 ♀, 1 ♂); Chiricahua Mts., Onion Saddle, 7600 ft, 22-VII-1981, on *Quercus,* H. A. Hespenheide (1 ♀).

MEXICO. BAJA CALIFORNIA NORTE, Arroyo Santo Domingo, 5.7 mi E Hamilton Ranch, dam site, 23-IV-1963, H. B. Leech and P. H. Arnaud (1 ♀). PUEBLA, 20 mi W Puebla, 29-XII-1940, G. E. Bohart (1 ♀). MORELOS, 6 mi E Cuernavaca, 1-IX-1974, G. E. Bohart and W. J. Hansen (1 ♀).

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New Records of Tephritidae (Diptera) from Santa Cruz Island, California

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Abstract.—Published records for five species of Tephritidae from Santa Cruz Island are reviewed. Nineteen species and nine genera of Tephritidae are newly reported from this island. Six new host-plant-species rearing records are included in these distribution data.

During annual or biannual visits to Santa Cruz Island, Santa Barbara Co., California, in conjunction with our continuing, long-standing evaluation of biological control of prickly pear cacti by means of sequential photography (Goeden et al., 1967; Goeden and Ricker, 1981), I have collected the Tephritidae recorded herein. Heretofore, only the following species were recorded from this large, coastal island: *Tomoplagia cressoni* Aczél in Foote and Blanc (1963); *Paroxyna genalis* (Thomson) in Novak (1974) and Goeden and Blanc (1986); *Tephritis californica* Doane, *Tephritis araneosa* (Coquillett), and *P. americana* Hering in Goeden and Benjamin (1985).

The following new island records are listed alphabetically and include only those of my collections involving the greatest number of flies reared or swept of each species. Voucher specimens of each species reported are stored in my collection of California Tephritidae at the University of California, Riverside, and are marked with a bright yellow place-label to allow ready location as suggested by Miller and Menke (1981). Their entomological bibliography of the California Islands partly inspired this study. The plant nomenclature follows Munz (1974); the insect nomenclature, mostly Foote and Blanc (1963) and Stoltzfus (1977).

Aciurina thoracica Curran, 2 ♂ and 1 ♀ swept from riparian shrubs near Cascada in east, central valley, 15 IV 1983.

Dioxyna picciola (Bigot), 1 ♂ and 2 ♀ swept from unidentified annual herbs in wash, Cervada Canyon, 1 X 1981.

Euaresta bullans (Wiedemann), 2 ♂ and 2 ♀ swept from the introduced weed, *Xanthium spinosum* L. (Hilgendorf and Goeden, 1983), mouth of Laguna Canyon, 30 IX 1981.

Euarestoides acutangulus (Thomson), 6 ♂ and 8 ♀ reared from a quantity of flower heads of *Ambrosia chamissonis* Lessing collected at Christy Beach, 8 X 1985.

Euarestoides arnaudi Foote, 1 ♂ and 2 ♀ reared from a quantity of flower heads of *Baccharis pilularis* deCandolle ssp. *consanguinea* (deCandolle) C. B. Wolf collected in central valley, 11 X 1983.

Neaspilota sp., 1 ♀ reared from a quantity of flower heads of *Haplopappus venetus* (Humboldt) Blake ssp. *vernonioides* (Nuttall) Hall at Stanton Ranch airport, 13 X 1983.

Tephritis baccharis (Coquillett), 5 ♂ and 5 ♀ reared from stem galls on *Baccharis glutinosa* Persoon collected in Cebada Canyon, 8 X 1985.

Tephritis stigmatica (Coquillett), 3 ♂ and 2 ♀ reared from mature flower heads of *Senecio douglasii* deCandolle collected in central valley, 9 X 1985.

Trupanea californica Malloch, 25 ♂ and 25 ♀ reared from flower heads of *Gnaphalium microcephalum* Nuttall collected in central valley, 7 X 1985.

Trupanea femoralis (Thomson), 2 ♀ reared from quantity of flower heads of *Haplopappus squarrosus* Hooker and Arnott ssp. *grindeloides* (deCandolle) Keck collected in central valley, 21 X 1983.

Trupanea maculigera Foote, 1 ♀ swept from *B. glutinosa* in central valley, 21 X 1981.

Trupanea nigricornis (Coquillett), 8 ♂ and 10 ♀ reared from same flower heads of *H. venetus* ssp. *vernonioides* collected at Stanton Ranch airport on, 13 X 1983.

Trupanea radifera (Coquillett), 4 ♂ and 2 ♀ reared from flower heads of *Heterotheca grandiflora* Nuttall collected atop west end of South Ridge just east of pine forest, 8 X 1985.

Trupanea signata Foote, 1 ♂ swept from *B. pilularis* ssp. *consanguinea* on South Ridge, 12 X 1983.

Trupanea wheeleri Curran, 27 ♂ and 28 ♀ collected from flower heads of *H. squarrosus* ssp. *grindeloides* collected atop South Ridge just east of pine forest, 7 X 1985.

Urophora formosa (Coquillett), 23 ♂ and 24 ♀ reared from same flower heads of *H. venetus* ssp. *vernonioides* collected at Stanton Ranch airport, 13 X 1986.

The above rearing records also represent new host-plant species records for *Euarestoides arnaudi, Trupanea californica, T. femoralis, T. nigricornis, T. radifera,* and *T. wheeleri* (Wasbauer, 1972; Goeden, 1983, 1985). In addition, my collection houses 4 ♂ and 6 ♀ of *Euaresta bellula* Snow swept at Christy Beach, 23–26 IV 1976 by J. D. Pinto. And, F. L. Blanc, Calif. Dept. of Food and Agric. (Ret.) kindly furnished me with new Santa Cruz Island records for *Chetostoma californicum* Blanc, 1 ♀ on *Pinus muricata* D. Don (a non-host), Canada de la Çuesta, 5 III 1969, and *Euaresta stigmatica* Coquillett, 1 ♀ from the central valley, 26 IX 1978, both collected by J. A. Powell.

All tephritid species reported also occur on the California mainland (Foote and Blanc, 1963; Novak, 1974). Interestingly, I consider *Trupanea nigricornis* the most widespread and common tephritid in interior parts of southern California. In coastal areas it is replaced largely by another generalist, *Trupanea wheeleri.* Yet, the former species also occurs in the central valley of Santa Cruz Island, a topographic feature unique among all the California islands. Also, I sampled mature flower heads of *Brickellia californica* (Torrey and Gray) Gray in the central valley in 1981, 1983, and 1985, which on the southern California mainland commonly yield *Procecidochares flavipes* Aldrich. This fly never was reared from island samples, although it apparently is restricted to the genus *Brickellia* (unpubl. data). This finding, my negative sweep records, and other rearings from island and mainland Asteraceae suggest that *Procecidochares* may be absent from the island.

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Larval and Pupal Parasites of *Rhinocyllus conicus* (Coleoptera: Curculionidae) in *Carduus nutans* in Northern California

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Abstract.—Thirteen species of parasitic Hymenoptera were found emerging from *Carduus nutans* Linnaeus (Compositae: Cynarae) stems and seedheads infested with *Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae); a European weevil introduced into North America to control *Carduus* spp. thistles. Seven Hymenoptera identified are believed to be primary parasites and include two species in genera which have unidentified members previously reported as parasites; and three species not previously reported in this association. Parasitism averaged 1.78% overall with no apparent impact on the weevil population. The attack rate for the stems was roughly 100 times greater than in the seedheads.

Rhinocyllus conicus Froelich (Coleoptera: Curculionidae) was introduced successfully from Europe into the United States in 1969 for the control of *Carduus* spp. (Boldt and Kok, 1982). It was first released in California at Mt. Shasta in 1974 on a localized population of *C. nutans* Linnaeus.

Although indigenous parasites often have little impact on the effectiveness of insects introduced for the biological control of weeds, in some cases they can severely limit the effect of the biological control agent (Goeden and Louda, 1976). Zwolfer and Harris (1984) present a list of reported parasites of *R. conicus* in its native range as well as its introduced range. Some of the parasites in Europe are well adapted to *R. conicus*; *Bracon urinator* Fabricius (Hymenoptera: Braconidae) achieves 40–50% parasitism and *Exeristes roborator* (Fabricius) (Hymenoptera: Ichneumonidae) reaches 13–43%. In contrast, parasites reported from *R. conicus* infesting *Carduus* spp. in Virginia and Montana, and infesting *Silybum marianum* in southern California were all found at very low levels and did not appear to limit the impact of *R. conicus*. Total parasitism in Montana did not exceed 1% (Rees, 1982). In Virginia, parasitism ranged from 1.8–2.5% for the flower heads but was much higher in the peduncles averaging 16.9% over two years (Dowd and Kok, 1982).

This study was undertaken to determine what larval and pupal parasites of *R. conicus* are present in the Mt. Shasta area and whether they may impose a limitation to the biological control of *C. nutans*.

METHODS AND MATERIALS

Fifty flowering stems of *Carduus nutans* with mature seedheads were collected from an infestation located on the west side of Mt. Shasta, three miles north of

Mt. Shasta City, Calif., on July 25 and again on July 31, 1985. The material was taken to the laboratory where heads were removed from the stems. Stems were cut to retain the top 30 cm, which contain the weevil larvae and pupae, and the remainder was discarded.

Heads and stems from each date were held in cages to observe parasite emergence. Emerging parasitic Hymenoptera were collected every 2–3 days until no further emergence occurred.

Infestation of the material by *R. conicus* was estimated by dissecting 10 stems or heads randomly selected from each cage, counting the weevil pupation cells, and multiplying the average by the number of heads or stems in each cage. The total number of cells present in the heads and stems and the number of parasites collected were used as a basis for calculating percent parasitization.

Parasite ovipositor lengths were measured by dissection of five females of each species. The correlation of average ovipositor length of a species with attack rate in the heads was computed to detect the degree of relationship.

RESULTS

Thirteen species of parasitic Hymenoptera emerged from the plant material. The seven most abundant species were *Neocatolaccus tylodermae* (Ashmead), *Trimerocerus maculata* Gahan, and *Pteromalus* sp. in Pteromalidae; *Eurytoma* sp. (Eurytomidae); *Microdontomerus anthonomi* (Crawford) (Torymidae); and *Macroneura vesicularis* (Ratzenburg) and *Eupelmus* sp. poss. *brevicauda* (Crawford) in Eupelmidae. These parasites and their abundances are presented in Table 1.

In addition, four pteromalid, one encyrtid and one scelionid species were recovered but in very low numbers. The encyrtid, *Apoanagyrus californicus* Compere, is a parasite of mealybugs; and members of Scelionidae are egg parasites. These are considered unlikely larval or pupal parasites of *R. conicus* and are excluded from further discussion.

Dissections of *C. nutans* material provided an estimate of 17,828 pupal cells in the cages with heads, and 1649 cells in the cages with stems. Although the number of parasites emerging from the stems was roughly 10 times that from the heads, the greater number of hosts made the attack rate roughly 100 times greater in the stems. The correlation between species ovipositor length and proportion of the attack in the heads is low ($r^2 = 0.40$) and not significantly different from 0 when tested using the t-statistic (df = 5, $\alpha = 0.05$).

Our dissections found *Neocatolaccus tylodermae, Pteromalus* sp. and *Eurytoma* sp. adults present in the pupal cells of *R. conicus.* In addition, some secondary ectoparasitism was observed but it is unclear which species were involved.

Two other Coleoptera found in the plant material were *Phyllobaenus scaber* (LeConte) (Cleridae) and an unidentified Anobiidae. Both are considered unlikely hosts of any of the identified parasites because they are quite small.

DISCUSSION

From previous host records and our dissections of the plant material, it appears that all named parasites are probably primary parasites of *R. conicus. Microdontomerus anthonomi* and *Macroneura vesicularis* occasionally are recorded as secondary parasites but only rarely so (Krombien et al., 1979). The unidentified

Table 1. Parasitic Hymenoptera emerging from heads and stems of *Carduus nutans* infested with *Rhinocyllus conicus.*

Species	Number emerged			% parasitism[1]		Proportion in heads
	Total	Heads	Stems	Heads	Stems	
Eupelmidae						
Macroneura vesicularis	25	2	23	0.01	1.39	0.08
Eupelmus sp.	11	2	9	0.01	0.55	0.18
Torymidae						
Microdontomerus anthonomi	29	9	20	0.05	1.21	0.31
Pteromalidae						
Trimerocerus maculata	71	2	69	0.01	4.18	0.03
Neocatolaccus tylodermae	68	3	65	0.02	3.94	0.04
Pteromalus sp.	35	4	31	0.02	1.88	0.11
Eurytomidae						
Eurytoma sp.	91	12	79	0.07	4.79	0.13
Overall	346	34	312	0.19	18.92	0.10

[1] Based on an estimated total of 17,828 *R. conicus* in the heads and 1649 in the stems, and assuming that all species listed are primary parasites of *R. conicus.*

pteromalids may include some secondary parasites since they are smaller than the others and since some secondary parasitism was discovered during plant dissections.

Previous lists of parasites of *R. conicus* in the U.S. include *Eupelmella* sp. (=*Macroneura*), *Eurytoma* sp., *Habrocytus* sp. (=*Pteromalus*), and *Neocatolaccus* sp. (Zwolfer and Harris, 1984). Although these are only reported to the level of genus, further work may show that some are the same species as ours and confirm their status as primary parasites. *Trimerocerus maculata* was not listed by Zwolfer and Harris but is one of the more abundant parasites here. Another major difference is that no Braconidae or Ichneumonidae were recovered here whereas they were found at other locations in the U.S. and include the most abundant parasites in Europe.

Host records of our parasites were examined to determine if any common biological or ecological thread could link these native parasites that have quickly adopted a new host. Reported host ranges of the parasites indicate that some are generalists. These include *Microdontomerus anthonomi, Trimerocerus maculata* and *Macroneura vesicularis,* the latter having hosts in the orders Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. *Neocatolaccus tylodermae* and *Eupelmus brevicauda* are more specialized; the former having ten recorded hosts, all Curculionidae; and the latter having one recorded host in Bruchidae, although other members of the genus attack Curculionidae and Bruchidae. Both the *Eurytoma* sp. and the *Pteromalus* sp. are members of large, diverse genera making it difficult to generalize about their host ranges (Krombein et al., 1979).

All known hosts of the parasite species identified are found in concealed locations, as is *R. conicus.* This suggests that the location of the host is more important than its taxonomic category in determining host acceptance.

The difference in attack rate of the parasites for hosts in the stems from those in the heads may be due to a preference of the parasites for searching the stems, a difference in ability to locate the host in the heads, or an inability to reach the host in the heads with the ovipositor. Of these, ovipositor length was the only quantifiable character within the means of this investigation. The fact that the correlation between ovipositor length and attack rate in the heads is low doesn't rule out ovipositor length as an important factor in the ability of the parasites to reach *R. conicus* in the heads for some of the species, but its role is clouded by other factors.

CONCLUSIONS

Since total parasitism of *Rhinocyllus conicus* was only 1.78%, it seems unlikely that the parasites in the Mt. Shasta area present any limitation to the level of biological control of *Carduus nutans*. This is similar to the findings of researchers in Virginia and Montana (Dowd and Kok, 1982; Rees, 1982).

Parasitism in the stems was 18.9%, much higher than in the heads, and again very similar to the 16.9% parasitism in the peduncles found by Dowd and Kok (1982). The weevils in the heads make up a large reservoir of currently unparasitized hosts and it is possible that at some time a parasite better adapted to parasitizing *R. conicus* in the heads might be able to exploit this resource and upset the current level of biological control.

Further study would provide a clearer picture of the impact of parasitism by the different species reported in this paper, but from the standpoint of biological control, it does not appear necessary at this time.

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New Pselaphidae from Oregon (Coleoptera)[1]

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Abstract.—Three new species from the H. J. Andrews Experimental Forest in central Oregon and four others from western Oregon are described: *Sonoma petersi,* n. sp., *Sonoma cascadia,* n. sp., *Sonoma quercicola,* n. sp., *Sonoma conifera,* n. sp., *Sonoma russelli,* n. sp., *Hylotychus schuhi,* n. sp., and *Oropus micropthalmus,* n. sp.

In the course of characterizing the pselaphid fauna of the H. J. Andrews Experimental Forest in central Oregon, three undescribed species of Pselaphidae were discovered. These species are here described to provide names for a forthcoming paper on the species and habitats of the Pselaphidae of this experimental forest. Four other new species occurring near the experimental forest also are described.

Holotypes of four species were cleared, disarticulated, and mounted in Canada balsam on slides. The other holotypes have the genitalia cleared, placed in microvials, and pinned beneath the specimens. Holotypes are deposited at the University of California, Davis, with paratypes of five of the species being deposited in the Systematic Entomology Laboratory of Oregon State University. All measurements are in millimeters.

I would like to thank Dr. John D. Lattin, Oregon State University, for arranging my visits to Oregon as a participating scientist in the Long Term Ecological Research Program at the H. J. Andrews Experimental Forest. Gary Parsons is thanked for his assistance during my travel in Oregon. Several individuals provided specimens examined in this work, and following their affiliations are the initials of institutions (four letter) or private collections (three letter) where specimens are placed: John D. Lattin, Oregon State University (OSUO); Gary L. Peters, Oregon State University (GLP); Paul J. Johnson, University of Idaho (PJJ); and Lee H. Herman, Jr., American Museum of Natural History (AMNH). Specimens whose deposition are not indicated are in the author's collection. Loren Russell, Oregon Environmental Protection Agency, and the late Joe Schuh, kindly allowed me to examine their collections. J. F. Burger and J. S. Weaver, University of New Hampshire, deserve my appreciation for checking the manuscript.

***Sonoma petersi,* NEW SPECIES**
(Fig. 1)

Length 1.50–1.62. Head with eyes possessing about 48 facets, frontal fovea short, roughly triangular, head with base subtruncate, wider than distance across

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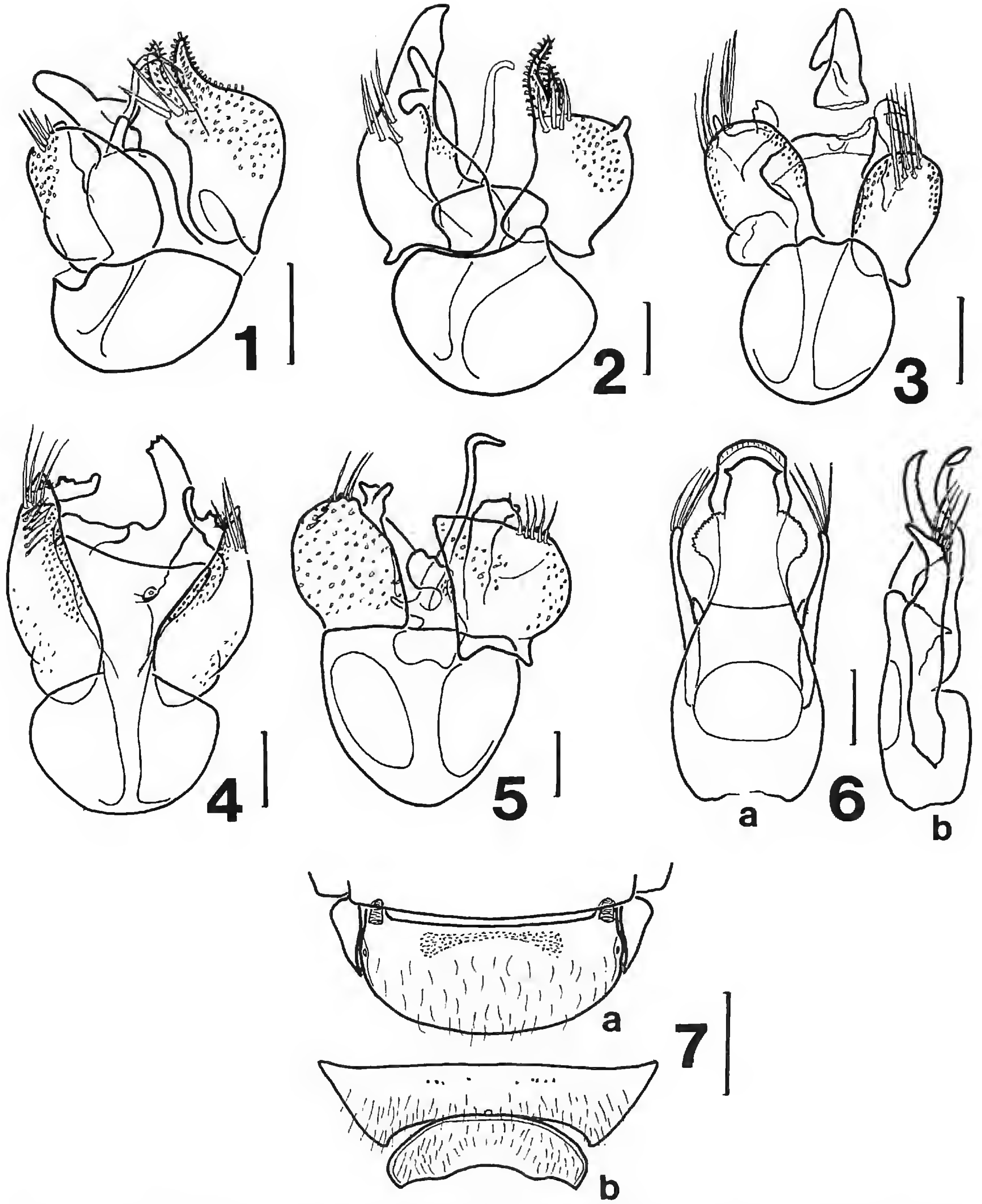

Figures 1–7. Line to right of illustrations equals 0.5 mm. 1. *Sonoma petersi,* n. sp., dorsal view male genitalia. 2. *Sonoma cascadia,* n. sp., dorsal view male genitalia. 3. *Sonoma quercicola,* n. sp., dorsal view male genitalia. 4. *Sonoma conifera,* n. sp., dorsal view male genitalia. 5. *Sonoma russelli,* n. sp., dorsal view male genitalia. 6. *Hylotychus schuhi,* n. sp., male; a. dorsal view genitalia; b. left lateral view genitalia. 7. *Oropus micropthalmus,* n. sp., male; a. dorsal view tergite IV; b. ventral view sternites V and VI.

eyes. Pronotum with median antebasal fovea inserted in deep rectangular impression which extends laterally to medio-lateral antebasal foveae, discal foveae distinct. Tergite I with transverse microsetigerous line.

Males with metatrochanters posteriorly angulate and carinate, metatibiae with small obscure tubercle on mesal margin near middle; head venter with transverse gular ridge, ridge densely setose on posterior margin and obscuring gular foveae; genitalia with phallobase asymmetrical, shortened on right side, left paramere with two tuberculate conical projections.

Females lack modifications of metatrochanters and metatibiae, and the head venter is simple at the area of the gular foveae; sternite VI apex with rounded midapical lobe deflexed, extending posteriorly just past middle of sternite VII, lobe about one-fourth the apical width of VI.

Male holotype.—Head 0.21 long, 0.25 wide across eyes, pronotum 0.23 long, elytra 0.42 long, genitalia 0.18 long.

Specimens examined, 6. HOLOTYPE male: *Oregon:* Benton Co.: MacDonald Forest, Oak Creek area, II-3-1973, G. L. Peters. Holotype mounted on slide. PARATYPES: 1 male, 3 females, eutopotypical (GLP, OSUO); 1 male, same data except, III-12-1973.

Discussion.—This species is clearly quite close to *corticina* Casey which is found from coastal Oregon into northwestern California. They share the angulate tempora of the head, microsetigerous line of tergite I, and the males with a modified gular area, weak tubercle of the metatibiae, strongly asymmetrical phallobase, and tuberculate processes of the left paramere. The gular area of *petersi* is developed into a transverse ridge obscuring the gular foveae, the discal foveae of the pronotum are distinct, and the median lobe and right paramere of the genitalia are different in form from those of *corticina.* Named for Gary L. Peters, the collector of the type series.

***Sonoma cascadia,* New Species**

(Fig. 2)

Length 1.38–1.47. Head with eyes possessing about 60 facets, frontal fovea lengthily triangular, tempora slightly angulate at head base. Pronotum with deep median antebasal fovea in narrow rectangular impression which extends laterally to medio-lateral antebasal foveae, discal foveae distinct. Tergite I with transverse microsetigerous line.

Male metatrochanters with angulate projection of posterior margin, metatibiae lacking tubercle on inner margin; genitalia with left paramere bearing two tuberculate projections, left paramere elongate, median lobe with thin heavily sclerotized bifurcate spine and more median slender lightly sclerotized spine which is curved at apex.

Female with metatrochanters simple, not angulate; sternite VI with wide evenly rounded apical lobe deflexed and projecting posteriorly to middle of sternite VII, lobe one-half apical width of sternite VI, VII granulate.

Male holotype.—Head 0.18 long, 0.24 wide across eyes, pronotum 0.22 long, elytra 0.45 long, genitalia 0.22 long.

Specimens examined, 2. HOLOTYPE male: *Oregon:* Lane Co.: HJAndrews Exp. For., Road 1508, 1750′, I-24-1981, G. Cassis, site 5, old growth, *Tsuga/Pseudotsuga* litter. Holotype mounted on point. One female not designated paratype bears the data: same locality, 1450′, R.S. 7, V-13-1983, D. S. Chandler, sift rotten Douglas-fir.

Biology.—Collected in conifer leaf litter and a rotten Douglas-fir log in old growth forests at the lower elevations of the experimental forest.

Discussion.—The two tuberculate projections of the left paramere place *cascadia* nearest *corticina* Casey and *petersi,* n. sp. The somewhat angulate basal angles of the head and the smaller right half of the phallobase reinforce this placement. *Cascadia* is perhaps closest to *petersi* by the presence of two processes of the median lobe. Males of *cascadia* are separated by the metatibiae lacking any trace of an inner tubercle, the simple gular area, angulate projection of the metatrochanters, and the long right paramere. Females of these species share the deflexed apical lobe of sternite VI, but in *cascadia* it is half as wide as the apical width of sternite VI, and sternite VII is granulate. The name is derived from the collection of this species in the Cascade Mountains.

Sonoma quercicola, New Species
(Fig. 3)

Length 1.62–1.71. Head with eyes possessing about 80 facets, frontal fovea elongate, widening slightly toward apex, tempora evenly rounded to head base. Pronotum with median antebasal fovea in deep depression which extends laterally to medio-lateral antebasal foveae, discal foveae lacking. Tergite I with transverse microsetigerous line.

Male with metatrochanters posteriorly angulate and carinate, metatibiae with small tubercle on mesal margin near middle; genitalia with each paramere bearing a supplementary tubercle, parameres lightly granulate, median lobe with thick apical hook.

Female with metatrochanters and metatibiae simple, lacking angulations or tubercles; sternite VI bearing a rounded apical lobe which is offset to the right and extends over sternite VII to sternite VIII, sternite VII visible only to left of lobe.

Male holotype.—Head 0.24 long, 0.28 wide across eyes, pronotum 0.30 long, elytra 0.54 long, genitalia 0.18 long, median lobe of genitalia with apex detached but retained in microvial.

Specimens examined, 2. HOLOTYPE male: MacDonald Forest, Oak Creek area, III-12-1973, G. L. Peters, collected by Berlese funnel. Holotype mounted on point. One female not designated paratype with same data as the holotype except, III-6-1973.

Discussion.—The male genitalia are similar to several other species in having granulate parameres bearing supplementary processes, and a large median lobe. The form of these structures is different from that in other known species, and *quercicola* cannot be placed near any at this time. The name is derived from the collection of the specimens along Oak Creek.

Sonoma conifera, New Species
(Fig. 4)

Length 1.71–1.92. Head with eyes possessing about 48 facets, frontal fovea elongate, enlarged at apex, tempora evenly curved to head base. Pronotum with median antebasal fovea in semicircular impression which extends laterally to medio-lateral foveae, discal foveae weakly impressed. Tergite I with transverse microsetigerous line.

Males with metatrochanters posteriorly angulate and carinate, metatibiae lacking mesal tubercle; genitalia with elongate parameres, median lobe well developed.

Females with metatrochanters simple; sternite VI medially produced at apex over VII to reach VIII, medial projection lightly bidentate at apex, projection and area anterior to it lightly granulate.

Male holotype. —Head 0.27 long, 0.33 wide across eyes, pronotum 0.27 long, elytra 0.41 long, genitalia 0.17 long.

Specimens examined, 8. HOLOTYPE male: *Oregon:* Benton Co.: Mary's Peak, 1800′, II-1-1976, L. Russell, sift cedar litter. Holotype mounted on slide. PARATYPES: 1 male, same data except, II-22-1976, sift hemlock litter; 1 male, same data except, 8 mi SE Hwy. 20, III-6-1976, Douglas-fir litter; 1 male, 6.5 mi SW Philomath, III-12-1975, G. L. Peters. Lane Co.: 1 male, HJAndrews Exp. For., Road 1508, 1750′, II-19-1979, G. Cooper, old growth, moss; 1 male, same locality, Road 1506, III-12-1981, G. Cassis, site 8, 1970 clearcut, litter (OSUO). Two females associated with these males are not designated paratypes and bear the data: Lane Co.: HJAndrews Exp. For., Road 359, 4100′, V-13-1984, D. S. Chandler, sift alder litter; same locality, Road 1508, 1750′, I-24-1984, G. Cassis, site 5, old growth, *Tsuga/Psudotsuga* litter (OSUO).

Biology.—Collected primarily in several types of conifer leaf litter, in both old growth and recently clearcut forests

Discussion.—*Conifera* approaches only *Sonoma hespera* Park and Wagner in the stout, relatively simple median lobe of the male genitalia. They differ in the apical armatures of the parameres, and both parameres are of equal length in *conifera.* The name is derived from the primary collection habitat, conifer litter.

Sonoma russelli, NEW SPECIES

(Fig. 5)

Length 2.22–2.58. Head with eyes possessing about 55 facets, frontal fovea broadly T-shaped, tempora evenly rounded to head base; pronotum with median antebasal fovea encircled by deep depression, lacking medio-lateral antebasal foveae, discal foveae usually distinct but occasionally absent. Tergite I lacking transverse microsetigerous band.

Males with metatrochanters angulate and carinate on posterior margin, metatibiae lacking mesal tubercle; genitalia with supplementary tubercle on each paramere, parameres granulate, median lobe with long thin spine abruptly hooked near apex.

Females with posterior margin of metatrochanters simply curved; sternite VI with rounded lobe on apical margin slightly offset to left, inserted in impression of sternite VII which extends to posterior margin, impression of VII with carinate margins along lobe of VI.

Male holotype.—Head 0.39 long, 0.41 wide across eyes, pronotum 0.39 long, elytra 0.60 long, genitalia 0.29 long.

Specimens examined, 31. HOLOTYPE male: *Oregon:* Benton Co.: Mary's Peak, 1800′, II-1-1976, L. Russell, sift litter around log. Holotype mounted on slide. PARATYPES: 2 males, same data except, I-18-1976, sift alder litter, sift Douglas-fir litter; 8 males, 3 females, same data except, II-1-1976, sift litter around log (4), sift moss (2), sift cedar litter (2), sift hemlock litter (2), sift alder litter (1); 5 males, 2 females, same data except, 1750′, II-16-1976, stump litter (4), sift hemlock litter (3); 1 male, 1 female, same data except, 1700′, III-16-1976, Douglas-fir litter; 2 males, same data except, 2000′, IV-11-1976, moss on logs; 1 male, Mary's Peak, Funny Bug Notch, 3000′, XII-5-1976, P. J. Johnson, litter (PJJ); 1 female, 10 mi W Philomath, 1700′, XII-5-1976, P. J. Johnson (PJJ); 1 male, 1 female, 14 mi WSW Philomath, NE slope Mary's Peak, 2000′, Chintimini Creek, VII-5-1978, L. & N. Herman, #1604 (AMNH); 2 males, MacDonald Forest, VI-16-1975, L. Russell.

Biology.—This species has been collected in various leaf litters, and rotten wood.

Discussion.—This species and several others share the supplementary tubercles that originate from the granulate parameres of the male genitalia. At this time *russelli* cannot really be placed close to any particular species. The long thin spine of the median lobe is abruptly angulate near the apex, and permits ready recognition. Named for Loren Russell, who has collected many uncommon pselaphids from western Oregon.

Hylotychus schuhi, New Species

(Fig. 6)

Length 1.23–1.32. Males with eyes possessing approximately 32 facets; pro- and mesotibiae with small apical tubercle on inner margin; metasternal area simple; sternite VI broadly impressed medially, distinctly emarginate at apex. Genitalia with dorsal lobe acutely pointed at lateral margins of apex, lateral margins expanded and denticulate anteriorly, ventral lobe with margins slightly expanded before apex, parameres reaching to tuberculate area of dorsal lobe.

Females with eyes possessing about 20 facets; lacking apical tubercles of pro- and mesotibiae.

Male holotype.—Head 0.24 long, 0.21 wide across eyes, pronotum 0.25 long, elytra 0.47 long, genitalia 0.31 long.

Specimens examined, 5: HOLOTYPE male: *Oregon:* Klamath Co.: above Geary Ranch, X-25-1971, J. Schuh, aspen duff at swamp. Holotype mounted on point. PARATYPES: 1 female, same data except, X-26-1971, pine-aspen duff; 1 male, same data except, XI-1-1971, willow duff; 1 female, same data except, XI-6-1972, duff under pine (OSUO); 1 female, Geary Canal, III-17-1972, J. Schuh, mixed duff.

Biology.—Collected in pine, willow, and aspen leaf litters.

Discussion.—Members of *Hylotychus* can only really be compared by the form of the male genitalia, as they are otherwise quite similar. The genitalia is most similar to that of *simplicis* Grigarick and Schuster from the west coast of Oregon by the form of the apices of both dorsal and ventral lobes. The dorsal lobe of *schuhi* separates this species from all others by the laterally denticulate medial expansion. The parameres of *schuhi* are straight, while those of *simplicis* are curved laterally near the apices. Named for the late Joe Schuh, who greatly contributed to the knowledge of the beetle fauna of south-central Oregon.

Oropus micropthalmus, New Species

(Fig. 7)

Length 1.26–1.47. Head with vertex lightly and sparsely punctate, granulate only at lateral margins posterior to eyes. Pronotum with small blunt baso-lateral tooth. Elytra with four basal foveae, innermost discal stria no more than one-third elytral length, second discal stria two-thirds elytral length. Second tergite 0.6× as long as first.

Males with eyes possessing 7–8 facets; tergite IV with narrow transverse sulcus at base, microsetigerous band medially constricted, lateral lobes expanded posteriorly; sternite IV with long setae originating on anterior margin, sternite V with about 8 pits widely dispersed in transverse row, row interrupted at center.

Females with eyes possessing 5–7 facets; tergite IV smoothly convex at base, not impressed.

Male holotype.—Head 0.22 long, 0.29 wide across eyes, left mandible with 5 teeth on inner margin, right with four teeth, none abruptly larger, pronotum 0.32 long, elytra 0.39 long, tergite I 0.22 long, 0.36 wide, tergite II 0.14 long, sternite IV with four long setae on anterior margin.

Specimens examined, 15. HOLOTYPE male: *Oregon:* Lane Co.: H. J. Andrews Experimental Forest, Watershed 10, XI-15-1972, J. Wernz. Holotype mounted on slide. PARATYPES: all from H. J. Andrews Experimental Forest. 2 males, same data as holotype except, II-26-1973 (GLP); 1 female, same data except, X-5-1972; 1 male, 1 female, Road 134, 1750′, I-24-1984, G. Cassis, site 4, 1975 clearcut, *Pseudotsuga* litter; 2 males, 3 females, Road 320, L502, 2000′, II-21-1981, G. Cassis, site 6, 1959 clearcut, *Pseudotsuga* litter (OSUO); 1 female, Road 320, 2000′, II-21-1981, G. Cassis, site 7, old growth, *Pseudotsuga* litter (OSUO); 1 female, Road 1506, III-12-1981, G. Cassis, site 8, 1970 clearcut, litter (OSUO); 1 male, 1 female, Road 1507, 2000′, III-25-1981, G. Cassis, site 10, old growth, *Tsuga* litter.

Biology.—Adults were collected in *Tsuga* and *Pseudotsuga* leaf litter at the lower elevations of the forest. Both old growth and clearcut forests of different ages yielded specimens.

Discussion.—This species has the ratio of length of tergites I/II 1.66, and tergite I with a width/length ratio of 0.62, which is intermediate to the ratios used by Schuster and Grigarick (1960) to separate the genus into two groups. However, presence of the long setae medially at the base of sternite IV clearly places this species into Group A. In Schuster and Grigarick's key to species, *micropthalmus* runs readily to couplet 9. It is separable from the three species of this couplet, and indeed the entire group, by its small size, few facets of the eyes, and in the males by the form of the impression and microsetigerous area of tergite IV. The name was suggested by the small size of the eyes in both sexes.

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Designation of Chrysidid Lectotypes in the Mocsáry Collection at the Hungarian National Museum, Budapest (Hymenoptera: Chrysididae)

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Abstract.—Lectotypes of 105 species and subspecies described by A. Mocsáry found at the Hungarian National Museum are designated. Fifteen of these are from the chrysidid subfamily Elampinae and 90 from the subfamily Chrysidinae. Comments on Mocsáry's life and notes on collection of Chrysididae at the Museum are included.

In April–May of 1985 we visited the Hungarian National Museum in Budapest to study the Mocsáry collection of Chrysididae. We were ably assisted by hymenopterists Jëno Papp and Lajos Zombori.

Alexandro (Sandor) Mocsáry (1841–1915) contributed more than any other worker to our knowledge of Chrysididae. Born and educated in Nagyvarad, Hungary, he later became Abteilungsdirektor of the Hungarian National Museum, where he worked for 44 years. His first paper on chrysidids appeared in 1878 and his last in 1914. According to Viereck (1922), his bibliography comprises 178 titles and 2594 pages, mostly devoted to Chrysididae. He is best known for his "Monographia Chrysididarum Orbis Terrarum Universi" (1889), a work of monumental proportions. The chrysidid collection at Budapest is one of the five largest in the world, and probably the most important with respect to numbers of type specimens. We found it in good order, but were told that Mocsáry's assistant, Ludovici Biró, arranged the species and added "type" labels after 1915. Most specimens were correctly identified as original type series, but in some instances they have been mislabeled. This has necessitated careful comparison with original descriptions, and workers should be aware that some of the specimens from these type series have also found their way into other European collections. It is interesting to note that Mocsáry traveled very little, and his large accumulation of specimens came from others. For instance, Biró collected for him in New Guinea, the Greek Islands, and in southern U.S.S.R., and the many species from southern Africa were largely sent to him by Hans Brauns. Many of Mocsáry's species and subspecies were based on syntypes. Móczár (1964a, 1964b, 1965) selected lectotypes for species of chrysidids occurring in the Carpathian Basin. Here, we designate others in the Elampinae (L. D. French) and Chrysidinae (R. M. Bohart). Species are listed alphabetically and include their original citation. Correct generic placement follows each citation, and we have made no attempt to show species level synonymy.

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Elampinae

Ellampus auratus gasperinii Mocsáry, 1889:92. Lectotype female, Yugoslavia: Dalmatia. *Omalus.*
Ellampus chilensis Mocsáry, 1911:444. Lectotype female, Chile: Concepción. *Pseudolopyga.*
Ellampus herbstii Mocsáry, 1911:445. Lectotype male, Chile: Concepción. *Omalus.*
Ellampus imbecillus Mocsáry, 1889:98. Lectotype female, Turkmen S.S.R.: Pendgikent. *Omalus.*
Hedychrum marianum Mocsáry, 1911:450. Lectotype female, China.
Hedychrum punctigerum Mocsáry, 1909:2. Lectotype female, Kazakh S.S.R.: Mt. Karatau.
Hedychrum rutilans veterrimum Mocsáry, 1914:11. Lectotype male, Turkey: Mt. Ararat.
Hedychrum shiratiense Mocsáry, 1911:453. Lectotype female, Ethiopia: Katona, Shirati.
Hedychrum simile Mocsáry, 1889:157. Lectotype female, China ("borealis"): Ta-schian-sy.
Holopyga almasyana Mocsáry, 1911:445. Lectotype female, Kirgiz S.S.R.: Naryn. *Haba.*
Holopyga elegans Mocsáry, 1911:450. Lectotype female, Turkey: Izmir (Smyrna). *Hedychridium.*
Holopyga incensa Mocsáry, 1914:7. Lectotype female, U.S.S.R.: "Turkestania." *Hedychridium.*
Holopyga obscurata Mocsáry, 1902b:536. Lectotype female, South Africa: Cape Province, Algoa Bay. *Hedychridium.*
Holopyga punctatissima turkestanica Mocsáry, 1909:1. Lectotype male, Kazakh S.S.R.: Mt. Karatau.
Holopyga ujhelyiana Mocsáry, 1914:7. Lectotype female, Colombia: Atlántico, Baranquilla.

Chrysidinae

Chrysis abdominalis Mocsáry, 1912b:579. Lectotype female, Peru: Puno.
Chrysis acheron Mocsáry, 1913a:28. Lectotype female, "Asia Arch., Insula Key."
Chrysis angustula Mocsáry, 1908b:514. Lectotype female, South Africa: Cape Province, Willowmore.
Chrysis armata Mocsáry, 1889:187. Lectotype female, Brazil: Santa Catarina, Blumenau. *Caenochrysis.*
Chrysis asmarana Mocsáry, 1913a:16. Lectotype female, Ethiopia: Eritrea, Asmara.
Chrysis assabensis Mocsáry, 1912a:391. Lectotype female, Ethiopia: Eritrea, Assab.
Chrysis auromarginata Mocsáry, 1912a:376. Lectotype female, Tanzania: Dar-Es-Salaam. *Trichrysis.*
Chrysis biangulata Mocsáry, 1902b:544. Lectotype female, South Africa: Cape Province, Uitenhage. *Primeuchroeus.*
Chrysis bidenticulata Mocsáry, 1914:289. Lectotype male, Philippine Islands: Luzon, Los Banos. *Trichrysis.*
Chrysis biroi Mocsáry, 1899:483. Lectotype female, Papua New Guinea: Stephensort, Astrolabe Bay. *Primeuchroeus.*
Chrysis breviceps Mocsáry, 1914:23. Lectotype female, Ethiopia: Eritrea, Keren.
Chrysis bucculenta Mocsáry, 1908a:262. Lectotype female, Madagascar: Antongil. *Chrysidea.*
Chrysis buddhae Mocsáry, 1913a:25. Lectotype male, Taiwan: Takao.
Chrysis callizona Mocsáry, 1904:411. Lectotype male, South Africa: Cape Province, Willowmore.
Chrysis chalcopyga Mocsáry, 1914:48. Lectotype female, U.S.A.: "Colorado."
Chrysis colonialis Mocsáry, 1908b:518. Lectotype male, South Africa: Cape Province.
Chrysis concinna Mocsáry, 1902b:560. Lectotype female, South Africa: Orange Free State, Bothaville.
Chrysis concolor Mocsáry, 1912b:586. Lectotype male, U.S.S.R.: eastern Siberia, Raddefka.
Chrysis confinis Mocsáry, 1912a:404. Lectotype female, South Africa: Transvaal, Shilouvane.
Chrysis consobrina Mocsáry, 1889:458. Lectotype female, U.S.S.R.: "Transcaspia."
Chrysis costaricana Mocsáry, 1912b:567. Lectotype female, Costa Rica: San José.
Chrysis csikiana Mocsáry, 1912a:406. Lectotype male, U.S.S.R.: western Siberia, "Altai."
Chrysis cubensis Mocsáry, 1913a:32. Lectotype female, Cuba: Guantánamo.
Chrysis cuprata Mocsáry, 1890:64. Lectotype female, Greece ("Graecia").
Chrysis cyanescens Mocsáry, 1913a:1. Lectotype male, Asia Minor: Bimbirkilisse.
Chrysis duckei Mocsáry, 1902a:343. Lectotype female, Brazil: Pará (*Neochrysis*)
Chrysis elevata Mocsáry, 1913a:4. Lectotype male, Ethiopia: Eritrea, Asmara. *Praestochrysis.*
Chrysis ellampiformis Mocsáry, 1914:13. Lectotype female, Costa Rica: San José. *Caenochrysis.*
Chrysis erigone Mocsáry, 1889:239. Lectotype female, U.S.S.R.: "Kaukasus." *Chrysura.*
Chrysis exsecata Mocsáry, 1908b:509. Lectotype male, South Africa: Cape Province.
Chrysis femorata Mocsáry, 1912a:385. Lectotype female, Ethiopia: Eritrea, Asmara.
Chrysis formosana Mocsáry, 1912a:380. Lectotype female, Taiwan: Takao. *Trichrysis.*
Chrysis gazella Mocsáry, 1904:407. Lectotype female, South Africa: Cape Province, Willowmore.
Chrysis heliaca Mocsáry, 1902b:551. Lectotype female, South Africa: Orange Free State, Bothaville.

Chrysis hemipyrrha Mocsáry, 1889:488. Lectotype female, "S. Celebes: Patuhuang."
Chrysis horvathi Mocsáry, 1912b:591. Lectotype female, Turkey: Ismir ("Smyrna").
Chrysis hyalinipennis Mocsáry, 1912a:392. Lectotype female, Ethiopia: Eritrea, Assab.
Chrysis inimica Mocsáry, 1902b:552. Lectotype female, South Africa: Cape Province, Uitenhage.
Chrysis inquisitor Mocsáry, 1913a:31. Lectotype female, Australia: Queensland, Cooktown.
Chrysis inseriata Mocsáry, 1902a:342. Lectotype female, Brazil: Pará. *Neochrysis.*
Chrysis insolita Mocsáry, 1913a:10. Lectotype female, Ethiopia: Eritrea, Takkeseh.
Chrysis japonica Mocsáry, 1889:490. Lectotype male, Japan.
Chrysis kerenensis Mocsáry, 1912a:387. Lectotype male, Ethiopia: Eritrea, Keren.
Chrysis kirbyana Mocsáry, 1912a:402. Lectotype female, South Africa: Transvaal, Potschestrom.
Chrysis korbiana Mocsáry, 1912a:412. Lectotype female, Uzbek S.S.R.: Gouldscha, Fergana.
Chrysis laminata Mocsáry, 1902b:568. Lectotype female, South Africa: Cape Province, Sunday River.
Chrysis lepida Mocsáry, 1889:278. Lectotype female, U.S.S.R.: "Kaukasus," Jerivan ("Erivan").
Chrysis leucocheila Mocsáry, 1889:408. Lectotype female, "Mexico." *Ipsiura.*
Chrysis leucostigma Mocsáry, 1889:410. Lectotype female, Brazil: Amazonas, Fonte Bôa. *Exochrysis.*
Chrysis longicollis Mocsáry, 1902b:556. Lectotype female, South Africa: Cape Province ("Capland").
Chrysis mongolica Mocsáry, 1914:24. Lectotype female, "Mongolia." *Trichrysis.*
Chrysis montivaga Mocsáry, 1912a:409. Lectotype male, U.S.S.R.: "Turkestania," Mt. Alexander.
Chrysis namaquensis Mocsáry, 1914:42. Lectotype male, South Africa: Cape Province ("Caffreria, Namaqualand").
Chrysis natalica Mocsáry, 1913a:2. Lectotype female, South Africa: Natal, Howick. *Praestochrysis.*
Chrysis nigeriaca Mocsáry, 1913a:1. Lectotype female, Tanzania: Shonga. *Praestochrysis.*
Chrysis nitidularia Mocsáry, 1912a:411. Lectotype male, Kazakh S.S.R.: Narynkol.
Chrysis papuana Mocsáry, 1889:493 (*lincea* ssp.). Lectotype male, Papua New Guinea: Stephensort, Astrolabe Bay.
Chrysis papuana Mocsáry, 1889:454. Lectotype female, Papua New Guinea: Stephensort, Astrolabe Bay. *Primeuchroeus.*
Chrysis partita Mocsáry, 1889:492. Lectotype female, Papua New Guinea: Stephensort, Astrolabe Bay.
Chrysis pauperata Mocsáry, 1908b:519. Lectotype male, South Africa: Transvaal, Lichtenburg.
Chrysis perezi Mocsáry, 1889:461. Lectotype male, Algeria: Bône.
Chrysis pleuralis Mocsáry, 1904:405. Lectotype female, South Africa: Cape Province, Willowmore. *Spintharina.*
Chrysis pleuretica Mocsáry, 1912b:582. Lectotype male, Argentina: Mendoza.
Chrysis polychroma Mocsáry, 1908b:509. Lectotype female, South Africa: Cape Province, Willowmore. *Spintharina.*
Chrysis porphyrea Mocsáry, 1889:284. Lectotype female, Greece: Morea Peninsula, Cumani.
Chrysis porphyrophana Mocsáry, 1890:64. Lectotype female, South Africa: Cape Province, "Cap.b.sp."
Chrysis practicola Mocsáry, 1914:50. Lectotype female, U.S.A.: Texas, Fedor.
Chrysis quadridens Mocsáry, 1912b:569. Lectotype female, Costa Rica: San José.
Chrysis regalis Mocsáry, 1912a:408. Lectotype male, U.S.S.R.: "Turkestania," Mt. Alexander.
Chrysis relegatus Mocsáry, 1911:469. Lectotype male, Australia: New South Wales, Sydney. *Primeuchroeus.*
Chrysis ribbei Mocsáry, 1889:524. Lectotype female, "S. Celebes: Bonthain." *Praestochrysis.*
Chrysis rubricata Mocsáry, 1902a:340. Lectotype male, Egypt: Cairo.
Chrysis rubroviolacea Mocsáry, 1913a:20. Lectotype male, South Africa: Cape Province, Willowmore.
Chrysis salisburyana Mocsáry, 1914:37. Lectotype female (not male), Zimbabwe: Salisbury.
Chrysis satrapes Mocsáry, 1913a:19. Lectotype female, Ethiopia: Shirati.
Chrysis schencklingi Mocsáry, 1913b:618. Lectotype female, Taiwan: Anping.
Chrysis scutata Mocsáry, 1912a:382. Lectotype female, Tanzania: Lukuledi.
Chrysis secernenda Mocsáry, 1912a:376. Lectotype male, Uzbek S.S.R.: Gouldscha, Ferghana. *Trichrysis.*
Chrysis sejuncta Mocsáry, 1914:51. Lectotype female, U.S.A.: Missouri.
Chrysis semiviolacea Mocsáry, 1889:484. Lectotype female, Algeria.
Chrysis somalina Mocsáry, 1889:512. Lectotype male, Somalia.
Chrysis spinicollis Mocsáry, 1912b:580. Lectotype male, Argentina: Salta.
Chrysis szalayana Mocsáry, 1912a:397. Lectotype male, Ethiopia: Katona.

Chrysis thakur Mocsáry, 1913a:22. Lectotype male, Burma: Tenasserim.
Chrysis transmutata Mocsáry, 1914:26. Lectotype female, Burma: Tenasserim. *Trichrysis.*
Chrysis transvaalensis Mocsáry, 1908b:520. Lectotype male, South Africa: Transvaal, Lichtenburg.
Chrysis triangulifera Mocsáry, 1890:55. Lectotype female, Brazil: Piauhy. *Caenochrysis.*
Chrysis turneri Mocsáry, 1914:22. Lectotype female, Australia: Tasmania, Eaglehawk Neck. *Primeuchroeus.*
Chrysis variipes Mocsáry, 1911:467. Lectotype male, India: Maharashtra, Lonauli.
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Response of *Plagithmysus bilineatus* Sharp (Coleoptera: Cerambycidae) to Healthy and Stressed Ohia Trees

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Abstract.—The attraction of both male and female *Plagithmysus bilineatus* Sharp beetles to stressed ohia (*Metrosideros polymorpha* Gaudichaud) trees was studied on the island of Hawaii in 1979 and 1980. Ohia trunks were severed to determine if stressed ohia were more attractive to *P. bilineatus* than were nonsevered trees. Beetles initially were attracted to severed trees before they demonstrated any external signs of stress. There was no host attraction or oviposition response to control trees. The number of beetle captures did not differ significantly between the upper and lower trap bands of stressed trees, the number of adult captures and subsequent larval infestations were not correlated. When adults were caged on severed and nonsevered trees, however, severed trees had a significantly greater abundance and survival of larvae.

The decline of ohia lehua (*Metrosideros polymorpha* Gaud., Myrtaceae) on the island of Hawaii intensified between 1954 and 1972 and now covers 49,762 ha (122,912 acres) of ohia-koa forested land on the eastern slopes of Mauna Loa and Mauna Kea (Petteys et al., 1975; Hodges et al., 1986). These decline areas appear as even-aged ohia forests with definite boundaries between dead and healthy trees. This boundary corresponds to distinct types of lava flows with obvious differences in elevation and drainage. Sites with trees declining in vigor are characterized by very moist soil habitats found on poorly drained pahoehoe or 'a'a lava (Jacobi, 1983).

The native, host-specific, cerambycid beetle (*Plagithmysus bilineatus* Sharp) has often been found associated with tree mortality or reduced tree vigor in declining ohia stands (Papp et al., 1979). Although several workers have reported the association of *P. bilineatus* with ohia trees in poor vigor (Swezey, 1954; Papp et al., 1979; Papp and Samuelson, 1981), definitive studies have not been conducted to demonstrate when beetle visitation (oviposition) takes place and what effect stressed trees have on survival of larvae. Adult beetles have repeatedly been observed mating and ovipositing on felled trees. Larvae have been recovered from felled and standing stressed trees. On occasion, larvae have been found in apparently healthy trees, and late-stage larvae have completed their development as implants in healthy trees (Papp and Samuelson, 1981).

We studied *P. bilineatus* on the island of Hawaii to determine: (a) its attraction to severed hosts; (b) when this attraction takes place; and (c) the association between adults captured on boles and subsequent larval development in the boles. The hypothesis was that, given the choice, *P. bilineatus* will use trees already under stress from a complex of undetermined edaphic or climatic factors.

METHODS

The study was conducted in a presumably even-aged ohia stand, at 1260 m elevation on the northeast flank of Mauna Loa on the island of Hawaii. The trees, of unknown age (lava flow was 125 years old), averaged 6 m in height and 9 cm in diameter. Trees were randomly selected—3 pairs in 1979 and 15 pairs in 1980—from a stand of apparently vigorous and healthy trees. Half of the sample trees from both years were braced with wire and turnbuckles and severed within 10 cm of the roots. The saw kerf was sealed with Tree Seal® and all traces of sawdust removed.[1] This procedure, similar to Heikkenen's (1977), maintained the tree's vertical position, provided a known time for the onset of stress, and prevented emission of potentially attractive chemicals from the wound. The other trees were designated as controls and left uncut. To trap adult beetles, two tanglefoot bands, 8-cm wide, encircled the trunk of each sample tree 1 and 2 m above the ground. A weather station was established in the study area to record hourly changes in temperature and rainfall.

Each tree was checked three times weekly for the number of adult beetles caught in the trap bands. During each visit, adult beetles were removed from the tanglefoot to prevent recounting. After 136 days, all trees were lowered to the ground and dissected. Larvae feeding in the cambium were counted. Analysis of variance or regression was used to test significance and functional relationships between variables.

Four additional healthy trees, randomly selected in 1980, were used with caged adults to determine oviposition and larval survival in healthy and severed trees. Two of these trees were braced and severed, the other two trees were controls. A 30 cm × 45 cm screen cage was constructed and fitted to the trunk of each tree. Six pairs of beetles were placed in each cage along with a sugar-water solution. After 35 days, that portion of bark under the cages was examined, the trees were debarked, and beetle larvae were counted.

RESULTS

Trees began to wilt and show discoloration of the foliage 5 days after severing. Within an average of 10.3 days, crown coloration progressed from green to brown without turning yellow. Both male and female adult beetles were initially attracted to the severed ohia trees before any visual detection of wilting. The *P. bilineatus* adults were first captured 4 days after the trees were cut. Although beetle captures continued on severed trees for the study duration, most were captured during the first 60 days.

The time lag betwen severing of the trunk and initial capture differed between 1979 and 1980 (Fig. 1). In 1979, 50% of the 41 responding beetles were captured within 14 days; whereas, in 1980, 50% of the 78 responding beetles were captured

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[1] Trade name is mentioned only for information. No endorsement by the U.S. Department of Agriculture is implied.

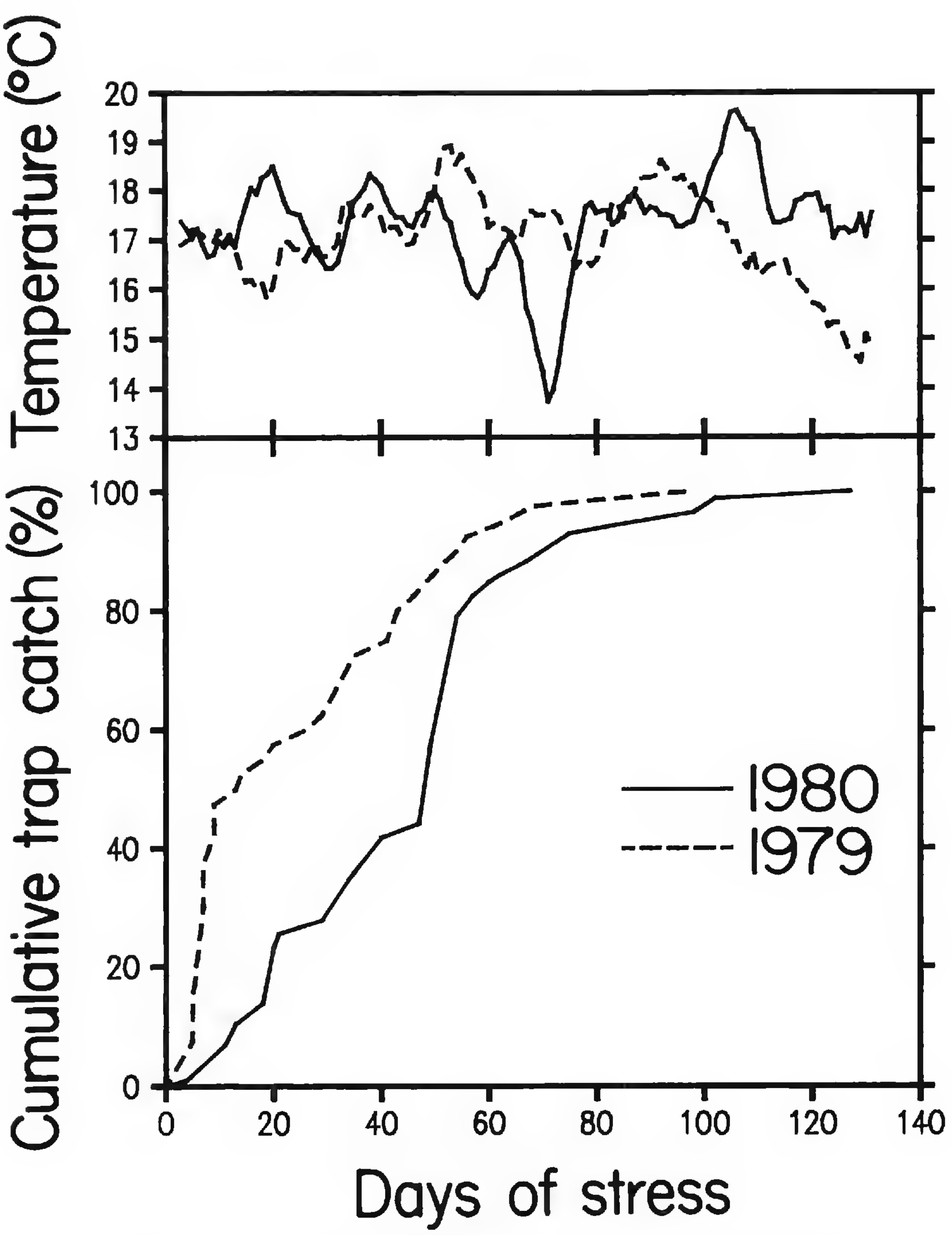

Figure 1. Capture of adult *Plagithmysus bilineatus* beetles on severed ohia trees in 1979 and 1980.

after a lapse of 46 days. No evidence of attraction to nonsevered trees was observed. Dissection of severed trees, however, revealed larvae. No larval infestation was found in nonsevered trees in either year.

Most adults were captured when it was sunny with a combination of average daily temperatures greater than 17.5°C and maximum temperatures above 21.1°C and no precipitation (Fig. 2). However, 17% of adult beetles were captured when daily precipitation was greater than 8.6 mm and the average temperature was below 17.0°C.

During the two field seasons, adults were captured on both the upper and lower tanglefoot bands on treatment trees; none were captured on the control trees. There was no significant difference ($P > 0.05$) in adult counts on the upper and lower tanglefoot bands of treatment trees, and no significant correlation between number of adults captured and the abundance of larvae. But the distribution of larvae in the tree differed significantly ($P < 0.05$). The mean difference of larvae between the top and bottom halves of trees was $\bar{X}_1 - \bar{X}_2 = 11.7$. The 95% confidence interval for this mean difference is given by $L_1 = 0.68$ and $L_2 = 22.79$. However, a positive correlation, expressed as $\hat{Y} = 8.92 + 1.23X$ ($r = 0.9124$, SE =

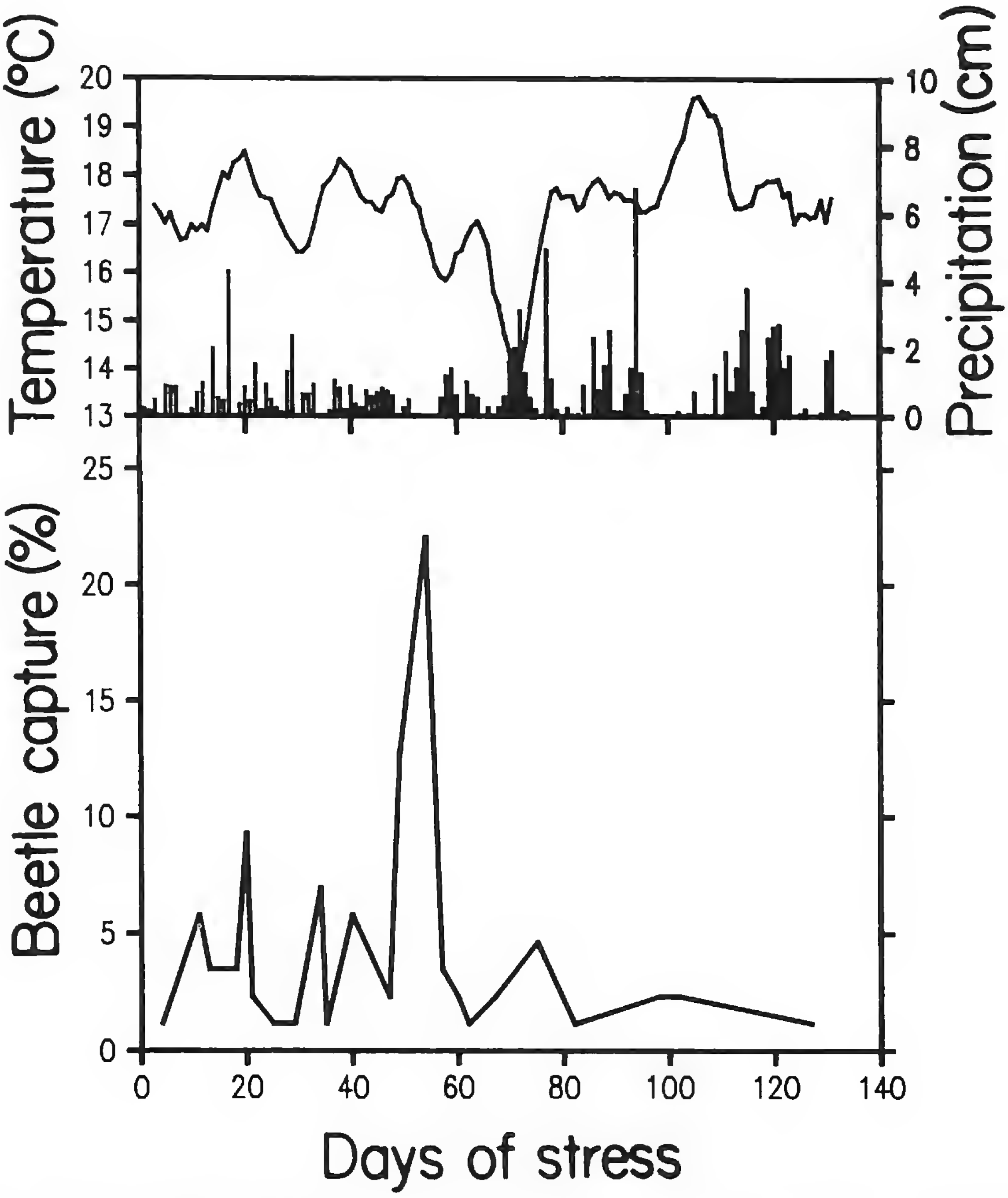

Figure 2. Percent of adult beetles captured on severed ohia trees together with a 3-day running average of temperature and precipitation (bars) in 1980.

10.1419), was found between the number of larvae in the upper half of the tree and total larvae in the entire tree. The estimating equation explained 83% of the variation in this relationship, with an estimate of 42.1 (SE = 2.62) total larvae for 27 larvae sampled in the upper half of the tree. This standard error of estimate suggests that the regression is an effective estimate of total larvae in a stressed tree by counting larvae in its top half.

Larval abundance and mortality differed significantly ($P < 0.05$) between severed and control trees with caged adults. The proportion of larvae in severed hosts was 47% greater than that in control trees ($\bar{X}_{Y_1-Y_2} = 46.5$, SE = 8.7321). The proportion of dead larvae was 75% greater in control trees ($\bar{X}_{Y_1-Y_2} = 75.29$, SE = 4.7241). The bark beneath the cages on the control trees had a total of 29 larvae. Twenty-six larvae died after tunneling 2 to 5 cm in the bark and cambium. The 3 surviving larvae averaged 4.0 mm in length. The 48 live larvae from galleries originating in bark sections beneath cages from the severed trees averaged 16 mm in length and produced an average gallery length of 39 cm. An additional 66 live larvae were recovered from galleries initiated beyond the caged portion of the severed trees, while none were found beyond the caged portion of the healthy trees.

DISCUSSION

Both bark beetles and ambrosia beetles show an attraction response to their host plants. Water stress in Douglas-fir caused anaerobic respiration and a release of volatiles that induced the "primary attraction" of the striped ambrosia beetle *Trypodendron lineatum* (Oliver) (Graham, 1968). Similarly, *P. bilineatus* initially responded to severed trees before any visual evidence of stress was detected. The strong preference of this beetle for the severed rather than nonsevered ohia trees in this study suggests that this cerambycid was attracted to stimuli (presumably volatiles) produced by physiological changes in the host associated with extreme water stress.

The initial response of adult beetles to standing stressed ohia trees (as defined in this study) was relatively slow compared with beetle response to open wounds. In this study beetles responded after 4 days; whereas, beetles can respond to exposed wounds on a tree within 5½ hours (Papp and Samuelson, 1981).

Abrupt physiological changes in ohia, which include alterations in the sugar and amino acids, may benefit the survival of first stadium larvae (Baldwin, 1934; Mittler, 1958). Papp et al. (1979) found that beetle attacks increased as the tree crown deteriorated, but larval survival did not correlate with host condition. However, our data suggest host physiology (condition) is related to survival. Larval survival increased from 10% for healthy trees to 83% for severed trees. Therefore, adult preference for host material may ensure a measure of success by first stadium larvae.

We found that weather is significant in determining *P. bilineatus* response. Dry, sunny conditions were optimal for beetle activity. During the first month of the experiment, capture of adults was nearly ensured in favorable weather; however, we also captured adults in temperatures below 17.0°C. This is lower than any previously recorded temperature for adult flight (Papp and Samuelson, 1981) and indicates more activity during cool, wet days than was previously suspected. Differences in weather in 1979 and 1980 could account for some of the 32-day difference in reaching 50% accumulative trap catch on severed trees. A slightly different temperature and moisture regime occurred between the 2 years.

The results suggest that *P. bilineatus* beetles prefer trees that presumably produce a primary attractant under induced stressed conditions. This hypothesis of primary attraction may explain the high incidence of beetles in unhealthy trees associated with progressive stages of wetland dieback on the northeast slope of Mauna Loa (Papp et al., 1979). Beetles seldom attack vigorous trees growing adjacent to dieback boundaries on healthy sites. Water-stressed trees attract beetles, provide aggregation sites for mating and oviposition, and provide host conditions favorable for increased survival of larvae. What actually predisposes apparently healthy ohia trees to beetle attack is still unknown.

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A New Species of *Serradigitus* from Central California (Scorpiones: Vaejovidae)

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Abstract.—The scorpion genus *Serradigitus* Stahnke is discussed, redefined, and resurrected. A new species, *Serradigitus torridus* Williams and Berke, is described and named. Sixteen species of *Vaejovis* are placed in *Serradigitus.*

In 1974, Stahnke proposed a new genus in the Vaejovidae which he called *Serradigitus.* At that time he placed several taxa, associated with the wupatkiensis group of *Vaejovis,* into this genus. The main criteria used to define *Serradigitus* were as follows: pedipalp tarsus (movable finger) with a continuous row of conspicuously serrate, subequal denticles uninterrupted, or indefinitely so, by larger denticles; pedipalp chela with a terminal denticle which is abnormally large, clawlike, and bears on its terminus an elongate whitish cap; inferior lateral, large flanking denticles (supernumerary denticles of chela movable finger) vary in position and number 6 to 16; female pectines with proximal teeth 1–3 more paddlelike and somewhat larger than others; and the number and location of pedipalp trichobothria. Regarding the latter character, Stahnke stated that *Serradigitus* possesses 27 trichobothria on the pedipalp chela. However, neither his summary table nor illustration of *Serradigitus* supports this statement. All of the *Serradigitus* we have examined have had 26 trichobothria on the chela, which is also typical for *Vaejovis.* Stahnke also attempted to distinguish *Serradigitus* from *Vaejovis* on the basis of the relative position of trichobothria on the pedipalp brachium. However, the level of variation observed in the location of these trichobothria does not support a diagnostic value for this character. The proposal of *Serradigitus* was attractive because the genus *Vaejovis* had become extremely large and diverse. The interpretation of *Serradigitus* subsequently became awkward as new species were found in Baja California, Mexico that appeared to be intermediate between *Vaejovis* and *Serradigitus* (Williams, 1980). This led to placing *Serradigitus* into synonymy (Williams, 1980) and restoring the wupatkiensis group of scorpions to *Vaejovis.*

Recent study of the wupatkiensis group suggests it was heterogeneous, as previously perceived. The following taxa appear to be members of *Vaejovis* that have secondarily evolved the elongate terminal denticle on the movable and fixed fingers of the chela, which is characteristic of *Serradigitus*: *Vaejovis peninsularis* Williams, *V. janssi* Williams, *V. baueri* Gertsch, *V. pacificus* Williams, *V. bechteli* Williams, *V. littoralis* Williams, and *V. minimus thompsoni* Gertsch & Soleglad. Examination of the dentition of the chela fingers of these taxa suggests they are evolved from forms that had more robust primary row denticles. In these taxa, the finger denticles are divided into 5–7 linear subrows by distinctly enlarged denticles. Of these, *V. peninsularis* and *V. janssi* have the primary row denticles distinctly divided into 6 subrows by enlarged denticles, as is common in *Vaejovis.* The fixed finger subrows are reduced to 5 in *V. littoralis* and to four in *V. bechteli, V. baueri,* and *V. pacificus.*

The genus *Serradigitus* is closely related to *Vaejovis* and is characterized as follows: Carapace frontal margin emarginate, lateral ocelli 3 per group, prosomal sternum pentagonal; chela with elongate, slender fingers, movable and fixed fingers terminating in elongate, hook-like denticle (fixed finger terminal-denticle length no less than ¾ depth of finger at this point); fixed finger with terminal denticle at least 5 times longer than first supernumerary denticle; chela with primary row denticles sharp, serrate, arranged in linear row, not subdivided or subdivided into 2–3 subrows by slightly enlarged denticles; metasoma with dorsal and dorsolateral keels terminating posteriorly in elongate denticle, ventral keels paired on segments I–IV, single on V; vesicle often with subtle subaculear tubercule; pectines with three anterior marginal lamellae, distal middle lamellae subcircular, fulcra triangular, females with proximal teeth 1–3 often more elongate or more swollen than more distal ones; genital opercula with genital papillae in males, no papillae in females; chelicerae similar to *Vaejovis,* lacking denticles on ventral margin of movable finger; walking legs with single row of short setae on ventral sole of telotarsi; two pedal spurs; tarsal spurs lacking; stigma of booklungs short oval.

The following species, previously placed in *Vaejovis,* are here considered to belong to *Serradigitus*: *S. adcocki* (=*V. adcocki* Williams), *S. armadentis* (=*V. armadentis* Williams), *S. calidus* (=*V. calidus* Soleglad), *S. deserticola* (=*V. deserticola* Williams), *S. dwyeri* (=*V. dwyeri* Williams), *S. gertschi* (=*V. gertschi* Williams), *S. gigantaensis* (=*V. gigantaensis* Williams), *S. gramenestris* (=*V. gramenestris* Williams), *S. haradoni* (=*V. haradoni* Williams), *S. harbisoni* (=*V. harbisoni* Williams), *S. hearnei* (=*V. hearnei* Williams), *S. joshuaensis* (=*V. joshuaensis* Soleglad), *S. minutis* (=*V. minutis* Williams), *S. subtilimanus* (=*V. subtilimanus* Soleglad), *S. wupatkiensis* (=*V. wupatkiensis* Stahnke). *Serradigitus joshuaensis* is included in *Serradigitus* even though the females are atypical in having the proximal pectine tooth smaller than the other ones.

Recently an undescribed species of *Serradigitus* was found in the Mojave Desert of central California. This species is here described, named, and added to the list of species recognized as belonging to *Serradigitus.*

Our appreciation is expressed to our colleagues who have contributed materially to this study: Vincent F. Lee and Jack T. Tomlinson read and criticized this manuscript; Paul H. Arnaud, Jr. made available research facilities at the California Academy of Sciences; Jett S. Chinn assisted with the illustrations. Research facilities were partially provided by the West Point Academy of Arts and Sciences.

***Serradigitus torridus* Williams and Berke, New Species**

(Fig. 1, Table 1)

Diagnosis.—Total length up to 31 mm in males, 34 mm in females; base color of body golden yellow, pectines white; dorsal and dorsolateral metasomal keels with 0-1-1-2 pairs of macrosetae on segments I–IV; ventrolateral keels crenular, with 2-3-3-3-5 pairs of macrosetae on segments I–V; ventral keels smooth to crenulate on I–II, crenular on III–IV, with 3-3-3-3 pairs of macrosetae on segments I–IV; chela with supernumerary denticles 6 on fixed finger, 7 on movable finger;

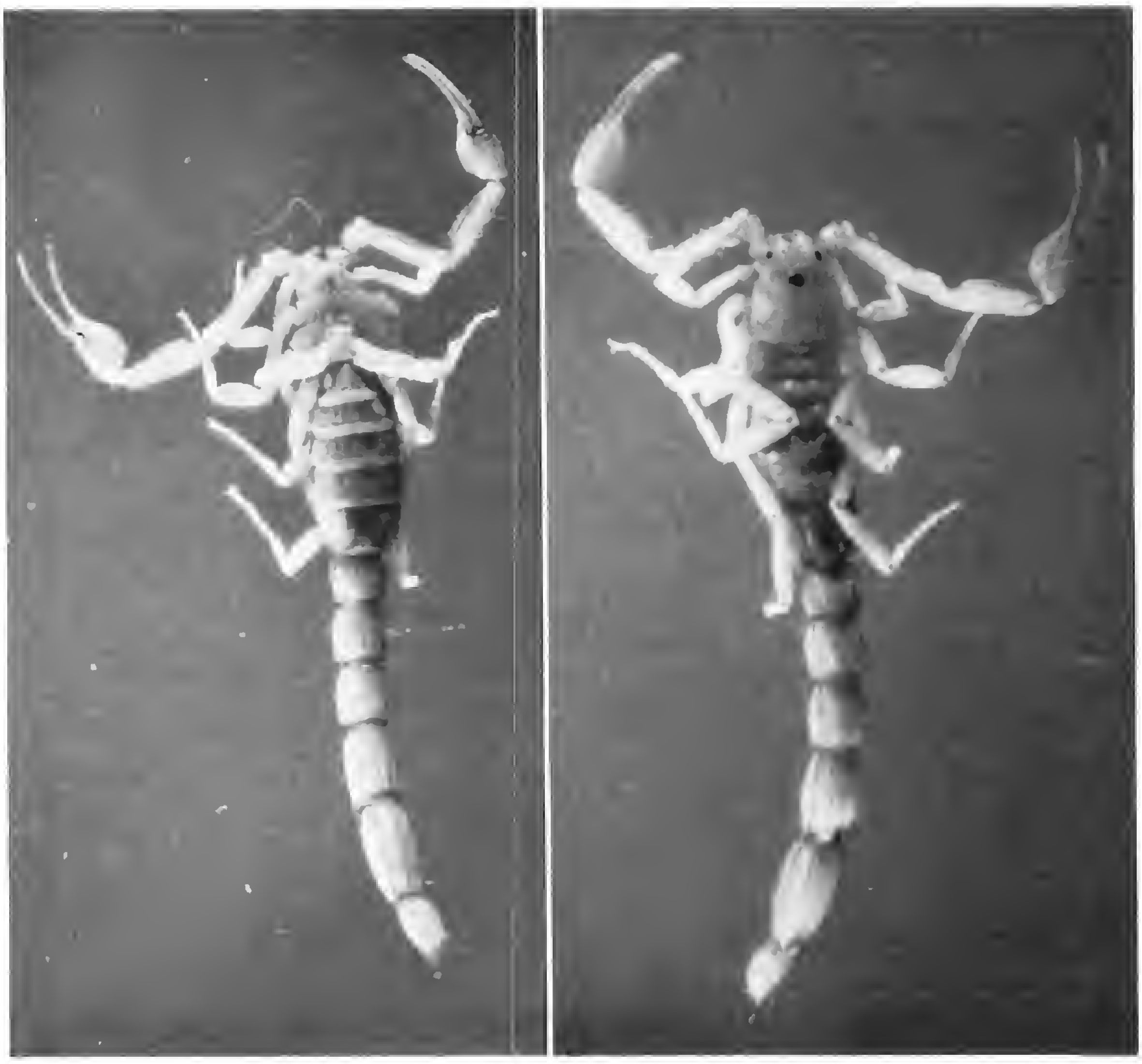

Figure 1. *Serradigitus torridus* Williams and Berke, holotype (male), dorsal and ventral views.

chela with primary row denticles of fixed and movable finger subtly divided into 2–3 linear subrows, denticles serrate; chela palm moderately swollen, ratio of chela length to palm width 3.9 in males, 4.1 in females; fingers moderately elongate, movable finger equal to carapace in length, or slightly longer; fixed finger with *id* and *ip* trichobothria above and between supernumerary denticles 5–6, located on proximal half of fixed finger; pectine teeth (single comb) 16–18 in males, 14 in females.

Related to *Serradigitus gertschi, Serradigitus wupatkiensis,* and *Serradigitus armadentis.* Distinguished from *S. gertschi* by presence of 2 pairs macrosetae on dorsal keels of metasomal segment IV (not 1 pair); pedipalp palm more swollen, ratio of chela length to width 4.3 or less. Distinguished from *S. wupatkiensis* by more swollen pedipalp palm, ratio of palm length to width 1.8 or less. Distinguished from *S. armadentis* as follows: Telson less hirsute, with about 7 pairs of ventral macrosetae (not greater than 9 pairs); fixed finger of chela with trichobothrium *ip* between supernumerary denticles 5–6 (not proximal to 6).

Description of holotype.—Male. Coloration: Base color of exoskeleton uniform golden-yellow; keels with slightly more contrasting amber coloration; fingers similar to palm in color; pectines white. Prosoma: Carapace anterior margin with slight median emargination, set with 3 pairs of macrosetae; carapace surface coarsely granular; median ocelli on slightly raised, smooth ocular tubercule; 3 pairs of sternal setae. Mesosoma: Terga completely and regularly granular; terga 3–6 with subtle obsolescent median keel, tergum 7 with irregular patch of about

Table 1. Measurements (mm) of *Serradigitus torridus* Williams and Berke, new species, holotype (male) and allotype. Abbreviations as follows: l = length, w = width, d = depth, fmd = frontal margin distance, ditd = distal internal trichobothrium distance, p-row = primary denticle row of chela, ff = fixed finger, mf = movable finger.

	Holotype (male)	Allotype
Total length	31.0	33.1
Carapace (l/w at median eyes)	3.7/2.7	4.2/3.1
Diad (width/fmd)	0.5/1.5	0.5/1.6
Metasoma, length	14.3	14.4
Segment I (l/w/d)	1.9/2.3/1.9	1.8/2.4/1.9
Segment II (l/w/d)	2.2/2.3/1.9	2.2/2.4/1.9
Segment III (l/w/d)	2.4/2.2/1.9	2.8/2.4/1.9
Segment IV (l/w/d)	3.3/2.2/1.9	3.2/2.3/1.9
Segment V (l/w/d)	4.5/2.2/1.8	4.4/2.3/1.8
Telson, length	3.8	4.0
Vesicle (l/w/d)	2.5/1.6/1.2	2.6/1.7/1.3
Aculeus (l)	1.3	1.4
Pedipalp, Humerus (l/w)	3.7/1.1	3.9/1.2
Brachium (l/w)	4.1/1.3	4.2/1.4
Chela (l)	6.2	6.6
Palm (l/w/d)	2.8/1.6/1.7	2.8/1.6/1.6
Movable finger (l/base)	3.9/0.7	4.3/0.7
Fixed finger (l/ditd)	3.4/2.2	3.8/2.4
Supernumerary denticles (ff/mf)	6/7	6/7
Fixed finger p-row denticles	12-7-22	13-27
Movable finger p-row denticles	8-6-26	8-30
Pectine teeth (left/right)	18/17	14/14
Stigma 3 (l/w)	0.17/0.7	0.23/0.10

16 granules medially; terga 1–6 lacking lateral keels; tergum 7 with 2 pairs of well-developed granular lateral keels; basal sternum of pectines with deep anteromedian groove extending one-fourth length of sternum; pectines with middle lamellae composed of angular basal sclerite plus 12 subcircular sclerites in single row, most fulcra with 3 ventral macrosetae, subcircular middle lamellae with 1–2 ventral macrosetae; sternum 7 with 1 pair of granular lateral keels. Metasoma: Dorsal and dorsolateral keels granular on I–IV, each terminates in enlarged posterior denticle; ventral keels smooth to crenulate on I–II, crenulate on III–IV; macrosetal formulae on metasomal segments I–IV respectively: 0-1-1-2 dorsals, 0-1-1-2 dorsolaterals, 2-3-3-3 ventrolaterals, 3-3-3-3 ventrals. Telson: Vesicle with 7 pairs of macrosetae ventrally, small broad subaculear tubercule. Chelicerae: Ventral margin of movable finger lacks denticles, with ventral setal comb on distal half of tyne. Pedipalps: Fingers terminate distally in elongated, hook-like tooth; terminal tooth length approximates finger depth at that point; fixed finger and movable finger each with primary row denticles subtly divided into 3 linear subrows by slightly enlarged denticles; palm with well-developed keels; no conspicuous scallop between fingers when chela closed; chela with 10 trichobothria on fixed finger, 16 on palm; brachial trichobothria: 2 dorsals, 14 retrolaterals, 2 ventrals, 1 prolateral; humeral trichobothria: 1 dorsal, 1 retrolateral, 0 ventral, 1 prolateral.

Allotype.—Similar to holotype in color and structure except as follows: Larger in size, pectines smaller, fewer pectine teeth, proximal 2 teeth more elongate than others; brachium slightly less elongate, primary row denticles of chela divided into 2 linear subrows on both fingers.

Paratype variation.—Little significant variation among paratypes except as follows: Adults varied in total length 24–32 mm, juveniles 16–20 mm; pectine tooth counts (per comb) 16–18 (mode = 16–17) in males, 14 in females; pedipalps with primary row denticles in 2–3 linear subrows on both fingers.

Type data.—Holotype (male), California: Kern Co., Red Rock Canyon State Recreation Area, 8 Oct. 1980, Coll. S. C. Williams. Allotype, same data except collected on 16 Aug. 1981. Holotype and allotype depository: California Academy of Sciences, Entomology Type No. 15750. This species is named *Serradigitus torridus* in reference to its hot, dry, desert habitat.

Paratypes.—California. Kern County: Red Rock Canyon State Rec. Area, 8 Oct. 1980, S. C. Williams (7 male topoparatypes); Red Rock Canyon, 16 Aug. 1981, S. C. Williams (1 male, 2 juveniles); Red Rock Canyon, 16 Aug. 1984, Bennett Berke (1 juvenile, 2 females); Jaw Bone Canyon, 2 Jun. 1972, R. M. Haradon, J. L. Marks (2 females); 20 miles N Mojave, 13 Apr. 1968, S. C. Williams, V. F. Lee, R. Lewert (3 females).

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A New Species of *Vaejovis* from Jalisco, Mexico (Scorpiones: Vaejovidae)

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Abstract.—A small, new species of vaejovid scorpion from Jalisco, Mexico is described and named *Vaejovis chamelaensis* Williams. This species is placed in the eusthenura group of *Vaejovis,* and it is concluded that it is one of the smallest species of *Vaejovis* known.

During July and August of 1985, I spent two weeks studying the scorpion fauna of the wildlife preserve maintained by the Estacion de Biologia at Chamela, Jalisco, Mexico. During this period, 385 scorpions belonging to four species were studied. By far the most common species was *Centruroides elegans* (Thorell). Lesser numbers of *Vaejovis subcristatus occidentalis* Hoffmann and *Vaejovis increpidus increpidus* Thorell were also encountered. Of special interest was a tiny *Vaejovis* of such a small adult size that, at first, it was mistaken for juveniles of the other species. This new species is here described and named. The measurements taken are as described by Williams (1980).

Alfredo Perez J. and Steven Bulloch, of the station staff, kindly made it possible to carry out the field study at the Estacion de Biologia Chamela that resulted in finding this new species. They also provided laboratory and library facilities, and facilitated the field study. Paul H. Arnaud, Jr. provided research facilities at the California Academy of Sciences. Thanks to Vincent F. Lee, Jack T. Tomlinson, and David Herlocker for reading and criticizing this manuscript, and to Jett Chinn for assistance with illustrations. This study was partially supported by the Universidad, Nacional Autonoma de Mexico, Instituto de Biologia, Estacion de Biologia, Chamela.

Vaejovis chamelaensis Williams, New Species
(Fig. 1, Table 1)

Diagnosis.—Member of eusthenura group. Minute in size, total length of mature males up to 14.5 mm. Base color of body golden-yellow; carapace with variegated black markings; metasomal keels outlined with dusky markings. Pedipalps with moderately swollen fingers, ratio of chela length to width 3.8, palm slightly deeper than wide, ratio of fixed finger length to palm width 1.6, ratio of carapace length to movable finger length 1.4; fingers with primary row denticles subdivided into 5 subrows on fixed and movable fingers. Telson with distinctly enlarged subaculear tooth.

Related to *Vaejovis puritanus* Gertsch and *Vaejovis viscainensis* Williams in having primary row denticles of pedipalp fixed finger subdivided into 5 subrows;

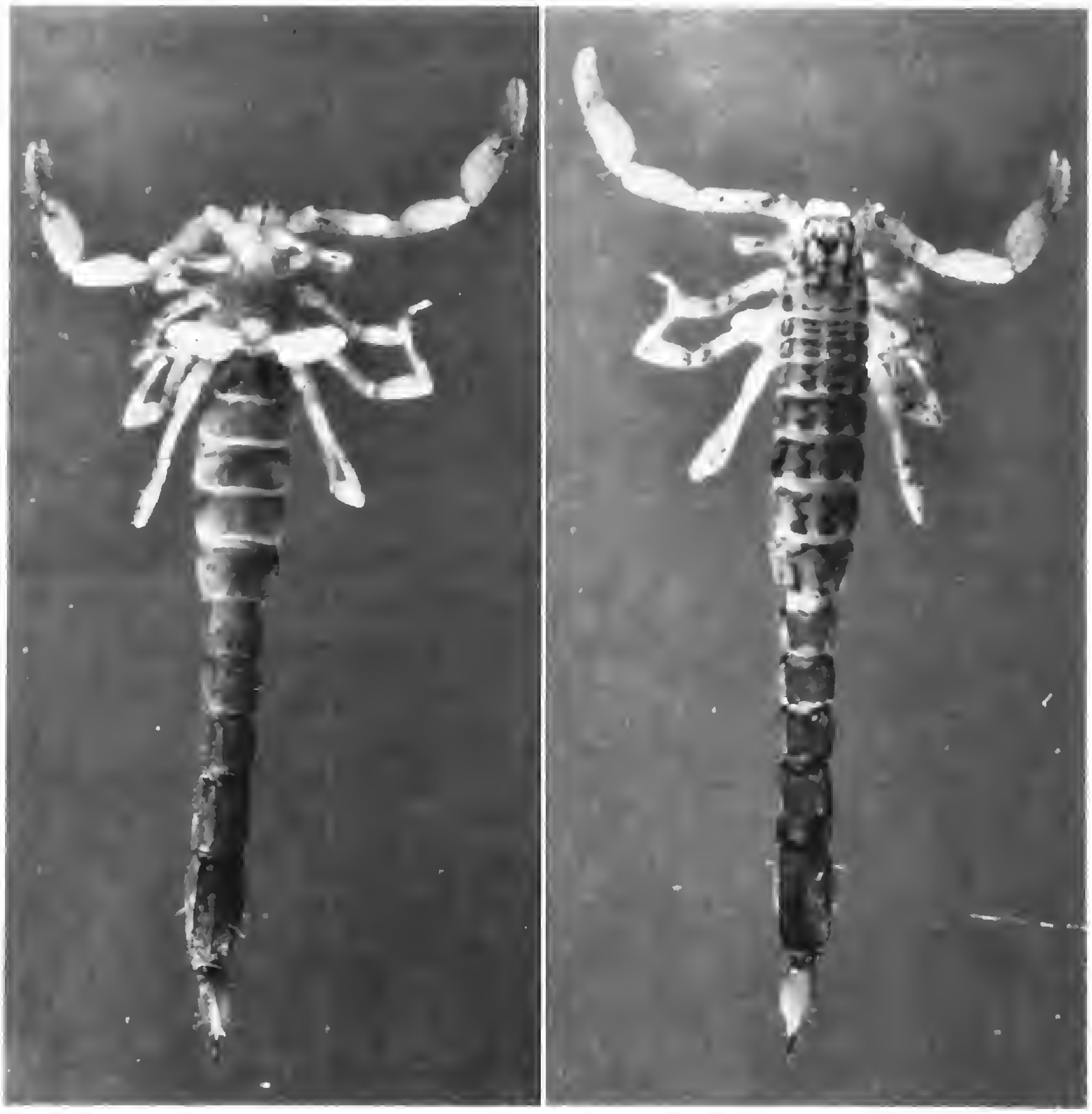

Figure 1. *Vaejovis chamelaensis* Williams, holotype, male, dorsal and ventral views.

distinguished from both species by small size, primary row denticles of pedipalp movable finger subdivided into 5 subrows (not 6), subaculear tooth present.

Holotype description.—Male. Coloration: Base color of exoskeleton golden-yellow; carapace with conspicuous variegated black markings; mesosomal dorsum with two pairs longitudinal black stripes; metasoma with keels outlined with dusky-black markings; humerus with irregular black markings; walking legs with distinctive dark markings; pedipalp fingers slightly darker than palm; palm with keel positions outlined with delicate dusky markings; movable cheliceral finger with dusky outline; cheliceral palm with dusky outline at movable finger articulation; pectines whitish; metasoma IV–V darker reddish than metasoma I–III and telson. Prosoma: Carapace anterior margin straight, set with 3 pairs stout setae; carapace finely and regularly granular; three lateral ocelli per group; median ocelli on raised, smooth ocular tubercule; sternum short, much broader than long; three pairs sternal setae. Mesosoma: Terga completely and regularly granular, granules fine textured; slightly developed median keel; tergum 7 with two pairs serrated lateral keels, terminate posteriorly in enlarged tooth-like denticle. Genital opercula triangular; distinct genital papillae, four pairs macrosetae on genital opercula, linearly arranged along posterior margin. Sterna finely granular, sternum 7 lacking keels. Pectines with basal sternum deeply grooved anteriorly; three marginal la-

Table 1. Measurements (mm) of *Vaejovis chamelaensis* Williams, new species, holotype and allotype. Abbreviations as follows: l = length, w = width, d = depth, fmd = frontal margin distance, ditd = distal internal trichobothrium distance, p-row = principal row denticles of chela.

	Holotype (male)	Allotype
Total length	14.3	16.3
Carapace (l/w at median eyes)	1.87/1.23	1.94/1.23
Diad (width/fmd)	0.39/0.68	0.42/0.74
Metasoma, length	6.24	5.99
Segment I (l/w/d)	0.83/1.06/0.94	0.77/1.10/0.98
Segment II (l/w/d)	0.96/1.03/0.90	0.84/1.10/0.98
Segment III (l/w/d)	1.00/1.03/0.90	0.97/1.10/0.98
Segment IV (l/w/d)	1.39/1.03/0.87	1.35/1.10/0.98
Segment V (l/w/d)	2.06/1.09/0.94	2.06/1.13/0.98
Telson, length	1.74	1.94
Vesicle (l/w/d)	1.19/0.61/0.52	1.29/0.71/0.55
Aculeus (l)	0.55	0.65
Pedipalp, Humerus (l/w)	1.39/0.45	1.42/0.48
Brachium (l/w)	1.58/0.55	1.68/0.58
Chela (l)	2.29	2.35
Palm (l/w/d)	1.32/0.61/0.65	1.29/0.55/0.55
Movable finger (l/base)	1.35/0.29	1.39/0.29
Fixed finger (l/ditd)	0.97/0.84	1.06/0.94
Supernumerary denticles (ff/mf)	6/7	6/7
Fixed finger p-row denticles	5-6-6-6-16	6-7-7-6-11
Movable finger p-row denticles	2-6-6-6-21	2-7-7-8-18
Pectine teeth (left/right)	11/10	10/10
Stigma 3 (l/w)	0.067/0.027	0.080/0.033

mellae; one basal and 6 sub-circular middle lamellae; fulcra triangular. Stigma tiny, oval, twice as long as wide. Metasoma: Ventral and ventrolateral keels granular on segments I–V; dorsal and dorsolateral keels terminate in enlarged pointed denticles posteriorly; standard metasomal keels present, granular; dorsal and dorsolateral intercarinal surfaces finely granular. Telson: Vesicle long, narrow, smooth, lustrous; distinct subaculear tooth flanked by four long macrosetae; vesicle with about 15 pairs macrosetae ventrally. Pedipalps: Palm smooth, no keels; no scallop between fingers; no elongated terminal tooth on fingers; primary row denticles divided into 5 subrows by four elongate, sharp denticles on fixed and movable fingers; fixed finger with supernumerary denticle 6 distal to trichobothria *id* and *ip*; supernumerary denticle 6 not paired with enlarged primary row denticle on fixed finger, supernumerary denticle 7 not paired with enlarged primary row denticle on movable finger; brachium with two dorsal trichobothria, 14 retrolateral trichobothria, two ventral trichobothria, one prolateral trichobothrium and four macrosetae.

Allotype description.—Similar to holotype in color and structure with following exceptions: Slightly larger size; pectines with 10 teeth per comb; primary row denticles of chela less robust, supernumerary denticles less robust, proximal two approaching obsolescence on fixed and on movable fingers, palm more slender; vesicle more elongate, subaculear tooth slightly less elongate.

Topoparatype variation.—Similar to holotype in size, color and structure with the following exceptions: Varied in total length from 13.5 to 14.0 mm; pectine tooth counts ranged from 10 to 11 (mode = 11).

Type.—Holotype (male), allotype and 7 topoparatypes (males), collected at Estacion de Biologia, Chamela (operated by Universidad Nacional Autonoma de Mexico), Jalisco, Mexico, 10–11 July 1985, S. C. Williams, ultraviolet detection. Holotype depository: California Academy of Sciences, type no. 15744. Named *Vaejovis chamelaensis* after the biological station where it was discovered.

Habitat.—Type locality is located 122 km north of Manzanillo, about 2 kilometers from the Pacific Ocean at an elevation of about 100 meters. The climate is a seasonally dry tropical one with rainy season from June to November. These scorpions were found on moderately well drained, flat sedimentary soil, in the center of a little used, unpaved, access road called Eje Central. The habitat was dominated by dense, deciduous, tropical forest, with stands of cacti in high, more exposed areas. The soil was fine textured and well packed.

Remarks.—*Vaejovis chamelaensis* appears to belong to the eusthenura group of *Vaejovis,* but has no known close relatives. It is only known from the specimens collected July 10–11, 1985, at the Estacion de Biologia, Chamela. It is of interest that during the two weeks of study this species was observed on only two nights, and 8 of the 9 specimens encountered were located in the center of an unpaved access road. Field observations suggest that this is an obligate burrowing species that does not frequent the ground surface and that perhaps the observations of the males were the result of a synchronized courtship behavior. This species is distinguished by its small body size. In this respect, it is the smallest member of the eusthenura group of *Vaejovis* and is perhaps the smallest sized member of the genus *Vaejovis,* with the possible exception of *Vaejovis minutis* Williams in which adults can occasionally be found in the 14 mm size range. This species was found sympatrically with *C. elegans, V. subcristatus occidentalis,* and *V. increpidus increpidus.* Land crabs were also found at the type locality.

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A New Species of *Uroctonus* from the Sierra Nevada of California (Scorpiones: Vaejovidae)

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Abstract.—A new species of *Uroctonus* is described and named *Uroctonus franckei* Williams. This species has only been found at elevations of over 2133 meters in the Sierra Nevada of California. The closest relative of this new species appears to be *Uroctonus mordax* Thorell.

During 1980, a series of collecting trips was conducted along the eastern slope of the Sierra Nevada of California. Sampling at higher elevations (i.e., over 2000 meters) indicated an abundant and diverse scorpion community. Of particular interest was a large, dark, previously undescribed species which was only found at elevations above 2133 meters on slopes dominated by yellow pine (*Pinus jeffreyi* Grer. & Balf.). This new species is here described and named. Measurements cited are as defined by Williams (1980).

I am indebted to Paul H. Arnaud, Jr. for furnishing research facilities at the California Academy of Sciences which aided this study. Much appreciation is due Vincent F. Lee, David Herlocker, and Jack T. Tomlinson who critically read this manuscript. Thanks also to Jett S. Chinn for help with illustrations.

Uroctonus franckei Williams, NEW SPECIES
(Fig. 1, Table 1)

Diagnosis.—Total length up to 57 mm; base color of body dark reddish-brown, often appearing blackish; frontal margin of carapace bilobed, median ocelli small, ratio of carapace width to diameter of diad 6.2–6.8; pedipalps with palm swollen prolaterally in oblique plane, ratio of chela length to palm width 3.3–3.4; fixed finger of chela with trichobothrium *id* at finger origin, supernumerary denticles 7 on fixed finger, 8 on movable finger, primary row denticles divided into 6 subrows on fixed finger, 7 subrows on movable finger; brachium with three ventral trichobothria; soles of telotarsi with single row of spiniform setae ventrally; pectine teeth 13–14 in males, 9–12 in females.

Related to *Uroctonus mordax* Thorell in size, structure, and coloration, but differs as follows: metasomal segments more slender, ratio of metasomal length to width of widest metasomal segment greater than 8.0; palm of chela more swollen, ratio of chela length to palm width 2.0 or greater; macrosetae along metasomal keels reduced in number, dorsolateral keels with macrosetal formula 1-1-1-2 on segments I–IV (not 1-2-2-2).

Description of holotype.—Male. Coloration: Deep reddish-brown with underlying black variegations on dorsum, legs, and metasoma; mesosomal sterna golden-yellow, lacking dark marbling, except sternum 7 with underlying dark pigment;

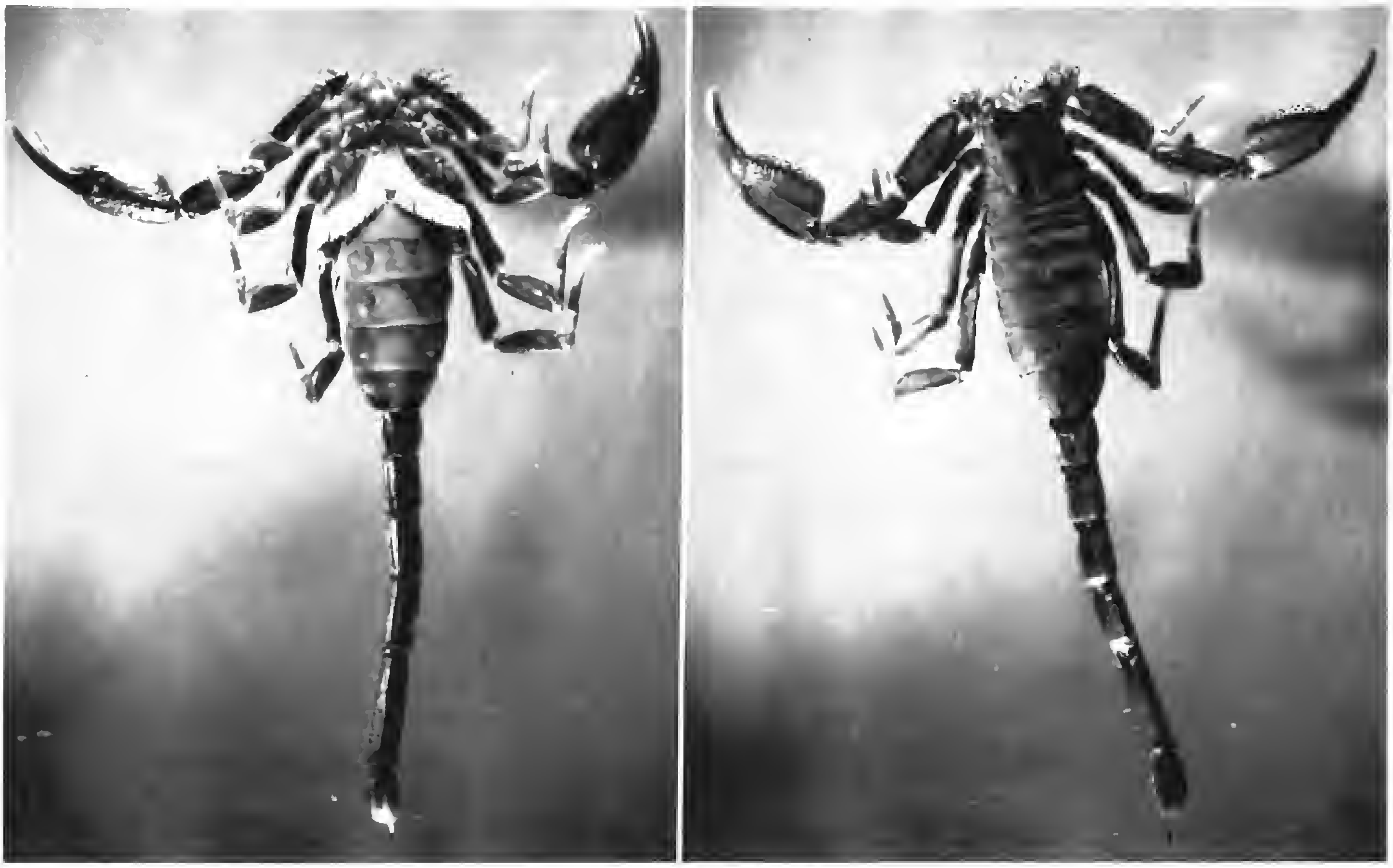

Figure 1. *Uroctonus franckei* Williams, holotype, male, dorsal and ventral views.

pectines whitish; ventral metasomal keels underlined with black pigment, vesicle ventrally blackish, with 1 pair of submedian and 1 pair of lateral golden-yellow stripes, telotarsi golden-yellow; pedipalps with keels outlined in black pigment; chelicerae with dusky variegation on golden cuticle. Prosoma: Anterior carapace margin bilobed, with distinct anterior median notch, set with 2 pairs of stout lateral setae and 1 stout seta in median notch; median ocelli small, on low, smooth ocular tubercule, ocelli separated by more than 1 ocellar diameter; carapace irregularly granular, lacking distinct keels; 3 lateral ocelli per group; sternum broad, pentagonal, 2 pairs of sternal macrosetae. Mesosoma: Terga 1–6 finely granular, lacking keels; tergum 7 lacking median keel, with 2 pairs of irregular, obsolescent lateral keels; sterna smooth, agranular, lacking keels; stigma oval, length to width ratio 2.7; genital opercula triangular, 1 pair of genital papillae, 4 pairs of genital setae; pectines with sternal plate not deeply grooved anteriorly, with only slight anterior median notch, 5 pairs of ventral macrosetae, 14 teeth per comb, 3 marginal lamellae, middle lamellae with proximal trapezoidal sclerite and 9 subcircular sclerites; fulcra triangular, each with 5–7 macrosetae. Metasoma: Dorsal keels I–IV granular; dorsolateral keels I–V granular; lateral keels granular along posterior ⅔ of I, composed of 6 irregular granules on II, obsolete on III–IV, granular on anterior one-half of V; ventral keels smooth on I–II, granular on III–IV, irregularly serrate on V, single keel branched at posterior terminus of V; ventrolateral keels smooth on I–II, smooth to crenular on III, granular on IV, flair laterally at terminus of V. Telson: Vesicle smooth, lustrous, agranular over most of surface, about 6 pairs of macrosetae ventrally, inconspicuous subaculear tubercule flanked laterally by 1 pair of macrosetae. Chelicerae: Ventral margin of movable finger with 6 distinct denticles, fixed finger with ventral surface lacking denticles; fixed finger base with 2 long, conspicuous macrosetae near movable

Table 1. Measurements (mm) of *Uroctonus franckei* Williams, new species, holotype (male) and allotype. Abbreviations as follows: l = length, w = width, d = depth, fmd = frontal margin distance, ditd = distal internal trichobothrium distance, p-row = primary row denticles of chela, ff = fixed finger, mf = movable finger.

	Holotype (male)	Allotype
Total length	58	52
Carapace (l/w at median eyes)	7.3/6.2	6.6/5.4
Diad (width/fmd)	1.0/3.0	0.8/2.7
Metasoma, length	26.5	19.5
Segment I (l/w/d)	3.6/3.6/2.8	2.6/3.0/2.3
Segment II (l/w/d)	4.2/3.0/2.7	3.1/2.5/2.2
Segment III (l/w/d)	4.7/2.8/2.6	3.5/2.4/2.1
Segment IV (l/w/d)	5.5/2.5/2.4	4.1/2.2/2.0
Segment V (l/w/d)	8.5/2.3/2.0	6.6/2.1/1.6
Telson, length	7.7	6.0
Vesicle (l/w/d)	5.3/2.7/2.6	3.9/2.1/1.8
Aculeus (l)	2.4	2.1
Pedipalp, Humerus (l/w)	7.3/2.5	6.4/2.1
Brachium (l/w)	6.4/3.3	5.8/2.6
Chela (l)	13.9	12.0
Palm (l/w/d)	8.2/4.1/5.4	7.3/3.6/4.4
Movable finger (l/base)	7.5/2.2	6.2/1.9
Fixed finger (l/ditd)	5.7/5.8	4.7/4.8
Supernumerary denticles (ff/mf)	7/8	7/8
Fixed finger p-row denticles	6-8-8-11-11-32	6-8-8-13-12-35
Pectine teeth (left/right)	14/14	11/11
Stigma 3 (l/w)	0.4/0.15	0.35/0.15

finger articulation dorsally. Pedipalps: Palm swollen obliquely; supernumerary denticles 7 on fixed finger, 8 on movable finger; proximal supernumerary reduced in size, inconspicuous on both fingers; primary row denticles divided into 6 linear subrows on fixed finger, 7 linear subrows on movable fingers. Brachial trichobothria: 2 dorsals, 13 retrolaterals, 3 ventrals, 1 prolateral; prolateral surface with transverse keel armed with 3 large dentate denticles. Humeral trichobothria: 1 dorsal, 1 retrolateral, 0 ventral, 1 prolateral. Legs: Soles of telotarsi each with 11–12 spiniform setae in single ventral row; basitarsal soles with 2 rows spiniform setae on legs 1–2, 1 row on leg 3, none on leg 4.

Allotype.—Similar to holotype in color and structure with the following exceptions: Slightly smaller body size; slightly lighter in color; pectine shorter, less robust, teeth shorter, teeth fewer, 6 middle lamellae; no genital papillae; movable finger of chela shorter than carapace; brachium length more than twice width; metasoma less elongate, segment IV length less than twice width.

Paratype variation.—Similar to holotype and allotype in size, color, and structure with following exceptions: Total length 39–57 mm in males, 38–54 mm in females; pectine tooth counts 13–14 (mode = 14) in males, 9–12 (mode = 11) in females; smaller individuals lighter in coloration than larger ones; population from near Whitney Portal less reddish in color than those further north.

Type data.—Holotype (male), and allotype, California: Inyo Co., 17.7 km (11 miles) W Big Pine, elevation 2376 meters (7796 feet), 17 Sept. 1980, S. C. Williams. Holotype and allotype depository: California Academy of Sciences, Entomology Type No. 15749. This species is named *Uroctonus franckei* after Oscar F. Francke of Texas Tech University in recognition of his many contributions to scorpion biology and systematics.

Paratypes.—Topoparatypes, 3 males, 2 females. California: Mono Co., Oh Ridge Camp, June Lake, elevation 2133 meters (7000 ft), 20 June 1980, S. C. Williams, 6 males; Inyo Co., 4.8 km (3 miles) E Whitney Portal, 30 Sept. 1980, S. C. Williams, 2 females.

Remarks.—This species was never found to be abundant, and was only collected by ultraviolet detection methods. It occurs sympatrically with *Paruroctonus boreus* (Girard).

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A Survey of the Parasitoid Complex Attacking Black Scale, *Saissetia oleae* (Olivier), in Central and Northern California (Hymenoptera: Chalcidoidea; Homoptera: Coccidae)

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Abstract.—One hundred eighteen samples of the black scale, *Saissetia oleae* (Olivier), taken from a variety of host plants in 22 central and northern California counties between 1976 and 1983, yielded a total of 10,915 adult parasitoids. Among these were 9 species of primary parasitoids and 3 species of secondary parasitoids. By far the most abundant and well distributed among these were the primary parasitoids *Metaphycus helvolus* (Compere), *M. bartletti* Annecke and Mynhardt and *Scutellista cyanea* Motschulsky, all of African origin. Together, these species represented 77% of all parasitoids taken. Conversely, the primary parasitoids *Metaphycus lounsburyi* (Howard), a primary species introduced from Australia, and *Coccophagus ochraceous* Howard, an accidental introduction, were much lower in abundance and were poorly distributed. The primary parasitoids *Coccophagus lycimnia* (Walker) and *C. scutellaris* (Dalman), both considered to be cosmopolitan species, also showed low levels of abundance but both were well distributed whereas *Metaphycus luteolus* (Timberlake), a native primary, was rarely taken and showed a poor distribution. Two of the secondary parasitoids, *Cheiloneurus inimicus* Compere and *C. noxius* Compere occurred in low numbers but the former showed a good distribution whereas the latter was poorly distributed. The third secondary parasitoid, *Tetrastichus minutus* Howard, was extremely rare, occurring at only 1 collection site. *Metaphycus inviscus* Compere, a recent (1979) introduction from South Africa, was recovered at colonization sites in 2 counties during the latter part of the survey. Other parasitoids of *S. oleae* introduced from South Africa during 1979–1982 did not show evidence of establishment during the later survey years but one of these, *Prococcophagus probus* Annecke and Mynhardt, was recovered at colonization sites in 1985.

As an adjunct to ongoing efforts to establish new exotic natural enemies of the black scale, *Saissetia oleae,* in central and northern California, a survey of the resident parasitoid complex in this region was initiated in 1976. Results obtained during the early stages of the survey concerning the distribution and abundance of two black scale parasitoids, *Metaphycus bartletti* Annecke and Mynhardt and *M. helvolus* (Compere), were reported earlier (Kennett, 1979). The results reported herein include data on all parasitoid species taken on *S. oleae* in central and northern California during the entire (1976–1983) survey period.

The general area of survey included a majority of the counties within the Sacramento and San Joaquin valleys (Central Valley), several coastal counties abutting on San Francisco Bay and several other coastal-subcoastal counties extending from San Luis Obispo County in the south to Napa County in the north. Counties surveyed in addition to those previously noted (Kennett, 1979) were Sonoma, Napa, Santa Cruz and Monterey.

Various host plants of *Saissetia oleae* were examined at approximately 360 sites distributed among 22 counties. Light to heavy infestations of *S. oleae* were sampled at 118 sites. At all other sites *S. oleae* was either absent or of insufficient density to permit a sampling deemed adequate for assessment of parasitoid activity. Although olive was the most frequently sampled host plant (ca. 60% of all samples), relatively few of the samples (ca. 10%) were obtained from this host in commercial orchards. Nearly 70% of the samples were taken from urban and rural landscaping (olive, *Olea europea* L.; oleander, *Nerium oleander* L.; *Citrus* cultivars, grapefruit, orange; Modesto ash, *Fraxinus velutina* var. *glabra* Rehd.; English holly, *Ilex aquifolium* L.) and about 20% from natural stands of native shrubs (Coyote brush, *Baccharis pilularis* ssp. *consanguinea* (DC) Wolf; Toyon, *Photinia arbutifolia* Lindl.). The seasonal distribution of black scale samples (all survey years combined) was as follows: spring, 43%; summer, 16%; autumn, 29%; winter, 12%.

After sampling, the scale-infested twigs and branches were brought into the laboratory and held in glass-topped sleeve cages for 4 to 6 weeks. Issuing parasitoids were collected thrice weekly and stored in 70% ethanol for later determination.

RESULTS

Twelve species of chalcidoid parasitoids were taken on *Saissetia oleae* during the survey. Of these, nine were primary parasitoids and three were secondary parasitoids. Five of the primary parasitoids are exotic species. Among these, *Scutellista cyanea* Motschulsky, *Metaphycus helvolus, M. bartletti* and *M. inviscus* Compere were introduced to California from South Africa whereas *M. lounsburyi* (Howard) was introduced from Australia. The initial year of introduction for each of these species was as follows: *S. cyanea,* 1901; *M. lounsburyi,* 1916; *M. helvolus,* 1937; *M. bartletti,* 1957; *M. inviscus,* 1979. The remaining primaries, *Coccophagus ochraceous* Howard, *C. lycimnia* (Walker), *C. scutellaris* (Dalman) and *Metaphycus luteolus* (Timberlake), are of indeterminate origin although *C. ochraceous* is thought to be an accidental introduction from South Africa (Bartlett, 1978), and *M. luteolus* was originally described from southern California (Timberlake, 1916). Among the secondary parasitoids, *Cheiloneurus inimicus* Compere and *C. noxius* Compere were originally described from *S. oleae* taken in southern California (Compere, 1925). The other secondary, *Tetrastichus minutus* Howard, has also been taken on *S. oleae* in southern California (Smith and Compere, 1928).

Other exotic primary parasitoids of *Saissetia oleae* reported (Bartlett, 1978) as permanently established in California but which were not taken during the survey, were *Metaphycus stanleyi* Compere, *Coccophagus rusti* Compere, *C. capensis* Compere, *C. cowperi* Girault, *Diversinervus elegans* Silvestri, *Encyrtus infelix* Embelton, *Lounsburyia trifasciatus* (Compere), *Lecanobius utilis* Compere and *Moranila californica* Howard. The latter three species have been reported (Bartlett, 1978) to be extremely rare in California.

All primary parasitoids excepting *Metaphycus inviscus* and *M. luteolus* were reared from *S. oleae* taken on olive, oleander, citrus, Coyote brush and Toyon. *Metaphycus inviscus,* a recent introduction, was recovered only from olive at colonization sites in Fresno and Tulare counties. *Metaphycus luteolus,* a rare species on *S. oleae,* occurred in samples from olive and oleander, principally at Sacramento Valley sites. The single samplings from Modesto ash and English holly each produced only 3 species of primary parasitoids. The secondary parasitoid, *Cheiloneurus inimicus* occurred in samples from olive and Coyote brush whereas its congener *C. noxius* was taken in samples from oleander, Coyote brush and citrus. *Tetrastichus minutus* occurred in a sample from olive at 1 site (Tehama County).

Of the 118 samples, 77 were obtained from interior valley (IV) counties and 41 were obtained from coastal and subcoastal (CSC) counties. Ninety-five percent of the CSC samples produced one or more parasitoid species whereas 75% of the IV samples were positive for parasitoids. Total parasitoid emergence for all samples combined was 10,915. Nearly 58% of these emerged from the CSC samples. Parasitoid emergence averaged 135 per sample for the CSC counties and 59 per sample for the IV counties. The average number of parasitoid species per sample for the CSC counties was nearly twice that observed for the IV counties (Fig. 1). About one-half of this difference is attributable to the relatively high number of IV samples which failed to produce adult parasitoids. Excluding those samples lacking parasitoids, the average number of species per sample was 4.2 and 3.0, respectively, for the CSC and IV counties. Approximately 51% of the CSC samples produced 5 or more species whereas about 14% of the IV samples produced 5 or more.

Ranking of parasitoids according to overall abundance, frequency of occurrence, counties of occurrence and months of occurrence showed a relatively consistent pattern among the various species (Table 1). *Metaphycus helvolus* and *M. bartletti* ranked first and second, respectively, in all categories whereas *Scutellista cyanea* and *Coccophagus lycimnia* ranked either third or fourth in all categories, with the exception that the latter species shared the second place ranking for "months of occurrence." Rankings of the remaining parasitoids were inconsistent across categories except that the 2 least abundant species, *Cheiloneurus noxius* and *Metaphycus luteolus,* ranked either last or next to last in all categories.

Grouping of parasitoid emergence data according to geographical areas, i.e., coastal-subcoastal (CSC) counties and interior valley (IV) counties, showed substantial between-area differences in parasitoid relative abundances (Fig. 2). Although *Metaphycus helvolus, M. bartletti* and *Scutellista cyanea* were the 3 most abundant parasitoids in both areas, their rankings differed both between areas and from the overall ranking. In the CSC area *Metaphycus helvolus* (39.7% of total emergence) outranked *Scutellista cyanea* (18.5%) and *M. bartletti* (11.7%) whereas in the IV area *M. bartletti* (40.4%) outranked *M. helvolus* (35.0%) and *S. cyanea* (11.5%). These species represented 70 and 87%, respectively, of the parasitoid emergence for the CSC and IV areas. The remaining portions of parasitoid emergence were distributed among 7 species in the CSC area and among 6 species in the IV area. Among these parasitoids, *Metaphycus lounsburyi, Coccophagus ochraceous* and *C. lycimnia* showed considerably higher relative abundances in the CSC area than in the IV area. With the exception of *Cheiloneurus noxius,* which was not taken in the IV area, each of the remaining parasitoids in

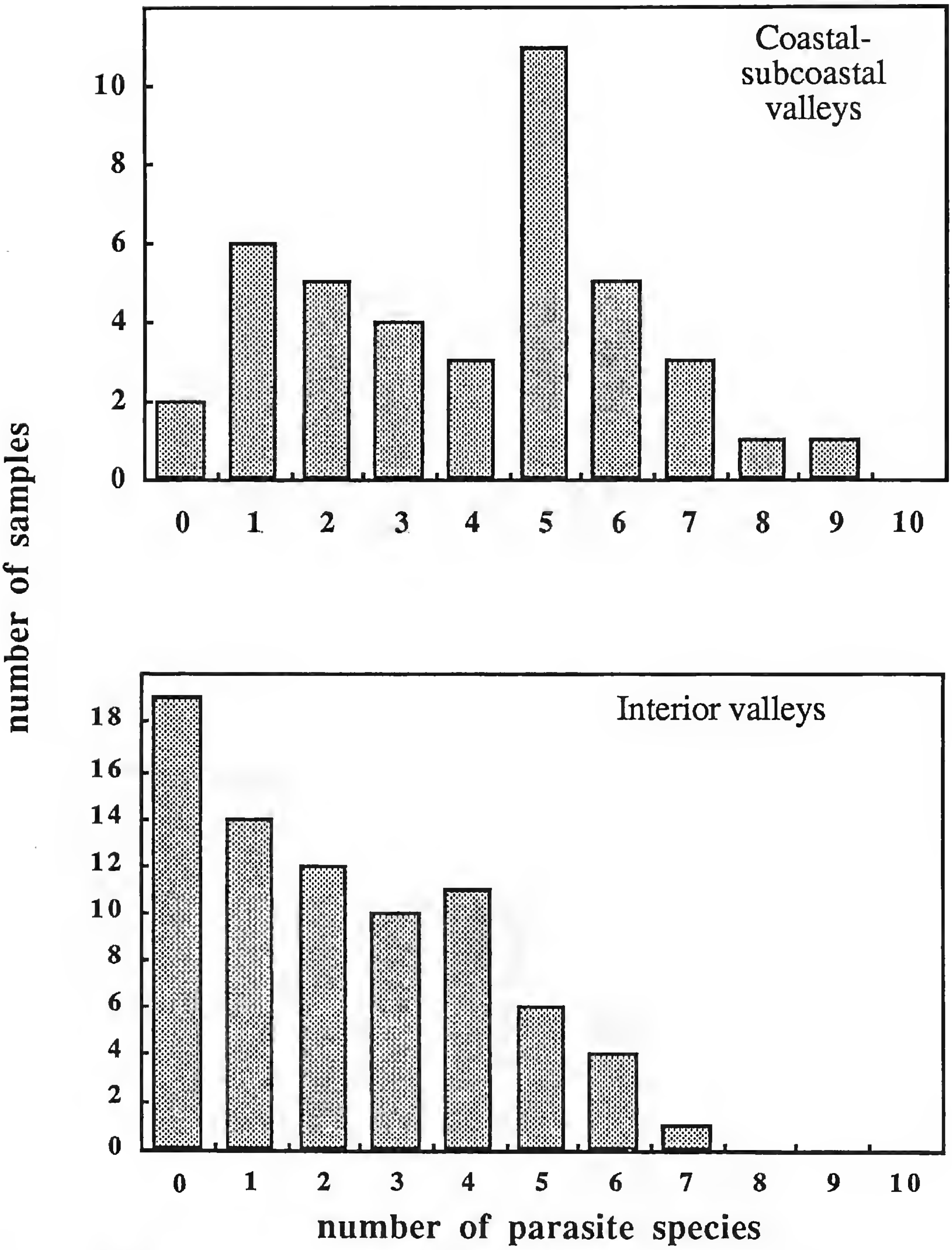

Figure 1. Frequency distributions of black scale (*Saissetia oleae*) samples according to the number of parasitoid species present at coastal-subcoastal (CSC) and interior valley (IV) collection sites in central and northern California. The mean number of parasitoid species per sample for the CSC and IV areas were 4.0 and 2.2, respectively.

this group (*Cheiloneurus inimicus, Coccophagus scutellaris, Metaphycus luteolus*) showed a similar relative abundance in both areas.

Among the introduced parasitoids, *Metaphycus helvolus, M. bartletti* and *Scutellista cyanea* showed good distribution and frequency of occurrence in both areas although the latter species rarely was taken in the southernmost portion of the IV area (lower San Joaquin Valley). Conversely, *Metaphycus lounsburyi* and *Coccophagus ochraceous* showed good distribution and frequency of occurrence

Table 1. Rankings of parasitoids reared from black scale samples taken in central and northern California according to relative abundance, frequency of occurrence, counties of occurrence and months of occurrence.[1]

	Abundance		Frequency of occurrence		Counties of occurrence		Months of occurrence	
	Percent of total abundance	Rank	Percent of samples[2]	Rank	Number[3]	Rank	Number	Rank
Metaphycus helvolus	37.8	1	84.5	1	19	1	12	1
Metaphycus bartletti	23.8	2	56.7	2	17	2	11	2
Scutellista cyanea	15.5	3	46.4	4	15	4	10	3
Coccophagus lycimnia	7.5	4	53.6	3	16	3	11	2
Metaphycus lounsburyi	4.5	5	18.6	7	8	7	8	5
Cheiloneurus inimicus	4.1	6	13.4	8	10	5	6	6
Coccophagus ochraceous	2.8	7	23.7	6	9	6	10	3
Coccophagus scutellaris	2.4	8	38.1	5	15	4	9	4
Cheiloneurus noxius	1.3	9	8.0	9	3	9	6	6
Metaphycus luteolus	0.3	10	8.0	9	6	8	3	7

[1] *Metaphycus inviscus,* a 1979–1980 introduction recovered at only 2 sites, and *Tetrastichus minutus,* a hyperparasitic species which was taken at 1 site, are not included in the rankings.

[2] Percentage of samples ($n = 97$) having 1 or more parasitoid species present.

[3] Total number of counties sampled was 22.

in the CSC area but both were of extremely limited distribution in the IV area with *M. lounsburyi* occurring at a few sites near the confluence of the 2 areas (Yolo County) and *C. ochraceous* occurring at a few scattered sites in the northern half of the IV area (Sacramento Valley). Among the remaining parasitoids, *Coccophagus lycimnia* and *C. scutellaris* showed good distribution and frequency of occurrence in both areas whereas *Cheiloneurus inimicus* showed a good distribution in both areas but exhibited a poor frequency of occurrence. *Cheiloneurus noxius* showed a poor distribution in the CSC area and was absent from the IV area whereas *Metaphycus luteolus* showed a good distribution in the IV area but not in the CSC area. Both of these parasitoids showed a poor frequency of occurrence.

Among the introduced parasitoids, *Metaphycus helvolus* and *Scutellista cyanea* each appears to be adapted about equally well to both areas whereas *M. bartletti* appears less well adapted to the CSC area than to the IV area. This latter species, however, is a relatively recent introduction in California and might, in time, show greater distribution and abundance in the CSC area. *Metaphycus lounsburyi* and *Coccophagus ochraceous* appear to be poorly adapted outside the CSC area, almost to the point of exclusion. Neither of these parasitoids was taken in the San Joaquin Valley and both showed a very limited distribution in the Sacramento Valley. This near complete restriction to one climatic zone suggests that the distribution of *M. lounsburyi* and *C. ochraceous* is limited by climate. The climate of the CSC counties is highly influenced by the Pacific Ocean and is typified by narrow diurnal and limited seasonal temperature fluctuations whereas the climate of the IV counties is predominantly free of ocean influence and is typified by wider diurnal fluctuations and much greater seasonal temperature changes (Kimball and Brooks, 1959).

Among the "non-introduced parasitoids," *Coccophagus lycimnia, C. scutellaris*

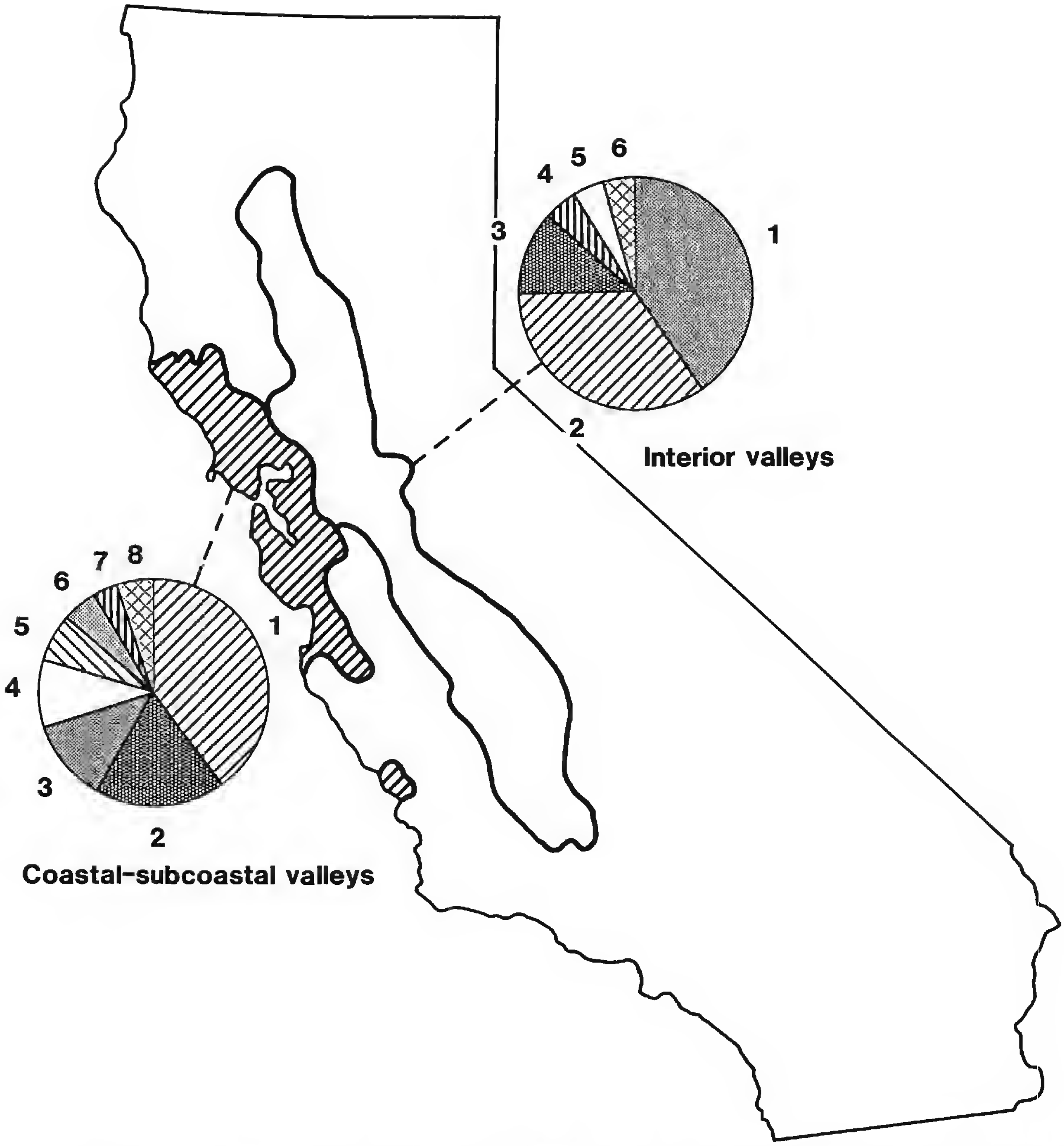

Figure 2. Relative abundances of black scale (*Saissetia oleae*) parasitoids which emerged from coastal-subcoastal (CSC) and interior valley (IV) samples taken in central and northern California. CSC area, 1 = *Metaphycus helvolus*, 2 = *Scutellista cyanea*, 3 = *Metaphycus bartletti*, 4 = *Coccophagus lycimnia*, 5 = *Metaphycus lounsburyi*, 6 = *Coccophagus ochraceous*, 7 = *Cheiloneurus inimicus*, 8 = *Coccophagus scutellaris, Cheiloneurus noxius* and *Metaphycus luteolus*; IV area, 1 = *M. bartletti*, 2 = *M. helvolus*, 3 = *S. cyanea*, 4 = *C. inimicus*, 5 = *C. lycimnia*, 6 = *C. scutellaris, M. lounsburyi, C. ochraceous* and *M. luteolus*.

and *Cheiloneurus inimicus* each appears equally adapted to both areas whereas *Cheiloneurus noxius* and *Metaphycus luteolus* appear adapted to only one area. Here again, the complete or near complete absence from one of the two climatic zones suggests that the distribution of these latter two parasitoids is restricted by climate.

Coincidental to the survey, several new parasitoids of South African origin were colonized on *Saissetia oleae* in central and northern California. Among these recent (1979–1982) introductions (*Metaphycus inviscus, Prococcophagus probus*

Annecke and Mynhardt, *P. saissetia* Annecke and Mynhardt, *Aloencyrtus saissetia* (Compere) and *Coccophagus rusti*) only *M. inviscus* has shown early and continuing evidence of permanent establishment. However, the recent (1985) recovery of *P. probus* at release sites in Tehama County (K. Daane, pers. comm.) some five years after the initial colonization, suggests that this species may also have become permanently established in California.

Current efforts to add to the parasitoid complex on *Saissetia oleae* in California are concerned with the mass production and colonization of *Metaphycus zebratus* Mercet, a recent (1985) acquisition from Spain.

ACKNOWLEDGMENTS

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Scientific Note

The Antibiotic Properties of Honey

Williams and Tomlinson (1985) observed honey bees collecting rust spores from willow tree leaves. This is a common phenomenon. Honey bees have a variable threshold of acceptance for food (von Frisch, 1967). When pollen is not available they collect a wide variety of things of the right particle size: Apple mildew conidia (Abushada, 1921); oat rust (*Puccinia graminis*) (Betts, 1942); rust spores from poplar leaves (*Melampsora populina*) (Minz, 1942); azalea flower spot (*Ovulinia azaleae*) (Smith and Weiss, 1942); and sawdust (Morse, 1975). I think there must be another 50 such references.

In a second paper, Tomlinson and Williams (1985) suggest that part of honey's "antibiotic qualities may, at least in part, be derived from fungal foraging by bees." However, their small data set does not substantiate their claim for two reasons. First, although many fungal spores have antibiotic properties, Williams and Tomlinson (1985) did not plate the spores found in their honey sample to determine whether they were in fact antibiotic. Second, it is possible to explain their results on the basis of several known intrinsic properties of honey.

Both articles neglect the extensive literature on honey and its special qualities. Tomlinson and Williams wrote "Although medicinal qualities have been claimed for honey since ancient times (Crane, 1980), its curative effect has been attributed variously to the hyperosmotic sugar content, and to unique, undefined components." It is true, as they state, that the medical qualities of honey have been known since ancient times. Majno (1975), a pathologist, states that honey was an ingredient in 500 of 900 known Egyptian remedies. He undertook some experiments using honey and found that, as the Egyptians knew, it was an effective ingredient in wound dressing. Majno reviews the properties of honey that account for its utility in this context.

Honey's natural bacteriostatic and bacteriocidal qualities stem from several factors. Its high sugar content is of great importance (Sackett, 1919; Burgett, 1985); bacteria introduced into honey are desiccated as water moves out of the bacterial cells into the hypertonic honey. In addition, honey has a low pH (ca. 3.9; White et al., 1962) that makes it an inhospitable medium for the growth of many microorganisms. Gluconic acid is the chief acid in honey and is largely responsible for the low pH. Its production is catalyzed by glucose oxidase, an enzyme added by the bees. The oxidation of glucose also produces hydrogen peroxide, whose ability to inhibit bacterial growth is well known. Glucose oxidase is first added to nectar by foraging bees but additional enzyme is probably contributed by hive bees that process the nectar into honey (White, 1966).

Of particular relevance to the Tomlinson and Williams (1985) paper is the fact that glucose oxidase is not active in honey with a moisture content of less than about 19 percent and is also easily destroyed by heat (Crane, 1975). Williams and Tomlinson (1985) did not measure the moisture content of the honey they tested, nor did they state whether it was heated or not. Since both factors are highly variable (Crane, 1975), the differences in antibiotic activity they reported were perhaps a result of differences in the physical properties of the honey samples.

Known bacteriocidal qualities of honey, coupled with the bees' irregular tendency to collect useless substances in lieu of pollen suggest the possibility that fungal foraging does not contribute significantly to the antibiotic properties of honey.

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Synopsis of the Classification of Neotropical Tortricinae, with Descriptions of New Genera and Species (Lepidoptera: Tortricidae)

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The Tortricoidea is a large, worldwide superfamily, consisting of the single family Tortricidae. Included are more than 5000 described species, members of two, three, or four subfamilies, and 6 to 19 tribes, varying with taxonomic opinion. In the Holarctic, the subfamily Tortricinae and its generic and tribal concepts are fairly well established, and there is general agreement among contemporary researchers between classifications used in the Old and New World faunas. As one proceeds into the Neotropical Region, however, many of the generic and tribal components become less clearly defined, or are replaced by other, often poorly known taxa. A much greater proportion and diversity of the known fauna has not been described, even at the species level, and many species which are described have been assigned artificially to obsolete generic groupings.

Thus there has been no comprehensive modern classification of New World tortricine moths. After the importance of genitalic characters was recognized, August Busck began an extensive study of Nearctic and Neotropical tortricid taxonomy in the 1920's, but little of his work was published (Busck, 1940), although some of his concepts were passed on as new generic names on specimens. Later contributions gradually established a generic classification for most North American species, particularly Obraztsov's treatment of the Palearctic fauna (Obraztsov, 1954–1957), and aided by an unpublished thesis on Sparganothini (Lambert, 1950), Freeman's (1958) revision of the Archipini, and our studies of genera of other tribes (Obraztsov, 1959a, 1962, 1963; Obraztsov and Powell, 1961; Powell, 1962, 1964; Powell and Obraztsov, 1977).

As a result, we have realistic placements of nearly all of the 250 described species, which are assigned to 31 genera (Powell, 1983), although several additional genera are described (Powell, 1985, present paper) or are defined in manuscript for species of the U.S. or Nearctic parts of Mexico.

In the Americas south of the U.S., about 450 species group names have been applied to the Tortricinae s. str. (exclusive of the Cochylinae and Chlidanotinae). About 415 species are considered to be valid; the remainder of the names are synonyms. This total includes North American species that range into the Antilles or Mexico. The descriptive era for Neotropical Tortricinae occurred primarily before the modern period when dissections and illustrations of genitalic characters had been employed as the main basis of classification. Most of the species (65%) were described between 1863 and 1920 by Walker, Zeller, Walsingham, Meyrick, Dognin, and Busck, and many others were added during 1920–1938 by Meyrick, who rigidly rejected the use of genitalic characters after they came into widespread use. Only 16% of the species names originate since 1940, although there are a great many undescribed species in collections.

Dissections of type specimens and preliminary steps towards refining systematic placements have been made for most of the described Neotropical species by Clarke (1949, 1956, 1958, 1963), who illustrated most of Meyrick's species, by Obraztsov (1959b, 1966a, 1966b, 1966c, and unpubl. studies), and by Razowski (1964, 1966, 1979, 1982a, 1982b, 1982c). Nonetheless, about 30% of the species remain without meaningful generic placements.

N. S. Obraztsov continued the work on a generic classification begun by Busck, and he studied the type specimens of most of the Neotropical Tortricinae during tenure at the American Museum of Natural History, New York, under sponsorship of National Science Foundation grants, during 1956–1965. Unfortunately, Obraztsov's research was terminated prematurely by his sudden death in 1966, and his card catalog of world Tortricidae was transferred to the British Museum (Natural History), London, making it inaccessible to Western Hemisphere researchers. Nevertheless, his notes and photographs of type specimens remain at the AMNH, and these have been invaluable in development of a classification.

I inherited the Neotropical tortricine project and began comprehensive research in 1970–1971, while a visiting research fellow at the Smithsonian Institution, Washington, D.C. I studied the Neotropical species of Sparganothini, both the older material used by Lambert, and the extensive more recent acquisitions accumulated in Washington and at Berkeley, as well as the type specimens in the BM(NH). This resulted in considerable revision of Lambert's (1950) concepts because he had not seen the type specimens of most of the older Neotropical species and had misinterpreted application of the names. In addition, I developed a catalog to all described Neotropical Tortricinae, based on library research and notes from Obraztsov. I studied the BMNH and U.S. collections and proposed tentative generic assignments for the described species for all tortricine tribes. Based in part on further study at the British Museum in 1984, this list has been revised to provide a basic framework for the classification of Neotropical Tortricinae (Powell and Razowski, 1986). This checklist defines 6 tribes, with 55 genera (Table 1). Among the described genera, 13 represent taxa described from the Holarctic, one is introduced from the Australian region, and the rest are exclusively Neotropical or are distributed in the Boreal Nearctic element of Mexico, extending northward only to the southwestern U.S. Effectively half the endemic genera, 21, have been described recently by Razowski (loc. cit.), Powell (1980) or in the present paper. The new genera help to establish a more complete framework for the described fauna, but it is obvious that much more extensive generic realignment and descriptions of many new genera will be necessary to bring an understanding of the Neotropical fauna into perspective with that of the Holarctic. The new genera are described here in order to make the names available for the forthcoming checklist.

The wing venation nomenclature follows that of Common (1970) and Horak (1984). Other abbreviations as follows: DC = discal cell of forewing; FW = forewing; HW = hindwing. Portions of the ductus bursae are described from basal (at the ostium bursae) to distal end of the invagination.

Table 1. Synopsis of the classification of Neotropical Tortricinae. (See Obraztsov, 1954–1957, or Powell, 1983, for synonymies of genera originally described from the Holarctic, indicated by an asterisk *.)

- Tribe ATTERIINI Busck, 1932
  - *ANACRUSIINA* Diakonoff, 1961
  - Anacrusis Zeller, 1877
  - Archipimima Powell, 1986
  - Atteria Walker, 1863
  - Holoptygma Powell, 1986
  - Templemania Busck, 1940
  - Tina Powell, 1986
  - Tinacrucis Powell, 1986
  - Sisurcana Powell, 1986
- Tribe SPARGANOTHINI Walsingham, 1913
  - *NIASOMINI* Powell, 1964
  - Aesiocopa Zeller, 1877
  - *Amorbia Clemens, 1860
  - Anchicremna Meyrick, 1926
  - *Coelostathma Clemens, 1860
  - Paramorbia Powell & Lambert, 1986
  - *Platynota Clemens, 1860
  - Rhynchophyllis Meyrick, 1932
  - Sparganopseustis Powell & Lambert, 1986
  - Sparganothina Powell, 1986
  - *Sparganothis Hübner, 1825
  - Sparganothoides Lambert & Powell, 1986
- TRIBE ARCHIPINI
  - *Argyrotaenia Stephens, 1852
    - *Subargyrotaenia* Obraztsov, 1961, new synonymy
  - *Choristoneura Lederer, 1859
  - *Clepsis Guenée, 1845
  - Idolatteria Walsingham, 1913
- Tribe CNEPHASIINI Stainton, 1859
  - *Decodes Obraztsov, 1961
  - Decodina Powell, 1980
- Tribe EULIINI Kuznetsov and Stekol'nikov, 1977
  - *Anopina Obraztsov, 1962
  - Anopinella Powell, 1986
  - Apolychrosis Amsel, 1962
  - *Apotomops Powell & Obraztsov, 1986
  - Bonagota Razowski, 1986
  - Chileulia Powell, 1986
  - Chrysoxena Meyrick, 1912
  - Clarkeulia Razowski, 1982
  - Deltinea Pastrana, 1961
  - Deltobathra Meyrick, 1923
  - *Dorithia Powell, 1964
  - Ecnomiomorpha Obraztsov, 1959
  - Neoeulia Powell, 1986
  - Nesochoris Clarke, 1965
  - Orthocomotis Dognin, 1905
    - *Sociophora* Busck, 1920
  - Paracomotis Razowski, 1982
  - Paraptila Meyrick, 1912
  - Proeulia Clarke, 1962
  - Pseudomeritastis Obraztsov, 1966
  - Quasieulia Powell, 1986
  - Rebinea Razowski, 1986
  - Rhythmologa Meyrick, 1926
  - Seticosta Razowski, 1986
  - Uelia Razowski, 1982
- Tribe TORTRICINI Guenée, 1845
  - *Acleris Hubner, 1825
  - Apotoforma Busck, 1934
    - *Emeralda* Diakonoff, 1960
  - *Croesia Hübner, 1825
- Tribe PHRICANTHINI Diakonoff, 1981
  - Phricanthes Meyrick, 1881 (introd. from Australia)
- Unplaced Genera
  - Apinoglossa Moeschler, 1890
  - Hypostromatia Zeller, 1866

TRIBE SPARGANOTHINI

Sparganothidae Walsingham, 1913.
Sparganothinae Busck, 1940.
Sparganothidini Diakonoff, 1961 (in part).
Sparganothidina Diakonoff, 1961.
Sparganothini Kuznetsov & Stekol'nikov, 1973.
Niasomini Powell, 1964.

The genera of Sparganothini described here share the following character states. *Head:* Antenna unmodified, scaling in two bands per segment. Labial palpus elongate, porrect; II segment length greater than 2× eye diameter, enlarged 1.8–

2.0 × basal diameter. Maxillary palpus minute or rudimentary. Chaetosema small. *Forewing:* Broad, length 2.4–2.6 × width. Length of DC 0.55–0.60 FW length. Accessory cell (chorda) absent; R_3 separate from $R_4 + R_5$, which are stalked with rare exceptions, R_4 to costa, R_5 to termen. No upraised scale rows or tufts (as there are in *Platynota, Synnoma,* etc.) *Hindwing:* Ten veins (including CuP), humeral vein absent; base of RS lost; CuP remaining, weak or a trace. No costal penicillus in male. *Abdomen:* No enlargement of VIII in male; no corethrogyne ovipositional scaling in female. *Male genitalia:* Uncus well developed, slender basally, without ventral setal tuft. Saccus not differentiated. No hami or subscaphium. Socii large, flat, kidney bean-shaped, extended posteriorly beyond attachment near middle; with dense elongate scaling. Transtilla complete, dentate, not fused to pulvinus. Valva simple, not plicate, pulvinus present, "clasper" absent; costa narrowly sclerotized or undifferentiated. Aedeagus without external spurs; vesica with a dense bunch of deciduous cornuti, attached laterally near base (base notched in *Sparganopseustis*). *Female genitalia:* Papillae anales weakly sclerotized compared to Atteriini, without differentiated setae. Ductus bursae well differentiated from corpus bursae, without antrum or accessory sac. Corpus bursae globose, without accessory pouch, signum a nearly straight or curved, well sclerotized crease.

Based on recent research, J. S. Dugdale (*in litt.*) believes that Sparganothini possess a rudimentary gnathos which arises from the gnathos base sclerite, separate from the socius base sclerite. According to this interpretation, the socii in several genera (e.g., *Sparganothis, Platynota*) are complex, two-part structures, and the so-called "gnathos arms" of prior taxonomists and in the descriptions that follow actually are lobes of the socii.

Sparganothoides **Lambert & Powell, New Genus**

Type species.—Sparganothis hydeana Klots, 1936.

Head: Antennal setulae in male >2 × segment diameter, borne on raised ridges. Labial palpus II segment enlarged at ca. middle, slightly curved; III segment ca. 0.4 as long as II. Scaling of frons slightly roughened or smooth with crown cap. Ocelli well developed. Periorbital strip bare. *Forewing:* Length of DC ca. 0.55 FW length; width of DC ca. 0.17 its length; Cu_{1b} arises 0.50–0.54 along length of cell; stem of M absent or weak (not visible on unstained wing) in cell, ending between M_1 and M_2; CuP present. Costal fold in male present or absent. *Hindwing:* $Sc + R_1$ and Rs closely adjacent, crossvein lost; Rs and M_1 closely adjacent, connate or short-stalked; M_3 and Cu_{1a} connate. Cubital hair pecten absent or nearly so in male, present in female. *Abdomen:* Dorsal pits absent. *Male genitalia:* (Klots, 1936, fig. 4) Uncus slender, simple or enlarged or forked apically. Gnathos arms separate, enlarged laterally into broad, paddle-like, setate clubs apically, or rarely only weakly enlarged. Transtilla finely dentate. Valva large, rounded; sacculus narrowly sclerotized, simple. Aedeagus slightly bent, pistol-shaped. *Female genitalia:* (Klots, 1936, fig. 5) Papillae anales parallel-sided, somewhat rectangular. Sterigma wide, box-shaped, well sclerotized dorsad and ventrad of ostium, lateral lobes not produced. Ductus bursae rather short, gradually enlarged distally; colliculum present, split ventrally, cestum not developed. Corpus bursae large, with undifferentiated scobination; signum long, nearly straight.

Sexual dimorphism.—Slight; size and color pattern similar, females average slightly larger in some species. Males possess well developed antennal setulae, a costal fold in some species and in one undescribed species a curious, longitudinally parted scale development on the head and thorax.

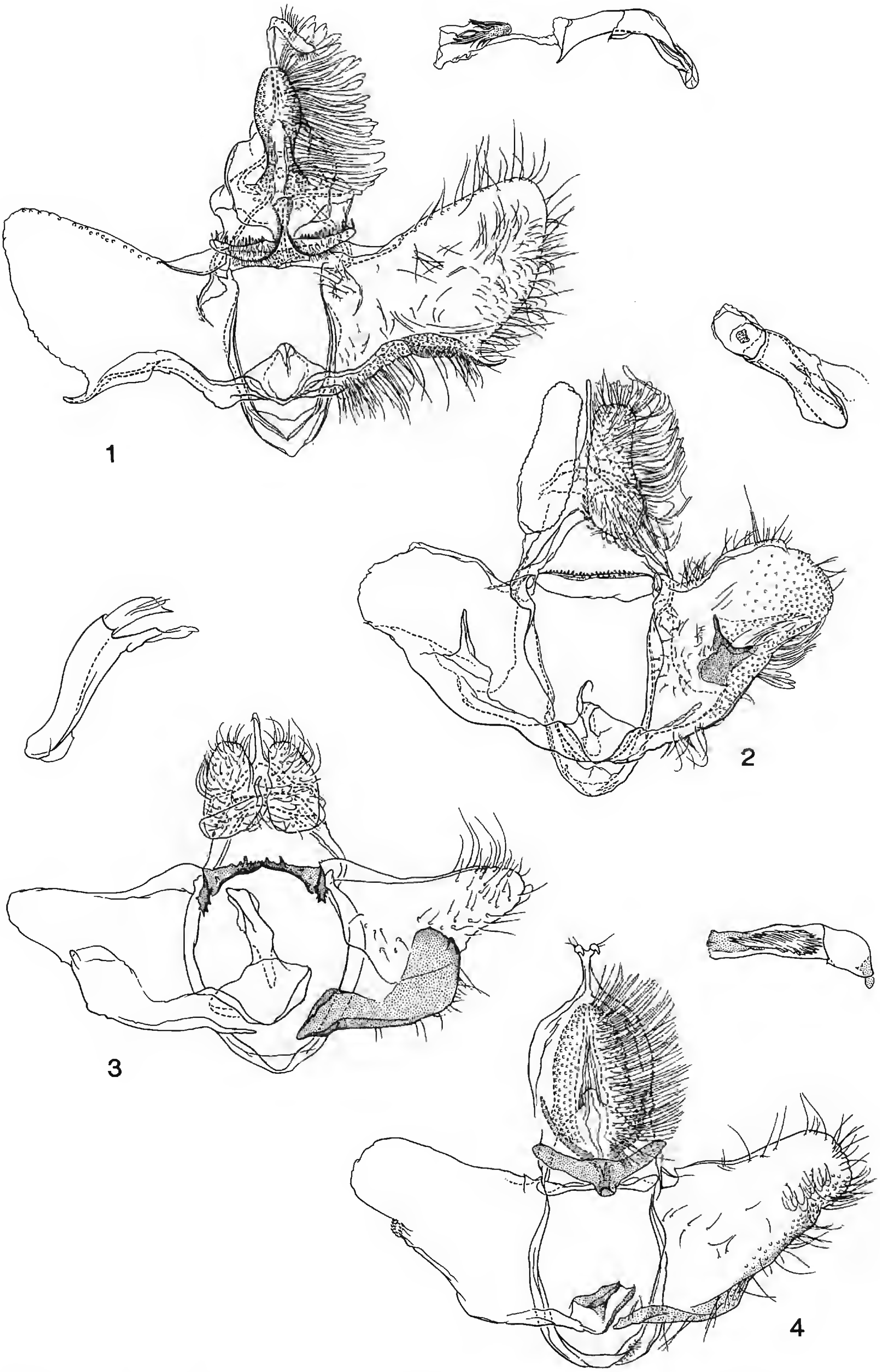
This new genus was conceived by Lambert (1950, Genus II), who later proposed the name *Sparganothoides* in a partially revised manuscript and assigned the following species: *S. albescens* (Walsingham, 1913), *S. castanea* (Wlsm., 1913), *S. hydeana, S. lentiginosana* (Wlsm., 1879), *S. lugens* (Wlsm., 1913), *S. machimiana* (Barnes & Busck, 1920), *S. morata* (Wlsm., 1913), *S. schausiana* (Wlsm., 1913), *S. spadicea* (Wlsm., 1913), and *S. vinolenta* (Wlsm., 1913). These and about 20 undescribed species are distributed from Arizona to Costa Rica. Lambert differentiated the group on the basis of the broadly, laterally expanded apices of the gnathos arms and by the anellus, which is produced posteriorly, with the manica attached beyond the middle of the aedeagus. However, the latter feature is variable in *Sparganopseustis* n. gen., described below. *Sparganothoides* also differs from *Sparganothis* Hbn., to which it appears most closely related, by having the sexes subequal in size and appearance.

Sparganothoides albescens, S. lugens, S. schausiana, and at least three undescribed species possess a forked uncus, yet they are quite dissimilar in other features. Their assignment to this genus is provisional. Several undescribed species have the gnathos arms attenuate or only slightly enlarged apically, which will further complicate the integrity of *Sparganothoides* when the species are thoroughly studied.

***Sparganopseustis* Powell & Lambert, New Genus**

Type species.—Sparganopseustis martinana Powell, new species.

Head: Antennal setulae in male moderately elongate, 1.60–1.75× segment diameter. Labial palpus II segment enlarged distally, slightly curved, with long scaling; III 0.40–0.67 as long as II. Scaling of frons modified, erect at base, sparse, smooth above, hidden beneath long, rounded hood of scaling from vertex. Ocelli rudimentary to well developed. *Forewing:* Length of DC 0.58–0.60 FW length; width of DC 0.15–0.17 its length; Cu_{1b} originates 0.60–0.65 along length of cell. Stem of M present in DC, without trace of fork, ending between M_1 and M_2; R_4 and R_5 usually stalked (usually separate in *S. ningorana* and *S. flavicirrata*); CuP present or a trace. Cubital hair pecten lacking in male, absent to weakly developed in female. No costal fold in male. Apex acute, subfalcate in most species. *Hindwing:* $Sc + R_1$ and Rs separate, crossvein reduced to a trace; Rs and M_1 stalked; M_3 and Cu_{1a} connate or short-stalked. *Abdomen:* Dorsal pits usually indicated on II in some species, absent on most. *Male genitalia:* (Fig. 1) Uncus weakly to moderately enlarged apically. Socii broadened posteriorly, elongated into clubbed projections anteriorly (evidently fused with gnathos arms). Gnathos rudimentary at base, weakly sclerotized, joined to socii by membranous connections, thence produced as separate, usually clubbed, distally setate arms. Transtilla usually enlarged medially. Valva oval; pulvinus rudimentary; sacculus narrowly to broadly sclerotized to beyond middle of valva, with a pronounced emargination in some species, usually with a free tip. Aedeagus pistol-shaped to evenly curved. *Female genitalia:* (Fig. 13) Papillae anales flat, rather oval, diverging anteriorly. Sterigma a broad plate posterior to ostium, sometimes weakly bowl-shaped but without pronounced lateral lobes. Ductus bursae straight, membranous, gradually enlarged



Figures 1–4. Male genitalia of Tortricinae, ventral aspect with valvae reflexed; aedeagus removed and shown in lateral aspect. 1. *Sparganopseustis martinana* Powell. 2. *Paramorbia rostellana* (Zeller). 3. *Sparganothina xanthista* (Walsingham). 4. *Sisurcana furcatana* Powell.

distally; colliculum split ventrally, located just proximal to ductus seminalis; cestum absent. Corpus bursae large, with pronounced scobination (spiculae in *myrota* complex); signum extending around half the bursa perimeter, a small membranous pouch protrudes just basad to signum (sometimes rudimentary).

Sexual dimorphism.—Pronounced; color pattern differs in all species, often markedly so. Males in most species have secondary features: either an expandable scale tuft of labial palpus; an eversible, densely scaled coremata between abd. II & III dorsally; or modified, erect scaling of the hindwing dorsally.

The genus is distributed from Arizona to Peru and includes the following described species: *S. acrocharis* (Meyrick, 1932), *S. aurolimbana* (Zeller, 1866), *S. elimata* (Meyr., 1930), *S. flaviciliana* (Walsingham, 1913), *S. flavicirrata* (Wlsm., 1914), *S. geminorum* (Meyr., 1932), *S. myrota* (Meyr., 1912), *S. ningorana* (Wlsm., 1914), *S. niveigutta* (Wlsm., 1913), *S. tessellata* (Wlsm., 1913), and *S. unipunctata* (Wlsm., 1914), each of which is known only from one sex. *Sparganopseustis martinana* is selected as the type species because there is an unequivocal collection of both sexes (27 males, 17 females) from one seasonal sample at one locality. In addition, I have reared F_1 sibs of two undescribed species in northern Mexico and have examined recently collected series of three others from Oaxaca, Mexico, Costa Rica and Venezuela in which association of the sexes can be inferred.

Although available material was so scant that correlation of males and females could not be made for any species, Lambert (1950) perceived this series of species to comprise an undescribed genus (his Genus IV). However, he failed to recognize the character that I believe is a fundamental synapomorphy, the uniquely derived socii-gnathos complex. Instead, Lambert defined the genus on a series of features, no one of which was common to all of the included species. Interpretation of the morphology is debatable; either the gnathos is rudimentary and its function has been taken by modification of the socii, or the two structures are fused. In any case, this is fundamentally different from all other New World Sparganothini. A similar arrangement occurs in *Lambertiodes harmonia* (Meyrick) in India, but in that species the rudimentary gnathos arms are joined medially and are not connected to the socii, which are drawn out into elongate arms anteriorly. Lambert (1950) misinterpreted this and described the gnathos as having free arms, as did Diakonoff (1959) when he described the genus *Lambertiodes.* Horak (1984) thought that the gnathos arms are apically separated and fused to the lower edge of the socii, but I believe the apically free arms are a development of the socii and are not connected to the joined gnathos arms. The relationships of these structures are difficult to see on slide-mounted preparations, particularly if they are severely flattened in the standardized method favored by many lepidopterists, but they are more easily interpreted in dissections in fluid. Lambert assigned *harmonia* to a monotypic new genus (his Genus III), a decision which was followed by Diakonoff shortly after Lambert's death. I consider the development of the gnathos and socii in *Lambertiodes* to be separately derived from that of *Sparganopseustis,* a parallel event that does not indicate relationship. *L. harmonia* resembles some species of *Sparganothoides* Lambert & Powell in size, color pattern and lack of appreciable sexual dimorphism.

Sparganopseustis martinana **Powell, NEW SPECIES**

Male.—Length of FW 10.0–11.8 mm (30n). *Head:* Labial palpus moderately elongate, length of II segment ca. 1.6 eye diameter; scaling white interiorly, pale orange-brown exteriorly. Scaling of crown tan flecked with orange-brown. Ocelli present, reduced. *Thorax:* Dorsal scaling tan, mottled with orange-brown; venter white. Legs whitish, prothoracic mottled with brownish. *Forewing:* Ground color rosaceous brown to pale purplish brown uniformly mottled with indistinct transverse strigulae; maculation poorly defined, dull ochreous, and strigulate: two broad, transverse fasciae, one from costa well before middle, angled outward into cell; the second beyond middle separated from 1st by a band of ground color of equal width, extending towards tornus, becoming indistinct or lost in tornal area; a faint blotch in subapical area; fringe yellowish, preceded by a darker line of ground color. Underside brownish showing the upperside pattern more distinctly, to mostly pale ochreous, obscuring pattern. *Hindwing:* Basal half covered by broad, erect, pale androconial scales on a brownish to ochreous-brown ground, distal half becoming pale ochreous except indistinctly brownish at margin. Underside whitish, faintly brownish in anal area. *Abdomen:* Dorsal pits readily evident on II as unscaled depressions but not on descaled pelt. I and II with apparent androconial scales dorsally; remainder of dorsum shining pale brownish; underside and genital scaling whitish. Genitalia as in Figure 1 (drawn from paratype, JAP prep. no. 2885; 4n).

Female.—Length of FW 10.2–12.4 mm (17n). Essentially as described for male except FW color pattern and lacks specialized scaling of HW and abdomen. *Forewing:* Entirely pale rust-brownish, strigulate with slightly darker brownish; fringe as in male, yellowish preceded by a darker line; maculation absent (2n) or distinct: two white or ochreous costal triangulate marks, the first at midcosta, subtended by, sometimes connected to a dot just above cell; second smaller beyond end of cell; sometimes a dot beyond lower corner of cell. *Genitalia:* As in Figure 13 (drawn from paratype, JAP prep. no. 5523; 2n).

In both sexes one individual also has black smudges on dorsal margin basally and before tornus.

Holotype male and allotype female.—Mexico, 10 mi W of El Salto, Durango, 8800 ft, Aug. 1, 2, 1964, at lights (J. A. Chemsak & J. Powell) (UCB). Paratypes (46): 5 ♂, 3 ♀ same data as holotype except VII-23 to VIII-2-64; 21 ♂, 13 ♀ same data except 9000 ft, VII-23 to VIII-11-64 (J. E. H. Martin & W. C McGuffin); 1 ♂ Mex., 8 road mi W El Palmito, Sinaloa, 6400 ft, VIII-8/12-72, at lights (C. D. MacNeill, D. Veirs & Powell), 3 ♂ same data except X-12-75 (Chemsak & Powell) (CNC, UCB, USNM).

There is a population in the Huachuca Mountains, Arizona, that may be conspecific. Adults are morphologically indistinguishable from typical; specimens taken in April are comparable in size to the type series, but August moths are smaller. Most males (6n) resemble the typical but have a paler, more washed-out FW pattern, while others (2n) have the FW unicolorous tan with only a faint indication of the pattern. Females (3n) lack the white costal markings. Two males and one female have some dorsal infuscation, as in the type series (AMNH, CNC, UCB).

Paramorbia Powell and Lambert, NEW GENUS

Type species.—*Oenectra rostellana* Zeller, 1877.

Head: Antennal setulae elongate in male, 2× segment diameter. Labial palpus II segment nearly straight, enlarged at middle, with widely flared scaling; III segment ca. 0.3 as long as II. Scaling of frons erect at base, appressed above, crown with weak to well developed hood. Ocelli absent or present. Periorbital strip bare, with a single row of scales ventrally. *Forewing:* Length of DC ca. 0.58 FW length; width of DC 0.17 its length; Cu_{1b} arises ca. 0.55 along length of DC; stem of M absent; CuP present. No costal fold in male. *Hindwing:* Sc + R and Rs adjacent, a trace of crossvein r persists; Rs and M_1 short-stalked; M_3 and Cu_{1a} separate; CuP represented by a crease. No cubital hair pecten. *Abdomen:* Dorsal pits absent. *Male genitalia* (Fig. 2): Uncus very slender, slightly curved. Gnathos absent. Transtilla finely dentate. Valva with pulvinus weak with sparse setae; sacculus variable, sclerotized but not distinctly defined posteriorly, extending to beyond middle of valva, with one projecting spur on or recessed from margin. Aedeagus short, stout. *Female genitalia* (Fig. 14): Papillae anales oval, moderately well sclerotized. Sterigma a rather simple plate posteriodorsad to ostium, with lateral lobes. Ductus bursae slender, straight, without colliculum; cestum absent, or as weekly sclerotized lateral bands extending to corpus bursae; latter large, signum an elaborate, nearly complete ring, elongated into two broad flanges curved distally into bursa.

Sexual dimorphism.—Slight; males have elongate antennal setulae; females possess more elongate labial palpi, are larger and tend to be darker in color. The wing patterns are similar. Associations are based on a short series taken at Rancho Grande, Ar., Venezuela (males of which compare well with the type of *P. rostellana* from Colombia (BMNH)), and on an undescribed species in Costa Rica.

In addition to *P. rostellana,* the genus includes *P. ithyclina* (Meyrick, 1926), *P. chionophthalma* (Meyr., 1932) and at least two undescribed species, all in Colombia and Bolivia, and one undescribed species in Nicaragua, Costa Rica and Panama.

In an unpublished treatment of Neotropical Sparganothini, Lambert (1950) included the species listed above in a proposed new genus (Genus I), with *Epagoge somatina* Dognin, 1912, as its type species. I believe this concept was based on an undescribed species similar to *P. ithyclina* from Colombia, which had been misidentified as *E. somatina* by Busck. Lambert also considered as congeneric the species here assigned to *Sparganothina,* n. gen., because he erroneously perceived members of that group also to lack the gnathos. Later, in a partially revised manuscript, he had decided that *E. somatina* was not a sparganothine, and although he proposed the name *Paramorbia* for the new genus, he did not designate another type from the remaining species, nor did he discuss diagnostic characters that would distinguish the group. The male of *E. somatina* still is not known with certainty, but its similarity to *Philedone aluminias* (Meyrick, 1912), which is known only from males, suggests that the two, if not a single species, are closely related. There is no doubt that both are Atteriini.

With the removal of *E. somatina* and separation of *Sparganothina,* the restricted *Paramorbia* is a discrete group with no close affinity to other described Sparganothini. Presumably the loss of the gnathos is a parallel reduction in *Amorbia* and *Paramorbia* and is not indicative of relationship. The projecting spur of the sacculus and the uniquely derived form of the signum, as well as the distinctive forewing pattern, serve as synapomorphies distinguishing this genus.

Sparganothina Powell, New Genus

Type species.—*Sparganothis xanthista* Walsingham, 1913.

Head: Antennal setulae in male short, ca. 0.7 segment width; scale band on basal part of segment reduced. Labial palpus II segment moderately enlarged, from before middle to well beyond, scarcely curved, with broad scaling dorsally and ventrally. Scaling of frons appressed, sparse. Ocelli reduced to a trace or lacking in male. Periorbital strip scaled. *Forewing:* Length of DC ca. 0.6 FW length, width of DC 0.20 its length; Cu_{1b} originates at ca. 0.70 along length of cell. Stem of M in DC absent, represented by a crease; CuP absent, represented by a faint crease. No costal fold in male. Transverse band scaling roughened in fresh specimens but no bands of upraised scales. *Hindwing:* $Sc + R_1$ and Rs separate, adjacent basally, with partial crossvein; Rs and M_1 short-stalked; M_3 and Cu_{1a} separate. No cubital hair pecten. *Abdomen:* No dorsal pits. *Male genitalia* (Fig. 3): Uncus moderately strongly curved, slightly enlarged apically. Socii not fused to gnathos, which is a weak transverse ridge dorsad to socii. Transtilla heavily sclerotized, with large lateral and small median spurs. Valva simple with weak pulvinus; sacculus large, heavily sclerotized, enlarged distally, with a projecting spur. Aedeagus slightly curved. Anellus in *S. xanthista* greatly elongated posteriorly, extending beneath aedeagus to its distal end in repose (but not in the other species). *Female genitalia* (Fig. 15): Papillae anales narrow, enlarged distally. Sterigma a shallow bowl subtending a broad, densely spiculate plate (*xanthista*) or with spiculate lateral lobes or unmodified. Ductus bursae without colliculum or cestum. Corpus bursae large; signum developed into a broad, nearly closed ring near proximal end of bursa.

Sexual dimorphism.—Slight; forewing pattern and shape similar; female apparently averages slightly larger.

Sparganothina is characterized by several apparent synapomorphies: the loss or reduction to a trace of the ocelli and of vein CuP of the forewing; the rudimentary, joined gnathos; and the heavily sclerotized sacculus, which is enlarged distally with a free tip or projecting spur. In females, the nearly closed, collar-like signum constricting the corpus bursae is distinctive.

The genus is proposed for *S. xanthista* and *S. amoebaea* (Wlsm., 1913), both of which were described from Guerrero, Mexico, and I have undescribed species similar to both from Sinaloa, Durango, and Vera Cruz, Mexico. In addition, *S. nephela* (Wlsm., 1913) from Panama and *S. decagramma* (Meyr., 1932) from Santa Catharina, Brazil, are provisionally referred to *Sparganothina,* although they differ in several details.

Sparganothina xanthista and *S. amoebaea* were described on the basis of males from Amula, Guerrero. The type specimen of *S. xanthista* lacks its abdomen; however the cotype (USNM), which was dissected by Lambert (RL #433) is superficially indistinguishable, as are three specimens with the same label data as the types, a male and two females (BMNH, USNM). My dissections of males collected recently in Guerrero (JAP 4957, vic. Iguala; JAP 5510, vic.Tixtla) show variation from the cotype, especially in the transtilla and sacculus, but the close phenotypic similarity of the moths and their near geographic and seasonal (Aug.–Sept.) origins are convincing that all represent one species and that the females are correctly associated. Moreover, in series of three undescribed species that resemble both *S. xanthista* and *S. amoebaea,* males and females are phenotypically quite similar. Thus, *S. xanthista* is selected as the type species of *Sparganothina*; the female of *S. amoebaea* is unknown.

As noted above, Lambert (1950) included *S. amoebaea* and *S. xanthista* in his Genus I, along with members of the genus now described as *Paramorbia.* Presumably this was because he thought the two Mexican species lacked the gnathos, as there is otherwise little similarity between the two species complexes. His later pencilled revisions to the manuscript indicated that *S. amoebaea* "should go with *Philedone aluminias* and *Epagoge somatina,*" apparently based on a photograph of the type slide of *amoebaea* (BMNH 3707, JDB), but *S. xanthista* was not included in this imponderable misinterpretation. Hence, Lambert did not recognize the relationships presently conceived for *Paramorbia* and *Sparganothina.*

TRIBE ATTERIINI

Atteridae Busck, 1932.
Atteriini Powell, 1964.
Anacrusiina Diakonoff, 1961.

The genera of Atteriini described here share the following character states. *Head:* Maxillary palpus tiny, not visible on whole specimen. Scaling of frons appressed or roughened above middle, without hood. Chaetosema well developed. *Forewing:* Discal cell short, 0.53–0.60 FW length. R_3 separate from $R_4 + R_5$, R_4 to costa, R_5 to termen; M_3 and Cu_{1a} separate. No upraised scale rows or tufts. *Hindwing:* Ten veins (including CuP), humeral vein absent. No cubital hair pecten or costal penicillus in male. *Abdomen:* No dorsal pits. Female with elaborate, differentiated corethrogyne scaling on venter of VI and VII (unknown in *Sisurcana*). *Male genitalia:* Uncus well developed, strongly sclerotized. Saccus not differentiated. No hami or subscaphium. Socii large, scaled, not produced posteriorly beyond basal attachment, not fused to gnathos. Gnathos arms strongly sclerotized, joined, smooth. Transtilla complete, dentate, not joined to pulvinus. Valva simple, not plicate, lacking "clasper." Aedeagus slightly to strongly bent, pistol-shaped, without external spurs. *Female genitalia:* (excluding *Sisurcana*). Papillae anales broad, comparatively well sclerotized, without differentiated floricomous setae. Ductus bursae slender, well differentiated from corpus bursae, without accessory sac. Corpus bursae large, globose, without accessory pouch; signum a large, hollow keel projecting inward, without capitulum.

Sisurcana Powell, New Genus

Type species.—Sisurcana furcatana Powell, new species.

Head: Antenna thickened basally, short, less than 0.5 FW length; setulae in male 0.8 to 2.0× segment diameter; scaling in two bands per segment, sometimes reduced on basal half. Labial palpus short, stout, upturned against front; II segment enlarged preapically to 1.5× basal diameter, nearly straight, scaling rather appressed; III segment small, ca. 0.13 as long as II, hidden in its scaling. Ocelli absent or reduced to a trace. Periorbital strip scaled. *Forewing:* Broad, length 2.24–2.40× width; width of DC 0.17–0.19 its length; Cu_{1b} position variable, arising 0.53–0.66 along length of cell. Stem of M and chorda present, weak (not visible on unstained wing), M ending at M_2; R_4 and R_5 separate; CuP present. No costal fold in male. *Hindwing:* $Sc + R_1$ and Rs separate, Rs nearly complete with trace of crossvein; Rs and M_1 separate, closely adjacent or connate; M_3 and Cu_1 connate; CuP weak. *Male genitalia* (Fig. 4): Uncus slender, attenuate or shallowly bifid apically, minutely setate ventroapically. Socii sparganothine-like, with long, dense scaling. Gnathos produced into a slender, broad or bifurcate tip. Transtilla twisted, usually without median dentate knob. Valva simple, lacking pulvinus, costal rim weak, sacculus strong, extending to ⅔, ending in a projection from margin. Aedeagus slender to stout, only slightly bent; vesica with cornuti of two forms: non-deciduous (?), thin, spine-like ones attached basally, and deciduous ones, broadened medially, attached laterally.

Female unknown.

The name *Sisurcana furcatana* was coined by Busck in the 1920's and used on specimens and a drawing in the USNM, though evidently not in a manuscript, and by Clarke in the 1940's on specimens in the BMNH. Included were paratypes of *Eulia umbellifera* Meyrick, 1926, and at least one specimen that is conspecific with neither that species nor *S. furcatana. Sisurcana* as presently conceived also includes *S. umbellifera, S. defricata* (Meyrick, 1926), *S. leprana* (Felder & Rogenhofer, 1875), *S. ranunculata* (Meyr., 1912) and at least 10 undescribed species (BMNH, USNM), all from Venezuela, Colombia, Bolivia, and Peru. Unfortunately, material is not available in sufficient series to enable association of the females with any of these; most likely there is marked sexual dimorphism. Until the female is known, the tribal status of *Sisurcana* is problematical.

It is possible that *S. ranunculata,* which has the forewing termen concave below the apex and a distinctive forewing pattern, is the male of *Anacrusis ruptimacula* (Dognin), new combination, or a similar species. The two show differences in sexual dimorphism comparable to those displayed by other *Anacrusis* species. However, there are no unassociated female *Anacrusis* specimens from the South American localities that have yielded most of the *Sisurcana* males, and the numbers of these suggest that females without typical atteriine corethrogyne scaling are the likely associates. For example, females of "*Tortrix*" *recurvana* Zeller have been taken at Rancho Grande, Venezuela, the type locality of *S. furcatana,* although not on the same dates. The cornuti deposited in their corpus bursae match those of *S. furcatana.* However, the chorda and M stem in *recurvana* are appreciably stronger than in *S. furcatana.*

The BMNH has males of undescribed *Siscurcana* and female specimens of at least three species with identical label data, from localities in Colombia and Peru. If these associations represent mates, females are larger than males, possess slightly to markedly emarginate costal margin of the forewing, the extreme of which is seen in *recurvana.* The forewing patterns provide no convincing clues to associate the pairs. These females lack specialized atteriine ovipositional scaling, but the genitalia are *Anacrusis*-like, with the ductus seminalis attached subbasally, followed by a long ductus bursae having weak sclerotization; the signum is a crease with shallow keel (*recurvana*) or a cone with long, acute keel.

Sisurcana furcatana **Powell, New Species**

Male.—Length of FW 9.9–12.4 mm (5n). Labial palpus short, length 1.15 eye diameter; scaling short, little flared, tan infused with variable red-brown exteriorly. Front whitish, crown scaling whitish mixed with red-brown. *Thorax:* Dorsal scaling pale to dark red-brown, reflecting a purplish sheen. Underside pale tan, coxae with variable dark brown, legs variable red-brown. *Forewing:* Subcostal area basally with a costally-directed scale flap (presumably a male secondary character). Costal half rust-brown with variable darker scaling, costal spots and poorly defined, subapical, triangular blotch; dorsal half heavily suffused with dark gray and variable dark brown mottling. Underside dark gray with pale red-brown subcostal area basally, costa narrowly whitish with dark spots of upperside reproduced, termen rust colored. *Hindwing:* Dark brown, becoming blackish in anal area; fringe rust colored distally. Underside, disk gray becoming mottled rust distally, costal and subcostal area rust mottled with white. *Abdomen:* Dark gray reflecting purplish sheen; lateral and genital scaling rust colored. Genitalia as in Figure 4 (drawn from paratype, Rancho Grande, JAP prep. no. 5032; 3n).

Female unknown.

Holotype male.—VENEZUELA, Rancho Grande, Aragua, 1100 m, Jan. 17–20, 1978, blacklight, cloud forest (J. B. Heppner) (USNM). Paratypes: 1 ♂ same data as holotype, 1 ♂ same data except V-16-67 (C. J. Rosales, L. Fernandez S.); 1 ♂ E Cordillera, Colombia, 7200 ft, "10–20"; 1 ♂ Rio Toche Quindiu, Colombia, 2400 m (BMNH, UCB, USNM, VIZA).

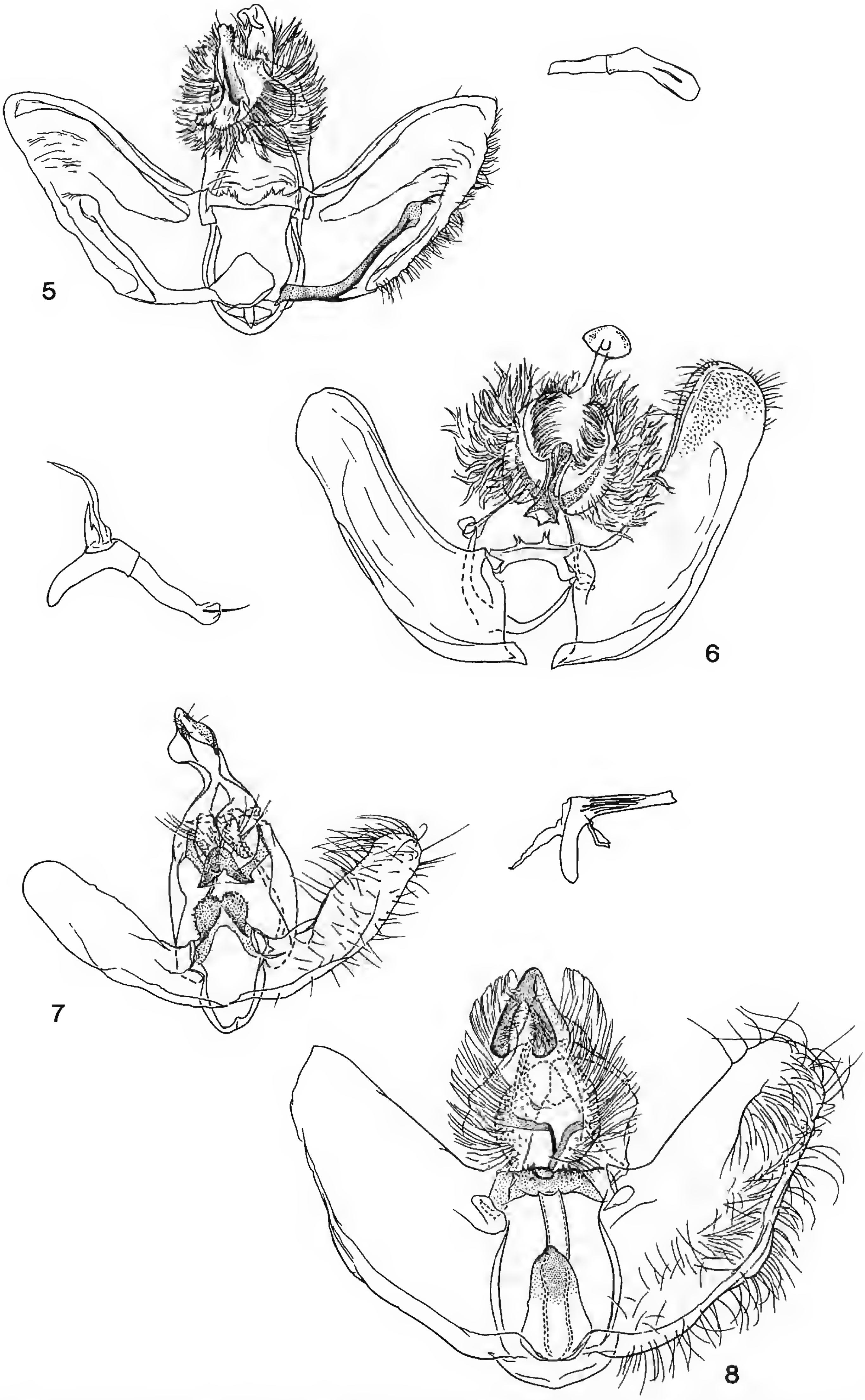
Archipimima **Powell, New Genus**

Type species.—*Tortrix flexicostalis* Dognin, 1908.

Head: Antenna unmodified; setulae elongate in male, 1.67× or greater the segment diameter, on raised ventral ridges; scaling in two well defined bands. Labial palpus elongate, upturned; II segment length 1.3× eye diameter, enlarged beyond middle 2× basal diameter, slightly curved, with broadly flared scaling; III segment small, 0.2 as long as II. Ocelli present. Periorbital strip narrowly bare posteriorly. *Forewing:* Length 2.5× width, costa strongly concave beyond middle; width of DC ca. 0.19 its length; Cu_{1b} arises 0.5 along length of cell. Chorda and stem of M present, weak, in cell, ending at M_2; R_4 and R_5 separate, CuP weakly developed. No costal fold in male. *Hindwing:* Sc + R and Rs separate, base of Rs and crossvein lost; Rs and M_1 closely approximate; M_3 and Cu_{1a} separate; CuP weak. *Male genitalia* (Fig. 5): Uncus slender, with a small apical hood, setate ventrally. Socii large, lobed, with short, stiff scales ventrally, long scaling anterolaterally. Transtilla narrow with dentate protuberances flanking middle. Valva lacking pulvinus; costal rim and sacculus well sclerotized, latter curving posteriorad into valva surface, with an enlarged but not free tip. Vesica with one (or more deciduous?) cornutus. *Female genitalia* (Fig. 16): Sterigma membranous with large, sclerotized lateral lobes. Ductus bursae with an elongate colliculum preceding the ductus seminalis, which originates 0.30–0.55 the length of d.b. from ostium; no antrum nor cestum. Corpus bursae large, globose, without accessory pouch, with a small, unsclerotized projecting pouch just basad to signum.

Sexual dimorphism.—Not as pronounced as in other non-mimetic Atteriini. Males possess moderately elaborate antennal setulae borne on raised ridges and a penicillus on the prothoracic tibia (weak in *flexicostalis*); the VIII abdominal tergum is elongated, hood-like over the genitalia. Females average larger and have slightly broader forewings, with a more deeply emarginate costa; VI, VII ventral scaling modified as in *Anacrusis* Zeller and *Atteria* Walker. The forewing color patterns are similar in the sexes.

The genus is proposed for four South American species, *A. flexicostalis, A. concavata* (Meyrick, 1930), *A. cosmoscelis* (Meyr., 1932), and *A. labyrinthopa* (Meyr., 1932), which superficially resemble some Holarctic *Archips* species in forewing shape and color pattern. The lack of marked sexual dimorphism and the undifferentiated scaling of the socii distinguish *Archipimima* from *Anacrucis* and related genera. Males and females of *A. flexicostalis* and *A. concavata* have been collected together in Peru and appear to be unequivocally associated (BMNH).



Figures 5–8. Male genitalia of Tortricinae, ventral aspect with valvae reflexed; aedeagus removed and shown in lateral aspect (except Fig. 8). 5. *Archipimima flexicostalis* (Dognin). 6. *Tinacrucis aquila* (Busck). 7. *Tina audaculana* (Busck). 8. *Holoptygma lurida* (Meyrick).

The former is selected as the type species because the holotype of *A. concavata* lacks its abdomen.

Tinacrucis Powell, New Genus

Type species.—*Homona aquila* Busck, 1914.

Head: Antennae usually unmodified; setulae in males moderately long, equal to width of flagellar segment (undescribed Venezuelan species), to more typically 1.5 to 2.5× segment width, in dense whorls; scaling in one band per segment. Labial palpus upturned, short, thickly scaled; II segment slightly enlarged distally, to 1.5× basal diameter, curved basally; III small, ca. 0.28 as long as II, nearly hidden in scaling of II. Ocelli apparently absent in most species (present in an undescribed species). Periorbital strip bare posteriorly, scaled anteriorly. *Forewing:* Variable in shape, costa in males weakly to strongly sinuate, emarginate in outer ⅓. Breadth ratio correspondingly variable, length 2.55–2.70× width. Width of DC 0.17–0.20 its length; Cu_{1b} originates at ca. 0.55 along length of cell; CuP present. Stem of M in DC well developed, usually with trace of fork, ending at M_2; accessory cell (chorda) present, weak in male; R_4 and R_5 stalked or separate; CuP present, short. No costal fold in male. *Hindwing:* Sc + Rs separate, Rs weak basally; Rs and M_1 closely approximate or connate; M_3 and Cu_{1a} connate in male, separate in female; CuP present, short or well developed. *Abdomen:* VIII segment enlarged in male, tergum forming a hood over genitalia. *Male genitalia* (Fig. 6): Uncus narrow, slightly enlarged apically to broadly capitate, with ventral setation. Socii triangulate, wrapped around gnathos, scaling differentiated into two types: huge, thick tufts of elongate scales laterally, shorter, stiff hairs posteroventrally. Gnathos tip elongate, spatulate. Transtilla narrow, with a pair of dentate projections near middle. Valva broad, curved posteriorly; no pulvinus; sacculus weakly defined basally, separated by a sclerotized band along inner face of valva, set in from anterior margin. Aedeagus slender, ca. 14–16 elongate cornuti, spine-like, deciduous with lateral attachment. *Female genitalia* (Fig. 17): Papillae anales setiferous nipples moderately raised. Sterigma a shallow bowl with large lateral lobes. Ductus bursae with membranous antrum proximal to a short colliculum, gradually enlarged and lightly sclerotized distally; ductus seminalis connects just distad of colliculum. Signum a scobinate patch, preceded by a small blind pouch (sometimes rudimentary).

Sexual dimorphism.—Extreme, although size not as variable and discrepancy not as great as in *Tina* n. gen.; female FW length 1.20–1.25× that of male. Forewing pattern differs markedly, males with reticulate patterning on yellow, females more or less unicolorous brown or with outwardly oblique bands suggested. Males have the elaborate antennal setulae and enlarged VIII abdominal segment, while females have specialized corethrogyne scaling of the abdominal venter, as in *Atteria* and *Anacrusis*.

The name *Tinacrucis* can be interpreted as of feminine gender. *T. aquila* is selected as the type because reared sibs from single egg masses are available that unequivocally demonstrate the association of the sexes.

Diagnosis.—Species of *Tinacrucis*, while superficially very similar to those of *Tina*, are most closely related to *Anacrusis* and perhaps the group may be treated best as a subgenus when the extent of variation in *Anacrusis* is better understood. The new genus is distinguished by having the sinuate costa similar in both sexes (unmodified in male *Anacrusis*, concave termen in females), by the markedly different forewing pattern between the sexes, elaborate antennal setulae in males and by lacking a well developed sacculus in the male genitalia. The valvae are not strongly curved posteriorly and thus are similar to the form in *Tina.*

The new genus includes the following described species: *T. aquila,* with the female *T. consobrina* (Bsk., 1914) as a subjective synonym, *T. apertana* (Wlsm., 1914), *T. patulana* (Walker, 1863), and *T. sebasta* (Wlsm., 1914). The last, which was described from a male from Guatemala, is virtually indistinguishable morphologically from the darker *T. aquila* in Panama and Costa Rica. *T. apertana* was based on the female, but I have reared F_1 sibs from Nuevo Leon that demonstrate the male is not another of the described species. In addition there are several undescribed species in Mexico, one of which ranges into southern Arizona.

Tinacrucis patulana was described from Oaxaca, Mexico, and the unique female type is lacking its abdomen (BMNH). Walsingham (1914) considered *Tortrix audaculana* Busck, 1907, to be a synonym of *T. patulana,* but on the basis of size, it seems more likely that *patulana* is a *Tinacrucis* rather than *Tina* according to present concepts. The type specimen of *T. patulana* is larger (FW length 18.9 mm) and has more distinct, black, transverse strigulae on the forewing than any specimen of *Tina audaculana* I have seen (FW 12.5–16.0 mm). Material collected in Oaxaca recently by E. C. Welling and K. Wolf includes at least two species of *Tinacrucis* but not in series that permit unequivocal associations of males and females. One female matches the Walker type in FW pattern but is smaller (FW 16.6 mm).

Tina Powell, New Genus

Type species.—Tortrix audaculana Busck, 1907.

Head: Antenna serrate in male, setulae greatly elongated, 3.0–3.3× segment width, in dense segmental whorls from raised ridges; scaling in one band per segment. Labial palpus upturned, short, thickly scaled; II segment only slightly expanded distally, to ca. 1.2× its basal width; slightly curved; III small, ca. 0.20 as long as II, nearly hidden in scaling of II. Ocelli apparently absent, reduced to a trace. Periorbital strip bare posteriorly, scaled anteriorly. *Forewing:* Costa sinuate in both sexes. Length 2.6–2.7× width at costal concavity. Width of DC 0.17–0.19 its length; Cu_{1b} originates at ca. 0.53–0.60 along length of cell. Stem of M present in cell, ending at M_2, trace of fork sometimes present in female; accessory cell (chorda) present, weak in male; $R_4 + R_5$ stalked ¼–⅜ their length in male, very short-stalked in female; CuP present. No costal fold in male. *Hindwing:* Sc and Rs separate, Rs weak basally; Rs and M_1 stalked or closely approximate; M_3 and Cu_{1a} connate; CuP weak. *Abdomen:* segment VIII normal, not enlarged. *Male genitalia* (Fig. 7): Uncus moderately broad basally, simple apically or expanded preapically to form a triangulate or T-shaped hood, or with enlarged lateral lobes projecting ventrally; sparsely setate ventrally. Socii elongate, pendant, broadest at middle, narrowed apically, without differentiated scaling. Gnathos tip broad, rounded. Transtilla heavily sclerotized with a pair of broad, fan-like, dentate lobes projecting posteriorly. Valva narrow, not much turned posteriorly, without armature or pulvinus; sacculus weakly differentiated in basal area, narrow. Aedeagus slender; 8–10 slender, spine-like, deciduous cornuti. *Female genitalia:* Papillae anales, posterior lobes slightly broader, setiferous nipples moderately raised. Sterigma a broad bowl with large lateral lobes, surface scobinate. Ductus bursae with membranous antrum proximal to a rather elongate colliculum, gradually enlarging to corpus bursae; ductus seminalis connects just distal to colliculum. Signum narrow, originating from a weakly sclerotized patch.

Sexual dimorphism.—Extreme: Females of *T. audaculana* from Veracruz average much larger, range in FW length = 1.05–1.60 × that of males, an impression that is enhanced by the relatively broader forewing of the female and the much bulkier abdomen. Females' forewings have a more sinuate costa. Males have a delicate network pattern of purplish brown on yellow, with a costal triangle weakly defined, while forewings of females are brownish, showing a typical Archipini-like pattern of pre- and postmedian, outwardly transverse bands, of whitish. Females lack the elaborate antennal setulae of males, while males have none of the enormous corethrogyne scaling of the abdominal venter.

Tina is a name used by August Busck[1] more than 50 years ago, on specimens of *T. audaculana.* Following Walsingham (1914), Busck considered *audaculana* to be a synonym of *patulana* Walker. Later the name *Tina* was applied to Obraztsov in manuscript to a diverse conglomeration including *Anacrusis ruptimacula* (Dognin) and *Tinacrucis sebasta* (Walsingham) but not other described species now assigned to *Anacrusis* and *Tinacrucis.*

As noted above, the type specimen of *Tinacrucis patulana* is larger than any known *Tina,* and is therefore more likely a species of *Tinacrucis.* Hence, *T. audaculana,* which was described from Orizaba, Mexico, is designated as the type; sufficient collections exist from the area of Orizaba, Cordoba, and Fortin de las Flores (100+ specimens, BMNH, UCB, USNM) to permit circumstantial association of the sexes with confidence. In addition, I have reared F_1 sibs to associate the sexes, of *T. audaculana* in Costa Rica and of two undescribed Costa Rican species.

Diagnosis.—*Tina* is most similar to *Tinacrucis,* differing primarily by the more extreme difference in size of the sexes, by lacking the enlarged VIII abdominal segment of male *Anacrusis* and *Tinacrucis,* and by the male genitalia, which differ markedly; in particular the simple socii without specialized scaling, and the broad, fan-shaped, transtilla distinguish *Tina.* Superficially, both males and females of *Tina* closely resemble those of several species of *Tinacrucis,* adding to the confusion in associating sexes within species.

***Holoptygma* Powell, New Genus**

Type species.—*Ctenopseustis lurida* Meyrick, 1912.

Head: Antenna in male pectinate, each ridge bearing 10–12 long setulae, ca. 2 × segment diameter, on each side; scaling in 2 bands per segment. Labial palpus slender, nearly porrect, with broad scaling dorsally; II segment moderately enlarged dorsally, to 1.66 basal diameter, slightly curved; III ca. 0.45 as long as II. Ocelli minute. Periorbital strip bare posteriorly. *Forewing:* Broad, length ca. 2.1 × width (costal fold reflexed); width of DC 0.20 its length; Cu_{1b} originates 0.70 along length of cell; chorda and stem of M with trace of fork present in cell, ending between M_2 and M_3; R_4 and R_5 separate; CuP present. Male with an elongate (0.8 FW length) costal fold. *Hindwing:* $Sc + R_1$ and Rs adjacent, crossvein and base of Rs lost; Rs and M_1 closely approximate; M_3 and Cu_{1a} connate; CuP represented by a trace. *Abdomen:* VIII tergum moderately enlarged. *Male genitalia* (Fig. 8): Uncus deeply bifurcate apically, with ventral setae. Socii broad, oval, pendant,

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[1] Named after Busck's daughter, according to J. F. G. Clarke (in litt.).

with elongate, dense scaling. Transtilla heavily sclerotized, dentate except at middle. Valva simple, pulvinus weak; sacculus weakly differentiated, narrow. Aedeagus slightly bent, cylindrical; vesica with deciduous cornuti having basal attachment. *Female genitalia:* Papillae anales oval. Sterigma simple, with broad, rounded lateral lobes. Ductus bursae without antrum, colliculum, or cestum. Corpus bursae with a small blind pouch posterad to signum.

Sexual dimorphism.—Pronounced; male with pectinate antennae and a huge costal fold. Female with well developed corethrogyne scaling, differentiated on VI and VII. Male FW strongly mottled with dark pattern, HW dark; FW of female primarily yellow, HW white.

The association of female is circumstantial. Meyrick described *H. lurida* on the basis of males from San Antonio, Colombia, and there are 7 males that appear to be conspecific with the types, from 5 localities in The Cordillera de Carabaya, Peru, collected in 1902–1904 by Ockenden (BMNH). There are 2 females from 2 of these sites which are associated with the males on the basis of similarity in size and facies. The females differ by lacking the costal fold and having the forewing primarily yellow, rather than heavily mottled with rust, with rust-brownish discal, tornal and terminal markings (which are suggested in paler examples among males), and females have a whitish, lightly mottled rather than a dark hindwing. The female characters of *Holoptygma* are summarized from these specimens (BM slide 23452).

TRIBE EULIINI, New Status

Euliae Kuznetzov and Stekol'nikov, 1977 (subtribe).

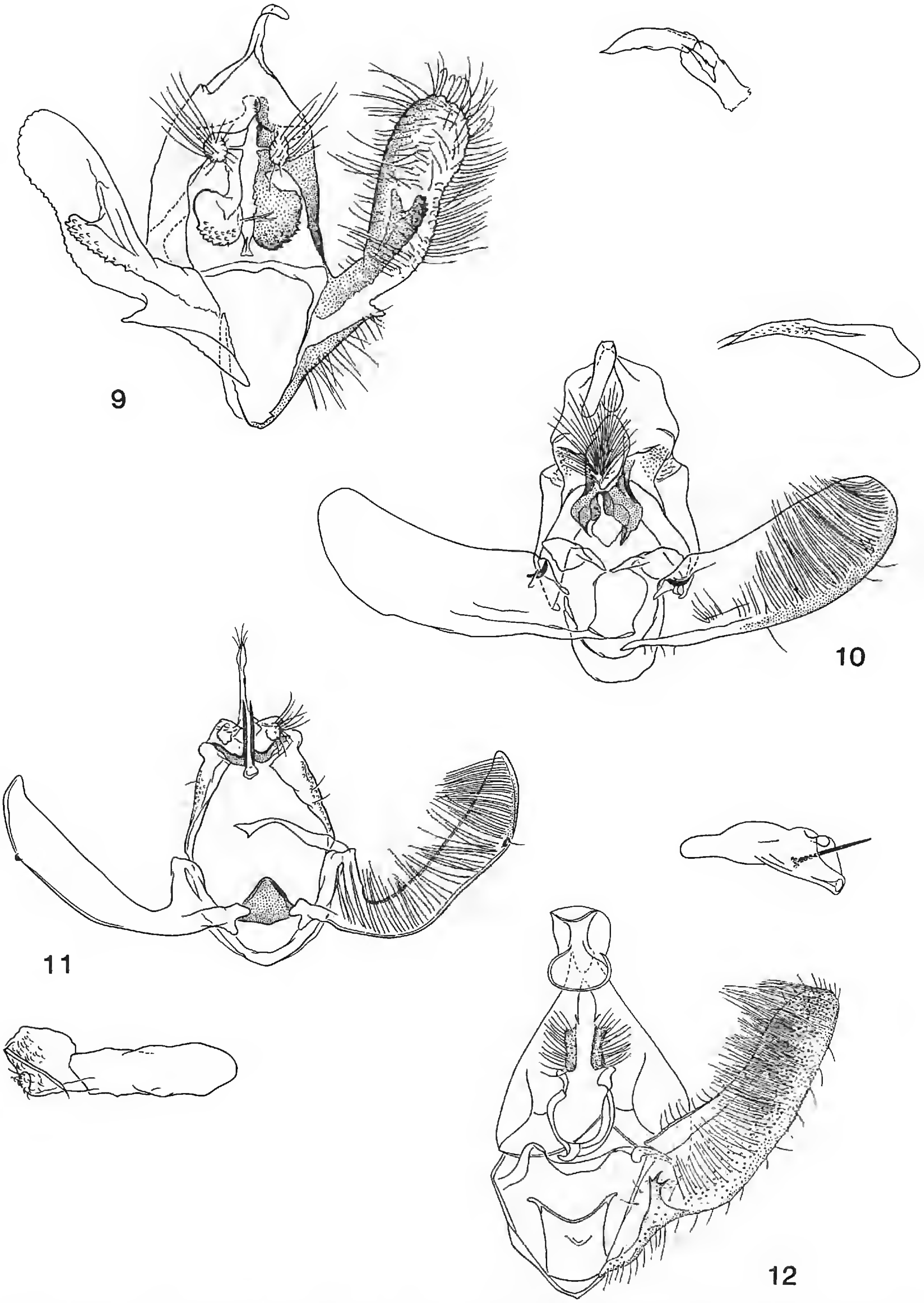
The following characters are shared by all the genera discussed here: *Head:* Antenna unmodified. Chaetosema well developed. *Forewing:* stem of M and chorda in cell absent or reduced to a trace; R_3, R_4 and R_5 separate, R_4 to costa, R_5 to termen. No upraised scale rows or tufts. No costal fold in male. *Hindwing:* Ten veins (including CuP); $Sc + R_1$ and Rs separate, crossvein and base of Rs lost. No cubital hair pecten. No costal penicillus in male. *Abdomen:* Dorsal pits absent. *Male genitalia:* Uncus well developed, without ventral setation. Saccus not differentiated. Neither hami nor subscaphium developed. Gnathos arms joined. Valva simple, narrow, lacking differentiated pulvinus, "clasper" and brachiola. Aedeagus without external spurs; vesica without deciduous cornuti. *Female genitalia:* Papillae anales flat, unmodified, without modified setae. Ductus bursae without antrum, colliculum or cestum. Corpus bursae without accessory pouch.

Sexual dimorphism.—Characteristically slight throughout the tribe, although the forewing pattern differs in some genera. Females usually slightly larger. Males lack secondary features except elongated antennal setulae. Females lack specialized scaling associated with oviposition.

Neoeulia Powell, New Genus

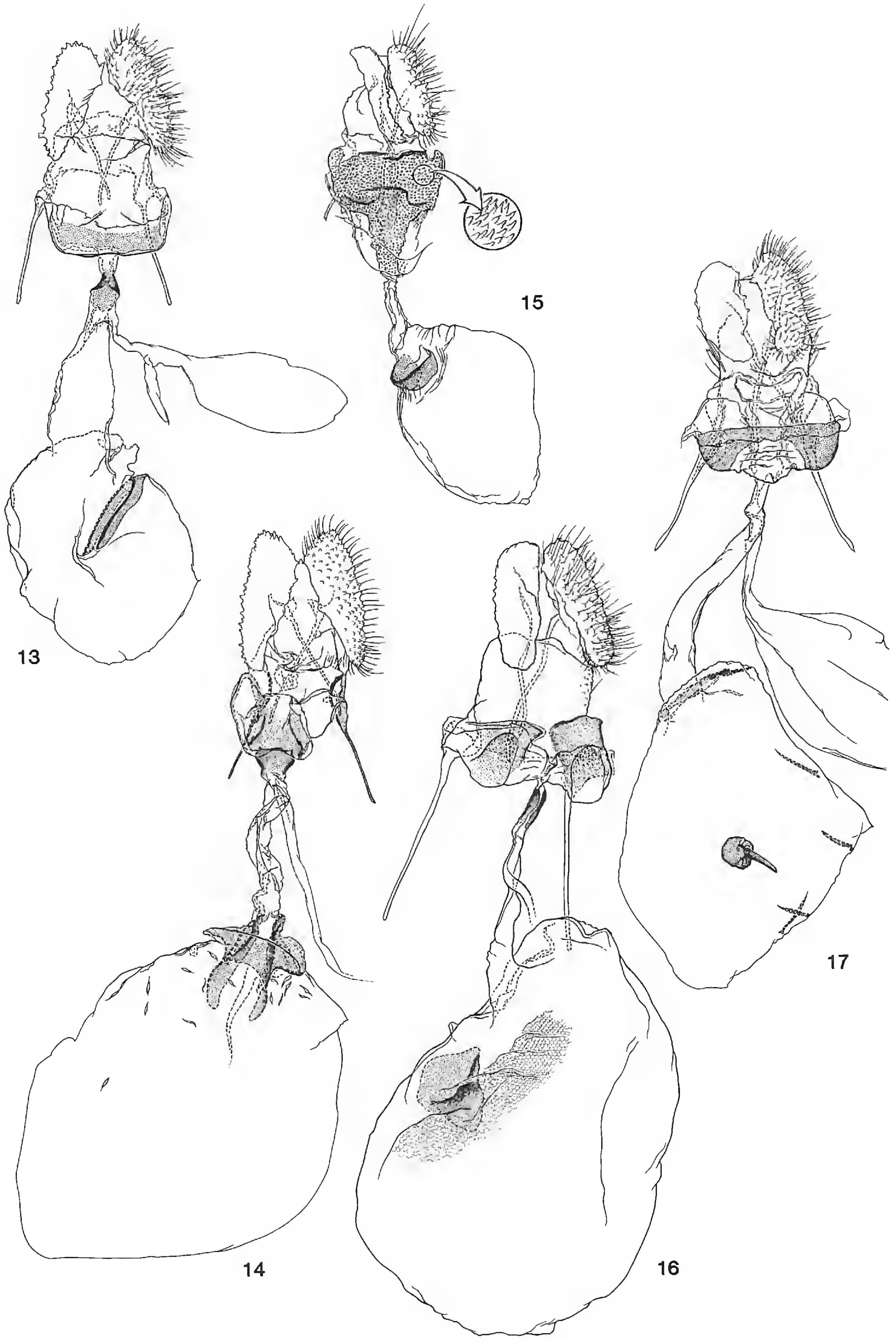
Type species.—*Phalonia dorsistriatana* Walsingham, 1884.

Head: Antennal setulae in male ca. 0.75 as long as segment diameter; scaling in two well developed bands per segment. Labial palpus porrect, II segment moderately enlarged distally, 1.6 × basal diameter, slightly curved, with broadened scaling; III ca. 0.45 as long as II. Maxillary palpus well developed, upturned, scaled, longer than pilifer. Scaling of frons appressed, sparse. Ocelli small. Peri-



Figures 9–12. Male genitalia of Tortricinae, ventral aspect with valvae reflexed; aedeagus removed and shown in lateral aspect. 9. *Neoeulia dorsistriatana* (Walsingham). 10. *Quasieulia mcguffini* Powell. 11. *Anopinella ophiodes* (Walsingham). 12. *Apotomops wellingtonana* (Kearfott).

orbital strip narrowly bare. *Forewing:* Length 2.9–3.0× width; DC ca. 0.55 FW length; width of DC ca. 0.17 its length; Cu_{1b} arises 0.67 along length of cell. Chorda and stem of M represented by a trace in cell; M_3 and Cu_{1a} separate; CuP present.



Figures 13–17. Female genitalia of Tortricinae, ventral aspect. 13. *Sparganopseustis martinana* Powell. 14. *Paramorbia rostellana* (Zeller). 15. *Sparganothina xanthista* (Walsingham). 16. *Archipimima flexicostalis* (Dognin). 17. *Tinacrucis aquila* (Busck).

Hindwing: Ten veins (including CuP); humeral vein absent; Sc + R_1 and Rs separate, base of Rs and crossvein lost; Rs + M stalked; M_3 and Cu_{1A} separate; CuP present. *Male genitalia* (Fig. 9): Uncus slender, unmodified. Socii short, globose, attached basally, with long setae, not fused to gnathos. Gnathos heavily sclerotized, dentate. Transtilla a simple, complete band, not joined to pulvinus. Valva elongate; sacculus differentiated, narrow, costa with heavily sclerotized ornamentation directed posteriorly. Aedeagus short, curved; vesica with sclerotized, curved band. *Female genitalia* (Fig. 18): Sterigma a broad band posterior-dorsad of ostium. Apophyses, VIII–IX+X segmental membrane, and bursa copulatrix short, so the whole genital structure is compact. Ductus bursae very short, almost lost. Corpus bursae simple; signum a broad, U-shaped band from proximal end of bursa.

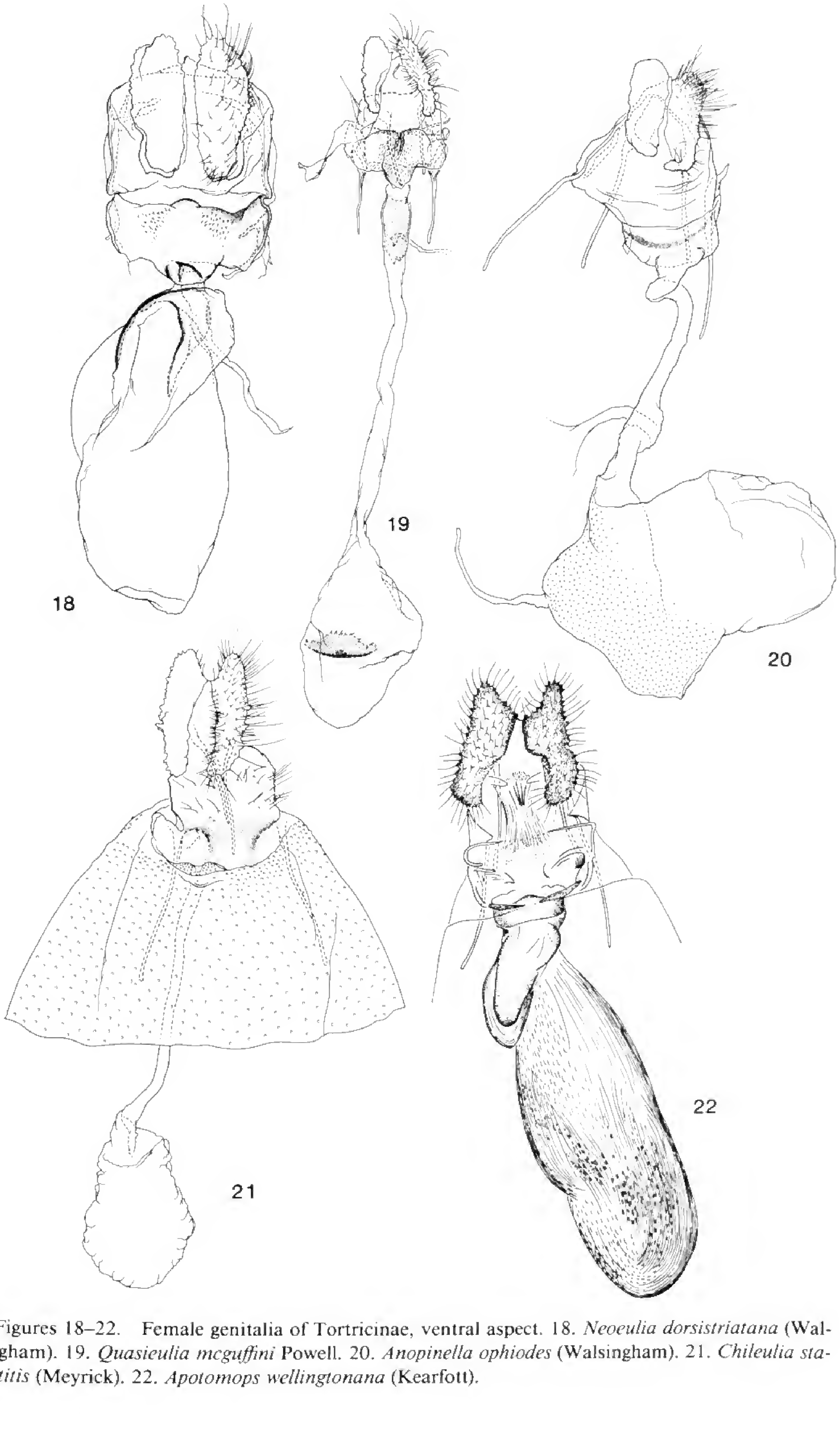
Neoeulia dorsistriatana was described more than a century ago from a male specimen labelled 'Arizona' and none has been collected there since. However, I have a series of females from the vicinity of El Salto, Durango, Mexico, that are phenotypically quite similar to the type. Hence, the association for the female characters in the generic description is provisional, pending discovery of both sexes in one population. The El Salto specimens may represent a closely related species. In addition to *N. dorsistriatana,* I have two or three undescribed species from Veracruz and Puebla, Mexico, in which males and females are phenotypically similar but are not associated in series.

Quasieulia **Powell, New Genus**

Type species.—Quasieulia mcguffini Powell, new species.

Head: Antennal setulae in male rather short, 0.75× segment diameter; scaling in two well developed bands per segment. Labial palpus nearly porrect; II segment only slightly enlarged distally, ca. 1.5× basal diameter, slightly curved, with spreading scaling; III less than 0.25 as long as II. Maxillary palpus rudimentary. Scaling of frons smooth below middle, roughened above. Ocelli absent. Periorbital strip with a single row of elongate scales posteriorly. *Forewing:* Length 2.5× width; length of DC ca. 0.55 FW length; width of DC 0.15 its length; Cu_{1b} arises ca. 0.55 along length of cell; M_3 and Cu_{1a} separate; CuP represented by a trace. Apex acute, subfalcate. *Hindwing:* Humeral vein absent; Sc + R_1 and Rs separate, crossvein and base of Rs lost; Rs and M_1 stalked; M_3 and Cu_1 connate; CuP short. *Male genitalia* (Fig. 10): Uncus heavily sclerotized, strongly curved. Tegumen heavily sclerotized and sculptured nearly completely to mid-venter. Socii slender, attenuate, pendant from basal attachment; setate, unscaled, not fused to gnathos. Gnathos smooth. Transtilla complete, narrowed medially, not joined to pulvinus. Valva with sacculus differentiated basally, narrow, simple. Aedeagus simple, gradually tapered from phallobase; vesica with one cornutus. *Female genitalia* (Fig. 19): Papillae anales narrow, well separated. Sterigma a broad shield dorsad to ostium, split medially, with prominent lobes posteriorly. Ductus bursae elongate, slender, straight, with a complete, weakly sclerotized band, possibly homologous with a colliculum. Corpus bursae simple, small; signum funnel-like, flattened into a keel projecting into bursa.

In addition to the type species, *Quasieulia* includes *Q. hirsutipalpis* (Walsingham, 1914) and *Q. endela* (Wlsm., 1914), both of which are known from single



Figures 18–22. Female genitalia of Tortricinae, ventral aspect. 18. *Neoeulia dorsistriatana* (Walsingham). 19. *Quasieulia mcguffini* Powell. 20. *Anopinella ophiodes* (Walsingham). 21. *Chileulia stalactitis* (Meyrick). 22. *Apotomops wellingtonana* (Kearfott).

male specimens from Guatemala. Superficially these moths resemble *Neoeulia,* but the fundamentally different genitalia features, particularly the modified tegumen and lack of costal ornamentation on the valva in the male and the long, thin ductus bursae in the female of *Quasieulia,* indicate that the two genera are not closely related. The genitalia characteristics suggest that *Quasieulia* may be most closely related to *Apotomops* Powell & Obraztsov, among described genera, although the two are dissimilar phenotypically.

Quasieulia mcguffini **Powell, New Species**

Male.—Length of FW 8.5–9.3 mm (3n). *Head:* Labial palpus moderately elongate, II segment length 1.5 × eye diameter; scaling pale straw yellow with scattered pale brown exteriorly. Scaling of crown pale straw colored. *Thorax:* Dorsal scaling pale straw colored with pale brownish tips; venter whitish, legs dusted with brown. *Forewing:* Pale straw colored with faint brownish clouding, highlighted by two metallic gray-brown lines, one outwardly angled across half the wing from dorsal margin before middle, the other subterminal before fringe; latter followed by dark ochreous subtending the fringe which is whitish except brownish at tornus. Underside pale brown with cream colored patches along outer half of costa, corresponding to pale areas of upperside. *Hindwing:* shining whitish; pale brownish along veins and outer margin. Fringe white. Underside white. *Abdomen:* Pale brownish dorsally; genital scaling and underside whitish. *Genitalia:* As in Figure 10 (drawn from paratype, JAP prep. no. 2621; 2n).

Female.—Length of forewing 9.3–10.4 mm (6n). Essentially as described for male except FW color pattern appreciably more distinct, the pale brown pattern contrasting distinctly with the pale yellow ground, which occupies basal area to the submedian line from before mid-dorsum, curving outward to costa beyond middle; and in the brownish distal half, a pale costal patch and poorly defined patches in middle and above dorsal margin; submedian and subterminal lines apparently not as distinctly metallic as in male. Genitalia as in Figure 19 (drawn from paratype, JAP prep. no. 5361; 3n).

Holotype male and allotype female.—MEXICO, 10 mi W of El Salto, Durango, 8800 ft, July 19 and 23, 1964 (J. Powell) (UCB). Paratypes: 1 ♂ same data as holotype; 1 ♂, 3 ♀ same data except 9000 ft, VI-30 to VII-10-64 (W. C. McGuffin), 2 ♀ same data except VII-18,29-64 (J. E. H. Martin) (CNC, UCB).

Anopinella **Powell, New Genus**

Type species.—*Eulia isodelta* Meyrick, 1912.

Head: Antennal setulae elongate in male, equal to segment width at base, 1.3 × segment width at ⅓. Labial palpus porrect, elongate, slightly broadened by scaling; II segment expanded, 1.6 × width at base, slightly curved; III ca. 0.4 as long as II. Maxillary palpus rudimentary, hidden. Frons smooth-scaled with overhanging crown tuft. Ocelli present, reduced. Periorbital strip partially bare. *Forewing:* Length 2.3–2.4 × width, DC 0.55–0.60 × FW length; width of DC ca. 0.21–0.23 length; Cu_{1b} originates at 0.60 the length of DC; M_3 and Cu_{1a} connate or separate; CuP absent. Chorda defined by a trace not visible basally. *Hindwing:* Sc and Rs closely approximate; Rs and M_1 closely approximate; M_3 and Cu_{1a} connate; CuP represented by a trace. *Male genitalia* (Fig. 11): Uncus slender, strongly curved, slightly enlarged preapically. Socii small, ovate, sparsely setate. Gnathos arms joined by membrane, not or slightly flared distally, spinulose apically. Transtilla complete, thin, non-dentate. Valva with or without a strong spur at lower corner of cucullus. Aedeagus short, moderately stout, cornuti present, one long spine or crease plus tiny spicules all over vesica. *Female genitalia* (Fig. 20): Papillae anales moderately broad, anteriorly narrowed and turned mesad. Sterigma a simple bowl. Ductus bursae narrow, membranous, ductus seminalis connects at ca. 0.75 distally along length of d.b. Corpus bursae rather elongate, distally extended caudad. Signa lacking, bursa with dense lining of spiculae.

Anopinella is a name that August Busck affixed to specimens of an apparently undescribed species from Panama more than 50 years ago, at a time when *Anopina* Obraztsov, 1962, also existed as an unpublished concept, indicated by Busck's labels. Obraztsov (1963) thought *Anopina* originated as an arbitrary combination of letters and treated it as a Latin noun of feminine gender. Therefore, *Anopinella* can be interpreted as feminine.

In addition to the type species, *A. isodelta,* from Colombia, *Anopinella* includes *A. ophiodes* (Walsingham, 1914) described from Panama, and *A. homosacta* (Meyrick 1930), from Argentina. There are at least 3 apparently undescribed, similar species, from Venezuela, Panama, Jamaica (USNM). In addition, there are USNM specimens from Volcan Santa Maria, Guatemala, and Juan Vinas, Costa Rica, that may represent another undescribed species or *A. ophiodes.* All of these are similar in wing pattern and in genitalia form. Nothing is known of the biology of any *Anopinella* species.

Diagnosis.—Both superficially and structurally, the new genus seems most similar to *Anopina* Obraztsov, among described genera. *Anopinella isodelta* differs primarily in lacking the sacculus armature of *Anopina,* in having a stout aedeagus that lacks the expanded phallobase seen in *Anopina,* and in the female by its markedly different arrangment of the ductus bursae, ductus seminalis and corpus bursae positions.

***Chileulia* Powell, NEW GENUS**

Type species.—*Eulia stalactitis* Meyrick, 1931.

Head: Antennal setulae in male short, ca. 0.4 segment width. Labial palpus elongate, porrect, smooth scaled basally, flaring distally on II segment, which is expanded ca. 2× its basal width, slightly curved; III ca. 0.5 as long as II, almost entirely exposed. Maxillary palpus, ocelli present. Periorbital strip scaled. *Forewing:* Length 2.5–2.6× width; DC ca. 0.60× FW length; width of DC ca. 0.20× its length; Cu_{1b} originates at ca. 0.63 along length of DC. CuP short, at margin; M_3 and Cu_{1a} separate. Accessory cell defined by a weak chorda. 1A + 2A rather strongly bowed beyond the basal fork. *Hindwing:* Sc and Rs separate; Rs and M_1, stalked; M_3 and Cu_{1a} separate; CuP present. *Male genitalia* (Clarke, 1958, pl. 69): Uncus short, slender. Socii small, boot-shaped, with long setae. Gnathos strongly sclerotized, tip flared, smooth. Transtilla partially developed, sclerotized as a frail bridge only over middle half. Valva with sclerotized costa; well-developed sacculus, ending in a free, flared tip at distal ⅔ of valva margin. Aedeagus slender, pistol-shaped, no visible cornuti. *Female genitalia* (Fig. 21): Papillae anales nearly parallel-sided, broadest anteriorly. Sterigma a simple bowl. Ductus bursae slender, elongate, frail. Ductus seminalis connects at proximal end of corpus bursae, which is without signum or spiculae.

The name *Chileulia* can be interpreted as a noun of feminine gender. The genus is monobasic, but "*Eulia*" *wilkinsonii* (Butler, 1883), may prove to be congeneric when its structural characters are known. *C. stalactitis* has been reared from a variety of situations associated with fruit crops in Chile: "grape" (1943–1944), "grape(fruits)" (1954), "orange" (1943), "plum" (1954), "apricot leaves" (1955), and "larva in fruit *Prosopis tamarugo*" (Chilean carob) (1956).

Diagnosis.—*Chileulia stalactitis* is most similar, both superficially and structurally, to *Anopina,* among described genera. Although there is considerable variation in phenotype, possibly representing seasonal or local geographical forms, the variation does not appear to be sex linked, as it is in *Anopina triangulana* (Kearfott) in North America. Both a pale form with distinct dark costal triangle, resembling males of *A. triangulana,* and a dark form like females of that species, occur in both sexes of *C. stalactitis.*

Male genitalia of *C. stalactitis* have a well developed uncus, not visible in Clarke's illustration (1958, pl. 69). It curves towards the venter in unflattened preparations. The tegumen in short, giving a stout appearance to the genitalia, similar to that of *Decodes* Obraztsov.

***Apotomops* Powell & Obraztsov, NEW GENUS**

Type species.—*Olethreutes wellingtonana* Kearfott, 1907.

Head: Antennal setulae in male minute, less than 0.1 as long as segment width. Labial palpus upturned, narrow, smooth scaled, II segment moderately expanded distally, to ca. 1.7 times basal width, slightly curved; III ca. 0.45 as long as II. Maxillary palpus longer than pilifer, scaled. Frons smooth scaled. Ocelli reduced in size. Periorbital strip bare. *Forewing:* Length 2.75 to 2.9× width, in female slightly broader than male; length of DC ca. 0.60 FW length; width of DC 0.19 its length; Cu_{1b} originates at 0.55–0.58 along length of cell; M_3 and Cu_{1a} separate; CuP short. Chorda represented by a trace. *Hindwing:* Sc and Rs separate, Rs and M_1 closely approximate or stalked; M_3 and Cu_{1a} short-stalked; CuP present. *Male genitalia* (Fig. 12): Uncus broad, capitate, with ventral expansion at base. Socii linear but not freely pendant, densely setate. Gnathos with broad lateral expansions subtending a thin tip, smooth. Transtilla complete, narrow, non-dentate. Valva parallel-sided, with a weak sacculus to basal ⅓ bearing a 3-pronged projection at posterior corner. Aedeagus short, blunt, with dorsal concavity; vesica with one large spine-like cornutus, attached basally. *Female genitalia* (Fig. 22): Papillae anales with posterior lobe larger, with elongated setae-bearing nipples. Sterigma a shallow, bilobed bowl, preceded by lateral, sclerotized concavities. Ductus bursae with small tapered side pouch, corpus bursae and ductus seminalis joining at antrum. No signa; corpus bursae lined with fine scobination.

Sexual dimorphism.—Forewing slightly narrower in male.

The new genus was recognized by August Busck, who applied the name *Eneria* on specimens many years ago. That designation was continued in manuscript by Obraztsov, but the name is preoccupied by *Eneria* Donisthorpe, 1948 (Hymenoptera). The new genus contains two described species, *P. wellingtonana* in the western U.S. and *P. texasana* (Blanchard & Knudson, 1984) in west Texas and Nuevo Leon. Specimens from the western Cordillera of Mexico appear to differ and may be found to represent a third species. Nothing is known about the biology.

Diagnosis.—*Apotomops* appears to be most closely related to *Bonagota* Razowski among described genera, although there are marked differences in genitalia. The wing venation is similar, with R_1 and R_2 originating widely separated, R_4 and R_5 close together on the forewing. Both genera possess the peculiar accessory pouch to the antrum, have the ductus bursae greatly reduced, and lack signa, so there is close similarity in female genitalia, as compared with other genera of Euliini. The highly modified uncus and tegumen distinguish members of *Apotomops* from all related genera I have seen.

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Announcement

Biosystematics and Beneficial Insects Institute Established at U.S. Department of Agriculture, Beltsville, Maryland

Research and service programs in biosystematics, biological control, and bee biology have recently been realigned and strengthened at the Beltsville (Maryland) Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture. The Insect Identification and Beneficial Insect Introduction Institute (IIBIII), established in 1973, has been expanded to include systematic botany, mycology, and nematology, and bee biology. Dr. Amy Rossman is Research Leader of the new Systematic Botany, Mycology, and Nematology Laboratory, which consists of 16 scientists formerly affiliated with various laboratories of the Plant Protection Institute. Dr. Hachiro Shimanuki is Research Leader of the Beneficial Insects Laboratory, replacing Mr. Jack Coulson, who continues as Director of the ARS Biological Control Documentation Center in this Laboratory. Dr. Douglass R. Miller recently was selected as Research Leader of the Systematic Entomology Laboratory when Dr. Paul M. Marsh returned to full-time research. Dr. Lloyd Knutson, who has served as Director of IIBIII since it was formed, continues as Director of the expanded Biosystematics and Beneficial Insects Institute.

The realignment reflects the continuing emphasis on taxonomic and biosystematics research and services, biological control, and apiculture by the Agricultural Research Service. In the Systematic Botany, Mycology, and Nematology Laboratory, renewed emphasis has been focused on producing the "Plant Pathogenic Fungi of the U.S.," completing the Nomenclature File for the Germplasm Resource Information Network, and continuing the computerization of the U.S. National Fungus Collections, the largest collection of dried fungal specimens in the world. While maintaining the strong program on morphologically based systematic research in the institute, biochemical and molecular biological methodologies also are being applied. The Institute recently obtained state-of-the-art image analysis equipment to improve its research and service program on Africanized bees. Computerization of taxonomic and biological control information, a long-time strength of the Systematic Entomology Laboratory and Beneficial Insects Laboratory, has been improved with enhancement of Wang Virtual Storage-100 hardware and software. The other systematic organization at the Beltsville Agricultural Research Center is the Biosystematic Parasitology Laboratory in the Animal Parasitology Institute (J. R. Lichtenfels, Research Leader) that was established in 1984. These recent realignments place the Beltsville Center in a unique position to continue to address major national and international needs in agriculture and in biotic diversity and germplasm conservation.

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Contents for Volume 62

THE PAN-PACIFIC ENTOMOLOGIST

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