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Bionomics, Evolution, and Zoogeography of Members of the Genus *Dicheirus*

(Coleoptera: Carabidae)

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The genus *Dicheirus* contains 6 species and subspecies: *D. brunneus* (Dejean), *D. dilatatus dilatatus* (Dejean), *D. dilatatus angulatus* Casey, *D. obtusus* LeConte, *D. piceus* (Menetries), *D. strenuus* (Horn) (Noonan, 1968). Evolution of the genus, with examination of other genera of the subtribe Anisodactylina are given by Noonan (1973, 1974). The present paper provides a detailed analysis of the evolutionary and zoogeographic relationships of the members of *Dicheirus* and includes additional bionomic information for some species.

BIONOMICS

The following statements are based on field observations of adults primarily in northern and central California but also in southern California, Oregon, and British Columbia.

Members of *Dicheirus* are adapted to grassy habitats lacking trees or with scattered trees such as in woodlands or along grassy forest edges. On rare occasions *D. dilatatus dilatatus* and *D. piceus* occur in moderately moist and possibly slightly brackish grassy areas near ocean bays.

Species occurring in forest climax areas inhabit natural clearings inside forests, the grassy edges of forests, and in man-made clearings. The clearing of forests to create pastures provides additional habitats for such species, and adults are more numerous in pastures than in many natural clearings. Pastures are probably more favorable habitats than many natural clearings due to: discontinuity and small size of many natural clearings; unfavorable factors (such as flooding in clearings formed by streams) present in many natural clearings; and additional

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shelter in pastures such as dried cow droppings, fallen fence posts and other debris. Dried cow droppings are especially beneficial to adults; pastures with them contain more individuals than similar areas without. The ground beneath dried cow droppings is often moister and cooler than that adjacent to them, and adults aggregate in these moister, cooler microhabitats.

In central and northern California, teneral adults appear from January to March and are active with adults from the previous year until the ground and vegetation dry during late April to June. Except for isolated lowland areas and mountainous areas in which the ground and vegetation dry later in the year or remain moist, adults are uncommon from approximately June to September. In September or October teneral adults appear, soon mature, and are active with previously matured adults.

In central and northern California an early activity period of adults coincides with winter rains, is reduced during the dry summer, and is renewed prior to and probably also during fall rains. Rainfall is the major factor influencing adult activity. During exceptionally dry years adults of *D. strenuus* and *D. dilatatus dilatatus* do not appear in the fall, and adults of *D. piceus* are greatly reduced in number. Additional field studies may reveal that adults of other forms also do not appear or are reduced in numbers in the fall of dry years.

Specimens of *Dicheirus* have not been observed flying. However, all species but *D. strenuus* have full and apparently functional hind wings. The winged species may have diurnal spring dispersal flights. I have noted in the spring while collecting in very small natural clearings that on warm days adults suddenly appear in areas that had been intensively examined (debris and top 3 or 4 inches of soil removed) just previously. Darlington (1943) suggested that flight is advantageous to species of Carabidae which inhabit relatively large areas with sparse unstable populations. Before the forest clearing activities of man, species of *Dicheirus* presumably were restricted to natural clearings in forest climax areas. Such clearings would have been sparsely distributed, and often small and unstable. Full-winged species probably remained so because of the importance of flight as a dispersal mechanism. The lack of flight records for *Dicheirus* may be due to flight being diurnal and restricted to early spring. Most Carabid flight records are based on captures at lights; if *Dicheirus* adults fly only during the day, then they will not aggregate at lights. Furthermore most insect collectors probably do not begin field work until after early spring.

TABLE 1. Plesiomorphic and apomorphic character states used in Fig. 1.

No.	Character	Character State plesiomorphic	 apomorphic
	Thorax		
1	pronotal pubescence	moderate to dense throughout	glabrous to sparse medially
2	proepisternal punctures	absent or very small	large and prominent
	Legs		
3	venter of articles 1 to 4 of ♂ foretarsi	with spongy pubescent vestiture	glabrous in most specimens, partial to complete spongy pubescent vestiture in some specimens
4	mid and hind tibia	without prominent tubercules at base of spines along sides	with prominent tubercules at base of spines along sides
5	♀ hindtibial apical spurs	lanceolate shaped	slightly laterally expanded a) spatulate shaped
	Elytra		
6	pubescence length	short	varied from short to long a) long in all specimens
7	type of pubescence	adpressed	erect
	Male genitalia		
8	median lobe	not twisted	twisted

Most forms of *Dicheirus* occur not only in the same geographic area (Figs. 2–6) but, at least in the adult stage, in the same microhabitat. In California I have taken adults together in the same hole beneath debris on the ground as follows: *D. brunneus*, *D. dilatatus dilatatus*, and *D. piceus* in Trinity County; and *D. strenuus* and *D. piceus* in Kern and Tulare Counties. Additional collecting will probably demonstrate that adults of all sympatric forms occur in the same microhabitats.

EVOLUTION

The principles used in evolutionary reconstructions are slightly modified from those of Hennig (1966) as discussed in detail in Noonan (1973). Figure 1 and Table 1 present the most probable hypothesis of evolution of the species and subspecies. All sister taxa in Figure 1 are linked by synapomorphies. Convergence in a character state has occurred once; all specimens of *D. dilatatus angulatus* and some specimens of *D. brunneus* have long elytral setae. A sequence of evolution other than that postulated in Figure 1 and Table 1 would not be consistent with available data.

CONTEMPORARY ZOOGEOGRAPHY

Species are restricted (Figs. 2–6) to western North America, probably due to limited adaptation to continental climate. Eastern limits are represented by specimens of *D. piceus* from Salt Lake County, Utah. Northern and southern limits are set by *D. piceus* in southern British Columbia and on Guadalupe Island off the western coast of Baja California. Guadalupe Island has a persistent summer fog belt in the summit section (Axelrod, 1967) and a milder, moister climate than the immediately adjacent mainland (Savage, 1967). These climatic factors probably explain survival of *D. piceus* on Guadalupe Island, approximately 220 miles farther south than mainland records of *D. dilatatus angulatus* in northwestern Baja California. *Dicheirus dilatatus dilatatus* and *D. piceus* occur on Santa Catalina and San Clemente Islands with *D. piceus* also present on Guadalupe Island. Distances of these islands from the mainland are (Philbrick, 1967) 20, 49 and 157 miles respectively.

Table 2 lists range extents (the linear distance between the 2 most distant occurrences of each form) of the 6 species and subspecies of *Dicheirus*. Previous workers such as Ball and Freitag (1969), Erwin (1970), Noonan (1973), and Whitehead (1972) used range extents to elucidate refugia, and centers of evolution, and to discuss probable adaptability of wide ranging versus narrow ranging forms. The small number of forms in *Dicheirus* and sympatry of most of them make it impossible to stipulate a present center of evolution other than the area now occupied by these forms.

The relatively large range extents of *D. piceus*, *D. obtusus* and *D. dilatatus* suggest that these 3 species are more tolerant than other forms to environmental extremes. Only *D. piceus* and *D. dilatatus dilatatus* show a possible tolerance to brackish habitats near ocean bays and are

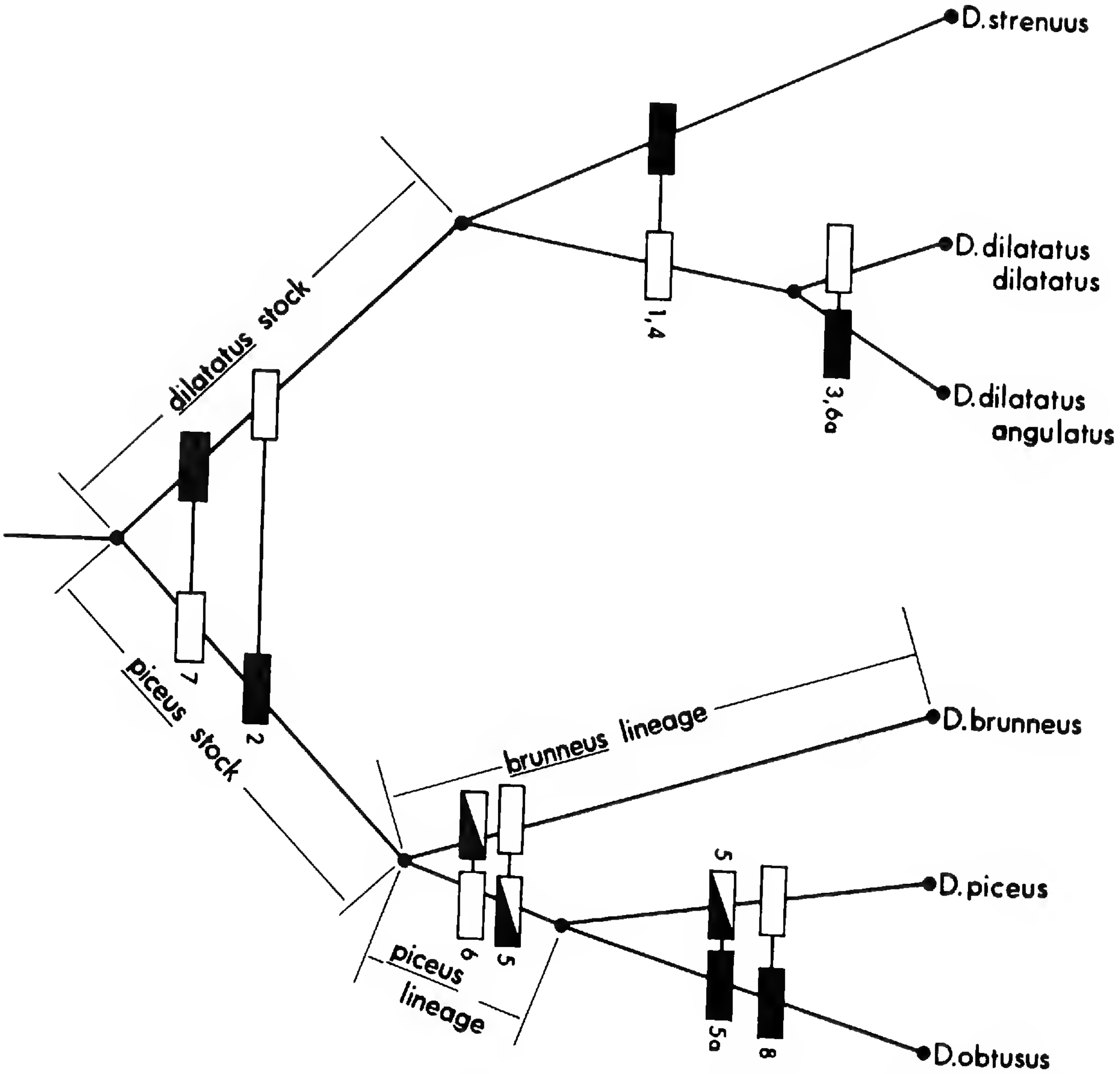


Fig. 1. Postulated evolution of species and subspecies of *Dicheirus* (hollow rectangles denote plesiomorphic character states, half black rectangles denote intermediate apomorphic character states, fully black rectangles denote apomorphic character states).

also the only forms recorded from islands. *Dicheirus piceus* also exists in habitats from which other forms seem excluded.

Dicheirus brunneus has a 450 mile range extent and is apparently adapted only to mesic environmental conditions in northern California and Oregon.

Dicheirus strenuus and *D. dilatatus angulatus* have restricted range extents of 73 and 30 miles respectively. *Dicheirus strenuus* is the only taxon with vestigial hind wings; this condition probably explains in part its restricted range from the Tehachapi and Greenhorn Ranges, Kern and Tulare Counties, California. This species may be adapted to only a narrow range of environmental conditions since it does not follow woodlands or grasslands down into the San Joaquin Valley or high up into the Sierras as do all other forms present in central California.

TABLE 2. Range extents of species of *Dicheirus*.

Species or Subspecies	Maximum Range Extent (in miles)
D. piceus	1700 (Guadalupe Island included) 1200 (mainland only)
D. obtusus	800
D. dilatatus (both subspecies)	750
D. dilatatus dilatatus	650
D. dilatatus angulatus	30
D. brunneus	450
D. strenuus	73

Possibly, *D. strenuus* evolved in its present restricted range. Alternatively, it may formerly have been more widespread, and its low dispersal ability may have resulted in its elimination from much of its range during Pliocene and Pleistocene climatic changes.

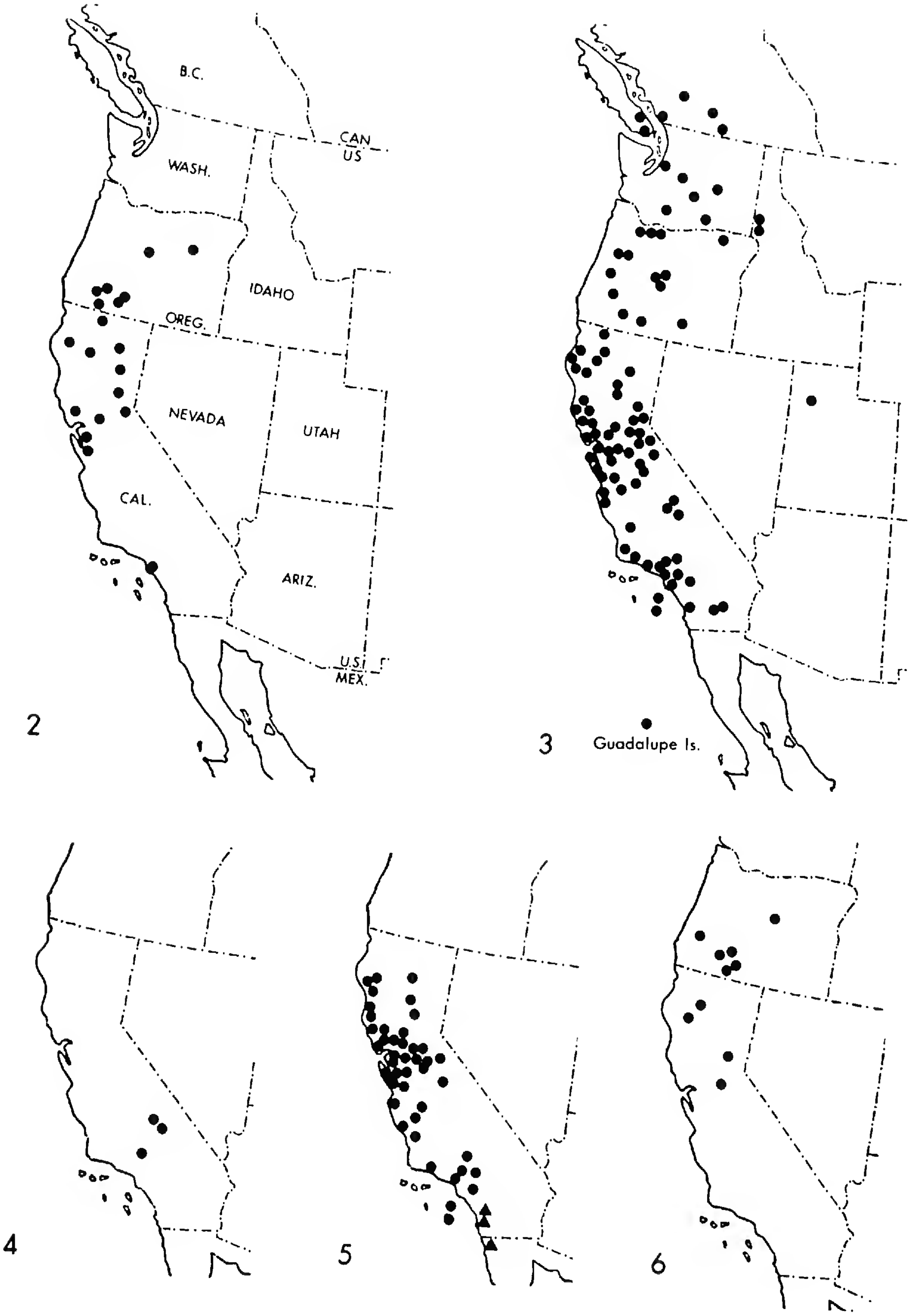
Dicheirus dilatatus angulatus is known only from coastal areas in San Diego County, California and northern Baja California. The factors responsible for such a restricted range are unknown. Possibly *D. d. angulatus* occurs further south in Baja California, but has not been collected.

HISTORICAL ZOOGEOGRAPHY

Taxa of *Dicheirus* demonstrate considerable sympatry (Figs. 2–6), and adults of several species share microhabitats in central and northern California. This sympatry and ecological similarity suggest that extant species have existed long enough to acquire isolating mechanisms enabling them to share the same geographical ranges and, at least as adults, the same microhabitats. The general lack of orderly patterns of vicariance suggest that species may have evolved elsewhere than their present ranges.

Species of *Dicheirus* are now concentrated from approximately southern California to Oregon, but initial evolution within the genus probably occurred in Alaska and northern Canada (Noonan, 1973). According to these ideas, the ancestor of *Dicheirus* crossed from Eurasia into North America via the Bering Land Bridge during the early Tertiary, probably during Eocene when the Bering Land Bridge was present (Hopkins, 1967), and the climate there was temperate (Dorf, 1960).

Eocene tropical and subtropical climates in the United States (Dorf, 1960) may have prevented initial dispersal southward. However, as



Figs. 2–6. Distribution of: (2) *D. obtusus;* (3) *D. piceus;* (4) *D. strenuus;* (5) *D. dilatatus dilatatus* (circles) and *D. dilatatus angulatus* (triangles); (6) *D. brunneus.*

climates cooled during Oligocene, Miocene and especially Pliocene, there were probably dispersals south into the area now occupied by species of *Dicheirus*. As climates continued to cool, *Dicheirus* became extinct in northern Canada and Alaska. The present irregular and mostly sympatric distribution of species is thus probably due to relatively old species being forced south from their center of evolution.

Eastward dispersal of *Dicheirus* was probably prevented by intolerance of continental climates and to a lesser extent by the Brooks Range and Rocky Mountains. The restrictive climatic factor may have been the past and present seasonal distribution of precipitation. Along the Pacific Coast precipitation is concentrated in winter, and severe drought regularly coincides with summer heat; inland there is a strong summer maximum of precipitation (Wells, 1970). This difference in climatic rhythm may also be the reason why many carabid species of interior grasslands (such as those of the subgenus *Glanodes*, genus *Harpalus*, see Ball, 1972) have not extended their ranges to the Pacific Coast.

The sympatric *dilatatus* and *piceus* stocks probably evolved during Eocene to Miocene north of the present range of *Dicheirus*. *Dicheirus strenuus* and *D. dilatatus* may be vicariant in that *D. dilatatus* is not recorded from the range of *D. strenuus*. However, *D. dilatatus* surrounds the range of *D. strenuus* on the north, south and west. I know of no past or present barriers between the known species ranges; additional collecting will probably establish sympatry.

Dicheirus dilatatus dilatatus and *D. dilatatus angulatus* are separated by a gap of approximately 100 miles in southern California (Fig. 5). Evolution of these subspecies is probably due to the coast corridor effect described by Peabody and Savage (1958) for amphibians and reptiles. During Pliocene and early Pleistocene (Fig. 7) the San Joaquin Valley consisted of a flooded embayment opening to the ocean by a wide strait in northern Baja California. Populations of *D. dilatatus* were probably isolated east of the embayment and evolved into *D. dilatatus angulatus* which has several apomorphies suggesting selection was acting on a small gene pool. Populations west of the San Joaquin embayment probably exchanged genes northward via the coast corridor with other populations and were thus part of a relatively large gene pool. These populations retained plesiomorphic features; their descendants constitute the nominate subspecies with relatively plesiomorphic features. This postulate, that the subspecies with apomorphic features was derived from a smaller gene pool than the sub-

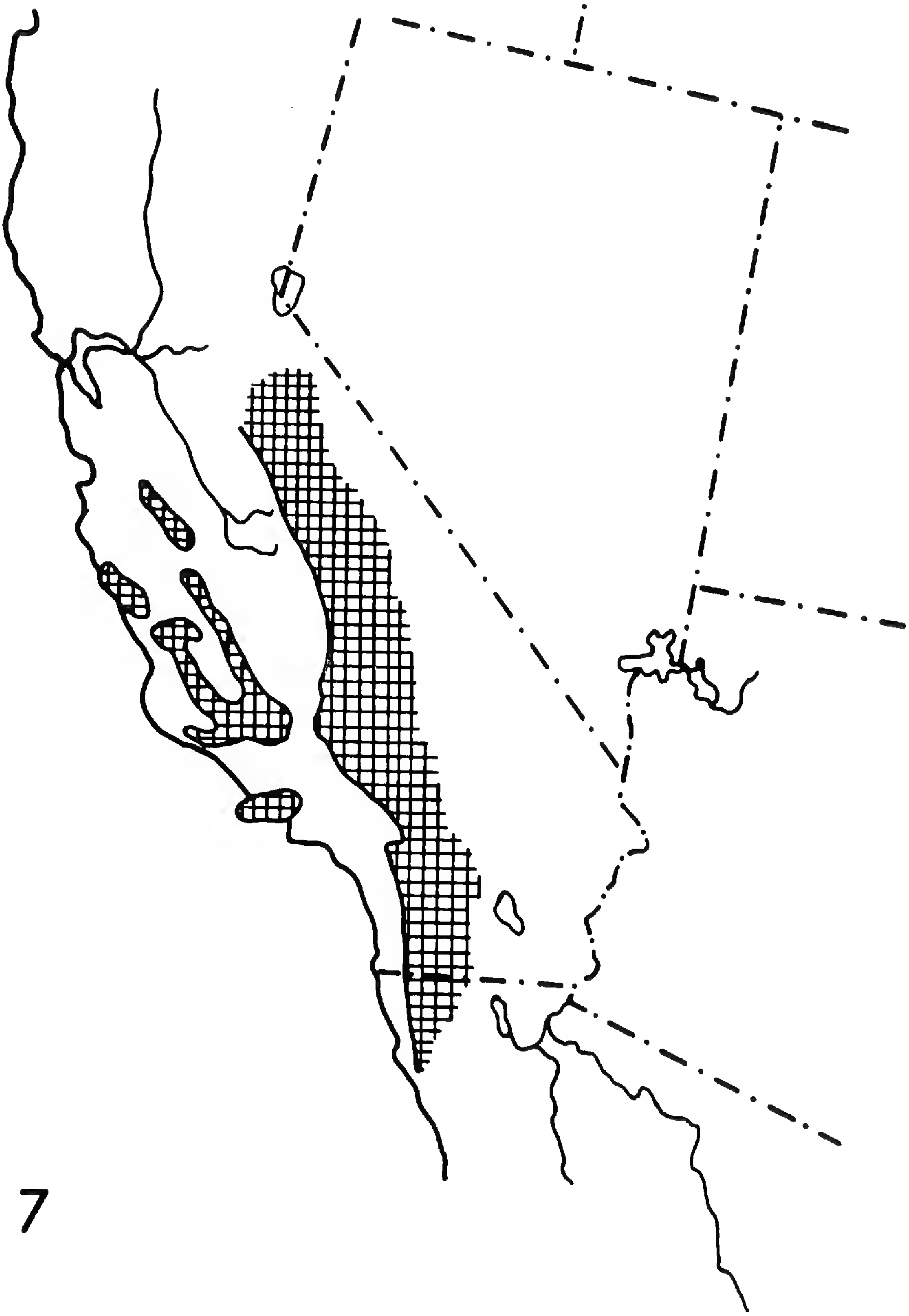


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Fig. 7. Pliocene and early Pleistocene paleogeography of California, showing archipelagic nature of Coast Range region, and presence of strait connecting Pacific with San Joaquin embayment. Cross hatching indicates flooded areas. (Adapted from Peabody and Savage, 1958.)

species with plesiomorphic ones, agrees well with Brundin's (1972) description of speciation by cleavage.

As the San Joaquin embayment dried, the climate of eastern southern California probably became drier and warmer; populations of *D. dilatatus angulatus* probably migrated westward toward cooler, moister coastal regions. The Xerothermic Period which lasted from 8,000 to 3,000 years ago constituted a time of warm climate (Axelrod, 1967) which placed particular stress on organisms along the Pacific Coast where precipitation is concentrated in the winter and severe drought regularly coincides with summer heat (Wells, 1970). Any populations of *D. dilatatus angulatus* which remained in eastern southern California after drying of the San Joaquin embayment probably were eliminated by stresses of the Xerothermic. The presence of *D. dilatatus dilatatus* on San Clemente and Santa Catalina Islands and the absence there of *D. dilatatus angulatus* supports the above hypothesis of evolution and dispersal. If *D. dilatatus angulatus* had been present along the coast during the Pliocene and early Pleistocene, it probably would have migrated to these 2 islands as did the nominate subspecies.

Species in Carabid genera other than *Dicheirus* may also have cleaved into subspecies or sister species due to the coast corridor effect. *Calathus ruficollis* Dejean has a distribution similar to that of the genus *Dicheirus* and is found in habitats similar to those of *Dicheirus* (Ball and Nègre, 1972). The coast corridor effect probably explains the differentiation of *C. ruficollis ignicollis* Casey from the nominate subspecies.

If the 2 subspecies of *D. dilatatus* evolved as a result of the San Joaquin embayment, then they have had approximately 2 million years since its disappearance in which to become parapatric. All apomorphic character states of *D. dilatatus angulatus* but long elytral setae vary toward the plesiomorphic state found in the nominate subspecies, and some individuals have the plesiomorphic state for one or more characters. This variation suggests that the 2 subspecies were parapatric in the past and had limited gene exchange. Such parapatry probably took place during cooler, moister (Axelrod, 1967) Pleistocene glacial periods.

My impression of the area now separating the 2 forms (Fig. 7) is that it does not have favorable habitats for *Dicheirus*; *D. piceus*, the most widespread species in the genus, is absent from this area but is found both to the south and north. Mainland records of *D. dilatatus dilatatus* north of the Tehachapi Mountains are mostly based on moderate to extensive series of specimens; records south of these mountains are mostly based on only a few specimens per locality. This apparent reduction in abundance south of the Tehachapi Mountains suggests that this subspecies is not well adapted to conditions in southern California. Finally *D. dilatatus angulatus* survives only in a small refugium along the coast from San Diego County, California to northern Baja California. Increasing warmth and aridity after Pleistocene glacial periods (Axelrod, 1967) probably eliminated all *Dicheirus* from the present gap between the subspecies of *D. dilatatus*.

Rates of differentiation in *D. dilatatus* can be estimated from geological dating of the San Joaquin embayment which existed from approximately 8 to 2 million years ago (dates personal communication from R. Fox). Thus, the subspecies are a maximum of 7 million years old and took 6 million or less years in which to evolve.

Whitehead (1972) calculated the period of time required for speciation in *Schizogenius* and *Brachius* by estimating the age of each group and then counting the number of bifurcations in the reconstructed phylogenies. Such calculations are prone to error both from mistakes in the estimated ages of groups and from errors in the reconstructed phylogenies which most often are simplifications of complex processes which occurred in nature (Noonan, 1973). When fossils are not available, the most reliable estimates of time required for speciation or subspeciation are those based on geologic dating of barriers which isolate or once isolated vicariant sister forms.

Whitehead calculated the average time required for speciation in North American *Schizogenius* and *Brachinus* carabids to be approximately 3 million years. Geological dating of the San Joaquin embayment is not exact; the period of isolation of populations of *D. dilatatus* may have been less than 6 million years, but certainly not less than 3 million.

The *brunneus* and *piceus* lineages are sympatric as are the species *D. brunneus*, *D. piceus* and *D. obtusus*; little can be concluded other than that these taxa probably evolved during the Eocene to Pliocene north of the present range of *Dicheirus*.

Present Utah populations of *D. piceus* are separated from the main species range by nearly 300 miles of Great Basin Desert. Precipitation in lower elevations of this desert is less than 4 inches per year while January/July temperatures average 44.5°/86°F at Las Vegas, Nevada, 32.5°/71°F at Reno, Nevada, and 30°/77°F at Salt Lake City, Utah (Morrison, 1965). This dry and moderately warm climate probably bars dispersal between the main range and the Utah populations, presumably localized in mountains east of Salt Lake City. However, Miocene and Pliocene climates of the Great Basin were subhumid with 25 to 30 inches per year of estimated precipitation, and the present desert climate did not begin until early Pleistocene (Morrison, 1965). Pleistocene glacial periods resulted in temperatures 8° to 15° F cooler than now, more rainfall, and shifts of life zones hundreds of miles north and south and thousands of feet up and down mountains. Before Pleistocene development of desert climate and during Pleistocene cool, moist periods, populations of *D. piceus* probably invaded the Great Basin Deserts and reached Utah. The desert climate of the present and of the interglacial periods probably eliminated *Dicheirus* from Great Basin lowlands and isolated populations of *D. piceus* in mountains presently moister and cooler than lowlands.

An alternative explanation for the presence of isolated populations of *D. piceus* in Utah is as follows. Before the development of desert climate and/or during Pleistocene glacial periods, populations of *D. piceus* (and possibly other species of the genus) may have dispersed around the northern periphery of the Great Basin Desert and then south into Utah via foothills of the Rockies. However, such dispersal would require greater tolerance to continental climate than now shown by species of *Dicheirus* and probably would have resulted in isolated populations of *D. piceus* in Montana, Wyoming, and Colorado. Collecting has not demonstrated the existence of such populations; dispersal directly across the Great Basin Desert seems more probable than dispersal along the northern periphery and Rockies.

The effects of Quaternary glacial periods on western North America are not as well elucidated as for the East. However, various workers (Crandell, 1965; Martin and Mehringer, 1965; Morrison, 1965; Wahrhaftig and Birman, 1965) agree that temperatures were cooler, precipitation greater, and that biotic zones shifted downward. Such climatic changes may have resulted in migrations south into Baja California. Continental climates probably prevented migrations southeast into mainland Mexico. If migrations had reached mainland Mexico, relict populations of *Dicheirus* would probably occur in the highlands as do other members of the subtribe Anisodactylina (Noonan, 1973).

The presence of *D. dilatatus dilatatus* and *D. piceus* on Santa Catalina and San Clemente Islands and of *D. piceus* on Guadalupe Island may be due to dispersal across present water gaps by wind or by rafting. Dispersal to the first 2 islands could not have been earlier than their formation during or after the mid-Pliocene (Valentine and Lipps, 1967). Ocean barriers between the mainland and these 2 islands were absent (Clements, 1955, as reported by Valentine and Lipps, 1967) or at least much narrower during late Pliocene and early Pleistocene (Valentine and Lipps, 1967). Colonization probably took place then. Migration onto other Channel Islands may also have occurred at that time. The lack of records of *Dicheirus* from other California Channel Islands may be due to lack of collecting or to chance extinction.

Guadalupe Island possibly was never connected to the mainland (Garth, 1967), and *D. piceus* probably colonized it by long distance dispersal over water. However, geological data regarding mainland connections of Guadalupe are somewhat inconclusive, and colonization via a land bridge remains a possibility.

The above discussion illustrates that species of *Dicheirus* are mostly sympatric and probably evolved north of their present ranges. It also demonstrates the difficulty of elucidating place or time of origin of forms which do not exhibit vicariance or have a fossil record.

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RECENT LITERATURE

The Ciid Beetles of California (Coleoptera : Ciidae). John F. Lawrence. Bulletin of the California Insect Survey. Volume 17, 41 pp., 7 figs., 15 maps. $2.25.

This summary of the biology, systematics and geographic distribution of the California representatives of an abundant but little-noticed family of fungus-inhabiting beetles could well be used as a model for similar faunal surveys. The systematics section is prefaced by concise but informative discussions of bionomics, host and habitat preference, seasonal occurrence, and patterns of geographic distribution, and supplemented by tables summarizing information that would have required many pages if presented as raw data. The taxonomic treatment includes introductory explanations of important characters, as well as brief differentiations from similar beetles which occur in bracket fungi and might be confused with Ciidae. The excellent keys to genera and species utilize features which mostly show clear, qualitative differences. Difficult characters are quantified, especially in keys to species. Maps showing characteristic types of distributions are provided for about one half the species. All maps have insets depicting the entire North American distribution, a very helpful addition which requires no additional space. The 37 figures include line drawings of most of the important taxonomic characters, and excellent half tone illustrations of 14 of the 27 species known or suspected to occur within the political boundaries of California.

A comprehensive summary of this nature might well alert ecologists to the opportunities these beetles offer for studies of competition, habitat preference and partitioning or species diversity and niche breadth.—*Editor.*

Ephemerella (*Cincticostella*): A Revision of the Nymphal Stages

(Ephemeroptera: Ephemerellidae)

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The following treatment includes a characterization of the subgenus *Cincticostella,* a description, or diagnosis, of the nymphal stages, a key to the nymphs, and the known distributional limits of each species. *Ephemerella* (*Cincticostella*) *orientalis* Tshernova, 1952, whose nymph is unknown is included with complete synonymy and known distribution.

Grateful appreciation is expressed to Professors Kazimitzu Kato and Valentina Zaydman, California State University, Los Angeles, for translating parts of the papers by Imanishi (1940) and Tshernova (1972), respectively.

SUBGENUS CINCTICOSTELLA ALLEN

nigra-group Imanishi 1938: 33.
Cincticostella Allen 1971: 513; Tshernova 1972: 614 (= *Asiatella*).
Asiatella Tshernova 1972: 611.

Imanishi (1938) placed *E. nigra* Uéno, 1928, in the *nigra*-group of the genus *Ephemerella* and Allen (1971) erected the subgenus *Cincticostella* for *E. nigra* and five other species. He transferred *E. levanidovae* Tshernova, 1952, and described *E. castanea*, *E. delicata*, *E. imanishii*, and *E. insolta.* Tshernova (1972) described the genus *Asiatella* to include *E. nigra*, *E. femorata* Tshernova, 1972, *E. orientalis*, *E. levanidovae*, and *E. tshernovae* Bajkova, 1962, to this taxon. In the same paper, as a footnote, she synonymized *Asiatella* with *Cincticostella* and placed *E. imanishii* as a junior synonym of *E. tshernovae.*

Cincticostella is confined to southeast and eastern Asia. *Ephemerella boja* n. sp., *E. gosei* n. sp., and *E. insolta* are known from Thailand; *E. castanea* from Korea; *E. delicata* from Japan and Manchuria; *E. femorata* from Vietnam; *E. levanidovae* and *E. orientalis* from Russia; *E. nigra* from Japan; and *E. tshernovae* from Japan, Korea, and Russia. The number of described species in the subgenus is ten.

The species of *Cincticostella* are all known from the nymphal stage except *E. orientalis* which was described from male and female sub-

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imagoes. *Ephemerella nigra* is the only species known from the nymph and the male imago.

Nymphal Stage.—Body flattened ventrally, convex dorsally. Head round to quadrangular; genae often truncate; maxillae without apical canines, with apical tuft of setae; maxillary palpi well developed, vestigial, or absent. Fore femora with band of transverse spines near middle; denticles on tarsal claws variable in number. Anterolateral corners of prothorax produced anteriorly; mesothorax expanded laterally in anterior portion. Abdominal terga with paired dorsal submedian tubercles; abdominal segments 7–9 with or without well developed posterolateral projections; abdominal terga 3–7 with lamellate, imbricated gills. Caudal filaments shorter than body.

On the basis of nymphal characters two groups of related species are recognized. *Ephemerella insolta*, *E. boja*, and *E. femorata* form the *insolta*-group. These species are characterized by possessing suboccipital head tubercles, and the second and third pairs of femora are enlarged with serrated margins and/or protuberances. The *nigra*-group includes *E. nigra*, *E. castanea*, *E. delicata*, *E. gosei*, *E. levanidovae*, and *E. tshernovae*. These species are without head tubercles and the second and third pairs of femora are narrow, not enlarged, and the margins are entire. *Ephemerella orientalis* cannot be placed to species-group until the nymphal stage is discovered.

The characters most useful for distinguishing the species of *Cincticostella* nymphs are as follows: (1) the number and degree of development of the paired dorsal abdominal tubercles; (2) the degree of expansion, the presence or absence of marginal serrations, and the presence or absence of spines and tubercles on the anterior surfaces of the middle and hind femora; (3) the degree of development of the posterolateral projections on abdominal segments 7–9; (4) the shape of the genae; (5) the color patterns on the head and body; and (6) the relative lengths of the body and caudal filaments.

The following key will serve to distinguish the known nymphs of the species of *Cincticostella.* Illustrations are not included but reference is made to previously published figures which are enclosed in parentheses in the couplets. That is, (Allen 1971: fig. 11) in couplet 1 makes reference to "New Asian *Ephemerella* with notes (Ephemeroptera: Ephemerellidae). Canad. Ent. 103: 512–528."

KEY TO THE NYMPHS OF EPHEMERELLA (CINCTICOSTELLA)

1. Middle and hind femora expanded and margins serrate; head with suboccipital tubercles (Gose 1969: fig. 23; Tshernova 1972: fig. 5) .... *insolta*-group, 2

—Middle and hind femora narrow, and margins entire (Allen 1971: fig.

9); head without suboccipital tubercles (Allen 1971: fig. 13) .... *nigra*-group, 4

2 (1). Abdominal terga with paired submedian tubercles on segments 1–10 (Allen 1971: fig. 18); fore femora with median band of tubercles (Allen 1971: fig. 12); head, body and legs with numerous pale spots (Allen 1971: fig. 14) .... *insolta*

—Abdominal terga with paired submedian tubercles on segments 2–10 (Gose 1969: fig. 23) or 4–9 (Tshernova 1972: fig. 5); fore femora without a median band of tubercles; head, body and legs without pale spots 3

3 (2). Head quadrangular; abdominal terga with paired submedian tubercles on segments 2–10 (Gose 1969: fig. 23); known distributional limits Thailand .... *boja*

—Head round; abdominal terga with paired submedian tubercles on segments 4–9 (Tshernova 1972: fig. 5); known distributional limits Vietnam .... *femorata*

4 (1). Head with three pale maculae on frons (Gose 1969: fig. 43); maxillae without palpi (Gose 1969: fig. 44); known distributional limits Thailand .... *gosei*

—Head without pale maculae on frons; maxillae with palpi; known distributional limits Manchuria, Korea, Japan, and Russia 5

5 (4). Head with truncate genae (Tshernova 1952: fig. 78); middle and hind femora with an anterior longitudinal ridge .... *levanidovae*

—Head with round genae (Allen 1971: fig. 13); middle and hind femora without a longitudinal ridge 6

6 (5). Abdominal terga with paired submedian tubercles on segments 2–9 (Allen 1971: figs. 16–17); caudal filaments more than 70% as long as body (Imanishi 1940: fig. 18) 7

—Abdominal terga with paired submedian tubercles on segments 5–9; caudal filaments less than 50% as long as body (Imanishi 1940: fig. 17) .... *tshernovae*

7 (6). Abdominal terga with dark sublateral stripes along line of submedian tubercles (Imanishi 1940: fig. 18); body short, less than 7 mm in length .... *delicata*

—Abdominal terga unicolorous, often with a pale median stripe, without sublateral dark stripes; body moderately long, more than 9 mm in length 8

8 (7). Abdominal tubercles on segments 2–4 distinct and sharp (Allen 1971: fig. 17); body reddish-brown; known distributional limits Korea .... *castanea*

—Abdominal tubercles on segments 2–4 barely discernible (Allen 1971: fig. 16); body dark brown to black, often with pale median longitudinal stripe; known distributional limits Japan .... *nigra*

Ephemerella (Cincticostella) boja, new species

Ephemerella TEA Gose 1969: 132.

This species was described and figured, but not named, from nymphs collected in Thailand. *Ephemerella boja* is a distinctive species with a quadrangular head and well developed posterolateral projections on segments 7–9.

Nymph.—Length: body 11.0–12.0 mm; caudal fliaments 7.0–8.0 mm. General color brown. Head quadrangular; maxillary palpi small, two segmented. Thoracic nota without tubercles or ridges; prothorax much wider than head; anterior surface of femora smooth, without protuberances; fore femora small, margins entire; middle and hind femora broadly expanded laterally, margins serrate; tarsal claws with 3–4 denticles. Abdominal segments 3–9 with well developed posterolateral projections; terga 2–10 with paired submedian tubercles; tubercles small on terga 2–3, well developed on 4–10; segments 7–9 with well developed posterolateral projections. Caudal filaments brown (rewritten from Gose, 1969).

Holotype nymph.—The specimen from which figure 23 in Gose was illustrated (Nature and Life in Southeast Asia, vol. VI, 1969) from Chanta Buri, Thailand, 20-VI-61, no other data, is designated as the type of the species. The other nymphal paratopotype is designated as a paratype.

EPHEMERELLA (CINCTICOSTELLA) CASTANEA Allen

Ephemerella castanea Allen, 1971: 514.

Nymph.—Length: body 10.0–11.0 mm; caudal filaments 7.0–8.0 mm. General color reddish-brown with dark brown markings. Head without occipital tubercles; maxillary palpi with moderately developed palpi. Thoracic nota without tubercles or ridges. Abdominal terga 2–9 with paired submedian tubercles; tubercles on segments 2–4 small and sharp, always discernible; tubercles on segments 5–9 moderately developed. Caudal filaments brown with dark brown annulations at apex of each segment.

Distribution.—South Korea, Kwang Nung and Seoul.

EPHEMERELLA (CINCTICOSTELLA) DELICATA Allen

Ephemerella "nay" Imanishi 1940: 206; Tshernova 1952: 274.
Ephemerella delicata Allen 1971: 517.

Nymph.—Length: body 5.5–7.0 mm; caudal filaments 5.5–7.0 mm. General color light brown to reddish brown and dark brown. Abdominal terga with paired submedian tubercles on segments 2–9; tubercles small on segments 2–4 and 9, well developed on segments 5–8; abdominal terga with dark submedian longitudinal stripes along line of submedian tubercles, pale medially and laterally, and with brown lateral maculae on segments 2–8. Caudal filaments with light thick setae on every second segment (rewritten from Imanishi 1940).

Distribution.—Kamo River, Kyoto, Yanashiro Prefecture, Japan, and Botankosho, Sekito-ga, Manchuria.

Remarks.—The following discussion is rewritten from Imanishi (1940): "Japanese specimens have white line on thorax, but these are absent on Manchurian collections. Abdominal markings are distinct on specimens from Manchuria, and indistinct or barely discernible on the Japanese. This species is almost identical to *E. nigra* in form and color, and the only difference is the smaller size and emergence is slightly later than *E. nigra* in Japan. The adult is unknown (adult probably smaller than *E. nigra*) and nymph is not as common as *E. nigra.*"

EPHEMERELLA (CINCTICOSTELLA) FEMORATA Tshernova

Asiatella femorata Tshernova 1972: 611, 614 (= *Cincticostella*).

Nymph.—Length: body 12.0 mm; caudal filaments 5.0 mm. General color light brown. Head with paired suboccipital tubercles; genae rounded; maxillary palpi reduced in size, two segmented. Thoracic nota without tubercles or ridges; prothorax broadly expanded laterally; anterior surface of fore femora without protuberances, dorsal margin with small protuberances; middle and hind femora broadly expanded laterally; middle femora with apical serrations; hind femora with apical and dorsal serrations; femora, tibiae and tarsi margined with setae; tarsal claws with 2 denticles. Abdominal terga with paired submedian tubercles on segments 4–9, tubercles increase in length on posterior segments; segments 7–8 with well developed posterolateral projections. Caudal filaments dark brown at base (rewritten from Tshernova 1972).

Distribution.—Red River (Song Koi), Back Thai, North Vietnam.

Ephemerella (Cincticostella) gosei, new species

Ephemerella TEB Gose 1969: 135.

This species, along with *E. boja*, was described and figured, but not named, by Gose (1969) from nymphs collected in Thailand.

Nymph.—Length: body 6.0–7.0 mm; caudal filaments 3.0–4.0 mm. General color dark brown. Head round; frons with pale markings mesad to compound eyes and pale marking over median ocellus; genae truncate; maxillary palpi absent. Thoracic nota without tubercles or ridges; tarsal claws with 6 denticles. Abdominal terga 2–9 with paired submedian tubercles; tubercles small on terga 2–3, better developed on 4–9. Caudal filaments light brown (rewritten from Gose 1969).

Holotype nymph.—The specimen from which figure 38 was illustrated (Nature and Life in Southeast Asia, vol. VI, Gose 1969) from Chanta Buri, Thailand, 20-VI-61, no other data, is designated as the type of the species.

EPHEMERELLA (CINCTICOSTELLA) INSOLTA Allen

Ephemerella insolta Allen 1971: 516.

Nymph.—Length: body 5.0–6.0 mm; caudal filaments 4.0–5.0 mm. General color light brown to brown with numerous small pale spots on head, body and legs. Head with paired suboccipital tubercles; genae rounded; maxillary palpi present, but reduced in size. Thoracic nota with ridges; femora expanded laterally and with spines and protuberances; tarsal claws with 5–8 denticles. Abdominal terga 1–10 with well developed paired submedian tubercles; segments 7–9 without posterolateral tubercles. Caudal filaments brown.

Distribution.—The species is known only from the type series collected from Chiengmai, Thailand.

EPHEMERELLA (CINCTICOSTELLA) LEVANIDOVAE Tshernova

Ephemerella levanidovae Tshernova 1952: 274; Tshernova 1958: 76; Edmunds 1959: 545; Allen 1971: 516; Tshernova 1972: 612.

Nymph.—Length: body 12.0 mm; caudal filaments 10.0 mm. General color brown. Head without occipital tubercles; genae truncate; maxillae with well developed palpi. Thoracic nota without tubercles or ridges; femora of middle and hind legs with longitudinal ridge on anterior surface; tarsal claws with 6 denticles. Abdominal terga 5–8 with well developed tubercles, tubercles small on other segments. Caudal filaments with spines on every segment (rewritten from Tshernova 1952).

Distribution.—This species is known only from the type series collected from the Hor River in eastern Russia.

EPHEMERELLA (CINCTICOSTELLA) NIGRA Uéno

Ephemerella nigra Uéno 1928: 44; Imanishi 1937: 325; Uéno 1950: 128 (male genitalia); Edmunds 1959: 546; Bajkova 1962: 204; Allen 1971: 513; Tshernova 1972: 611.

Chitonophora (?) *nigra* Uéno 1931: 224.

Nymph.—Length: body 9.5–11.5 mm; caudal filaments 7.0–8.0 mm. General color dark brown to black. Head without occipital tubercles; genae round; maxillary palpi well developed. Thoracic nota without tubercles or ridges. Abdominal terga 2–9 with paired submedian tubercles; tubercles on segments 2–4 barely discernible; tubercles on segments 5–9 moderately developed. Caudal filaments brown.

Distribution.—This species has been reported from several localities on the Island of Honshu, Japan.

EPHEMERELLA (CINCTICOSTELLA) ORIENTALIS Tshernova

Ephemerella orientalis Tshernova 1952: 279; Tshernova 1958: 75; Tshernova 1972: 612.

This species was described from a male imago collected in the vicinity of the Amur River in eastern Russia and the nymphal stage has not been associated at this time. Tshernova (1972) placed *E. orientalis* in *Cincticostella* (as *Asiatella*) with the following statement, "The imago described by me as *E. orientalis* Tshern. (Tshernova, 1952: 279, table XIV, fig. 99) due to the structure of the genital appendages is very close to *E. nigra* Uéno and by all means belongs to the genus *Asiatella*."

Distribution.—The adult of this species was described from Sudhuhynshi Preserve, USSR and records of additional specimens have not been published.

EPHEMERELLA (CINCTICOSTELLA) TSHERNOVAE Bajkova

Ephemerella "nax" Imanishi 1940: 205; Tshernova 1952: 274.

Ephemerella tshernovae Bajkova 1962: 203; Tshernova 1972: 612, 614 (= *imanishii*).

Ephemerella imanishii Allen 1971: 517.

Ephemerella tshernovae nymphs are easily distinguished from those of the other species in the *nigra*-group as they possess paired submedian tubercles only on segments 5–9.

Nymph.—Length: body 10.0–11.0 mm; caudal filaments 4.0 mm. General color reddish brown to dark brown with purple to purple black markings. Abdominal terga with large paired submedian tubercles on segments 5–9; abdomen with posterolateral projections on sgements 4–9; poorly developed on 4–6, well developed on 7–9; abdominal terga with short heavy setae; abdominal segment 9 with concave lateral margins. Caudal filaments less than one-half body length; caudal filaments with heavy setae around each segment (rewritten from Imanishi 1940).

Distribution.—This species is reported by Imanishi (1940) from Gifu Prefecture, Japan, and four localities in Korea.

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Seasonal Abundance and Distribution of Adult Stoneflies of Sashin Creek, Baranof Island, Southeastern Alaska

(Plecoptera)

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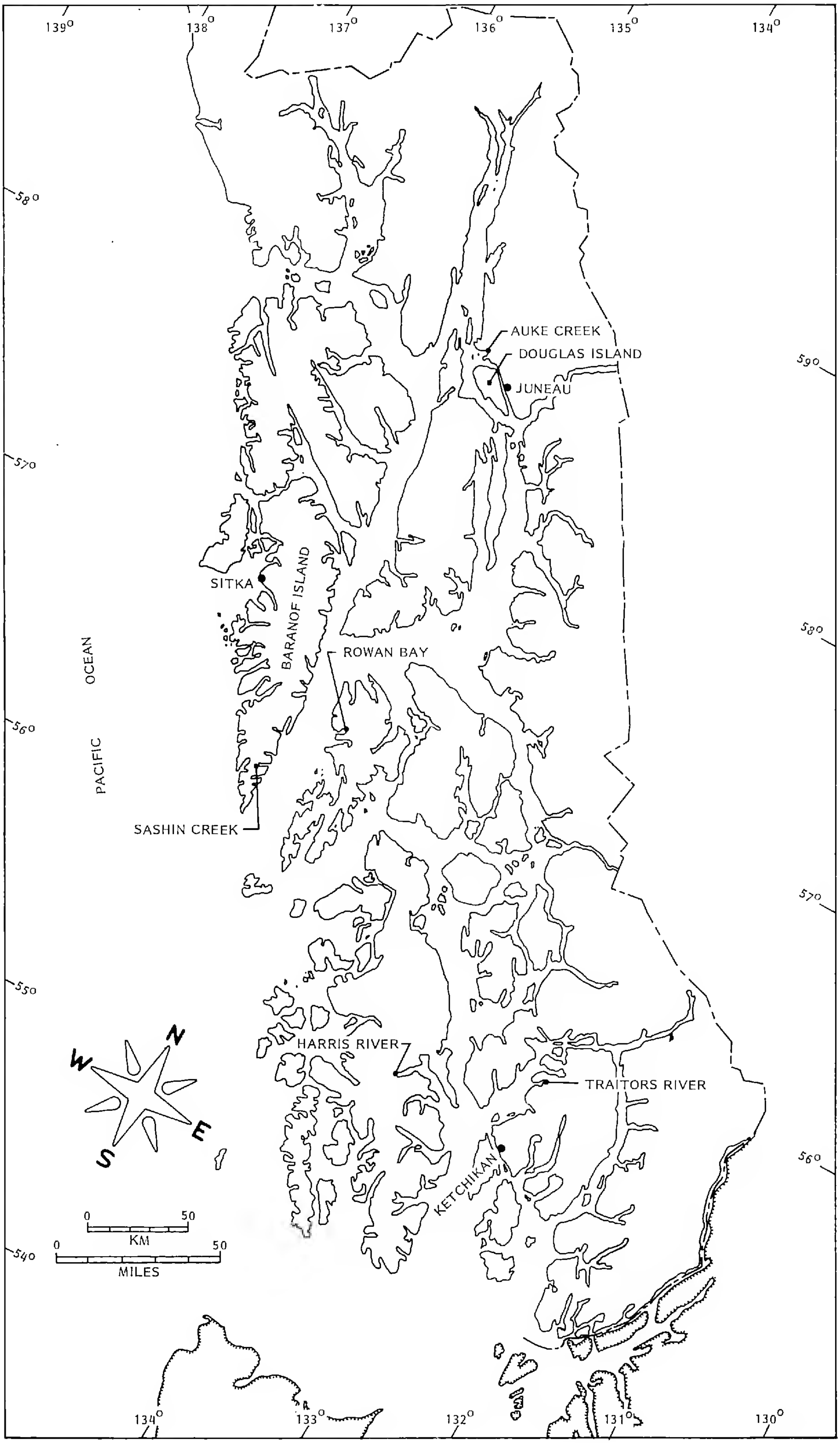
In this paper I record the species of stoneflies in the study area and describe the relative abundance and seasonal and spatial distributions of the adults. In addition I record some incidental observations on the biology of some species. The collections were made intermittently from 1965 to 1972.

Sashin Creek is located at approximately lat 56°23′N, long 134°44′W, on the southeast shore of Baranof Island, southeastern Alaska (Fig. 1). Sashin Creek originates about 4,000 m from the ocean in a lake 56 ha in area nested between mountains at 83 m elevation and also receives waters from several smaller lakes and ponds. Precipitation averages about 560 cm per year at sea level near the mouth of Sashin Creek. Snow usually covers the ground from late October to April—usually to depths exceeding 1 m after November. The annual range in volume of flow of Sashin Creek is about 0.2 to 20 m^3/s. This study was concentrated in that portion of the stream between its mouth at tidewater and a 30-m falls about 1,200 m upstream. The gradient of the stream increases from about 0.1% near tidewater to about 0.7% close to the falls where the elevation is about 5 m above sea level. The size of the stream bottom gravel increases similarly—from about 47% cobbles near tidewater to 81% close to the falls. The stream runs through a forest of western hemlock (*Tsuga heterophylla* [Raf.] Sarg.) and Sitka spruce (*Picea sitchensis* [Bong.] Carr.) and has releatively stable banks with overhanging brush, mostly alder (*Alnus*). Also present are salmonberry (*Rubus spectabilis* Pursh.), blueberries (*Vaccinium*), and devilsclub (*Oplopanax horridus* [Sm.] Miq.). The stream bottom along the shores frequently contains branches and logs in various stages of decomposition.

The resident fish of Sashin Creek in approximate order of abundance are juveniles of coho salmon (*Oncorhynchus kisutch* (Walbaum)) and rainbow trout (*Salmo gairdneri* Richardson) and both juveniles and adults of Dolly Varden (*Salvelinus malma* (Walbaum)) and coastrange sculpin (*Cottus aleuticus* Gilbert). Many pink salmon (*O. gorbuscha*


139°
138°
137°
136°
135°
134°
58°
59°
57°
58°
56°
57°
55°
56°
54°
AUKE CREEK
DOUGLAS ISLAND
JUNEAU
SITKA
BARANOF ISLAND
ROWAN BAY
PACIFIC OCEAN
SASHIN CREEK
HARRIS RIVER
TRAITORS RIVER
KETCHIKAN
N
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S
0
50
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0
50
MILES
134°
133°
132°
131°
130°

(Walbaum)), and fewer chum salmon (*O. keta* (Walbaum)) spawn in the stream, but their progeny go to the ocean soon after they emerge from the gravel in April, May, or June.

MATERIALS AND METHODS

I made 204 collections of adult stoneflies intermittently as part of larger programs. Stoneflies were collected by air-net sweeping and beating of streamside brush, hand-picking with forceps, and by rearing nymphs. Specimens were killed and stored in 70% alcohol. A reference collection of adult stoneflies is maintained at the Auke Bay Fisheries Laboratory.

In the following list of adult stoneflies from Sashin Creek, each species occurred throughout the study area below the falls unless otherwise noted. Most of the collecting was done below the falls and special mention will be made if I collected the species also above the falls or in other streams in southeastern Alaska.

SEASONAL DISTRIBUTION AND ABUNDANCE

I made collections in Sashin Creek that could have yielded adult stoneflies on 75 days from the first week of March to the first week in October. Unusually low winter temperatures can cause delay in onset of emergence of stoneflies in temperate climates (Elliott, 1967; Harper and Pilon, 1970). Sashin Creek however, has a combination of relatively high latitude, marine situation, and several tributary lakes or ponds which greatly reduces within and between season variations in water flow and temperature. I have therefore assumed that timing and sequence of emergence of the species of stoneflies in Sashin Creek is essentially the same from year to year and combined collections from all years to compare seasonal occurrence and sequence of emergence of adult stoneflies. The distribution of sampling effort by week is summarized in Figure 2 along with periods of occurrence for each species. No collections were made between the first weeks of October and March, but incidental observations have never revealed adult stoneflies at this time in Sashin Creek.

The several species of stoneflies differed in abundance and length of period of occurrence and I define seven general categories from

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FIG. 1. Map showing location of streams and rivers mentioned in the text.

consideration of the collection data (Table 1 and Fig. 2). The categories and species involved are:

1. Very abundant for several weeks: *Suwallia pallidula*
2. Abundant for several weeks: *Capnia excavata*, *Sweltsa exquisita*, *Zapada cinctipes*
3. Common for several weeks: *Sweltsa borealis*, *Sweltsa oregonensis*
4. Very abundant for many days: *Capnia nana*
5. Common for many days: *Capnia melia*
6. Abundant for a few days: *Zapada frigida*
7. Rare for a few days: *Doddsia occidentalis*, *Megarcys signata*, *Despaxia augusta*, *Paraleuctra occidentalis*, *Paraleuctra sara*, *Podmosta decepta*, *Zapada oregonensis*, *Alloperla serrata.*

The seasonal progression of emergence and varying lengths of the periods of occurrence make it likely that four to six species of adult stoneflies could be collected from Sashin Creek on any day from mid-March to mid-September. Two of the common seasonal categories of species are evident in Figure 2 where "spring" (*Capnia*, *Zapada*) and "summer" (*Alloperla*, *Sweltsa*) groups appear.

Collection Data for Adult Stoneflies from Sashin Creek

The collection data are summarized in Table 1 and further details are presented along with the annotations for each species. Jewett (1959) brought together illustrations of characters for identification of all the males and most of the females of the Pacific Northwest which covers all species found in Sashin Creek. Jewett supplies references for illustrations of the other females that have been described. First records for Alaska are indicated in Table 1.

COLLECTION DATA

NEMOURIDAE.—Four species of Nemouridae were found but only *Zapada cinctipes* was abundant. For the entire collection *Z. cinctipes* was one of the five most common species in total numbers, number of collections, and number of days on which it occurred. The other three species of Nemouridae were among the six least common species (Table 1).

Podmosta decepta (Frison).—One of six least common stoneflies collected at Sashin Creek but found from lowest area to above falls and in Traitors River, Harris River, and "Middle Creek" (Rowan Bay).

Zapada cinctipes (Banks).— One of the most common stoneflies of Sashin Creek; occurred from early spring with earliest winter stone-

TABLE 1.—Number of specimens, collections, and collection days for each species of adult stonefly collected in Sashin Creek, 1965–72 (*indicates first record for Alaska).

Family and Species	Number of Specimens		Number of collections	Number of collection days
	Male	Female		
Nemouridae				
*Podmosta decepta**	9	16	5	3
Zapada cinctipes	260	233	54	28
Zapada frigida	21	7	2	1
Zapada oregonensis	7	1	5	3
Leuctridae				
Despaxia augusta	23	3	14	9
Paraleuctra occidentalis	11	6	9	4
*Paraleuctra sara**	3	3	4	3
Capniidae				
*Capnia excavata**	445	169	68	29
*Capnia melia**	58	21	26	12
*Capnia nana**	855	1,221	59	13
Taeniopterygidae				
Doddsia occidentalis	1	0	1	1
Perlodidae				
*Megarcys signata**	0	1	1	1
Chloroperlidae				
Alloperla serrata	1	0	1	1
Suwallia pallidula	1,007	800	68	34
Sweltsa borealis	17	28	23	18
Sweltsa exquisita	88	242	39	26
Sweltsa oregonensis	9	30	24	20

flies of genus *Capnia* to July. Although *Z. cinctipes* was found up to 15 m away from stream on snow, it did not seem to be actively migrating. *Z. cinctipes* was collected at Auke Creek and the lowest area to above the falls in Sashin Creek.

Zapada frigida (Claassen).—One of six least common stoneflies collected at Sashin Creek. It was found only above falls and although found on only 1 day, was then abundant. Type locality for *Z. frigida* is across Baranof Island and somewhat north at Sitka, Alaska.

Zapada oregonensis (Claassen).—Although one of six least common stoneflies collected at Sashin Creek, this species was found both above and below falls.

LEUCTRIDAE.—Adult Leuctridae occurred only rarely—the three species captured were among the six least commonly captured species and were never abundant.

Despaxia augusta (Banks).—A late summer-early fall form and the most abundant of the Leuctridae. The other two species, *Paraleuctra occidentalis* and *P. sara*, are early summer forms. *D. augusta* was found both above and below falls.

Paraleuctra occidentalis (Banks).—An early summer form found in all areas below falls.

Paraleuctra sara (Claassen).—An early summer form, collected both above and below falls and in Traitors and Harris rivers.

CAPNIIDAE.—The three species of Capniidae from Sashin Creek are winter forms and begin their emergence while the ground is deeply covered by snow. Two of the three are among the five most abundant species. *Capnia melia* and *C. nana* appeared to actively migrate by walking over the snow away from the stream and into the forest. I observed hundreds of individuals, all moving at nearly 90° to the stream across the snow. A few were found on a steep hillside among mature spruce and hemlock trees 150 m away from Sashin Creek. The fate of these migrants is unknown.

Capnia excavata Claassen.—One of most abundant and commonly present stoneflies of Sashin Creek, although the long period of occurrence may be due to a long-lived adult. One female was collected above falls. *C. excavata* was also collected at Traitors River.

Capnia melia Frison.—Least abundant of the *Capnia* in Sashin Creek and not collected above falls. *C. melia* was part of cross-snow migration at Sashin Creek and was also collected on snow near an unnamed stream on Douglas Island at about 200-m elevation.

Capnia nana Claassen.—Second most abundant of the stoneflies from Sashin Creek and the major species in migration across snow both above and below falls. *C. nana* occurs abundantly with *C. excavata*, *C. melia*, and *Zapada cinctipes* on snowbanks in early spring.

TAENIOPTERYGIDAE.—A single species, *Doddsia occidentalis* (Banks). Only one specimen collected, but collection site, weather, and snow conditions at the time make it likely that this specimen originated in Sashin Creek.

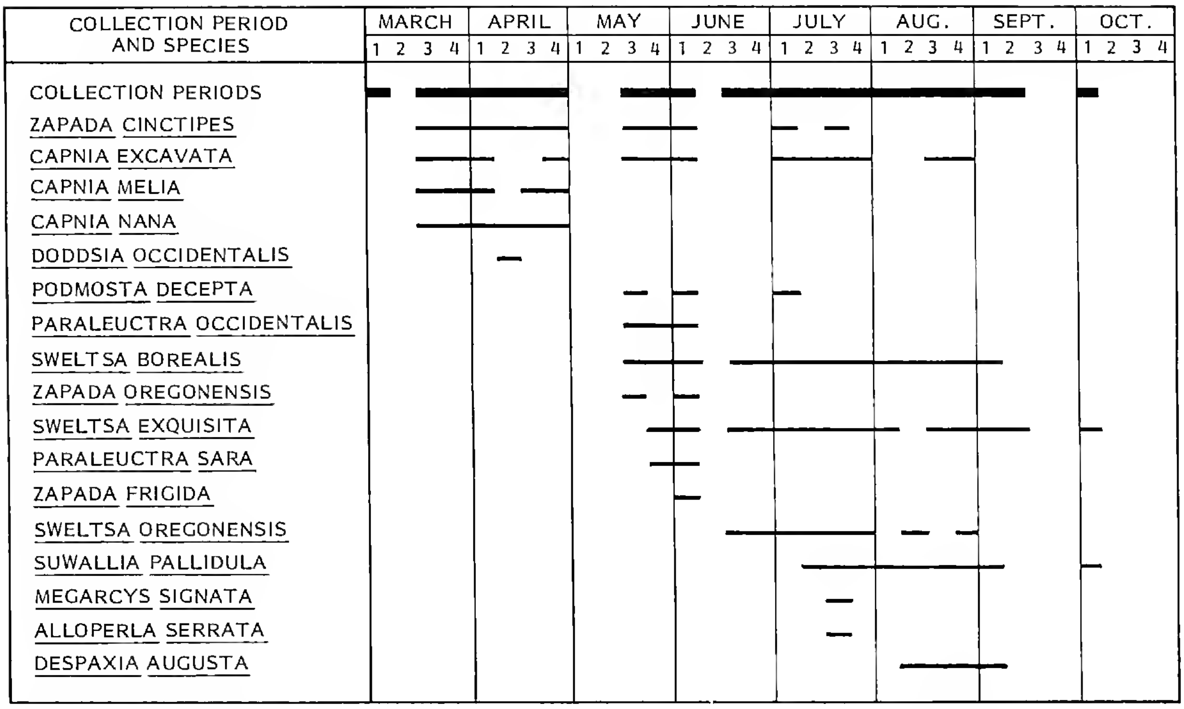

Fig. 2. Periods when collections of stoneflies were made in Sashin Creek, 1965–72 (top line), and periods of occurrence of adults of each species.

Perlodidae.—A single species, *Megarcys signata* (Hagen). Only one adult was collected from Sashin Creek, but several *Megarcys* nymphs were found. All collections of nymphs and the adult are from above falls.

Chloroperlidae.—Chloroperlid nymphs are a significant part of the intergravel fauna of salmon spawning beds in southeastern Alaska (Nicola, 1968; Ellis, 1970) and are also common on logs in Sashin Creek. Nearly half the adult stoneflies of this study were chloroperlids.

Alloperla serrata Needham and Claassen.—Only one specimen was collected and that from above the falls. The same collection contained several *Sweltsa borealis*, *S. exquisita*, and *Suwallia pallidula.*

Suwallia pallidula (Banks).—This bright yellow stonefly was the most abundant species of this study (closely followed by *Capnia nana*) and by far the most abundant chloroperlid. *S. pallidula* collected both above and below falls, often abundantly—several collections contained more than 100 specimens. *S. pallidula* often seen on fruit of both red and yellow salmonberry along stream.

Sweltsa borealis (Banks) and *S. exquisita* (Frison)—Collected both above and below falls in Sashin Creek.

Sweltsa oregonensis (Frison).—Common during summer but never abundant. *S. oregonensis* found both above and below falls in Sashin Creek and at Traitors and Harris rivers and Auke Creek.

ACKNOWLEDGMENTS

Stanley G. Jewett, Jr., supplied encouragement and identified or confirmed the identifications of representatives of all species found in this study.

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SCIENTIFIC NOTE

***Trichophaga tapetzella* Linnaeus in the Galapagos Islands (Lepidoptera: Tineidae).**[1]—Early in 1973 Dr. Pierce Brodkorb (Department of Zoology, University of Florida) found exuviae of a lepidopterous larva on the skin of a dead Galapagos flightless cormorant, *Nannopterum harrisi* (Rothschild), at Punta Espinosa, Fernandina Island. On March 23, 1973 an adult carpet moth, *Trichophaga tapetzella* Linnaeus, emerged. The specimen is deposited in the Florida State Collection of Arthropods, Division of Plant Industry, Gainesville.

Although cosmopolitan, *Trichophaga tapetzella* has not previously been recorded from the Galapagos Islands (Linsley and Usinger, 1966, Proc. Calif. Acad. Sci. 33(7): 113–196). The moth was reared in 1966 at Barrington Island (DeVries—Calif. Acad. Sci.) but this was not reported. Host preferences of the carpet moth when not an economic pest include general detritus and various kinds of animal matter.

Dr. Donald R. Davis (Department of Entomology, U.S. National Museum of Natural History, Washington, D.C.) kindly confirmed my determination of the adult moth from Fernandina Island and also told of captures of moths reared from owl pellets on the Galapagos Islands as related in correspondence to him, which could also be *Trichophaga tapetzella.*

Probably an accidental introduction by man, *Trichophaga tapetzella* may be firmly established in the Galapagos Islands by indication of the three reports of its occurrence there since 1966 noted herein.— J. B. HEPPNER, *Department of Entomology and Nematology, University of Florida, Gainesville, Florida* 32611.

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[1] Florida Agricultural Experiment Station Journal Series No. 5398.

An Arboreal Cleidogonid Milliped from Chiapas

(Chordeumida: Cleidogonidae)

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During studies on the fauna of bromeliads in the Mexican state of Chiapas, Mr. Kenneth E. Lucas (California Academy of Sciences) obtained a number of millipeds which were sent to me for identification. Most of the species were represented only by immature specimens in the orders Polydesmida and Spirobolida and not identifiable with certainty, but of exceptional interest was the occurrence in large numbers of an undescribed species referable to *Cleidogona* in the present, rather broad, concept of that genus.

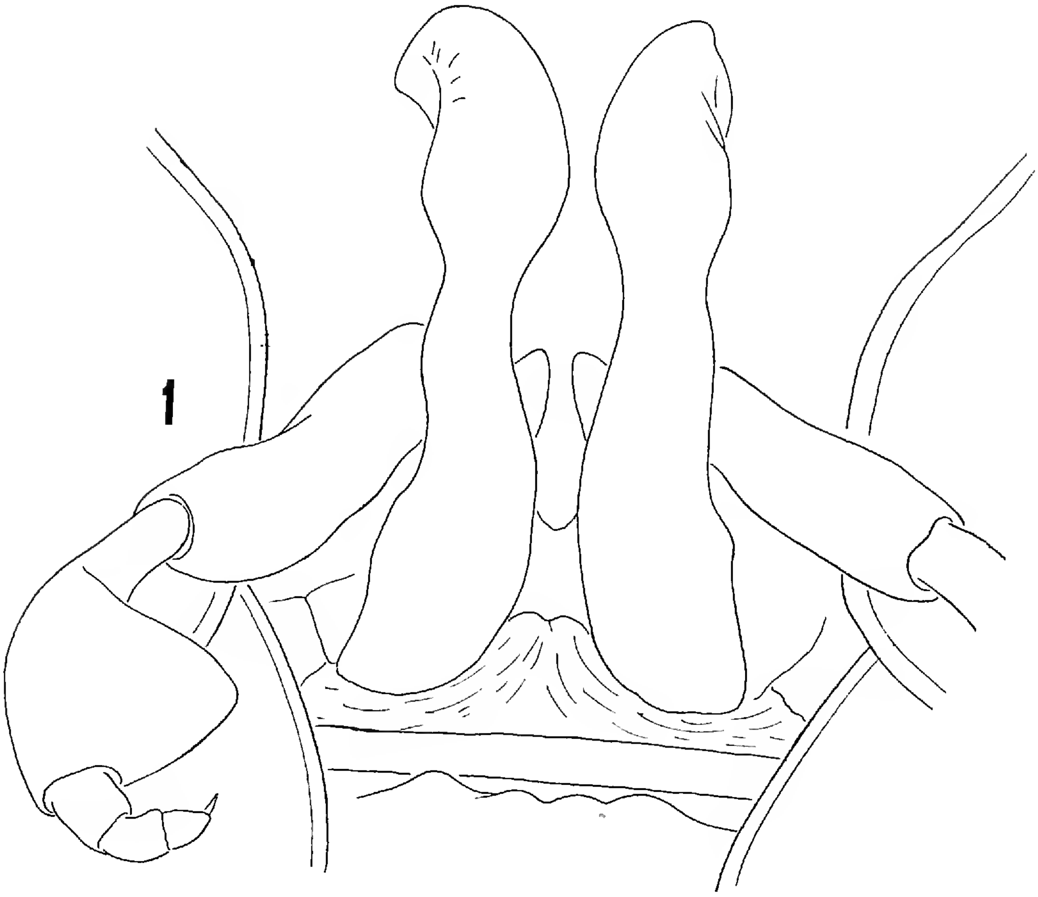
Up until 1943, only a handful of cleidogonids were known from Mesoamerica, and even these in a very inadequate way. During the past three decades, however, a considerable number of species and several genera have been described from that region, and the "Checklist of the Millipeds of Mexico and Central America" compiled by H. F. Loomis (1968) accounted 26 species dispersed through nine genera (literature surveyed through 1964).

In 1972 appeared a detailed monograph on the Cleidogonidae by William A. Shear, in which our knowledge of this group was systematized and vastly augmented in an exemplary fashion. Having access to a large quantity of new material from Middle America, as well as to types of many of the established species, Dr. Shear was able to combine the majority of the existing generic names, and listed a total of 47 species of cleidogonids from south of the Rio Grande: two species in *Solaenogona*, three in *Dybasia*, and 42 in *Cleidogona.* Although a fair number of Mexican cleidogonids are known to be troglobitic or troglophilic, none have so far, to the best of my knowledge, been recorded from any kind of arboreal habitat, such as bromeliads.

Not only is the habitat of the present species unusual, but the gonopod structure is likewise disjunct from the pattern apparently normal for the genus, so that in publishing a name for the use of Mr. Lucas's studies, I take the occasion to append some observations on the morphology of the genitalia.

CLEIDOGONA Cook

Cleidogona Cook, 1895, Ann. New York Acad. Sci., vol. 5, p. 3.—Shear, 1972, Bull. Mus. Comp. Zool., vol. 144, no. 4, pp. 195 et seq. [monographic revision].



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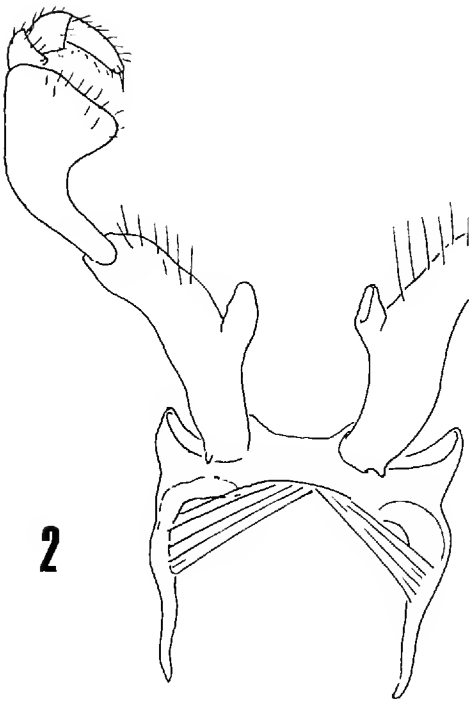

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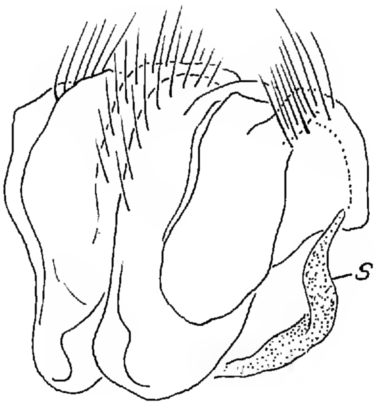

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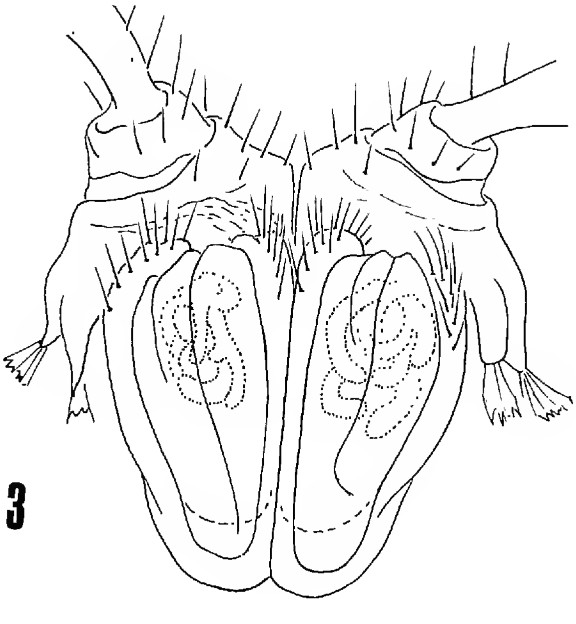

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The reader is referred to Dr. Shear's revision for a complete account of the generic synonymy, distribution, phylogeny, and species of this large and dominantly Nearctic genus.

Cleidogona scandens, new species

(Figs. 1–7)

Male holotype and 46 paratypes of both sexes, from 17 km. SE. of San Cristobal de las Casas, 2195 m., Chiapas, Mexico, collected 15 January 1973, by Kenneth E. Lucas. Deposited in the California Academy of Sciences.

Diagnosis. A moderately small, well-pigmented species in which the gonopod telopodites are strongly reduced and the colpocoxites very greatly elongated but simple in form (Figs. 1, 6); coxae widely separated from sternum by prominent peristigmal projections; females lacking postgenital plate, cyphopodal sternum small and obscure (Fig. 4).

Holotype. Adult male, total length ca. 15 mm., maximum diameter (at segment 7) 1.7 mm. Color pattern to the eye appearing dark brown dorsally with a pale median stripe and pale legs; with magnification each segment is basically light horn-brown dorsally with a paramedian dark brown area on each side of midline, each such area containing two small round pale spots, the light brown area laterad to these with a larger and ovoid pale spot which is strongly areolated on anterior segments; lower sides and legs whitish-gray. Each segment thus has a transverse row of six pale spots, four small and two large, and a narrow mid-dorsal pale area. Lateral sides of femora and tarsi brown; both lateral and dorsal surfaces of postfemora brown. Antennae uniformly light brown except for some whitish mottling on articles 1 and 2.

External structure typical of the genus; body widest at segments 6 and 7, tapering very gradually caudad, metazona smooth, very slightly larger than prozona but without trace of paranotal development. Segments with 3–3 dorsal setae in a transverse row, the outermost on each end set near caudal margin, the inner two located near midlength of segment. Head evenly convex above antennae, the frons slightly but evidently concave. Mandibular bases strongly enlarged and convex. Ocellaria triangular, each with 27 ocelli in 5 rows.

Anterior legs of male unmodified, except first two pairs smaller as usual. Gonopods enormously elongated, *in situ* the apices inserted between the sterna of the 12th and 13th pairs of legs, and of the form shown in Figures 1, 5, 6, and 7.

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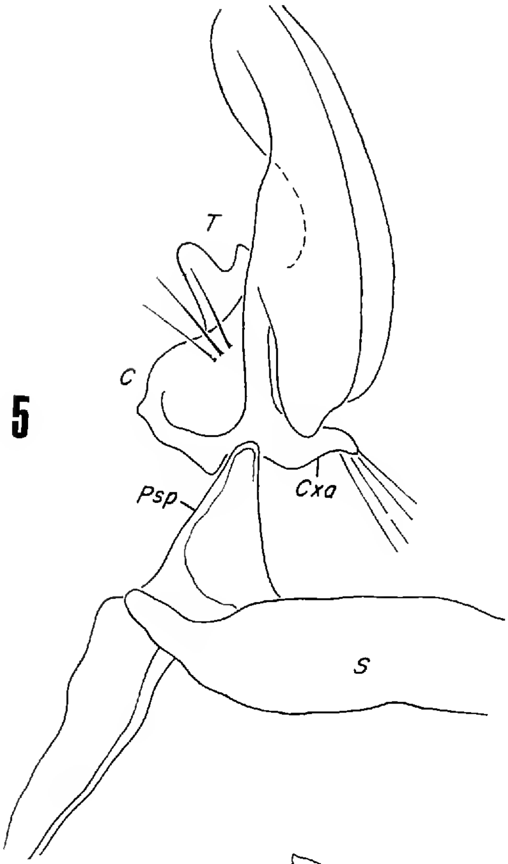
Figs. 1–4. *Cleidogona scandens*. Fig. 1. Gonopods and legs of the 9th pair, anteroventral aspect, ventral ends of pleuroterga of segments 6 and 7 shown. Fig. 2. 9th pair of legs and sternum, anterior view. Fig. 3. Cyphopods and base of 2nd pair of legs, aboral view, apodematic diverticula (seminal vesicles) indicated by dotted lines. Fig. 4. Cyphopods, oblique posterolateral view, the reduced sternum (S) shown by stipple.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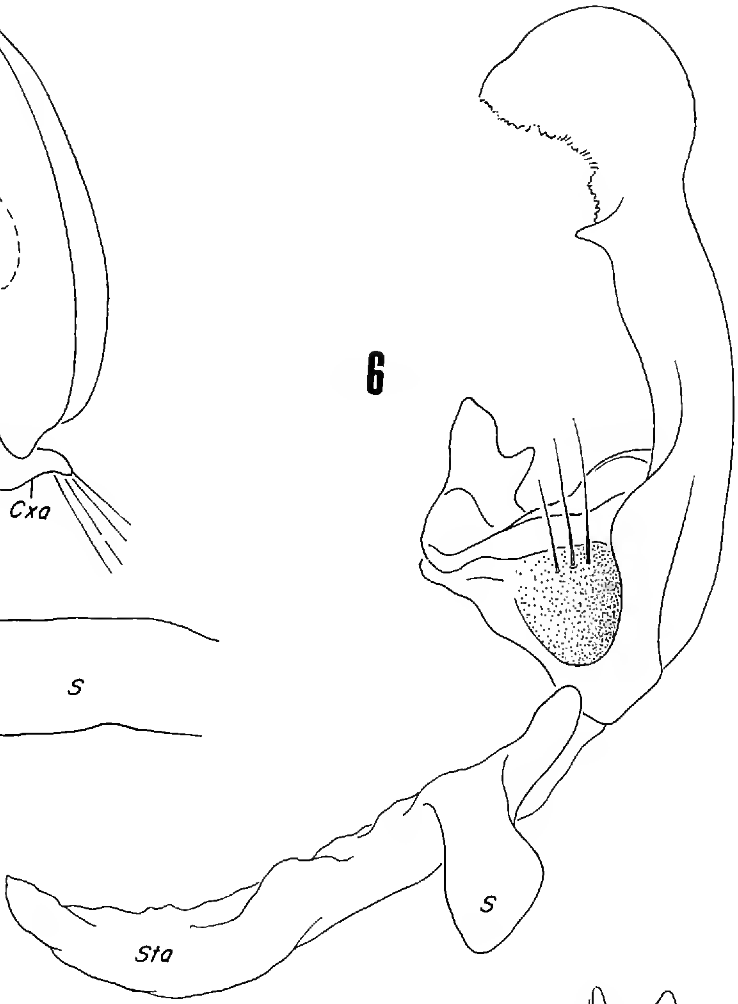
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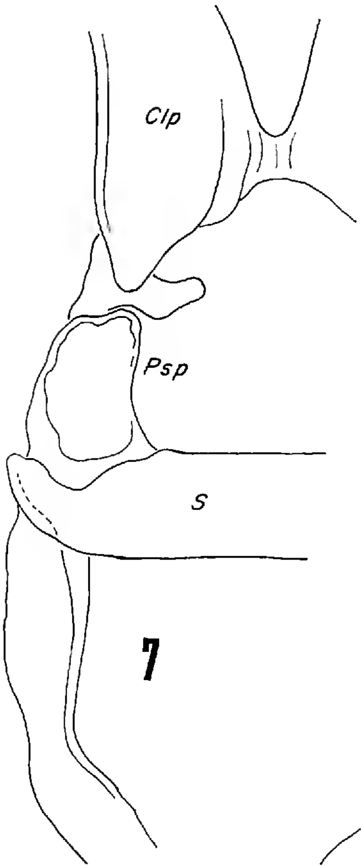
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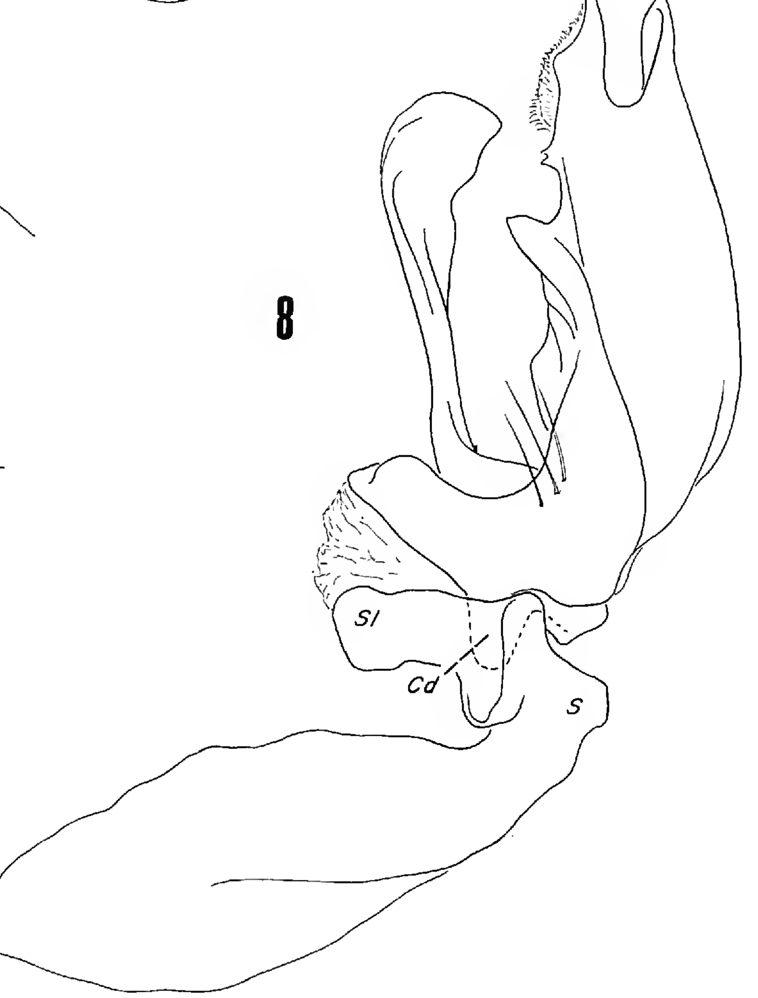
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Sternum distinct, transverse, strongly sclerotized, not produced medially; lateral end with a long, laminate sternal apodeme (Sta) extending dorsad nearly to inside of pleuroterga, and with a prominent triangular lobe containing the stigmal opening (Fig. 5, 7, Psp). Coxae small, pivoted upon end of the peristigmatic process and thus far removed from sternum, a small medially directed basal coxal apodeme for attachment of the tracheo-coxal muscle; colpocoxites long, slender, apically expanded, with a triangular subapical lobe on posterior edge, the latter finely laciniate distad to lobe. Lateral surface of coxae concave, with three macrosetae. Telopodites small, medially in contact but not fused, less than one-third length of colpocoxites, each with subapical triangular lobe on the anterior side.

Posterior gonopods (9th pair of legs) of the form shown in Fig. 2, the basal article with an adenostyle near midlength of ventral surface, second article narrow at base, broadly expanded distally; three small terminal segments.

Median process of 12th sternum elongate, simple, apically blunt, without peculiarities.

Female paratype. Similar in general to male except slightly larger, 17.2 mm. in length, 1.8 mm. in width, body not enlarged at segments 6 and 7. Genitalia as shown in Figs. 3 and 4; no trace of postgenital sclerite, sternum reduced to a narrow remnant (Fig. 4, S) hidden above the cyphopods. Latter with densely setose distal margins, the valves containing an intricate system of convoluted seminal vesicles.

Distribution and habitat. The species is known so far only from the type locality. A large series of specimens was taken from *Tillandsia violaceae* growing on *Quercus* sp. at elevations of 3, 6, and 12 meters above the ground. Specimens taken at the same locality in September 1972, were all immature.

Relationships. So far four species of *Cleidogona*—*C. forficula*, *C. laquinta*, *C. conotyloides*, and *C. decurva*—have been recorded from Chiapas, all named by Shear in 1972 and all from the vicinity of San Cristobal. *C. scandens* shows little close affinity with any of them, and in fact I have been unable to confidently place it in or near any of the various species-groups recognized by Dr. Shear. In the key to Mexican species, pages 206 and 207 of his monograph, it runs out to couplet 24, but in general appearance the gonopods have little re-

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FIGS. 5–7. *Cleidogona scandens*. Fig. 5. Right side of gonopods, oblique anterolateral view. Fig. 6. Right side of gonopods, lateral view. Fig. 7. Right side of gonopod bases, anterior view. Fig. 8. *Cleidogona major*, lateral view of gonopods. Abbreviations: C, coxa; Cd, condyle; Cxa, coxal apodeme; Clp, colpocoxite; S, sternum (the transverse element of the sternal apparatus); Sta, sternal apodeme; T, telopodite; Psp, peristigmatic projection of sternum. The capital letter S in Figs. 6 and 8 is placed in anatomically the same position for the two species.

semblance to those of *C. stolli* and *C. mirabilis.* There appears to be actually greater similarity between *scandens* and *C. maculata* (Verhoeff) in the shape of both pairs of gonopods, but the considerable geographic separation of these two taxa (by over 650 km. and the isthmus of Tehuantepec) would seem to militate against the likelihood of close phylogenetic affinity.

I think that a case could be made for the allocation of *Cleidogona scandens* to a monospecific group of its own, located perhaps near the "Crucis Group." The reduction of the gonopod telopodites, and loss of the cyphopodal postgenital sclerite, suggest a derivative or specialized status for the species.

REMARKS ON GONOPOD MORPHOLOGY

Examination of the gonopods of *C. scandens* following removal of extraneous tissue provided the occasion to consider this subject in some detail, and I venture to set forth here a few comments and observations.

To be sure that we were in agreement on basic concepts, I prepared by trypsin digestion a specimen of *Cleidogona major*, the species upon which Shear's account (pp. 197, 198) and figures 184 and 185 were based, to use as a standard. As Shear illustrated the gonopod from anterior and posterior aspects, I provide here a drawing (Fig. 8) made from the lateral aspect to complete the picture. I found general concordance with his treatment of anatomy, with the following exceptions (some of which merely reflect personal preferences in the derivation of terminology):

(1) In my material, the lateral ends of the sternum were not bifurcated and separate from the lateral extension, but actually formed a continuous unit somewhat broader on the sides than across the middle. I think that what Shear has called "lateral sternal sclerites" (LSS) may be regarded merely as a region of the sternum, set off by a vertical fold reflecting an internal thickening of chitin, and labeled on my drawing as "Sl."

(2) The proximomedian processes from the coxae, referred to as "coxal knobs" (CK) by Shear, I prefer to call "coxal apodemes" since they are, as he noted, the point of attachment for tracheocoxal muscles originating on the opposite side of the gonopod complex. On my figures they are labeled "Cxa."

(3) As noted by Dr. Shear, the coxae articulate against the sternum by a proximal lobe, designated by him "basal coxal bar" (CB), and shown on his Fig. 184. I could verify this structure, but because of its form (hardly a "bar") and function, suggest that it be given a more

descriptive name, such as "coxal condyle" as it obviously is a hinge point for movement of the coxa. As seen in lateral view (Fig. 8, Cd) it lies just internally to a corresponding thickened region of the sternum which may represent a pivot against which the condyle moves.

(4) Shear mentions a ". . . membranous front plate (FP) of the sternum . . ." which is said to be attached to the coxae, but no such plate is shown on his drawings. I found that the space between the colpocoxites and sternum appears to be somewhat sclerotized in untreated material, but after removal of the muscles nothing remains in that area except very thin connective tissue, the appearance being very correctly shown in Shear's Fig. 184. Perhaps there is no true "plate" in the sense of an anatomically discrete sclerite present in any cleidogonids, and even without examination of material I doubt that the sternum is medially produced in any cleidogonid.

Comparison of the cleared gonopod of *C. major* with that of *C. scandens* showed at once some interesting features, such as the absence, in the latter, of any trace of lateral extension of the sternum (compare Figures 7 and 8), and the considerable prolongation of the peristigmal region into a long projection which effectively functions as a pivot for the coxa. The normal internal coxal condyle of *C. major* appears to be quite wanting from *scandens.*

These are differences of considerable magnitude, and doubtless of more basic importance than the sometimes spectacular modifications of the colpocoxites and telopodites which have occasioned the proposal of new genera in the past. But as Dr. Shear has shown convincingly that anatomical continuities can be found between the most bizarre gonopodal extremes in this genus, I think that any move to set *scandens* off taxonomically would be undesirable, if done prior to a general re-examination of the coxosternal morphology throughout the genus. Such an enterprise, as might go without saying, would have to be predicated upon the exclusive use of genitalia cleared of all non-sclerotized tissue by the use of trypsin or dilute caustic solutions.

At the present I have neither the material nor opportunity to enter into such a project, and can only emphasize the position of *C. scandens* as a cleidogonid of considerable interest both as regards its phylogenetic position, and from the standpoint of its biotope. How many other bromeliadicolous cleidogonids remain to be found in Middle America?

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SHEAR, WILLIAM A. 1972. Studies in the Milliped Order Chordeumida (Diplopoda): A Revision of the Family Cleidogonidae and a Reclassification of the Order Chordeumida in the New World. Bull. Mus. Comp. Zool., 144(4): 151–352, figs. 1–538, maps 1–18, diagrams 1–10.

ZOOLOGICAL NOMENCLATURE

Announcement A (n.s.) 94

Required six-months' notice is given of the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number:

(see *Bull. Zool. Nom.* 31, part 3, 20th September 1974)

1888. Suppression of *Cicada cingulata* (Fabricius) var. *obscura* Hudson, 1891 (Homoptera).
2048. Suppression of *Polygramma* Chevrolat, 1837 (Coleoptera).
2057. Suppression of *Coccus sativus* Lancry, 1791, *Coccus mexicanus* Lamarck, 1801 and *Coccus silvestris* Lancry, 1791 (Homoptera).
2062. Conservation of *Aphis pyri* Boyer de Fonscolombe, 1841 and the suppression of *Aphis pyri* Kittel, 1827 and *Aphis pyri* Vallot, 1802 and seven other binominals proposed by Kittel in 1827 (Homoptera).
2091. Designation of type-species for *Dactylopius* Costa, 1835 and *Pseudococcus* Westwood, 1840; proposed suppression of Diaprosteci Costa, 1828 (Homoptera).

(see *Bull. Zool. Nom.* 31, part 4, 13th January 1975 [exact publication date]).

1884. Supression of *Parnalius* Rafinesque, 1815 (Rhopalocera).
2012. Suppression of *Calomicrus taeniatus* Wollaston, 1867 (Coleoptera).
2025. *Striglina* Guenée, 1877 to be given precedence over *Daristane* Walker, 1859 (Lepidoptera).
2036. Designation of *Hydrophorus binotatus* Fallén, 1823 as type-species of *Hydrophorus* Fallen, 1823 (Diptera).
2060. Suppression of *Xiphidium glaberrimum* Burmeister, 1838 and *Orchelimum cuticulare* Audinet-Serville, 1838 (Grylloptera).
2063. Designation of a type-species for *Kerrichiella* Rosanov, 1965 (Hymenoptera).
2067. Suppression of *Thrips rufa* Gmelin, 1790 (Thysanoptera).
2069. Suppression of *Phloeotrogus* Motschulsky, 1863 (Coleoptera, SCOLYTIDAE).
2070. Suppression of *Anodius* Motschulsky, 1860 (Coleoptera).
2071. Suppression of *Leiparthrum* Wollaston, 1854 (Coleoptera).
2072. Suppression of *Olonthogaster* Motschulsky, 1866 (Coleoptera).
2075. Designation of type-species for *Megasternum* Mulsant, 1844 and *Cryptopleurum* Mulsant, 1844 (Coleoptera).
2078. Designation of type-species of *Platyrhacus* Koch, 1847 (Diplopoda).

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London SW7 5BD, England. Those received early enough will be published in the Bulletin of Zoological Nomenclature.—MARGARET GREEN, Scientific Assistant.

Biology of the Thimbleberry Gallmaker *Diastrophus kincaidii*
(Hymenoptera: Cynipidae)[1]

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The cynipid wasp, *Diastrophus kincaidii* Gillette, is a widely distributed species in western North America and is known to be the causative agent of a conspicuous gall of thimbleberry (*Rubus parviflorus* Nutt.). These galls, which are characteristic in form, may be extremely abundant on the host plant. Weld (1957) has reported that *R. parviflorus* is the only known host of *D. kincaidii.* According to Weld (in lit.), distribution extends from Los Gatos, California to British Columbia. Localities are listed for California, Oregon, Washington and Idaho. It is possible that *D. kincaidii* occurs outside of this range and its distribution may be coextensive with that of thimbleberry which extends from San Diego County, California north to Alaska and east into Idaho.

Little information on the biology of *D. kincaidii* has been reported in the literature, therefore a study was initiated to examine its life history and habits, its relationship to gall development and to establish its insect associates. The study was conducted in a redwood forest habitat east of Humboldt State University, Arcata, California, and supplemented with laboratory rearings from September 1970 to May 1973.

THE GALL

Mature galls on thimbleberry are abrupt swellings on the stem or petiole (Fig. 1). They are irregularly swollen or lumpy and glabrous. Their size and shape vary greatly depending on the number and precise location of cynipid larvae present in the gall. Larval cavities may be numerous and usually are situated closely together. The majority are located in the vascular zone but many extend into the pith and cortex as well. The tissue immediately surrounding each larval cavity is hard and woody as are the outer tissues of the gall but the tissue between cavities is loose and pithy. Each cavity is irregularly ovoid and about 2 × 3 mm in size.

Gall development proceeds rapidly following oviposition by the adult

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[1] A portion of a thesis submitted for an M.A. at Humboldt State University, Arcata, California 95521.

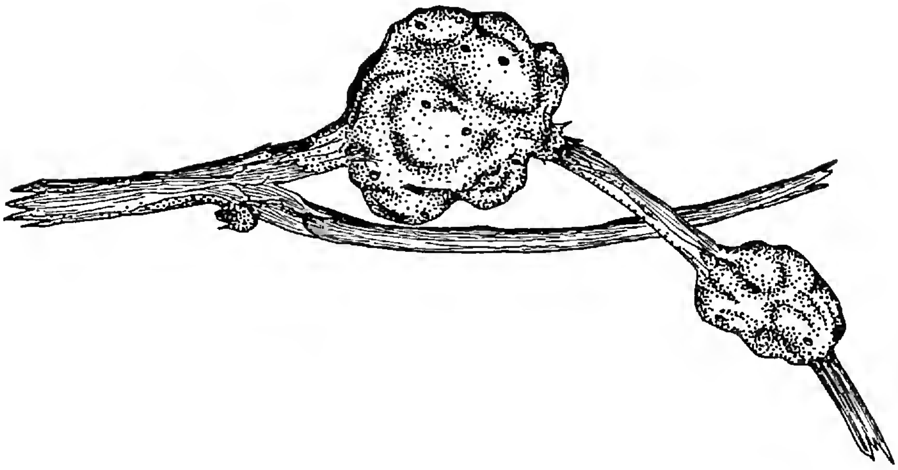

FIG. 1. Mature galls on thimbleberry, .5×.

female in the spring. First evidence is a slight swelling on a stem seven to ten days following egg deposition. The swelling is due to enlargement of cortical, xylem and phloem cells. At this stage of development larval cavities are not yet formed and the eggs and first instar larvae are wedged between plant cells.

In three to four weeks after oviposition larval cavities have developed and a gall is present as an abrupt and noticeable enlargement of the stem. The cavities are formed by a proliferation of parenchyma tissue that surrounds individual larvae. Xylem and phloem tissues of the gall are disrupted and only the uninfected portions of the stem have normal vascular tissue.

The tissues of most galls show signs of woodiness by the end of summer and during the fall all become woody.

DESCRIPTION OF LIFE STAGES

ADULT

Descriptions of the adult by Gillette (1893) and Fullaway (1911) will serve in the recognition of this species. The general characters are as follows: the female (Fig. 3a) ranges in size from 2.0 to 2.5 mm in length and the male is approximately 1.75 mm in length. The body is black. The antennae, tegulae and ovipositor sheath are brown to brownish. The legs are brown and the tips of the tarsi are black. The laterally compressed abdomen is larger in the female, approximately half the length of the body. The antennae are 13 segmented in the female and 14 segmented in the male.

EGG

The egg of *D. kincaidii* is readily recognized by its oblong shape and long stalk (Fig. 3b). Measurements of ten eggs averaged 0.65 mm (0.59–0.70) in length and 0.077 mm (0.052–0.104) in width. The stalk of the egg is approximately 1.3 × longer than the elongate oval body. The stalk is narrow along its length

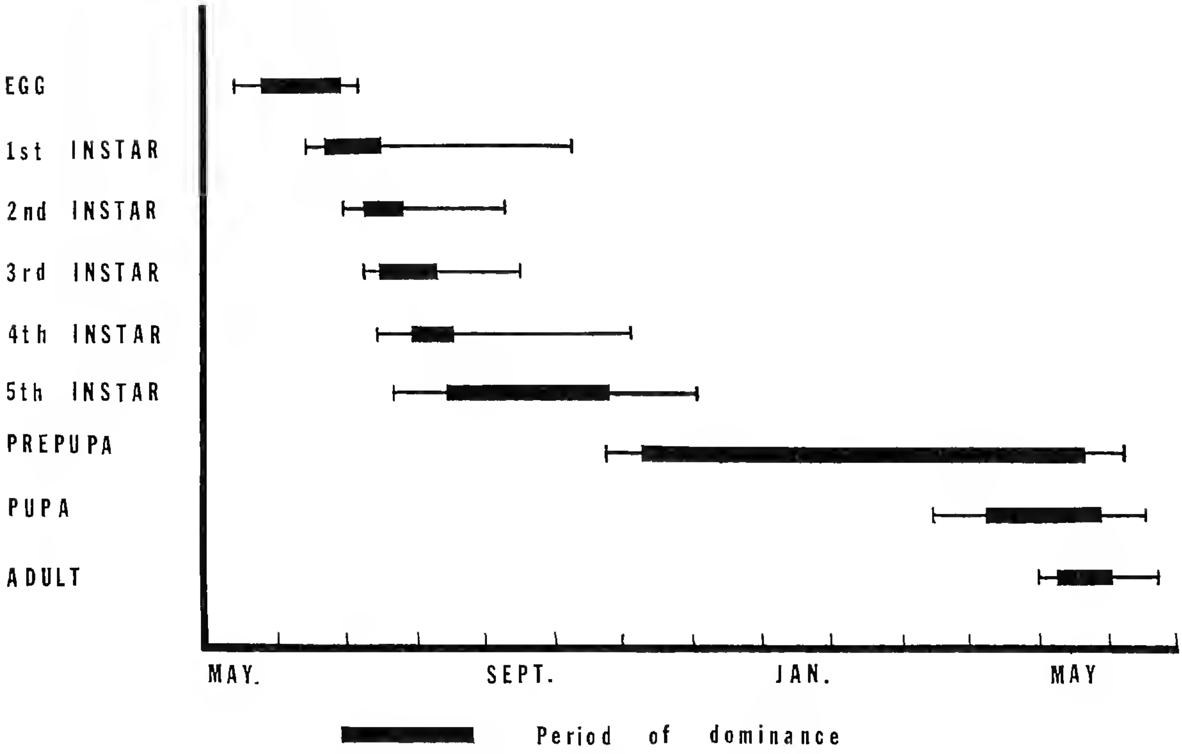

Fig. 2. Seasonal occurrence of life stages of *Diastrophus kincaidii.*

with a swelling at the distal end. The body is white and opaque and the stalk is clear. The chorion is smooth.

Larva

This species has five larval instars that are similar in appearance (Fig. 3, c–e). The larvae range in size from 0.3 mm to 2.5 mm in the normal curved position. They are best distinguished by head capsule measurements (Fig. 4). The body is 13 segmented, white, translucent, tapering posteriorly, and is apodous. Waste products are visible and become darker with age and are confined to the center of the abdomen as an oval mass. The integument is smooth and lacks setae. The antennae are not visible. Mandibles are present but inconspicuous in the first instar. They are tridentate in the fifth instar (Fig. 3h).

Pupa

In *D. kincaidii* there is long-lasting prepupal stage in addition to a shorter pupal stage (Fig. 3, f–g). The prepupa is distinguished by the arcuate body and opaque yellowish color. The body is fatter than in larval stages so the head capsule is only about half the size of the prothoracic segment in lateral view. In older individuals the red pigment of the developing compound eyes is visible in the prothoracic segment and legs (not yet fully formed) can be seen beneath each thoracic segment. The mandibles of the larva are forced to the surface as the pupa develops and come to lie fully exposed on the face.

The free pupa is white to yellowish during early development becoming dark brown to black with age. The antennae and legs extend caudad and reach the abdomen. The overall shape is robust, especially in females. Pupae range in size from 2.0–2.5 mm.

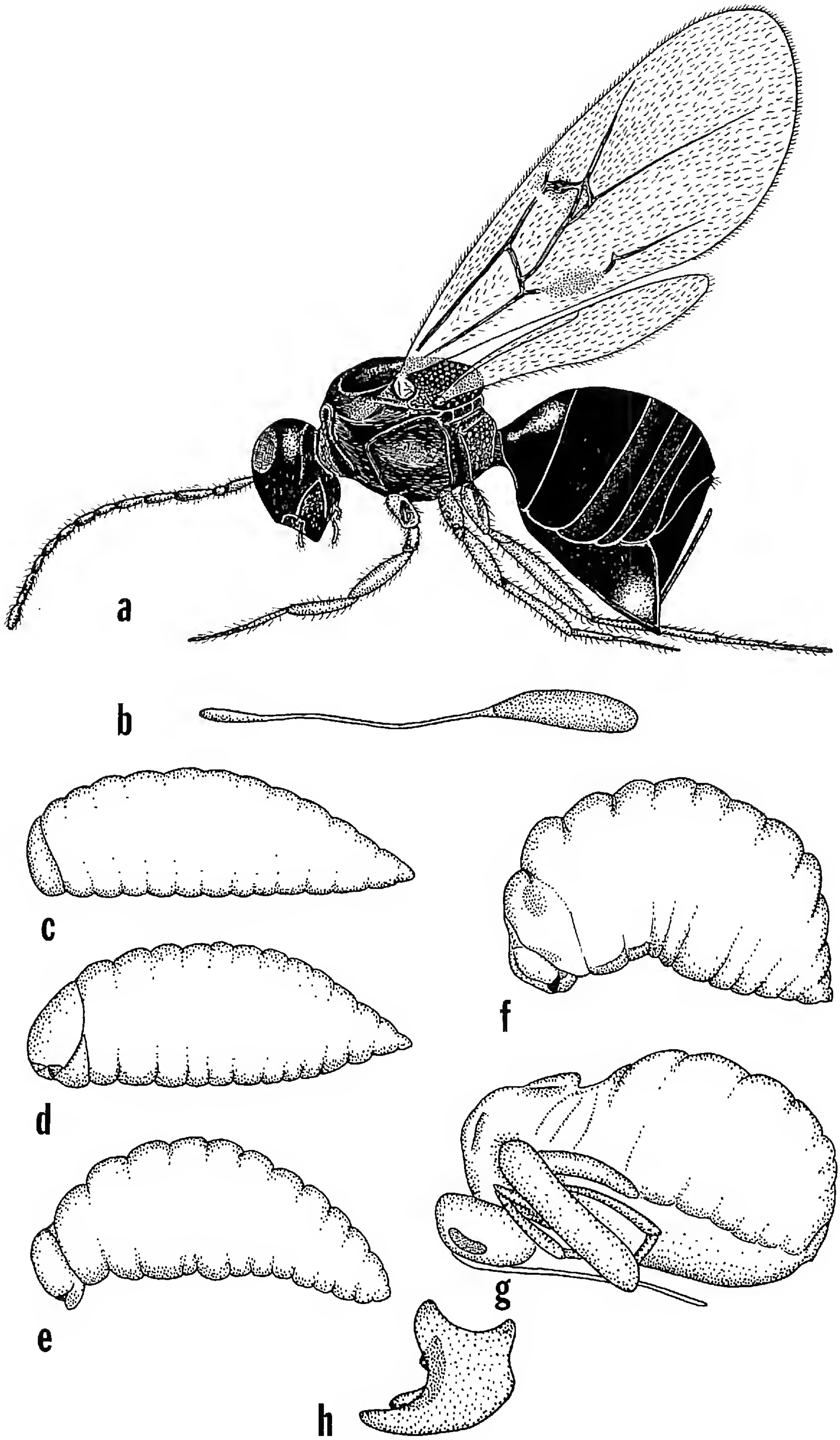

FIG. 3. Life stages of *D. kincaidii.* (a) adult, 22×, (b) egg, 68×, (c) 1st instar larva, 150×, (d) 2nd, 3rd and 4th instar larva, 90×–25×, (e) 5th instar

LIFE HISTORY

Diastrophus kincaidii is a univoltine species. The adults are relatively short lived following emergence in the spring. During the summer *D. kincaidii* passes through five larval instars and its galls become noticeable on thimbleberry. A long diapause begins as a prepupa in the fall and is broken the following spring when pupation occurs within the gall. The seasonsal occurrence of the life stages of *D. kincaidii* is summarized in Figure 2.

ADULT

Emergence. Adults emerge from galls in the spring and the emergence of all individuals within a gall is well synchronized. However, males emerge prior to females. Each adult chews through tissues of the gall to escape. The wings are fully expanded at this time. Chewing for the most part follows paths of least resistance and many adults work their way into the pith. Most adults fortuitously use exit holes created by others. Once the adult is free of the gall it is fully capable of moving about, but usually a few minutes are spent grooming or resting on the gall surface or adjacent stems. A striking characteristic of the adult is its unwillingness to fly. Neither males nor females were observed to fly in the field or laboratory. Generally, individuals wander over the surfaces of the host plant throughout adult life.

Courtship and Mating. Courtship, which occurs on various parts of the host plant, was observed many times in the laboratory and field. Upon encountering a female a male immediately shows excitement, hurriedly walks behind her and mounts from the rear without delay. In many instances males were observed to fan their wings once or twice prior to mounting. The female's response to these initial activities is always the same and is identical to her reaction to any other disturbance. Once touched by the male she crouches upon the stem or leaf so her venter touches or nearly touches the surface. Her head and antennae are held in contact with the surface and she remains motionless in this position.

The male caresses her thorax rapidly with his palps, usually touching the prothorax but sometimes caressing the mesonotum and scutellum. Simultaneously, his antennae move rapidly in front of her face, although

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larva, 17×, (f) prepupa, 13×, (g) pupa, 19×, (h) left mandible of 5th instar larva, 175×.

while she is in the crouched position they do not touch her. After three to five minutes the male may turn and touch her wings and/or abdomen with his palps; he then returns to his original position and continues caressing the thorax. It is common for the male to fan his wings at brief intervals during courtship.

The female usually remains motionless on the stem throughout the three to five minutes of courting until the male dismounts and walks away. The female then rises and continues to walk along the plant surface. Frequently the same male is attracted again and a second mating attempt may occur. It is also common for a female to simply drop from the plant to escape from the male.

After frequent encounters the female will begin to walk with a male in position for mating. He continues to court in the typical manner but with the female standing, their antennae touch. The antenna of the male alternately rubs the corresponding antenna of the female from the distal to proximal end. This movement is rapid and occurs while he continues to caress her thorax with his palps.

While the female is in the crouched position, the frequent attempts by the male to copulate are unsuccessful. Once the female is standing, however, the male is able to initiate copulation. This is accomplished when the male moves to one side of the female, grasps her wings and thorax with his forelegs and lowers himself alongside her abdomen. Their genitalia unite and mating occurs in this position.

Copulation lasts from thirty to sixty seconds. Both sexes are motionless during this period except for slight antennal movements and pulsating movements of the male's abdomen. Following copulation the male remains mounted on the female for a few seconds.

Males were often observed courting the same or different females following mating; however it is not certain that an individual male or female actually mates more than once. Males also commonly courted and attempted to mate with other males.

Oviposition. The time interval between insemination and oviposition is not known. In a single instance a female was observed to oviposit immediately after mating but the possibility of a prior mating could not be excluded in this case.

The search for a suitable oviposition site begins after the female has climbed up the stem to the current season's growth. She immediately begins an investigation of the green shoot axis and, occasionally, the petioles with her antennae. While she walks slowly and erratically over the stem, her antennae are moved up and down at a moderate rate, coming very near the surface but touching it only occasionally. When a suitable site is located she stops and both antennae are held downward with the tips directed toward this site. The antennae quiver in this position for a few seconds, then the female steps forward, arches her abdomen and inserts her ovipositor. In so doing, the sternites are bent downward forming a "V" and the ovipositor is inserted in a smooth, continuous motion. In many instances females partially insert, pause, and then may withdraw the ovipositor. This apparent testing of the site may occur once or twice before the female locates a position on the stem suitable for oviposition. Once the ovipositor is fully extended and the venter touches the stem oviposition is accomplished.

During oviposition there are pumping movements of the lower abdomen while the female remains motionless, although the antennae and legs may sometimes quiver slightly. Testing of a site with the ovipositor lasts only a few seconds but actual oviposition lasts two or three minutes. Although the passage of eggs was never observed, a brown fluid was clearly seen passing into the plant tissue at the time of oviposition. This fluid occupies the entire path of the ovipositor in the plant tissues.

The ovipositor is withdrawn in a smooth motion and the female moves and reinserts it into the stem very near the previous ovipositional site. When a number of insertions have been made, brown wounds are visible on the plant surface. These wounds occur in clusters that range in size from 4–100 mm^2 and may be located on a side of the stem or may completely encircle it.

The number of eggs deposited by a female is not known, although it must exceed 30 to 50 as this is the number of larvae in an average sized gall.

The majority of the eggs are deposited in the xylem or phloem but a few are usually also located in the cortex or outer edges of the pith. Egg orientation does not appear to follow a regular pattern.

Oviposition was observed throughout the day. Such activity is greatest with sunshine and warm temperatures. An individual female may oviposit for an entire day and I believe in some instances into the following day. By the second day when oviposition is completed, the female leaves the oviposition site and moves to the tops of the plant. Females probably do not live very long following oviposition. In some instances individuals were found dead with the ovipositor still inserted in the plant.

A gall can result from the ovipositional activities of one female but it is not uncommon for two or three individual cynipids to oviposit in the same gall site. An individual will often oviposit in a second area

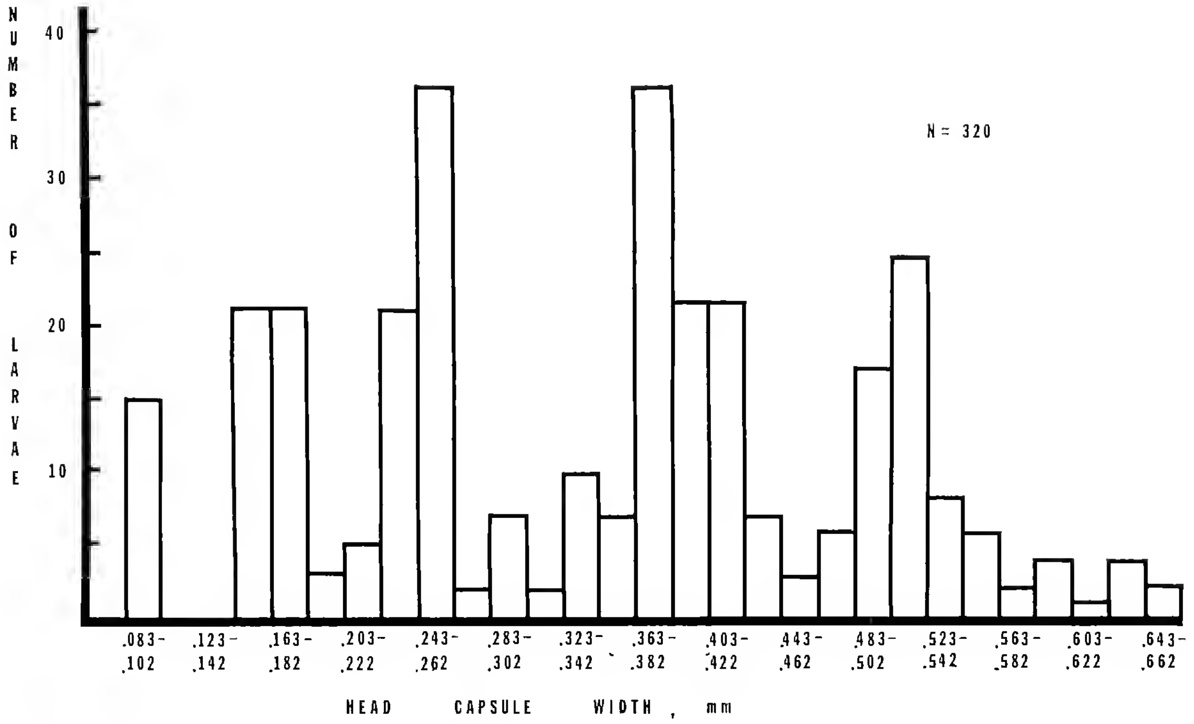

FIG. 4. Larval instars of *D. kincaidii.*

on the stem, usually above the first, but the galls which develop are consistently smaller and contain fewer larvae.

LARVA

First instar larvae are difficult to discern upon dissection of young galls. The larval cavities are not fully developed so there is little space between the larva and adjacent plant cells. The gall tissue is very wet and I believe that during the first instar ingestion of the surrounding fluid provides nourishment. The mandibles at this stage are barely detectable at 50 × magnification and movement of mouthparts cannot be seen.

By the time the second larval instar is attained, the larval cavities are well developed in a gall. The amount of parenchyma tissue surrounding the larva is extensive but the larva can move within the cavity it has made. Movement of the mandibles is now clearly visible. No changes in larval habits were observed from the second through the fourth instar.

During the fifth larval instar most galls become woody, to some extent. The fifth instar has larger, more heavily sclerotized mandibles which are adapted for chewing the dry tissues that line the larval cavity. These larvae are active within their cavities and move about to feed, thus their orientation in the cavity is not consistent. During feeding, it is common for a larva to chew through the tissue wall separating it from an adjacent larval cavity. Apparently no harm is caused when two individuals occupy a common cavity because two pupae have been frequently found within one cavity in mature galls.

PUPA

Prior to pupation the characteristic coloration of mature larvae is an opaque yellowish due to the accumulation of extensive amounts of fat body. The development of pupal characters is gradual. Pigmentation of the eyes is most evident in older individuals and the outline of legs is only vague. *D. kincaidii* undergoes diapause during the winter in this prepupal stage. The prepupa is long lasting and one can expect to find galls containing prepupae 7 months out of the year.

By late April and May most individuals are in the pupal condition. In the laboratory the pupal condition lasted from one to two weeks at room temperature; in the field this period is probably longer. The development of the pupae within a gall is well synchronized with the others and the interval passed in this stage is relatively short.

INSECT ASSOCIATES

Ten species of parasitic hymenopterans were found associated with *D. kincaidii* on thimbleberry. Most are parasites of *D. kincaidii* but some are hyperparasites. Parasitism of *D. kincaidii* larvae is extensive during the summer and oftentimes only those individuals deepest within the gall tissue escape attack. The parasitic species emerge in succession throughout the summer and *D. kincaidii* is subject to parasitism for its entire larval life.

In addition, an inquilinous weevil and an undetermined cecidomyiid midge were occasionally present within galls.

The relationships of these species and the structure of the gall community will be discussed in a subsequent paper. The following is a listing of the insect associates inhabiting galls on thimbleberry.

Parasites—Ichneumonidae:	*Orthopelma californicum* Ash.
Torymidae:	*Torymus fagopirum* O. S.
	Torymus solitarius O. S.
Pteromalidae:	*Habrocytus* sp.
	Artholytus sp.
Eurytomidae:	*Eurytoma* n. sp. near *auriceps*
Eupelmidae:	*Eupelmella vesicularis* (Retz.)
Ormyridae:	*Ormyrus* sp.
Eulophidae:	*Tetrastichus* sp.

Inquiline—Curculionidae: *Rhynchites bicolor* (Fabr.)
Uncertain relationship—Cecidomyiidae: undetermined species

ACKNOWLEDGMENTS

I wish to thank Dr. J. R. Barron, Dr. R. deRuette, Dr. C. M. Yoshimoto (Canada Department of Agriculture), Dr. E. E. Grissell (Florida Department of Agriculture) and Dr. R. E. Bugbee (Allegheny College) for the identification of the specimens. Appreciation is also extended to Dr. R. J. Lyon (Los Angeles City College) for the use of L. Weld's notes and collection. I am grateful to Dr. W. F. Barr and Dr. J. M. Gillespie (University of Idaho) for reviewing this manuscript. Finally, I wish to thank Dr. R. Hurley (Humboldt State University) for his assistance during the entire course of the study.

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GILLETTE, C. P. 1893. Two new cynipids from Washington State. Can. Entomol., 25: 110–111.

WELD, L. H. 1957. Cynipid galls of the Pacific slope. Ann Arbor, Michigan. 80 pp.

BOOK NOTICE

THE BIOLOGY OF TRIBOLIUM WITH SPECIAL EMPHASIS ON GENETIC ASPECTS. A. SOKOLOFF. Oxford University Clarendon Press, Ely House, London W. 1. Volume 1. Pp. xix + 300, 22 tables and 76 figures in text. £12.00.

This is the first of 3 volumes which will form a study of the flour beetles of the genus *Tribolium.* Judging by this part they will also be an invaluable reference for workers on other genera and families of Coleoptera, and for students in other fields, since the coverage is monographic. The 8 chapter headings are: Introduction, Taxonomic position and evolutionary trends, Morphology, Internal anatomy and histology, Electron microscopy, Developmental and post-embryonic studies, Teratological abnormalities.

Each chapter is fully documented; the figures are nearly all compound (as many as 30 drawings), and the names of anatomical parts are fully spelled out. Keys include Hinton's on the genera of Ulomini of America north of Mexico and the species of adult *Tribolium* (with Sokoloff's summary of more recent findings), and to the pupae and mature larvae of *Tribolium* from Ho. Chapter 8 on teratological abnormalities, with illustrations of examples from the genus *Tribolium*, is a particularly useful summary and includes a 4-page tabulation of recorded abnormalities in the Coleoptera.—HUGH B. LEECH, *1435 Howell Mountain Road N., Angwin, California* 94508.

The North American Species of *Triploechus* Edwards

(Diptera: Bombyliidae)

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Prior to Hull's 1973 studies of bombyliid genera, *Triploechus* Edwards was considered by most American workers to be a subgenus of *Heterostylum* Macquart. Paramonov (1947) had more or less established the generic validity of *Triploechus*, but he was never followed.

Perhaps some of the uncertainties of *Triploechus* as a distinct genus in North America lie in the fact that the genus was originally described from Chile. The two North American species were placed at that time in either *Bombylius*, *Heterostylum* or *Triplasius*. Painter, 1940 possibly unaware of Edwards' 1936 description of *Triploechus* placed all the North American species in *Heterostylum*, removed *novum* Williston from *Triplasius* Loew and synonymized *Bombylius recurvus* Coquillett with *novum*.

Paramonov (1947) was the first to point out reliable differences between *Triploechus* and *Heterostylum* and placed Loew's *Triplasius* in synonymy with *Bombylius*. Hull (1973) considers *Triplasius* a subgenus of *Bombylius*.

Triploechus was established by Edwards on the basis of the indented posterior margin of the eye, the short pulvilli and the presence of three submarginal cells in the wings. These characteristics are possessed by all of the South American species but not by all of the North American forms. Hull's recharacterization of *Triploechus* is readily available and need not be reiterated here, but in the light of present knowledge a few changes need to be made. Possibly of more significance than the number of submarginal cells is the course of vein R_{2+3}, the presence of the upper intercalary vein or medial crossvein at the base of the second posterior cell, the width of the head and the configuration of the male genital armature. A study of all the North and South American species of *Heterostylum* and *Triploechus* has led to the conclusion that *Triploechus* is a valid genus.

Most of the North American forms in *Triploechus* will not run to that genus in Hull's key to genera primarily because most have only two submarginal cells. Vein R_{2+3} is always curved upward apically or recurved and meets the costa at a right angle or less in *Triploechus*. Also in *Triploechus* the upper intercalary vein is nearly always present

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even though shorter than the r-m crossvein. It is never or rarely present in *Heterostylum.* In conjunction with these differences in venation the head in *Triploechus* species is never wider than the thorax while in *Heterostylum* it is always as wide as or wider than the width of the thorax. There are also differences to be found in the configuration of the male genitalia especially in the shape of the epiphallus.

Differences other than the number of submarginal cells between the North and South American species of *Triploechus* should be mentioned in order to establish a broader base for the genus. The North American species never have the costa tuberculate while in all the South American species this is the normal condition although a number of specimens of *bellus* (Philippi) have a smooth costa. The pulvilli in the North American species are much longer than those found in the South American forms except *novus.* Other than *novus*, the northern species are much smaller than their southern cousins. These smaller specimens actually resemble, in habitus, *Bombylius* more than *Heterostylum. T. novus* and the Chilean species *heteroneurus* (Macquart) are remarkably similar but rather easily separated by the male genitalia.

The new species described herein are all similar in habitus. As stated above they resemble *Bombylius* species more than *Triploechus* species. In some respects they occupy an intermediate position between *Bombylius*, *Heterostylum* and *Triploechus* sharing characteristics with all three genera. They are placed in *Triploechus* on the basis of the indented posterior margin of the eye, the apically upward curvature of vein R_{2+3} and the male genitalia, although it should be mentioned that the genitalia of *sackeni* (Williston) approaches that of *Heterostylum.*

KEY TO THE MALES OF *TRIPLOECHUS*

1. Eyes separated, usually only narrowly so by less than width of median ocellus 2
– Eyes contiguous; arista distinctly two segmented; pulvilli short, less than half the length of the claws .... *novus* (Williston)
2. Legs mostly fulvous, femora may be dusky at base or middle 3
– Legs black, tibiae may be testaceous at most .... *sackeni* (Williston)
3. Black hairs present on underside of hind femora and usually on mid femora; first antennal segment fulvous with black hairs above .... *stagei* new species
– Legs entirely white pilose; basal antennal segment black with white hairs above .... *luridus* new species

KEY TO THE FEMALES OF *TRIPLOECHUS*

1. Legs black, tibiae testaceous at most 2
– Legs fulvous, femora dusky toward base at most; first antennal segment fulvous with yellow hair .... *stagei* new species

2. Hind femora with at most a few bristles on apical half; pulvilli more than half as long as claws 3
– Hind femora with strong bristles along the ventral surface; pulvilli less than half as long as claws .... *novus* (Williston)
3. Abdominal segments two to seven with black hairs on posterior margin; body pile in general whitish .... *sackeni* (Williston)
– Body pile predominately yellowish, no black hairs on the abdomen .... *luridus* n. sp.

Triploechus sackeni (Williston), new combination

Comastes sackeni Williston, 1893: 255.
Heterostylum sackeni, Painter, 1930: 3, Painter and Painter, 1965: 411.

Williston's type female in the Snow Collection at the University of Kansas is in fair condition, but one wing, four legs and one antenna are missing; however the body vestiture is quite intact. In general it is a little larger than most of the specimens before me and the color of the wings is quite light.

Since the original description is short and incomplete and of the female only, the male and female of this species are herein redescribed completely.

Male.—Small, 6–7 mm. Ground color dull grayish, in some lights with a greenish cast, head cinereous, tibiae brownish to dark testaceous; occasionally with three gray longitudinal stripes on thoracic dorsum. Eyes separated by a little less than width of median ocellus. First antennal segment five times length of second segment, with black and white hair above, white hair at sides and below, second segment bare, one-third wider than long; third segment four times longer than first, linear, gradually tapering from base to apex, arista terminal, small, shorter than width of third segment at apex. Head white pilose with a few black hairs on ocellar tubercle and upper half of face on each side of antennae. Proboscis projecting beyond oral margin for a distance more than length of hind femur. Palpi short with short white hair. Thorax and scutellum white pilose with scattered black hair present on former, tomentum wanting, bristles white. Legs with white hair and tomentum, bristles testaceous; pulvilli more than half as long as claws. Halter stem testaceous, knob white. Squama brownish with fringe of long white hair. Widened base of costa with black setulae, costa without tubercles. Wing hyaline, basal half or less suffused with light brown, outline of color indistinct; vein R_{2+3} curved upward meeting the costa at a right angle, petiole at tip of first posterior cell about equal in length to r-m crossvein, upper intercalary vein present, shorter than r-m crossvein, two submarginal cells, r-m crossvein beyond middle of discal cell, axillary cell at base wider than anal cell, alula well developed. Abdomen white pilose and tomentose, posterior margins of all segments except the first with long scraggly black hair, tomentum dense on apical segments; venter white pilose. Genitalia small, (Fig. 1), epiphallus thick, curved upward apically, rounded below, aedeagus short, straight, not projecting beyond epiphallus; dististylus not strongly hooked apically, concave on outer margin; basistylus boat-shaped, lower margin convex.

Female.—Eyes separated by four times width of ocellar tubercle; front with black hair laterally; tibiae light testaceous; proboscis projecting beyond oral margin for distance twice length of hind femur; a few white hairs at base of costa, white tomentum present on mesonotum, pubescence on abdomen much denser than in male, seventh sternite broadly rounded apically; otherwise as described for male.

Holotype female from ARGUS MTS., SAN BERNARDINO CO., CALIFORNIA, May 1891. In Snow Collection, University of Kansas. Painter, 1930 designated a male in the S. J. Hine collection as the androtype (sic).

Specimens have been studied from: California, San Bernardino Co., 17 ♂ ♀, Kramer Hills, IV-18-62 (J. C. Hall); 1 ♂, 5 mi. W. Desert Springs, IV-11-62 (J. C. Hall, E. I. Schlinger); 2 ♀, 20 mi. N. Adelanto, IV-18-62 (J. C. Hall, E. I. Schlinger); 4 ♂ ♀, Granite Pass, IV-27-68 (E. I. Schlinger, C. Beesly), 3800–4320 ft.; ♂ ♀, Phelan, IV-4-71, V-4-66 (T. Plichta, J. C. Hall); 12 ♂ ♀, 8 mi. N. Llano, IV-11-62 (J. C. Hall, E. I. Schlinger); ♀, Little Morongo Cyn.; V-1-62 (J. C. Hall). Riverside Co., 7 ♂ ♀, Riverside, IV-9-37, V-1-69, III-15-39, IV-2-69, IV-15-73 (P. H. Timberlake, J. C. Hall, M. E. Irwin, T. Plichta); 3 ♂ ♀, Palm Springs, III-5-33, III-24-35, III-3-71 (P. H. Timberlake, J. C. Hall); 4 ♂ ♀, Chuckwalla Mts., III-29-58 (G. M. Nicolls); ♀, Mecca, III-31-58 (F. Colley); ♀, 6 mi. S. Cottonwood Spgs., IV-5-66 (F. G. Andrews); 2 ♀, 11.5 mi. N.W. Alberhill, V-11-69 (J. C. Hall); ♀, Coyote Creek, III-22-63 (E. I. Schlinger); 1 ♂, Millard Cyn., IV-26-69 (B. Hunt); 1 ♀, 3 mi. E. Edom, III-14-37 (P. H. Timberlake); ♀, 3 mi. N. North Palm Springs, II-25-68 (M. E. Irwin); P. L. Boyd Desert Research Center, Deep Canyon, 3.5 mi. S. Palm Desert, numerous dates in April and May (various collectors). Imperial Co., 2 ♀, 6.2 mi. W. Glamis, III-2-69 (M. E. Irwin). San Diego Co., ♂, 4 mi. E. Jacumba, IV-31-66 (J. Wilcox); ♂, 5 mi. E. Calexico, I-27-73 (J. Pinto); ♂, Vallecito, III-15-68 (J. C. Hall); ♀, Fallbrook, V-1-60 (G. Goldman). Los Angeles Co., 3 ♂ ♀, Soledad Cyn., 3 mi. N. Acton, IV-27-67 (J. C. Hall). Kern Co., ♀, 14.4 mi. N. Johannesburg, III-27-71 (T. Plichta). Inyo Co., ♂ ♀, Nine Mile Cyn., IV-6-71 (T. Plichta). Arizona, ♀, 4 mi. E. Benson, Cochise Co., IV-10-63 (G. L. Stage); ♂ Aztec, Yuma Co., IV-16-41 (J. Wilcox, Jr.).

Triploechus luridus new species

Quite similar to *stagei*, new species from which it can be separated by the black basal antennal segments and the absence of black hair on the head.

Male.—9–10 mm. Ground color dull black, head cinereous, mesonotum with three gray stripes, palpi, base and sometimes apex of femora, tibiae, sides of apical

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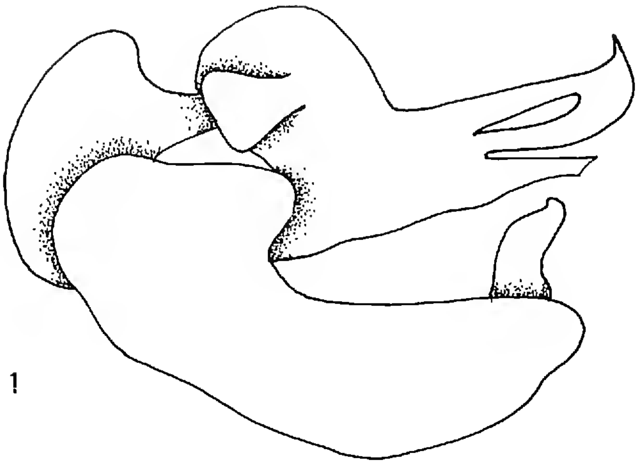
Lateral view of the male genitalia. All drawn at the same scale.

FIG. 1. *T. sackeni* (Will.)
FIG. 2. *T. luridus* n. sp.
FIG. 3. *T. novus* (Will.)
FIG. 4. *T. stagei* n. sp.



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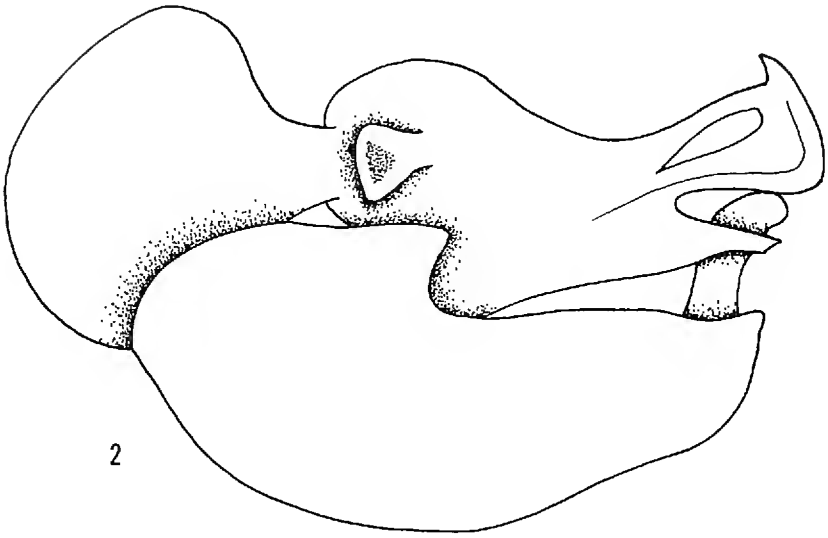

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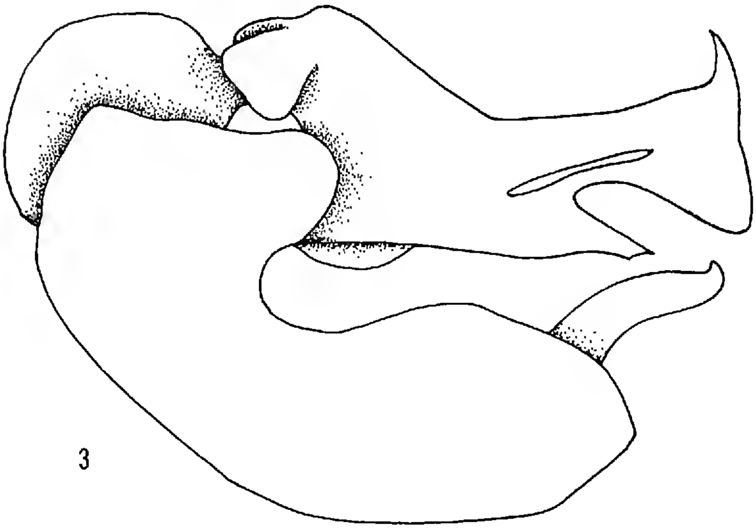

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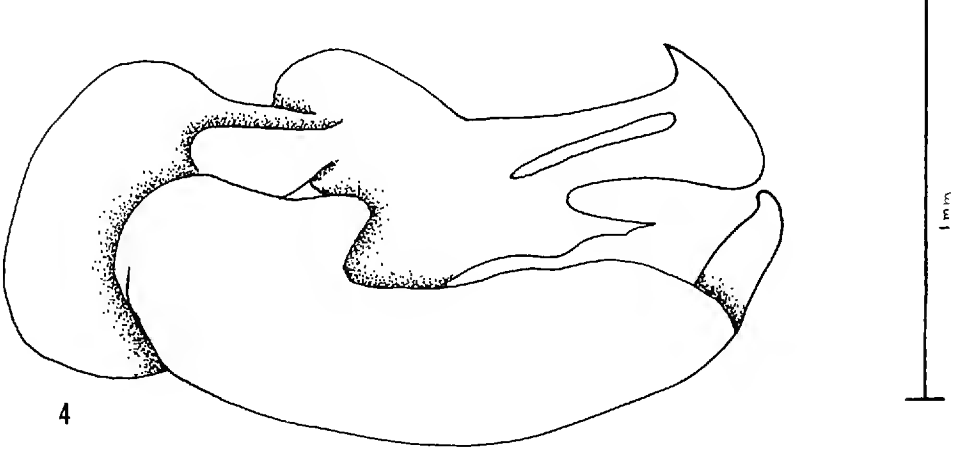

4

abdominal segments and nearly all of venter fulvous. Eyes separated by little less than width of median ocellus. Antennae black, first segment at least three times longer than second segment which is a little wider than long, third segment linear, tapering from base to acuminate apex, twice as long as two basal segments combined. Proboscis projecting one and one-half times length of hind femur beyond oral margin. Head white pilose as is first antennal segment, front with a narrow median longitudinal bare stripe from anterior ocellus to base of antennae. Body pile whitish to pale yellow, lighter on pleura, legs and venter. Apical bristles on hind femur thin, hair-like. Pulvilli more than half length of claws. Squama brownish with fringe of pure white hair. Halter stem testaceous, knob white. Basicosta with whitish-yellow hair and black setulae. Wing hyaline, lightly suffused with brown on basal half, outline of color indistinct; apex of vein R_{2+3} curved upward meeting costa at right angle; petiole of first posterior cell as long as r-m crossvein; upper intercalary vein small; r-m crossvein beyond middle of discal cell; axillary cell wider than anal cell on basal half; alula well developed, hyaline. Abdomen entirely pale yellowish to white pilose, tomentum of same color not dense, scattered on apical segments. Genitalia small, (Fig. 2), epiphallus, in lateral view parallel sided, apex curved upward rounded and slightly lobed below; aedeagus straight, projecting about half length of epiphallus; dististylus not apically hooked, curved outward; basistylus narrow, lower margin broadly curved.

Female.—Eyes separated by four times width of ocellar tubercle; front with yellow tomentum, body pile and tomentum yellowish; wing nearly entirely hyaline, brown coloring light, legs entirely fulvous. Otherwise as described for male.

Holotype male and *allotype* from P. L. BOYD DESERT RESEARCH CENTER, 3 MI. S. PALM DESERT, RIVERSIDE, CALIFORNIA, III-28-73, IV-10-73 (A. Tabet). Both in California Academy of Sciences.

Paratypes. Four topotypic collected with types. 1 ♂, Borrego, Riverside Co., California, IV-19-41 (J. Wilcox, Jr.); 2 ♂, 25 mi. N.W. New Cuyama, Santa Barbara Co., California, VI-8-63 (G. I. Stage).

TRIPLOECHUS NOVUS (Williston)

Triplasius novum Williston, 1893: 254.
Heterostylum vierecki Cresson, 1919: 186 new synonymy.
Bombylius recurvus Coquillett, 1902: 100.
Heterostylum novum, Painter, 1940: 279.
Triploechus novum, Paramonov, 1947: 191; Painter and Painter, 1965: 411. (as a subgenus of *Heterostylum*); Hull, 1973: 141.
Triploechus vierecki, Painter and Painter, 1965: 411 (as a subgenus of *Heterostylum*).

T. novus is a widespread species commonly found in the deserts of Arizona and California. Because of the rather wide distribution a considerable amount of variation is present particularly in the distribution of the black hair on the head and body. Likewise, most of the specimens studied have only two submarginal cells, some have two in one wing and three in the other and some have three submarginal cells in each wing. In nearly all of the specimens with two submarginal cells there is a stump of a vien projecting downward towards vein R_4 which if continued would form the third cell.

In general the females have paler hair than the males. The major differences noted between *vierecki* and *novus* are the white hair and shape of the antennae and more abundant black hair on both the scutellum and the abdomen. In a series of specimens collected at the same time and place variation in all three characters is evident. The females usually have mostly white hair on the antennae while in the males the black predominates. The shape of the antennae varies according to what angle viewed from. The scutellum may be entirely black haired, with only one or two black hairs, or any gradation between. Several conditions are found on the abdomen; black hair on segment two and at apex only, on segments two and three or on two, three and four as well as at the apex. The ground color of the fourth and fifth abdominal segments is also subject to considerable variation. It may be as in *vierecki*, that is, pale except for median spots of black or only one of the two segments pale or both entirely black. I have two specimens which have the sides of all the segments except the first pale. A study of the male genitalia (Fig. 3) leaves little doubt as to the synonymy listed above.

This species is known throughout southern California, Arizona, New Mexico and Texas. Most of the specimens were collected in April.

Triploechus stagei new species

Readily separated from other species by the nearly entirely fulvous legs and first antennal segment.

Male.—9–10 mm. Ground color dull black, head cinereous; first antennal segment, upper side of face somewhat, legs except coxae and trochanters, sides of fourth and following abdominal segments and genitalia partially fulvous. Eyes nearly contiguous above, separated by about width of a single ommatidium. First antennal segment four times longer than square second segment, third segment linear, gradually tapering from base to apex, about one and one half times longer than two basal segments combined. Front with black to brown hair becoming yellowish towards side below; ocellar tubercle and first antennal segment above with black hair, the latter with pale yellow hair at side and below. Face yellow pilose, with black hair laterally above, white hair on underside of head and on occiput. Proboscis projecting beyond oral margin for a distance about equal to length of hind femur. Body pile pale yellow to light yellowish-gray, lighter on pleura and venter. Legs white to pale yellow pubescent, mid and hind femora with scattered black hair on antero-ventral surface, bristles on hind femur on apical half only; pulvilli nearly as long as claws. Squama brownish with fringe of long pale yellowish hair. Halter stem flavo-testaceous, knob white. Basicosta with short whitish hair and black setulae; costa not tuberculate. Wing hyaline, basal half suffused with brown, color not sharply delineated; vein R_{2+3} curved upward at apex to meet costa at nearly a right angle; petiole of first posterior cell as long as r-m crossvein; upper intercalary vein short; r-m crossvein a little beyond middle of discal cell; axillary cell at base much wider than anal cell; alula well developed. Abdominal dorsum pale yellowish to whitish pubescent, long black hair across posterior margin of all segments except the first; tomentum consists of short, recumbent, somewhat curly hair. Venter white pilose, a few black hairs present at apex. Genitalia small, (Fig. 4), epiphallus eurved upward apically, lower portion of tip of epiphallus somewhat lobed; aedeagus short extending about half length of epiphallus; diststylus not strongly hooked apically, posterior margin nearly straight; basistylus narrow, curved below.

Female.—Eyes separated by two and a half times width of ocellar tubercle. Front entirely yellow pilose, a few black hairs present on each side at vertex, bare stripe present down front from ocellar tubercle to antennae. Side of abdomen fulvous at base, last three or four segments entirely fulvous. Wing coloring lighter than in male. Body pile and tomentum more yellowish, tomentum more dense. Otherwise as described for male.

Holotype, *allotype* and seven paratypes from SAN FELIPE, BAJA CALIFORNIA, MEXICO, III-27-63 (G. I. Stage). Types in California Academy of Sciences.

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Siricid Woodwasps and Their Associated Parasitoids in the Southwestern United States

(Hymenoptera: Siricidae)

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Since 1962 the Division of Entomology, CSIRO, has been involved in the biological control of *Sirex noctilio* F which was accidentally introduced into and has become established in plantations of *Pinus radiata* D. Don in southeastern Australia. Insect parasitoids and parasitic nematodes of siricids have been collected in the northern hemisphere and consigned to Tasmania for culturing and subsequent release in infested areas of Tasmania and Victoria. Earlier collecting in North America has been confined to California and Nevada and eastern Canada (Taylor 1967; Lloyd 1968, 1970). Ten species of siricids and six species of hymenopterous parasitoids were known to be present in Arizona, Colorado, and New Mexico (Cameron 1965), the three states I surveyed in 1971.

During April to August 1971 dead or dying coniferous trees and associated branches, logs and stumps were examined for signs of siricid larvae or galleries. Infested material was cut into one metre lengths and transported to outdoor cages at Flagstaff, Arizona. The logs were separated into groups according to locality and tree species. With limited time available the main emphasis of the work was placed on obtaining exact identifications of trees and the insects emerging from them. Precise daily records were made of insect emergence and from these their flight periods were determined. Insects were reared from 11 localities in northern Arizona, 2 localities in New Mexico, and from the San Juan Mountains in Colorado.

RESULTS

The siricids *Sirex cyaneus* F., *S. juvencus californicus* (Ashmead), *S. longicauda* Middlekauff, *Urocerus californicus* Norton, *U. gigas* L., *Xeris morrisoni morrisoni* Cresson and *X. spectrum* L. were reared from *Abies concolor* (Gord. & Glend) Lindl, *A. lasiocarpa* (Hook) Nutt, *Picea engelmanni* Parry and *Pinus ponderosa* Laws. (Table 1).

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TABLE 1. Insect emergence from stored material.

Host Tree	No. of Logs	Mean Diam. (cm.)	Sir.c	S.j.c.	S.l	U.c.	U.g	X.m	X.s	R.h	R.p	M.n	Sch.c	I.l.e	I.m	I.rc	I.rp	P.m
P. ponderosa	54	9.3	—	—	—	—	—	—	x	x	—	—	x	—	—	—	—	—
Pa. engelmanni	8	28.0	—	—	—	—	—	—	x	—	x	—	—	—	—	—	—	x[a]
A. lasiocarpa *A. concolor*	14	41.0	x[a]	—	—	—	—	—	x	—	x[a]	—	—	—	—	—	x[b]	x
P. ponderosa	19	9.1	—	—	—	—	—	—	x	—	x	—	—	—	—	—	—	—
P. ponderosa	23	9.5	—	—	—	—	—	—	x	x	x	x	x	—	—	—	—	—
A. concolor	13	28.1	x[b]	—	x	x[a]	—	x[a]	—	—	x[b]	x	x	—	—	—	x[b]	—
P. ponderosa	76	12.4	—	x[a]	—	—	—	—	x[a]	x	x[b]	x[a]	x[a]	—	—	x	x[b]	—
Pa. engelmanni	17	27.4	x[a]	—	—	—	—	—	x[a]	—	x[b]	x	—	x	—	—	—	—
A. concolor	6	15.3	—	—	—	x	—	x[a]	—	—	x	x	—	—	—	—	—	x
A. concolor	4	27.4	x[a]	—	—	—	x[a]	—	x	—	x[a]	—	—	—	—	—	x[b]	—
P. ponderosa	4	9.3	—	x[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P. ponderosa	23	7.4	—	—	—	—	—	—	x	x	—	—	x	—	—	—	—	—
A. concolor	14	16.7	—	—	x	x	—	x	—	—	x[a]	—	x	—	x[a]	—	—	—
A. concolor	48	26.0	x[a]	—	—	—	—	—	x[a]	—	x[a]	x[b]	—	—	—	—	x[b]	—
EMERGED 1971			347	186	106	41	11	113	150	161	111	64	358	10	43	210	—	10
EMERGED 1972			106	51	—	2	2	10	148	—	198	79	41	—	4	—	115	10

[a] Part emerged 1972.
[b] All emerged 1972.

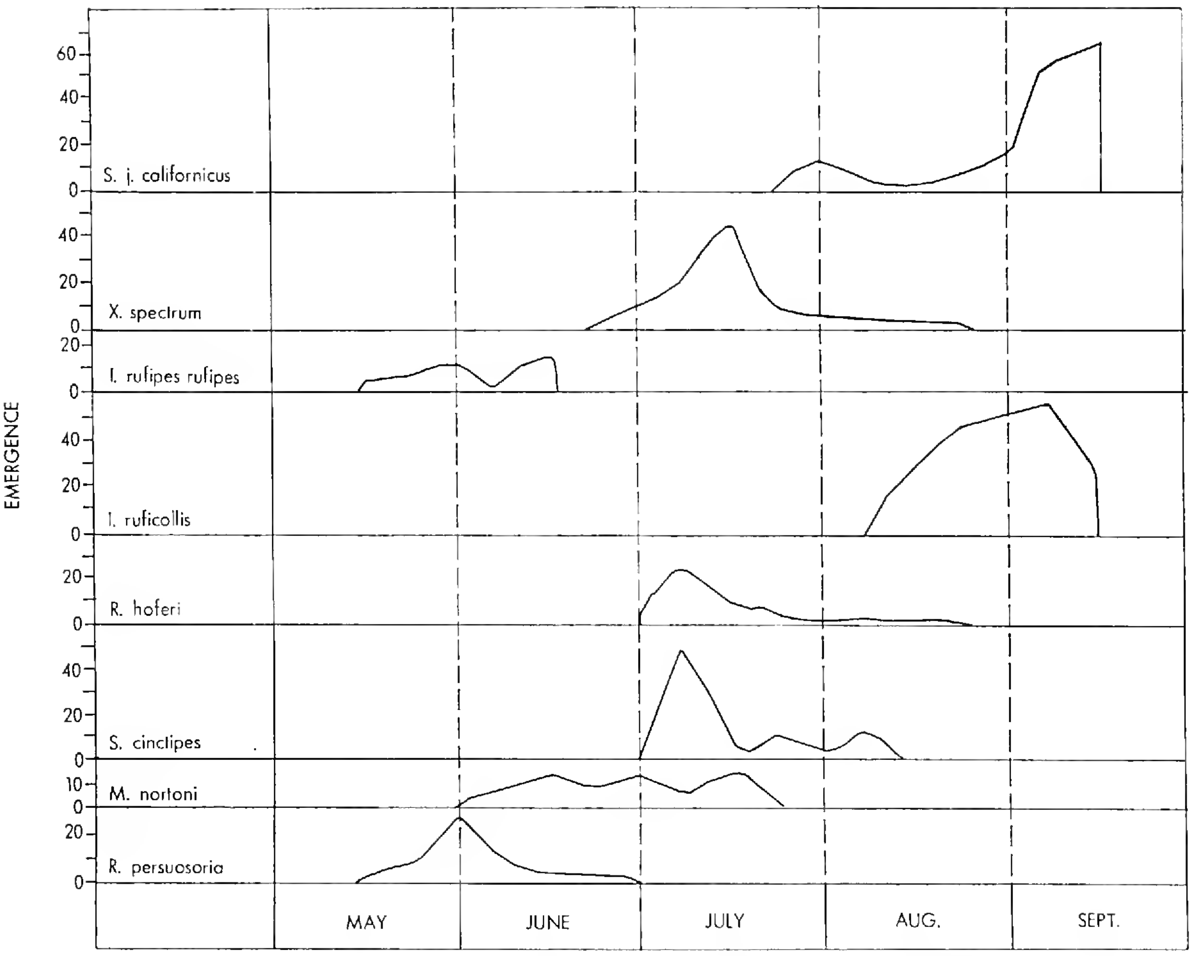

Fig. 1. Seasonal emergence of siricids and associated parasitoids from logs collected at Happy Jack, Arizona.

Nine species which are known to be parasitoids also emerged. These were the ichneumonids *Rhyssa alaskensis* Ashmead, *R. hoferi* Rohwer, *R. persuasoria* L. and *Megarhyssa nortoni nortoni* Cresson; the ibaliids *Ibalia leucospoides ensiger* Norton, *I. montana* Cresson, *I. ruficollis* Cameron and *I. rufipes rufipes* Cresson; and the stephanid *Schlettererius cinctipes* (Cresson) (Table 1). The cleptoparasite *Pseudorhyssa maculicoxis* (Kreich) was found associated with *R. persuasoria* at three localities in Arizona (Table 1). The timber was stored over the winter of 1971/72 and another 766 insects emerged during 1972 (Table 1). More than 50% of the insects which emerged were parasitoids, but this cannot be taken as a true figure for parasitism because insect emergence had already taken place from some of the material collected.

Discussion

Rather homeostatic conditions prevail in many of the undisturbed western United States coniferous forests (Hagen *et al.*, 1971), and epidemic outbreaks of insects are relatively rare (Balch, 1960). No evidence was found of current siricid epidemic outbreaks during the

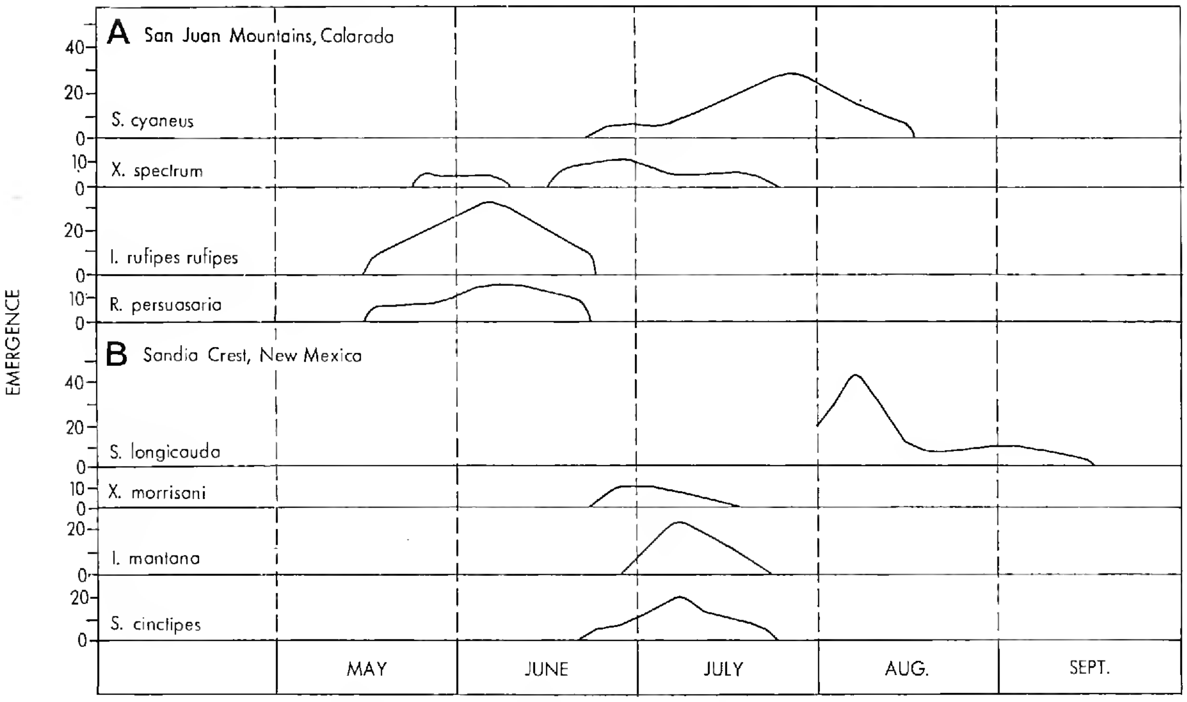

FIG. 2. Seasonal emergence of siricids and associated parasitoids from logs collected at A. San Juan Mountains, Colorado; B. Sandia Crest, New Mexico.

survey. The coniferous forests of the southwestern United States appear to be very diverse and stable communities, therefore it seems likely that host specific associations between insects and trees would have evolved. Evidence that seems to substantiate this is that *S. juvencus californicus* was associated only with *Pinus* spp. and *S. longicauda, U. californicus* and *X. morrisoni* were associated only with *Abies* spp. (Table 1). Less specialized relationships were found with *S. cyaneus*, which emerged from both *Abies* and *Picea*, and *X. spectrum*, which emerged from these as well as *Pinus* (Table 1). In addition Spradbery and Kirk (unpublished data), after eight years of extensive survey work and intensive collecting of siricid infested material and subsequent meticulous rearing, have evidence that there are distinct siricid coniferous tree associations in Europe and neighbouring areas. While the apparent siricid host tree associations in the southwestern United States described above cannot be regarded as conclusive without further data, there are good reasons for thinking that they are firm associations.

R. hoferi and *I. ruficollis* only emerged from *Pinus* (Table 1) and may be associated with *S. juvencus californicus. R. persuasoria, M. nortoni nortoni* and *S. cinctipes* attacked a wider range of siricid species from different host tree species (Table 1).

Relationships between siricids and parasitoids are clearly seen when the flight periods of the three ibaliid species are examined. *I. rufipes*

rufipes and *I. montana* have early summer flight periods and could only attack overwintered siricid larvae (Figs. 1, 2). The closely related *I. rufipes drewseni* Borries in Europe (Kerrich, 1973) behaves in the same way (Spradbery, 1970). *I. ruficollis* has an early autumn flight period and was observed to attack *S. juvencus californicus* larvae late in September. The closely related *I. leucospoides leucospoides* (Hochenwarth), (Kerrich, 1973), from Europe and neighbouring areas also attacks siricids in autumn, active females being noted in Tunisia as late as November (Spradbery and Kirk, unpublished data).

Much further work needs to be done to clarify the role of parasitoids in the suppression of siricid populations in the southwestern United States, but present evidence indicates considerable importance.

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A Reconsideration of the Nearctic *Rhexoza*[1]

(Diptera: Scatopsidae)

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The examination of two collections of specimens sent to me for identification by Dr. H. J. Teskey of the Entomology Research Institute of the Canadian Department of Agriculture revealed two new species of the scatopsid genus *Rhexoza.* This has prompted me to reexamine the North American species of this group and has also given me the opportunity to make a decision on the status of the Quatei group of that genus which I described in 1956. I noted in both 1971 and 1972 that this group is certainly distinct from *Rhexoza, sensu stricto.*

Swammerdamella, *Rhexoza* and the species constituting the Quatei group are closely related, or at least they share characters not present in other genera. There are also several shared characters with *Coboldia*, so these 4 genera should all be included in the Swammerdamellini. This is a new placement for *Coboldia* since I previously included it in the Scatopsini. However, the large, reniform maxillary palpi; the long, triangular, anterior spiracular plate; the relatively short R complex, ending only slightly beyond the middle of the wing; and the presence of lower epimeral setae all indicate a much closer affinity with *Rhexoza* than with *Scatopse* or *Reichertella.*

The tribe Swammerdamellini, then, consists of *Swammerdamella*, *Rhexoza*, *Coboldia* and the new genus described here.

The genera in this tribe can be readily discriminated by use of the following key.

1. Length of costa between R_1 and R_3 less than or no longer than length of R_1; fork of M no longer than or shorter than stem. Males with abdominal segment 7 concealed in segment 6 .... *Swammerdamella*
   Length of costa between R_1 and R_3 greater than length of R_1; M fork longer than stem; abdominal segment 7 visible in males 2
2. Male with tergum 7 produced posteriorly as a narrow, spatulate process, genitalia with elongate, coiled penis; female with small valvifers on sternum 8, with rounded, bare emargination on posterior margin of sternum 7 .... *Coboldia*

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Male with tergum 7 produced posteriorly as a broad triangle, penis small, never coiled; female without posterior emargination on sternum 7 3

3. Male genitalia laterally compressed, tergum 9 produced ventrally in a beak-like process (fig. 6); female with tergum 8 medially divided (fig. 4) .... *Quateiella*

Male genitalia not laterally compressed, tergum 9 not produced ventrally; female with tergum 8 entire .... *Rhexoza*

QUATEIELLA, New Genus

The existence of a super specific taxon for the species included here was first recognized by Cook in 1956. The taxon was then treated simply as the quatei group of the genus *Rhexoza.* I now believe that the group is sufficiently distinct to raise to full generic status. It shares the four characters noted above with the other genera in the Swammerdamellini but the male genitalia are very distinctive. They, in fact, are more like those of some *Reichertella* in the Scatopsini.

Description.—Antennae 10-segmented (8 flagellomeres), about as long as total head height; cardo-stipites rather broad, bandlike, sclerites fused posteriorly and beset with setae on each side; maxillary palpi large, reniform, 0.10–0.13 mm long; occiput setose and microtrichiose; eyes with setae between facets. Thorax with elongate, triangular spiracular sclerite (fig. 1); supraalar setae 8–18, in a single row (fig. 1); preepisternals 7–14; anepisternals 18–28; upper episternals 5–12; subalars 6–12; subspiraculars 3–7; lower epimerals 3–8; pedicellars 1–4; wing venation like that of *Rhexoza* with costal-radial complex ending near middle of wing; M fork long, M1 and M2 diverging to wing margin; setae on costa, radial complex and posterior wing margin; setae rarely on ventral surface of R3, always present on dorsal surface; membrane with dense microtrichia. Abdomen with 7 segments; sterna 1–4 unsclerotized; abdomen setose and microtrichiose; tergum 7 of male posteriorly produced, sternum 7 with modified posterior margin. Genital vesica and apodemes of male small; male genitalia rotated 180°, with only 1 pair of appendages, penis inconspicuous, tergum 9 without processes but produced more or less "beak-like" ventrally. Female genitalia with tergum 8 medially divided, cerci small, no obvious appendages or valvifers, spermatheca spherical to broadly elliptical. Type-species of the genus: *Rhexoza quatei* Cook.

KEY TO ADULTS OF QUATEIELLA

Tergum 9 of male with dorsally projecting horns; female with sternum 9 bearing 10 or more setae in elongate cluster .... *miniscula*

Tergum 9 of male without dorsal horns; female with sternum 9 bearing 5–7 setae near posterior margin only .... *quatei*

QUATEIELLA QUATEI (Cook), New Combination

Rhexoza quatei Cook, 1956: 8–10.

Male.—Total length 1.20–1.55 mm; greyish brown to dark blackish brown, dull to feebly shining; halteres dark grey; wings clear, shining. Antennae with each flagellomere bearing 10–13 setae; cardo-stipites fused posteriorly, each side with 12–15 setae in 2 irregular rows; maxillary palpi large, reniform, 0.11–0.13 mm long; 2 campaniform sensilla on each side of occiput immediately behind eyes and below level of antennae, 1 sensilla laterad of each lateral ocellus. Supraalar setae 8–13; preepisternals 8–12; anepisternals 23–28; upper episternals 5–8; subalars 6–12; subspiraculars 3–5; lower epimerals 4–7; pedicellars 2–3. Wing length 1.00–1.20 mm; R3 extends 0.49–0.53 of total wing length; M1 and M2 divergent to wing margin; setae on costa and R, none on M, only on dorsal side of R3; wing surface with obvious microtrichia. Abdomen with sterna 1–4 unsclerotized, terga all present; terga and sterna setose and microtrichiose; 7 pairs of spiracles; tergum 7 (fig. 2) with 2 stout, setose processes arising from under posterior margin (possibly tergum 8); sternum 7 with deep, triangular emargination posteriorly; genital vesica and apodemes small, 0.12–0.13 mm long. Genitalia in fig. 5.

FEMALE.—Like male in color, structure and chaetotaxy except rather more setose. Each flagellomere with about 8 setae; cardo-stipites with 16 setae on each side. Supraalar setae 8–18; preepisternals 13–14; anepisternals 25–37; upper episternals 5–12; subalars 8–12; subspiraculars 3–7; lower epimerals 6–8; pedicellars 1–2. Wing length 1.30–1.38 mm.

DISTRIBUTION.—Originally described from California: Davis, Riverside, Coachella, Rialto, Anaheim, Olive. A long series of additional specimens has become available from San Bernardino, California, June 6, 1960, reared from *Echinocactus polycephalus*. Earlier records included specimens from Citronella bait traps.

The females reared from *E. polycephalus* seem to be one species only. These were associated with large numbers of males of *quatei* and a few males of *R. ryckmani*. Also associated were even larger numbers of *Coboldia fuscipes* (Mg.).

QUATEIELLA MINISCULA (Cook), New Combination

Rhexoza miniscula Cook, 1956: 10.

MALE.—Total length 1.30–1.74 mm; dark grey brown, feebly shining; halteres dark grey. Antennal flagellomeres each with about 9 setae; cardo-stipites with 11 setae on each side; maxillary palpi 0.10 mm long, reniform; campaniform sensilla as in *Q. quatei*. Supraalar setae 9–11; preepisternals 7; anepisternals 18; upper episternals 7; subalars 8; subspiraculars 5–7; lower epimerals 3; pedicellars 1–4. Wing length 1.00–1.24 mm; R3 .50 total wing length; setae on costa and R, none on M; R3 with only dorsal setae; wing with obvious microtrichia. Abdomen with sterna 1–4 undifferentiated; terga all present; terga and sterna setose and microtrichiose; tergum 7 (and possibly 8) as in *Q. quatei* except posterior processes stouter (fig. 3). Genital vesica and apodemes 0.18 mm long; genitalia as in fig. 6.

FEMALE.—Total length 1.55–1.97 mm; wing length 1.10–1.38 mm; colored as in male. Like the males except some differences in pleural setal counts. Flagellomeres each with 10 setae; cardo-stipites with 14 setae on each side. Supraalar setae 9–10; preepisternals 7; anepisternals 26; upper episternals 7; subalars 7; subspiraculars 7; lower epimerals 1–2; pedicellars 1–2. Genitalia as in fig. 4.

DISTRIBUTION.—Originally described from Virginia, South Carolina and Texas. Additional specimens have been seen from Texas and from Nogales, Arizona.

RHEXOZA Enderlein

Rhexoza Enderlein, 1936: 55; Cook, 1956: 1–12; 1972: 58–61; 1972: 632–634. Type-species: *Rhexoza zacheri* Enderlein = *Scatopse subnitens* Verrall.

DIAGNOSIS.—Antennae with 8 flagellomeres; maxillary palpi large (0.09–0.18 mm), reniform, sometimes apically acute ("slipper-shaped"); cardo-stipites a band-like sclerite fused posteromedially, bearing several rows of setae; with campaniform sensilla as in *Quateiella*; occiput setose and microtrichiose; eyes with setae between facets. Supraalar setae numerous, a dense row of 9 or more; the usual pleural setae present and some with lower epimeral setae, episternal setae very evident. Wing venation like that of *Coboldia fuscipes* (Mg.) with costal-radial complex ending near middle of wing (0.45–0.57 of total length from base); M fork complete; setae present on costa, R and posterior wing margin only; membrane with short, abundant microtrichia. Abdomen with 7 evident segments in both sexes; male with 7 pairs of spiracles, females with 8; all terga evident, anterior sterna reduced or absent; terga and sterna with microtrichia in addition to setae; segment 7 of male posteriorly modified either on tergum, sternum or both; genital vesica and apodemes small. Male genitalia rotated 180°, with only 1 pair of appendages; tergum 9 without processes; penis stout, conspicuously sclerotized. Female genitalia with tergum 8 large or small, never completely divided longitudinally, cerci large or small, setose; spermatheca spherical to elliptical.

KEY TO THE SPECIES OF RHEXOZA

MALES: (males of *R. borealis* and *R. amaryllis* unknown)

1. With lower epimeral setae (fig. 1); R3 with only dorsal setae 4
   Without lower epimeral setae; R3 with dorsal and ventral setae 2
2. Tergum 7 with median notch on posterior margin (fig. 7) .... *grossa*
   Tergum 7 with posterior margin entire 3
3. Genitalia with tergum 9 short, broadly and shallowly incised posteriorly (fig. 13); genital vesica and apodemes short (0.20–0.24 mm); subalar setae 5–6 .... *incisa*
   Genitalia with tergum 9 produced posteriorly, apically rounded (fig. 14), genital vesica and apodemes long (0.35 mm); subalar setae 14 .... *iowensis*
4. Sternum 7 without posteriorly directed processes; aedeagal plate broadly spatulate (fig. 18) .... *melanderi*
   Sternum 7 with posteriorly directed processes (fig. 8); aedeagal plate absent or narrow, spatulate 5
5. Sternum 7 with a pair of bilobed processes on posterior margin (fig. 8) .... *similis*
   Sternum 7 with 2 simple processes on posterior margin 6
6. Sternum 7 with 2 short, divergent, apically truncate processes on posterior margin (fig. 9); only 1–2 subspiracular setae .... *aterrima*
   Sternum 7 with 2 long, slender processes on posterior margin; subspiracular setae 3 or more 7
7. Penis short; long apically bifurcate aedeagal plate also present (fig. 19) .... *teskeyi*

Penis sclerotized, longer than penis valves; aedeagal plate absent (figs. 20, 21) .... *ryckmani*

FEMALES: (female of *R. iowensis* unknown)

1. With lower epimeral setae; R3 with only dorsal setae 4
   Without lower epimeral setae; R3 with dorsal and ventral setae 2
2. Tergum 8 medially separated; with a row of stout setae on anterior margin (fig. 22) .... *grossa*
   Tergum 8 deeply emarginate but without anterior setal row 3
3. Tergum and sternum 7 with numerous, small, lobelike processes on posterior margin (fig. 25) ; sternum 8 with apically narrowed valvifers (fig. 24) .... *incisa*
   Tergum and sternum 7 without posterior processes; sternum 8 with valvifers broadly rounded posteriorly (fig. 27) .... *borealis*
4. With 10 or more lower epimeral setae; valvifers short, rounded somewhat transverse (fig. 28) ; spermatheca reniform .... *amaryllis*
   Usually with 6 or fewer lower epimerals; valvifers elongate, not transverse 5
5. Subspiracular setae 2–3; spermatheca spherical .... *aterrima*
   Subspiracular setae 6–8 (rarely 4) ; spermatheca elliptical 6
6. Tergum 8 without spiracles; with median, longitudinal suture on posterior half (fig. 31) .... *ryckmani*
   Tergum 8 with spiracles, no median, longitudinal suture 7
7. Anterior half of sternum 7 densely microtrichiose, devoid of setae .... *teskeyi*
   Anterior half of sternum 7 with only a narrow band without setae 8
8. Sternum 8 not produced anteriorly; distinct space between valvifers (fig. 30) .... *melanderi*
   Sternum 8 produced anteriorly as median lobe; valvifers contiguous mesally (fig. 23) .... *similis*

RHEXOZA INCISA Cook

Rhexoza incisa Cook, 1956: 6–7; 1963: 12.

The original description was fairly extensive but additional characters of value will be noted in the following brief description.

MALE.—Very dark blackish brown, dull to feebly shining; halteres grey; total length 1.38–1.86 mm. Cardo-stipites with 10–14 setae on each side; antennal flagellomeres with 12–14 setae in a single irregular whorl; maxillary palpi 0.09–0.12 mm long. Supraalar setae 16–20; preepisternals 6–7; anepisternals 20–25; upper episternals 5–6; subalars 5–6; subspiraculars 4–9; lower epimerals absent; pedicellars 1–2. Wing length 1.27–1.60 mm; vein R3 terminates at .53–.56 of

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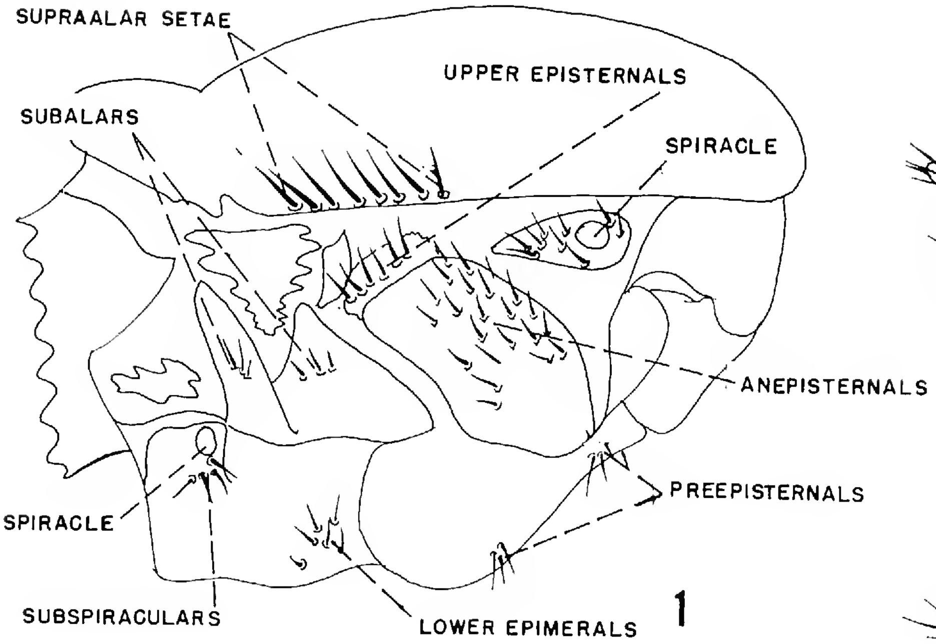
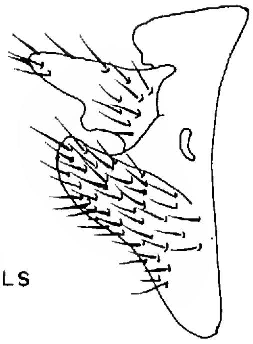
FIGS. 1–9. Fig. 1. *Quateiella quatei*, thorax; Fig. 2. *Q. quatei*, segment 7, male; Fig. 3. *Q. miniscula* process of segment 7, male; Fig. 4. *Q. miniscula*, female genitalia; Fig. 5. *Q. quatei*, male genitalia; Fig. 6. *Q. miniscula*, male genitalia. Fig. 7. *Rhexoza grossa*, male segment 7; Fig. 8. *R. similis*, male segment 7; Fig. 9. *R. aterrima*, male segment 7.


SUPRAALAR SETAE
UPPER EPISTERNALS
SUBALARS
SPIRACLE
ANEPISTERNALS
PREEPISTERNALS
SPIRACLE
SUBSPIRACULARS
LOWER EPIMERALS

1



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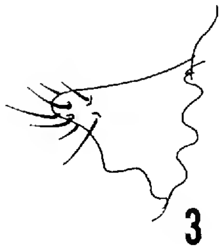
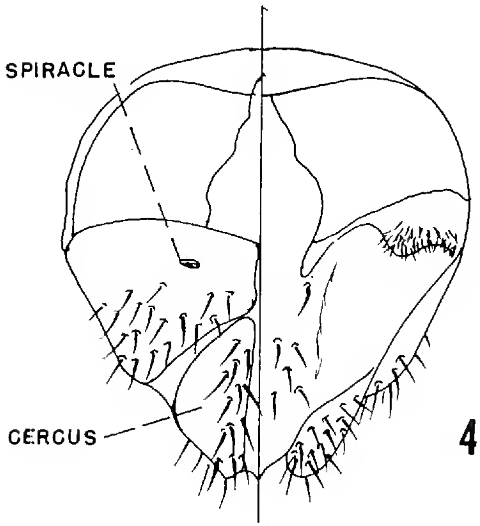
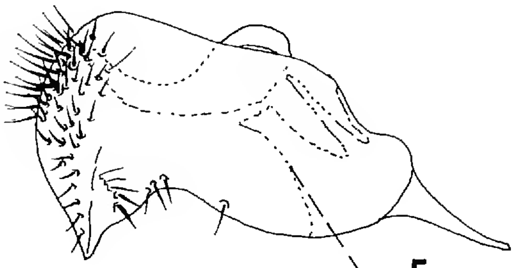


3


SPIRACLE
CERCUS

4



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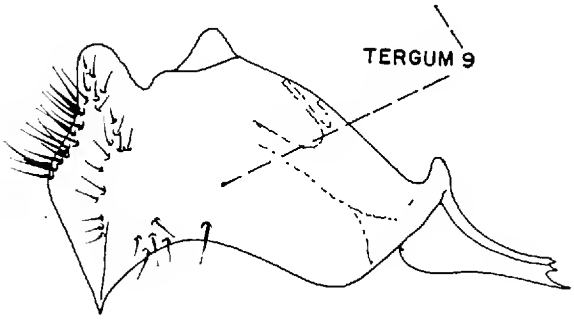
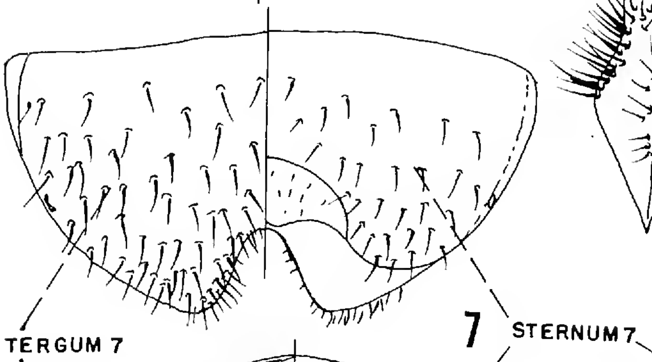
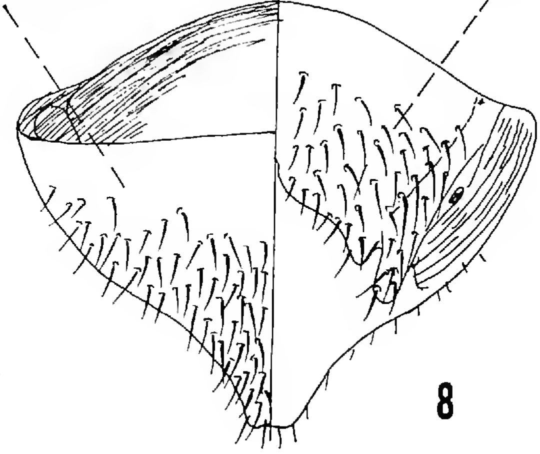

TERGUM 9

6


TERGUM 7
STERNUM 7

7



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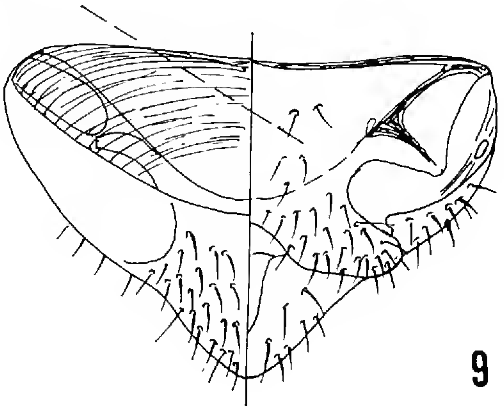

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total wing length; R3 with setae dorsally and ventrally. Abdominal segment 7 with tergum slightly produced posteriorly and sternum posteromedially notched; genital vesica and apodemes 0.20–0.27 mm long; genitalia in fig. 13.

FEMALE.—As in male in color and otherwise except setae of flagellomere up to 15; preepisternal setae 4–5; anepisternal setae 17–18; subalar setae 4–9 and pedicellar setae 2–3; spermatheca nearly spherical; sternum and tergum 7 with seta bearing lobes on posterior margins (fig. 25) ; genitalia in fig. 24.

DISTRIBUTION.—Minnesota, Iowa, Illinois and Ontario. Larvae have been found in wet areas under the bark of decaying cottonwood, elm and boxelder.

RHEXOZA GROSSA Cook

Rhexoza grossa Cook, 1956: 6

A larger species than *R. incisa*, with a western distribution.

MALE.—Dark blackish brown, somewhat shining, halteres grey; total length 2.38–2.60 mm. Cardo-stipites with 24 setae on each side (more than *incisa*) ; each flagellomere with about 18 setae in a single whorl; maxillary palpi 0.15–0.16 mm long. Supraalar setae 12–18; preepisternals 16; anepisternals 30; upper episternals 6; subalars 14; subspiraculars 10; lower epimeral 0; pedicellars 2–5; wing length 1.90–1.96 mm; R3 with setae both dorsally and ventrally. Tergum and sternum 7 both with posterior emargination (fig. 7) ; genital vesica and apodemes 0.29–0.30 mm long. Genitalia in fig. 15.

FEMALE.—As in the male in color and otherwise except cardo-stipital setae 17–22; maxillary palpal length 0.14–0.18 mm; antennal flagellomeres with 14–15 setae. Supraalar setae 11–19; preepisternals 13–17; anepisternals 24–25; upper episternals 5–7; subalars 6–11; subspiraculars 5–12; lower epimerals 0; R3 extending 0.52–0.57 of total wing length. Genitalia in fig. 22; spermatheca nearly spherical.

DISTRIBUTION.—California, Oregon, British Columbia (Richter Pass Road, 7 mi. W. Osyoos, B.C., 2-VI-1958).

Rhexoza iowensis, New Species

MALE.—About 1.75 mm long; dark blackish brown, head and thorax somewhat shining, abdomen dull; halteres grey. Cardo-stipites with 18 setae on each side; maxillary palpi 0.11 mm long; flagellomeres with about 12 setae arranged in a single whorl. Supraalar setae 18; preepisternals 8; anepisternals 33; upper episternals 8; subalars 14; subspiraculars 10; lower epimerals 0; pedicellars 3. Wing length 1.75 mm; R3 extending 0.57 of total length; R3 with dorsal and ventral setae. Abdomen with sterna 1–4 undifferentiated, other sterna and terga present, both setose and microtrichiose; tergum 7 somewhat produced posteriorly,

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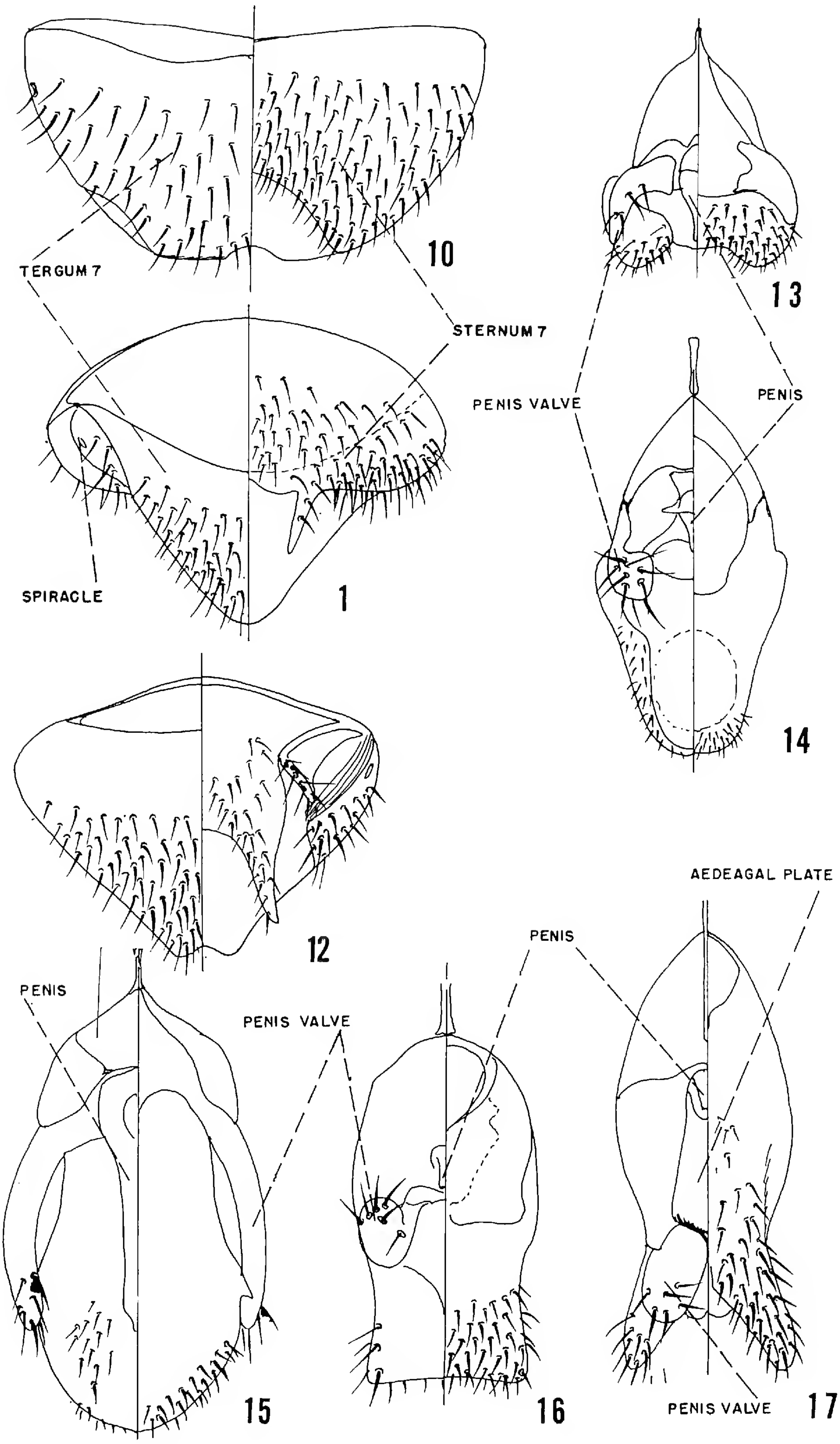
FIGS. 10–17. Male terminalia of *Rhexoza*. Fig. 10. *R. owensis*, segment 7; Fig. 11. *R. ryckmani*, segment 7; Fig. 12. *R. teskeyi*, segment 7; Fig. 13. *R. incisa*, genitalia; Fig. 14. *R. iowensis*, genitalia; Fig. 15. *R. grossa*, genitalia; Fig. 16. *R. aterrima* genitalia; Fig. 17. *R. similis*, genitalia.


10
TERGUM 7
STERNUM 7
1
SPIRACLE
13
PENIS VALVE
PENIS
14
12
AEDEAGAL PLATE
PENIS
PENIS
PENIS VALVE
15
16
PENIS VALVE
17

a broadly truncated triangle with small, shallow posterior emargination medially (fig. 10); sternum 7 with deep posterior emargination; tergum 7 setose but devoid of microtrichia, sternum with setae and sparse microtrichia. Genital vesica 0.35 mm long. Genitalia in fig 14.

FEMALE.—Unknown.

HOLOTYPE MALE: Ames, Iowa, 18-V-1951, W. L. Downes. Type in the University of Minnesota Collections.

Rhexoza borealis, New Species

MALE.—Unknown.

FEMALE.—Very dark grey brown, dull; halteres dark grey, head black; total length 2.25 mm. Antennae short, flagellomeres wider than long, 8 present, each flagellomere with about 12 setae in a single, irregular whorl; 2 campaniform sensilla on occiput on each side below level of antennae, 1 laterad of each lateral ocellus; cardo-stipites with 12 setae on each side in an irregular double row; maxillary palpi large, reniform, 0.11 mm long. Supraalar setae 18; preepisternals 12; anepisternals 26; upper episternals 5; subalars 11; subspiraculars 9; lower epimerals 0; pedicellars 2; wing length 2.00 mm; setae on costa and R but not on M; setae on both dorsal and ventral surfaces of R3; R3 extends 0.58 of total wing length. Abdominal sterna 1–3 absent, other terga and sterna present, both microtrichiose and setose; tergum 7 with straight posterior margin; sternum 7 broadly and shallowly emarginate; genitalia in fig. 27; spermatheca spherical, 0.13 mm in diameter.

HOLOTYPE FEMALE: Umiat, Alaska, 8-VII-1958, J. E. H. Martin. Type in the Canadian National Collections.

RHEXOZA ATERRIMA (Melander)

Rhegmoclema aterrima Melander. 1916: 14 Cook, 1956: 4–5 (*Rhexoza*).

This species is fairly well described in the references cited but the following additional characters should be noted.

MALES.—Dark blackish brown, feebly shining, halteres dark grey; total length 1.50–1.65 mm. Cardo-stipites with 10–15 setae on each side; maxillary palpi 0.09–0.12 mm long; flagellomeres with 12–13 setae in a single whorl. Supraalar setae 10–13; preepisternals 5–7; anepisternals 12–23; upper episternals 6–7; subalars 5–7; subspiraculars 1–4; lower epimerals 3; pedicellars 2; wing length 1.0–1.50 mm; R3 terminating at 0.48–0.50 of wing length; R3 with dorsal setae only. Segment 7 of abdomen with tergum somewhat produced medially; sternum 7 with a pair of setose processes on posterior margin (fig. 9); genital vesica and apodemes 0.17–0.20 mm long. Genitalia in fig. 16.

FEMALE.—Color and structure as in male except 1.35–2.00 mm long; wing length 1.20–1.50 mm. Genitalia in fig. 26.

DISTRIBUTION.—Early collections were from Idaho, Montana and California. I now have 1 male, Hempstead Co., Arkansas 18-X-1957, reared from Bk.Btl. logs [sic]; 1 female, Constance Bay, Ontario, 3-I-1952, from log of Jack pine (I originally misidentified this specimen as *R. similis*). Some Idaho specimens have been taken from *Pinus ponderosa.*

RHEXOZA SIMILIS (Beekey)

Scatopse similis Beekey, 1938: 151–154; Cook, 1956: 6; 1963: 11.

Well described in the original description and by Cook, but some additional characters can be noted.

MALE.—Total length 1.80–2.00 mm; dark blackish brown, feebly shining, halteres dark. Cardo-stipites with 12–14 setae on each side; maxillary palpi 0.10–0.12 mm long; flagellomeres with 14–18 setae each in an irregular whorl. Supraalar setae 16–21; preepisternals 10–15; anepisternals 22–23; upper episternals 7–10; subalars 6–11; subspiraculars 3–7; lower cpimerals 4–8; pedicellars 2–4; wing length 1.50–2.00 mm; R3 extending 0.51–0.54 of total wing length; R3 with dorsal setae only. Tergum 7 of abdomen produced posteriorly, often apically truncate; sternum 7 with pair of bilobed, posterior projections (fig. 8) ; genital vesica and apodemes 0.25–0.30 mm long. Genitalia in fig. 17.

FEMALE.—Total length 1.72–2.20 mm; wing length 1.50–1.70 mm; colored as male; chaetotaxy essentially as in male. Spermatheca elliptical; genitalia in fig. 23.

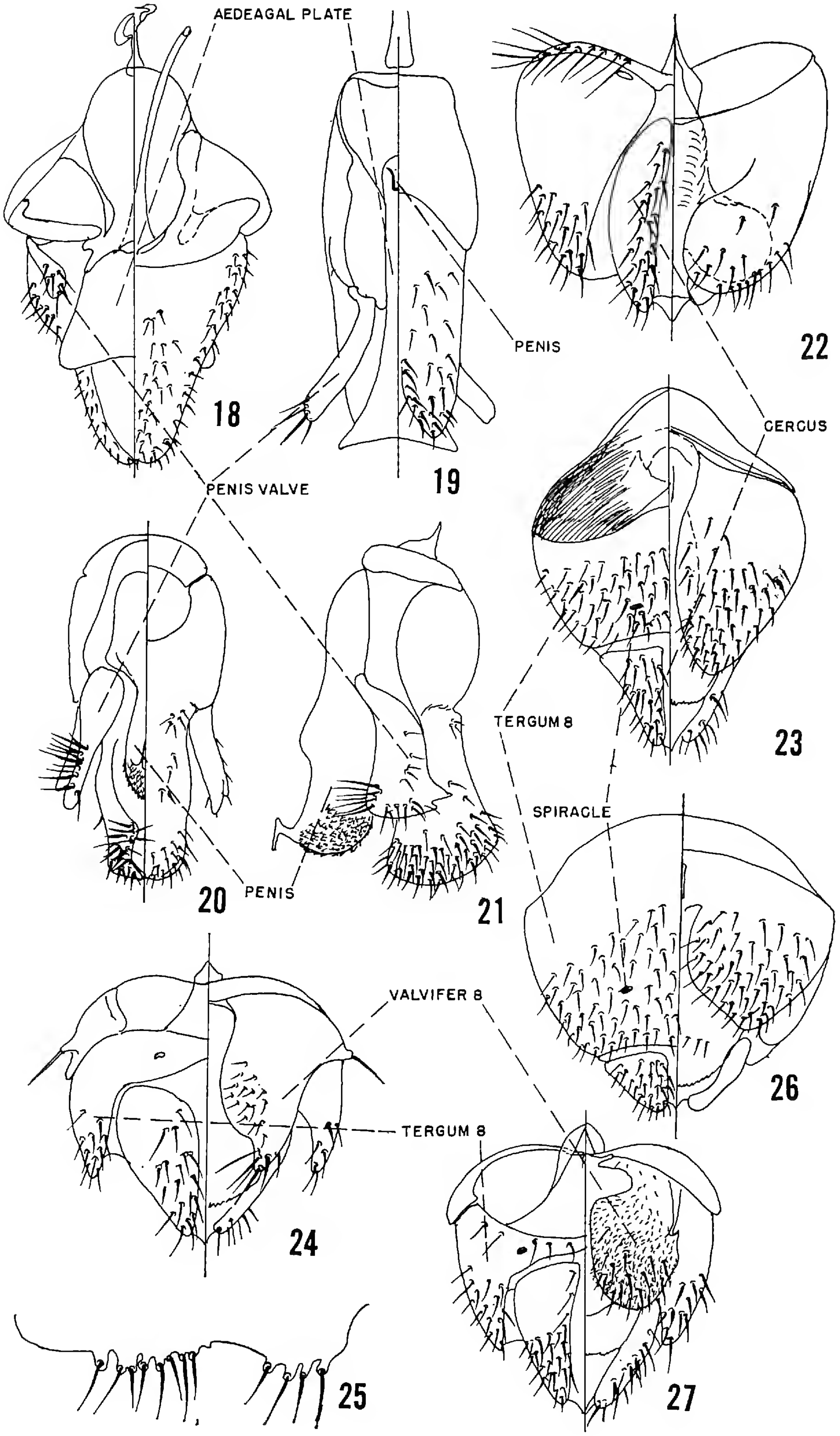
DISTRIBUTION.—Maine, Ontario, Quebec. A single male from Lisadale Lake, British Columbia, 5-VIII-1960, 4000 ft., has extended the range considerably. The latter locality is in the northwestern corner of the province. Both *R. similis* and *R. aterrima* probably occur in the central Canadian provinces as well.

Rhexoza teskeyi, New Species

MALE.—Total length 1.30–1.70 mm; dark greyish brown, head darkest; thorax and head somewhat shining, abdomen dull; halteres grey; antennal flagellomeres each with about 14 setae in a single whorl; cardo-stipites with 10–12 setae on each side; maxillary palpi 0.11–0.12 mm long, reniform; occiput with usual campaniform sensilla. Supraalar setae 15–19; preepisternals 14–15; anepisternals 20–32; upper episternals 6–9; subalars 7–8; subspiraculars 3–5; lower epimerals 4–6; pedicellars 2–3. Wing length 1.40–1.50 mm; R3 extends 0.50–0.52 of total wing length from base; R3 with dorsal setae only. Abdominal sterna 1–3 absent, other terga and sterna present, both densely setose and microtrichiose; tergum 7 produced posteriorly, triangular, with apex shallowly notched (fig. 12) ; sternum 7 with a pair of long narrow, acute processes posteriorly. Genital vesica and apodemes 0.19–0.20 mm long; genitalia in fig. 19.

FEMALE.—Total length 1.60–1.95 mm; wing length 1.45–1.46 mm; color identical with that of male. Flagellomeres with 11 setae each in a single whorl; cardo-stipites with 16 setae on each side; maxillary palpi 0.12 mm long. Supraalar setae 14; preepisternals 11–13; anepisternals 27–30; upper episternals 6–8; subalars 8; subspiraculars 6–8; lower epimerals 2–3; pedicellars 2–3; wings as in male. Abdominal sterna 1–3 absent, other terga and sterna present; terga and sterna setose and densely microtrichiose; tergum 7 with nearly straight posterior margin; sternum broadly and shallowly emarginate; spermatheca cylindrical to elliptical, 0.20 mm long. Genitalia in fig. 29.

HOLOTYPE MALE: Stonecliffe, Ontario, coll. 12, Aug. 1962, em. 80, Sept, 1962. Ex twigs of red pine. In C.N.C. collections. Paratypes: 6 females, 7 males, 1 larva, 2 pupal skins. Same data as holotype. Types in the Canadian National Collections.


AEDEAGAL PLATE
PENIS
22
18
CERCUS
19
PENIS VALVE
TERGUM 8
23
SPIRACLE
20
PENIS
21
VALVIFER 8
26
TERGUM 8
24
25
27

Rhexoza amaryllis, New Species

A single series of teneral adult females as well as a few larvae and pupae collected from decaying amaryllis bulbs was recently referred to me by H. J. Teskey.

MALES.—Unknown.

FEMALES.—Total length about 2.20 mm (specimens in alcohol) ; color grey brown, dull; halteres grey. Antennae typical, each flagellomere with 14–15 setae in a single whorl; cardo-stipites with 19 setae on each side; maxillary palpi 0.13–0.14 mm long, reniform. Supraalar setae 13; preepisternal setae 9–11; anepisternal setae 35–38; upper episternals 7–9; subalars 8–9; subspiraculars 7–8; lower epimerals 10–13; pedicellars 4. Wings 1.65 mm long; R3 extending 0.53 of total wing length; R3 with setae dorsally only; wing densely microtrichiose. Abdomen with sterna 1–6 undifferentiated; sternum 7 and all terga evident; terga and sternum 7 setose and microtrichiose; tergum and sternum 7 with straight posterior margin; spermatheca reniform, 0.21 mm long. Genitalia in fig. 28.

HOLOTYPE FEMALE: Pt. Credit, Ontario, Nov. 1966, ex. rotting amaryllis bulbs. Paratypes: 3 females, 4 larvae, 2 pupae, with above data. Types in the Canadian National Collections.

Rhexoza ryckmani, New Species

MALES.—About 1.50 mm long; greyish brown to dark blackish brown, dull to feebly shining; halteres dark grey; wings colorless, shining. Antennal flagellomeres with 12–15 setae; cardo-stipites with 12–14 setae on each side; maxillary palpi large, reniform, 0.09–0.12 mm long. Supraalar setae 11–15; preepisternal setae 9–11; anepisternals 23–30; upper episternals 6–8; subalars 6–9; subspiraculars 6–10; lower epimerals 6–10; pedicellars 2–4; wing length 1.20–1.36 mm; R3 terminates from .50–.56 of total wing length; M1 and M2 diverge to wing margin; setae usually on dorsal side only of R3, occasionally a very few on ventral surface; wing microtrichiose. Abdomen with sterna 1–4 unidifferentiated, other sterna and terga present, setose and microtrichiose; tergum 7 triangular, produced posteriorly (fig. 11) ; sternum with 2 elongate, slender processes posteriorly, a small notch medially (fig. 11) ; genital vesica and apodemes 0.25–0.27 mm long (longer than other species in the genus). Genitalia in figs, 20, 21.

FEMALES.—A single female of this genus was collected in the same locality as a male of *R. ryckmani* although about 1 month earlier (San Dimas Canyon, Los Angeles Co., Calif.). This female is distinct from females of *Quateiella quatei* and it is also distinct from a single female collected in the type locality of *R. melanderi.* The male, female associations of *R. ryckmani* and *R. melanderi,* which follow are certainly tentative, but the association in the case of *Quateiella quatei* would seem to be firmly based.

Generally like the male in size, color and chaetotaxy. Antennal flagellomeres

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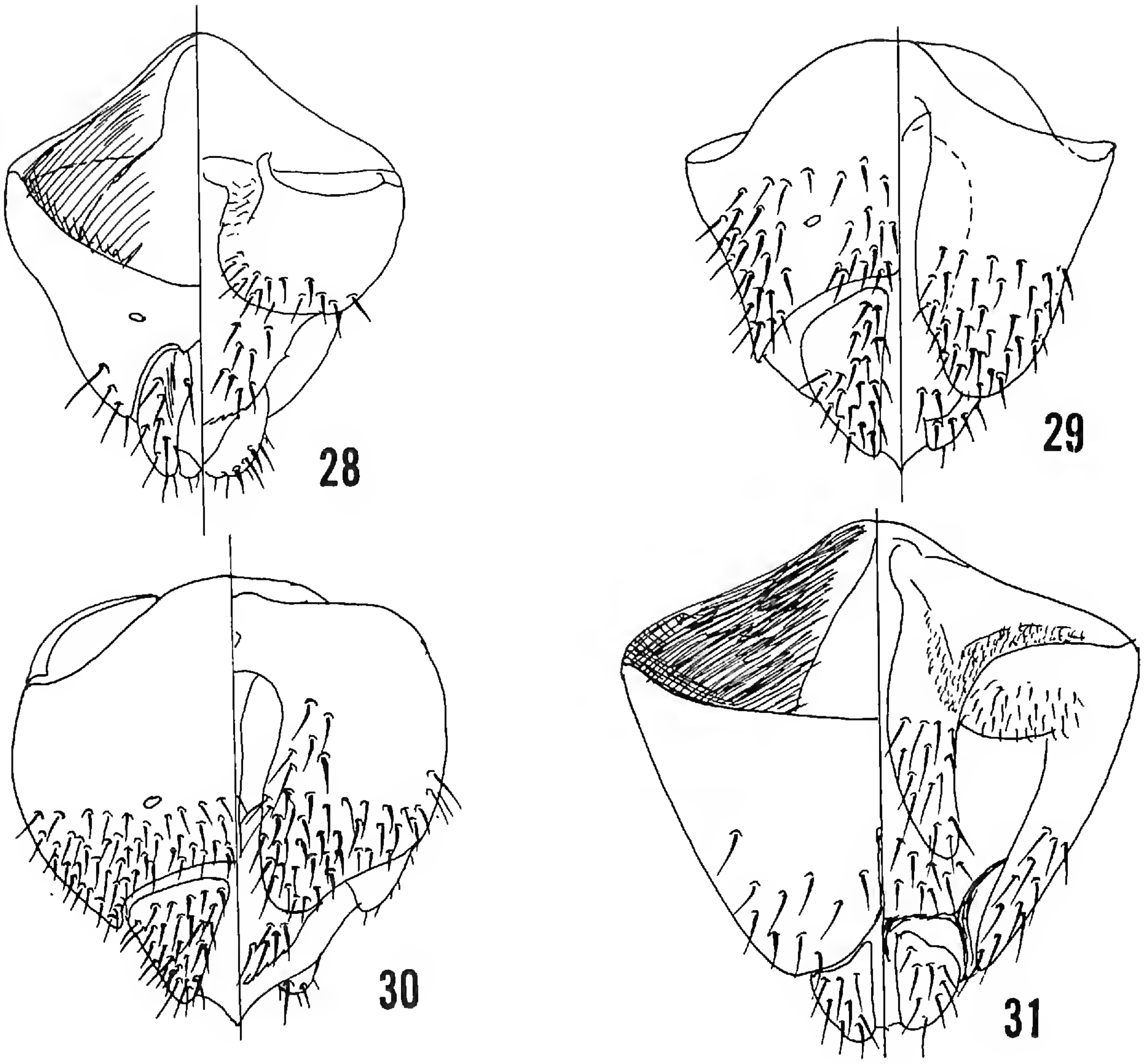
FIGS. 18–27. Genitalia of *Rexoza.* Fig. 18. *R. melanderi,* male; Fig. 19. *R. teskeyi,* male; Fig. 20. *R. ryckmani,* dorsal-ventral aspect; Fig. 21. *R. ryckmani,* male, lateral aspect; Fig. 22. *R. grossa,* female; Fig. 23. *R. similis,* female; Fig. 24. *R. incisa,* female; Fig. 25. *R. incisa,* female, posterior margin of tergum 7; Fig. 26. *R. aterrima,* female; Fig. 27. *R. borealis,* female.



FIGS. 28–31. Female genitalia of *Rhexoza.* Fig. 28. *R. amaryllis*; Fig. 29. *R. teskeyi*; Fig. 30. *R. melanderi*; Fig. 31. *R. ryckmani.*

each with 12 setae; cardo-stipites with 18 setae on each side; maxillary palpi 0.15 mm long. Supraalar setae 14; preepisternal setae 10; anepisternals 25; upper episternals 8; subalars 7; subspiraculars 9; lower epimerals 10; pedicellars 4. Spermatheca broadly elliptical, 0.20 mm long; genitalia in fig. 31; tergum 8 not longitudinally divided completely but with a median longitudinal suture on posterior ½.

HOLOTYPE MALE: San Bernardino, San Bernardino Co., Calif, 6-VI-1960, Host *Echinocactus polycephalus*, reared, R. E. Ryckman et al. Paratypes: 3 males, data as above; 1 male, same locality but 24-XI-1957; 1 male, Verdemont, Calif., 1-V-1946; 1 male San Dimas Canyon, Los Angeles Co., Calif., 24-XI-1957; 1 female, San Dimas Canyon, Los Angeles Co., Calif., 10-X-1957. San Bernardino specimens reared in association with numerous *Quateiella quatei* males and females and some *Coboldia fuscipes* (Mg.). Types in the University of Minnesota Collections.

Rhexoza melanderi, New Species

MALES.—Total length 1.50 mm; head and thorax dark brown, feebly shining; abdomen brown dorsally, black ventrally; halteres dark grey brown. Antennal flagellomeres each with 12 setae in a single whorl; cardo-stipites with 11 setae on each side; maxillary palpi large, reniform, 0.12 mm long. Supraalar setae 14; preepisternals 6; anepisternals 19; upper episternals 5; subalars 8; subspiraculars 8; lower epimerals 4; pedicellars 3; wing length 1.30 mm; R3 terminates at 0.42 of wing length; R3 with setae on dorsal surface only. Abdomen with sterna 1–4 undifferentiated, other sterna and terga present, both setose and microtrichiose; 7 pairs of spiracles; tergum 7 produced posteriorly; sternum 7 expanded laterally and dorsally; genital vesica and apodemes shorter than in preceding species. Genitalia in fig. 18.

FEMALE.—Size and color as in male. Antennal flagellomeres each with 15 setae in a single whorl; cardo-stipites with 12 setae on each side; maxillary palpi 0.11 mm long. Supraalar setae 11; preepisternal setae 8; anepisternals 22; upper episternals 7; subalars 9; subspiraculars 4; lower epimerals 6; pedicellars 1–2; wing length 1.50 mm; R3 extends 0.50 of total wing length. Genitalia in fig. 30. Tergum 8 not divided; spermatheca broadly elliptical, 0.13 mm long.

HOLOTYPE MALE: S. Fk. Santa Ana R. Calif., 1-IX-1946, A. L. Melander. Paratype: female, as above but 18-VI-1945. Types in the U.S. National Museum.

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Observations on the Life Cycle of *Heliconius hecale zuleika* (Hewitson) in Costa Rica

(Lepidoptera: Nymphalidae)

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The neotropical butterfly *Heliconius hecale* (Fabricius, 1775) is one of the most widespread and variable species of *Heliconius* in many regions of Central and South America. In the Pacific dry lowlands of Guanacaste Province, Costa Rica, the form *H. hecale zuleika* (Hewitson) (Fig. 1) is very abundant in pockets of moist secondary and riparian forests along rivers. In fact, densities of this butterfly approach the unusually high densities of the closely related species, *H. ethilla* Godart, reported in some regions of Trinidad (Ehrlich and Gilbert, 1973). Along with *H. ethilla*, this species, *H. melpomene* and others belong to the "silvaniform" group of *Heliconius* (Brown and Mielke, 1972; Ehrlich and Gilbert, 1973). The widespread occurrence of *H. hecale* and it's regional differentiation into distinct subspecies or races is probably the result of it's ability to thrive in a variety of different habitats, including man-made (Brown, 1972), over a wide geographic area (Brown and Mielke, 1972). Thus there occur no less than fifteen distinct subspecies in Amazonian and near "extra-Amazonian" Brazil alone (Brown and Mielke, 1972). The present paper summarizes some observations on life cycle, larval food plant, and behavior of the subspecies *zuleika* in lowland Guanacaste Province, Costa Rica, including what is apparently the first published account of its immature stages and larval host. Such information, especially food plant records, is crucial for understanding the population dynamics of *Heliconius* butterflies, since at least some populations of *H. erato* in Costa Rica are limited by the larval food plant (Benson, 1972).

MATERIALS AND METHODS

The majority of field observations on adult behavior, larval food plant, and interactions with other heliconiines were done near the town of Miramar, along the Inter-American highway in Guanacaste Province, Costa Rica. The actual study site is the "Barranca site" a patch of semideciduous tropical wet forest in the lowlands. Orians (1969) gives a good description of the site, and it is supplemented by Janzen (1971).

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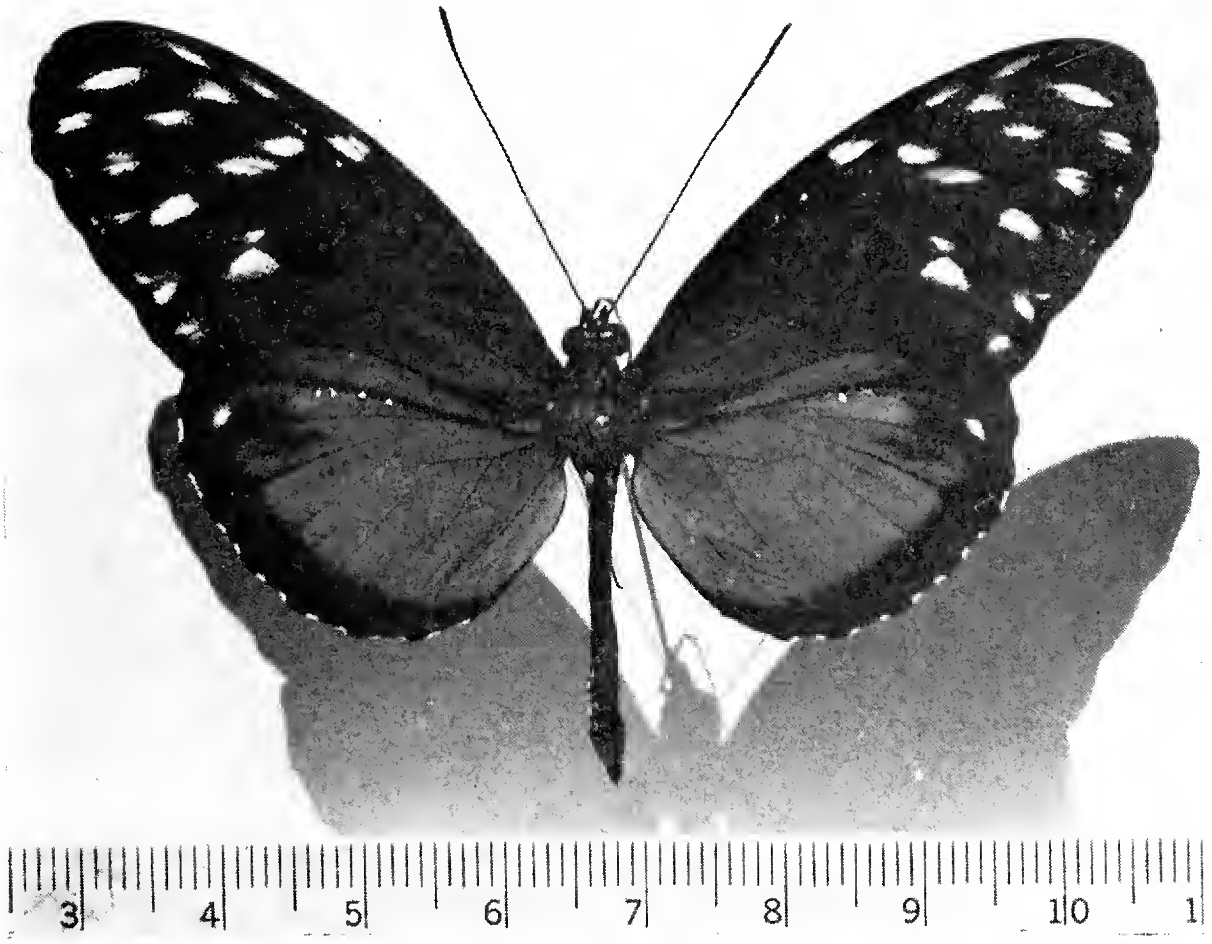

Fig. 1. Adult male *Heliconius hecale zuleika* (Hewitson), dorsal view. Scale in mm. This specimen was reared in the laboratory from the egg stage.

Activities of *H. hecale* were generally limited to the thinned-out peripheral regions of the forest.

A total of four eggs were collected July 30, 1973 and five were collected June 23, 1974. Rearing was accomplished by confining the eggs with fresh clippings of the plant in a single, large, clear-plastic bag kept tightly shut. The developmental time and other life history events of individuals confined to the plastic bag were measured from the egg stage to eclosion. But during this period the caterpillars were moved to several different localities in Costa Rica, perhaps distorting the actual developmental time of this species at the Barranca site resulting from uncontrolled temperature effects.

RESULTS

HABITAT AND FOOD PLANT.—In my experience, adults of *H. hecale zuleika* are most frequently encountered in dense, old secondary forest

FIG. 2. A habitat of *H. hecale zuleika* in lowland Guanacaste Province, Costa Rica. The larval food plant, *Passiflora vitifolia*, is found in the dense secondary forest at the Barranca site. This photograph was taken during the wet season (July 1973). Adult *H. hecale* exhibit some "promenading" around *Passiflora* vines here and visit conspicuous red flowers (inset).

(Fig. 2) and in the thinned-out understory of primary forest. The butterflies are fond of visiting the understory flowering plant *Cephaelis tomentosa* Aubl (Vahl) (Rubiaceae) in many parts of Costa Rica (Fig. 2, inset). Perhaps the prime reason that the butterflies are found here is the occurrence of the larval food plant in these places: at the Barranca site the plant used for oviposition and larval development of *H. hecale* is *Passiflora vitifolia*, and it is the same food plant used by this species at Finca Tirimbina in the Carribbean wet lowlands of Costa Rica. This plant occurs as a low, vine sprawling over other plants, both in sunny and shaded places (Fig. 3). This species of *Heliconius* is found along with several other heliconiines on *P. vitifolia* at the Barranca site, even to the extent that several species occur together on the same vine. As I have not done a thorough search for other food plants of this butterfly at the Barranca site, it is quite possible that others also occur there.

FIG. 3. *Passiflora vitifolia* (Passifloraceae), the larval food plant of *H. hecale* over much of Central and South America. Note the low position of the vine on the herbaceous canopy in secondary forest; a large, lobed, older leaf is apparent directly above the machete near the center of the photograph (June 1974).

P. vitifolia at the Barranca site occurs in small, scattered clumps, at least 50 meters apart. Over two years, I have found that the same clumps of this vine (a total of six examined in different parts of the forest) are infested with heliconians. Some of these clumps are so small that I would estimate that about 70% of the green foliage is destroyed during mid-July by heliconian caterpillars and perhaps other herbivores.

LIFE CYCLE.—The large, squarish egg (Fig. 4-A) is initially light yellow, darkening to orangish-yellow within one day. The distribution and numbers of vertical and horizontal ribs are identical to those of *H. melpomene* (Beebe, Crane, and Fleming, 1960). The egg is 1.4 mm high by 0.9 mm wide at the middle. The egg stage lasts five days.

The first instar larva is about 4.0 mm long at hatching, translucent, dirty-orange with a light tan head capsule. It is covered with many fine setae, and very similar to the larva of *H. melpomene* (see Beebe, Crane, and Fleming, 1960). The second instar (Fig. 4-B) is similar

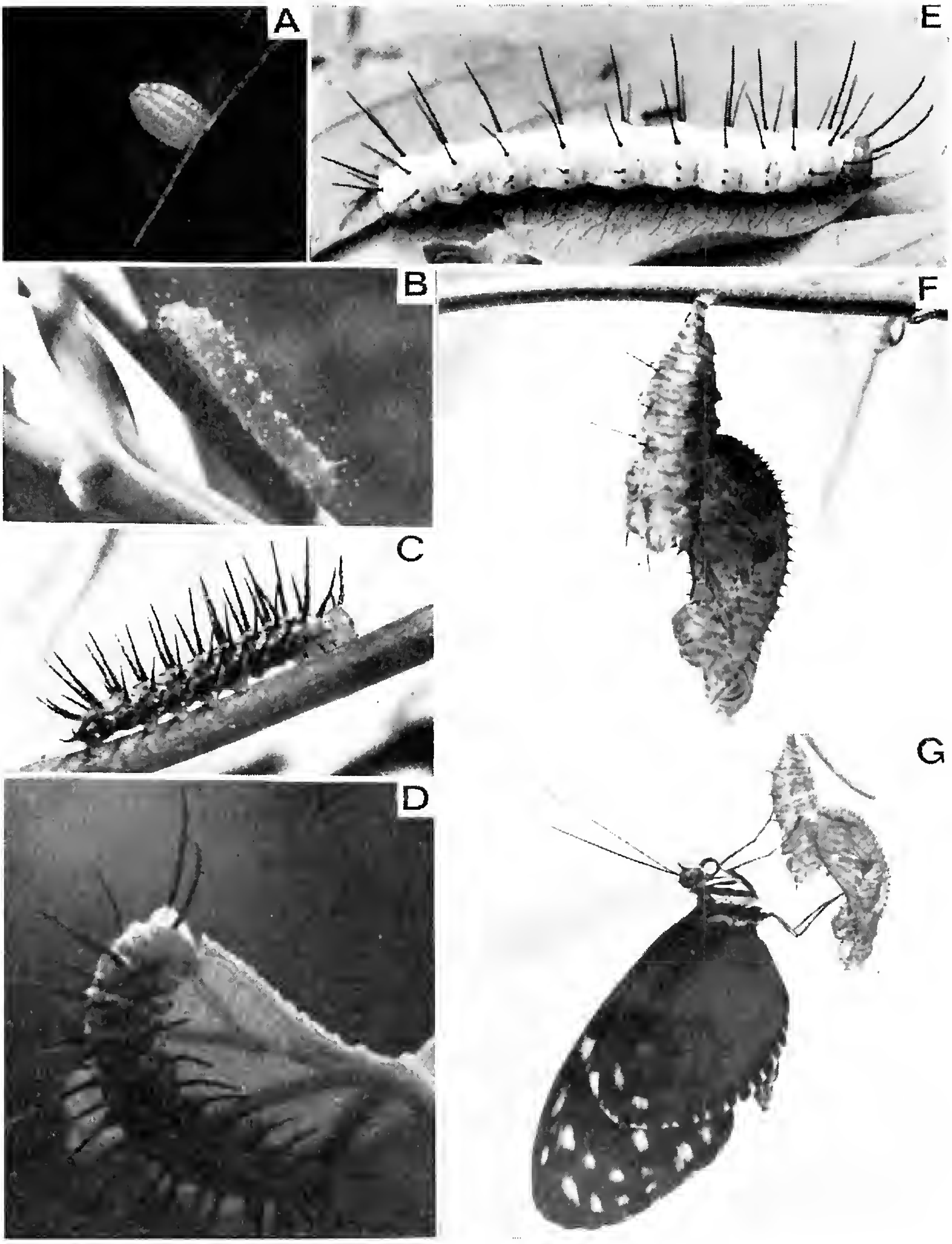

Fig. 4. The juvenile stages of *H. hecale zuleika*. A. egg; B. second instar caterpillar; C. third instar; D. fourth instar; E. fifth instar; F. pupa; G. eclosion. Sizes are given in the text.

to the first, but the head capsule is more orangish and margined posteriorly lightly in black. The prothoracic plate is brown and all scoli and legs are black. The distribution of scoli is set in this instar: the rows of dorsal, lateral, supralateral, and sublateral scoli are all apparent (see the excellent diagram for scoli distribution of *Heliconius* in Beebe, Crane, and Fleming, 1960). The first instar lasts three days and the second instar lasts four days.

The third instar (Fig. 4-C) is very similar to the fourth instar (Fig. 4-D) but lighter in the orange color of the body. The head capsule is light orange and the trunk region is light bluish-white above and orange below. The head scolus is black and about 1.8 mm long, curved strongly to the posterior end of the body. The anal plate is light orange and all scoli are black and bear spinules. The third instar reaches a length of 16 mm in four days. The general appearance is very similar to that of *H. melpomene.* The whitish regions of the body become more pronounced in the fourth instar (Fig. 4-D) and the recurved head scoli are now about two mm long. All scoli are black and longer in this instar (Fig. 4-D). The prolegs remain orange as in the previous instars. This instar attains a length of about 27 mm in four days.

The fifth instar (Fig. 4-E) is strikingly different in appearance from the previous stages. The body is now chalky-white and the head capsule glossy light orange. The recurved head scolus is now almost 6 mm long and all scoli are black. All spiracles are black and a lateral black dot occurs at the posterior edge (fold) of each segment; a second, less distinct black spot occurs just above the sublateral scolus. The fifth instar attains a length of about 38 mm in six days, and it is strikingly similar in appearance to the fifth instar of *H. cydno* (see Young, 1973[1]).

The pupa (Fig. 4-F) fits into the general description of "Group C" *Heliconius* in Beebe, Crane, and Fleming (1960); it is very similar to the pupae of *H. melpomene* and *H. numata.* The pupae of this group are characterized by (1) spines on the thorax, abdomen, and antennae, (2) subdorsal flanges on the abdomen, and (3) three to five pairs of gold-colored spots on the thorax and abdomen. In *H. hecale* there are three pairs of gold spots on the abdomen. The length of the pupa is 33 to 34 mm and the general coloration is mottled light and dark brown. The spines on the ventral side of the abdomen are very long and black. The subdorsal flanges are very well developed on the first two abdominal segments. The first five abdominal segments bear alternating long and short spines, a single spine on the first segment, pairs of spines on succeeding segments. The head region is coarsely sculptured with a pair of distinct anterad projections. Along the dorsal line of each wing pad there is a series of short, curved black "hooks" that continue to the prothoracic midline and to the head (ventrally). The

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[1] The fifth instar was incorrectly labelled in that publication as the third instar (switch captions for Figs. 2 B–C, p. 243).

cremaster silk is orange. When touched, the pupa is capable of violent twitching movements from side to side. It is not known if the pupa is capable of sound or odor production although Alexander (1961) mentions that the pupa of the closely related *H. melopmene* does both. The pupal period lasts 10 to 14 days, falling within the upper limit of range reported for Group C pupae (9–10 days). Eclosion (Fig. 4-G) is rapid and the first meconium is brownish; Alexander (1961b) reports that the first meconium of the related species *H. melpomene* ranges from brown to chestnut.

BEHAVIOR OF ADULT BUTTERFLIES.—Oviposition behavior usually entails the female flying very low through an area where the larval food plant is found. A female may fly back and forth through the area many times before actually landing and depositing an egg. I have noticed similar prolonged pre-oviposition flight habits in *Philaethria dido* and other unidentified *Heliconius*. Eventually an egg is laid on either a very young (unfolding) leaflet or tendril; in a total of four oviposition acts observed, the egg was never laid on older leaves and other structures.

Adults are usually encountered singly during the morning and I did not determine if nocturnal communal roosting, known for some species of *Heliconius* (see summary in Benson, 1971), occurs in *H. hecale*. Adults probably visit a variety of flowers, but are known to be attracted to the bright red flowers of *Cephaelis tomentosa* (Fig. 2-inset). At least two closely related species, *H. ethilla* and *H. melpomene* show strong preferences for red flowers in Brazil (Brown and Mielke, 1972). Collected adults have been noted with at least two types (colors) of pollen, also suggesting lack of food plant specificity.

BEHAVIOR OF CATERPILLARS.—As with species closely related to this butterfly (see Alexander, 1961a; Brown and Mielke, 1972), the caterpillars of *H. hecale* are solitary, a condition very likely the result of single oviposition. It often happens that caterpillars in different instars will be found on the same vine of *P. vitifolia*, but generally highly scattered with no apparent interaction. It is likely that a single vine is exploited repeatedly throughout the year for egg-laying by this species and several other *Heliconius*. The youngest caterpillars are invariably found on terminal and subterminal leaflets and even tendrils. Older caterpillars also feed on subterminal leaflets (Fig. 4-D), although fifth instars are generally found on older leaves. Caterpillars generally feed from undersides of leaves, although I have seen fifth instar caterpillars on the dorsal side of drooping older leaves of the food plant. Such individuals are extremely conspicuous. Caterpillars often share adjacent leaflets and leaves with other heliconians on *P. vitifolia*: at Finca Tirimbina, *H. hecale* co-occurs with at least *Philaethria dido* (Young, 1974), while at the Barranca site it co-occurs with *H. cydno*, *H. isemenius*, and *Dione.*

Discussion

As one of the "silvaniform" species of *Heliconius*, *H. hecale* displays close morphological resemblance in the early stages to other members of this group, such as *H. ethilla* (formerly *numata*) and *H. melpomene.* The life cycle characteristics described for *H. hecale* agree with the general features of *Heliconius* biology as summarized by Brown and Holzinger (1973) : eggs are usually laid on young ("growing meristem") structures, and adults collect pollen. The egg is large and yellowish, and the head capsule does not bear stripes. The pupa usually hangs vertically.

The fifth instar bears a striking resemblance to *H. cydno* and it is interesting to speculate that the two species participate in a Müllerian mimicry complex as caterpillars, especially since both species occur on the same food plant and in the same habitats in Costa Rica. Mimicry has been suggested by Brown (1972) with respect to other *Heliconius* in Brazil.

Brown and Mielke (1972) comment that *H. hecale* is very widespread in Brazil, not only geographically but also in terms of habitats; the apparently high degree of distinct sub-speciation in this species in Brazil is believed to be the result of phenotypic flexibility perhaps coupled with restricted gene flow. In Central and South America, the widespread occurrence of *H. hecale*, clearly far more extensive than many other species of *Heliconius*, must be due in part to the widespread occurrence of *Passiflora vitifolia* and other food plants. Keith S. Brown, Jr. (pers. comm.) states that *P. vitifolia* is used by *H. hecale* throughout Central America and Colombia and as far as Ecuador. Young (1974) discussed *P. vitifolia* as a larval food plant of *Philaethria dido* in northeastern lowland Costa Rica. At least three genera of heliconians and a large number of species (of *Heliconius*) use *P. vitifolia*, probably for the following reasons: (1) the widespread geographical distribution of the plant makes it an attractive resource for heliconians, (2) the plant species occupies several different habitats within a geographic (regional) zone, and (3) the plant is unusually low in those defense systems that normally deter heliconians and perhaps other herbivorous insects. Whatever the precise reasons for it's abundance over much of tropical America, this and perhaps other species of

Passiflora are easily penetrated (in the evolutionary or ultimate sense of Ehrlich and Raven, 1964) by local complexes of heliconians.

Acknowledgements

This research is a by-product of National Science Foundation grant GB-33060 with logistic support from the Costa Rican program of the Associated Colleges of the Midwest. The butterfly was identified by Dr. Lee D. Miller (Allyn Museum of Entomology) and the larval food plant by Dr. Keith S. Brown, Jr. (Rio de Janeiro), who made several helpful comments regarding his studies of the butterfly in Brazil. From Brown I have also learned that several researchers are doing extensive studies on the ecology and genetics of this butterfly.

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RECENT LITERATURE

Biology, Ecology, and Host Specificity of Microlepidoptera Associated with Quercus agrifolia (Fagaceae). Paul A. Opler. University of California Publications in Entomology, Vol. 75, 83 pp., 38 figs., 7 plates, 8 tables. $4.25.

Taxonomically, the microlepidoptera remain one of the most poorly known groups of insects, as demonstrated by the fact that 57% of the species treated in this study were undescribed at the time the research was conducted. Nevertheless, this work is primarily ecological, containing no descriptions of new species, and no keys. The text contains a wealth of documentary data concerning interrelationships between the moths, their host, and important climatic and distributional variables. This descriptive information is balanced with extensive discussion of life cycle adaptations, host specificity, biogeographic distribution, and evolution. The diversity of biological adaptations of the moths to avoid unfavorable seasons or to reduce interspecific competition reveal these small insects, usually ignored by all but specialized taxonomists, to be highly interesting and significant subjects for ecological analysis. The evolution of the moths is related to evolution of their host, emphasizing the fossil record of the oak and the host relationships and present distribution of the insects. The antiquity of the leafmining habit is documented by Miocene fossil impressions which are practically indistinguishable from mines of extant moths. The text is accompanied by useful tables and figures comparing the chronology of development of different species, host relationships, and details of geographic distribution. Plates include photographs of examples of larval mines and shelters and eggs in typical oviposition sites.—*Editor.*

Revision of the Millipede Family Andrognathidae in the Nearctic Region (Diplopoda: Platydesmida). M. R. Gardiner. Memoirs of the Pacific Coast Entomological Society, Vol. 5, 61 pp., 46 text figures. (Available from Pacific Coast Entomological Society, c/o California Academy of Sciences, Golden Gate Park, San Francisco, California 94118. $3.00).

Taxonomic study of the five nearctic genera of platydesmid millipeds, including one new species from northern California.

Fifty Years of the Pan-Pacific Entomologist[1]

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PROCEEDINGS

THREE HUNDRED AND FIFTY-SIXTH MEETING

The 356th meeting was held Friday, 18 January 1974 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Philip presiding.

Members present (44): F. G. Andrews, P. H. Arnaud, J. W. Bass, M. M. Bentzien, L. G. Bezart, F. L. Blanc, R. G. Blair, I. A. Boussy, R. J. Bushnell, W. Carstens, H. J. Denk, D. G. Denning, F. Ennik, B. Ehreth, B. K. Eya, M. R. Gardner, A. R. Gillogly, J. Guggolz, K. S. Hagen, R. M. Haradon, Jr., L. Hawkins, T. W. Hewton, Jr., A. I. Kaplan, C. Y. Kitayama, R. L. Langston, H. B. Leech, K. L. Lipps, A. C. Mehrer, R. L. Morrison, D. W. Moss, Jr., G. M. Nishida, R. W. Pemberton, R. L. Peterson, C. B. Philip, M. J. Robey, W. E. Savary, H. I. Scudder, M. V. Silveira, R. W. Thorp, R. E. Stecker, T. Toren, D. J. Voegtlin, M. Wasbauer and S. P. Welles.

Visitors present (22): N. Arnaud, M. C. Beugler, N. Blair, F. Blanc, A. Bush, J. A. Cate, T. L. Delgman, L. Denning, S. Ferguson, J. Hawkins, K. S. Heston, A. Hunter, F. O. Lewis, R. Locatelli, V. Maggi, V. Mayer, M. Mehrer, E. Parker, K. Taylor, J. T. Thorp, D. Veirs, and J. Wasbauer.

The minutes of the meeting held 14 December 1973 were summarized.

The following persons were elected to membership. Student membership: Don R. Harris, Ron Locatelli, Mona Lyon, Mark A. Santana. Regular membership: Kathleen Hesketh, Albert Mehrer and Mike Mehrer.

Dr. W. E. Ferguson exhibited slides of an undescribed thrombidiid mite parasitic on camel crickets which is being studied at California State University, San Jose, by visiting Professor Dr. Pierre Robaux.

A. I. Kaplan presented slides of a dipterous larvae, collected 29 November 1973, from a rotting and liquified fungus found on the University of California, Berkeley campus. The fungus was tentatively identified as *Armillaria* sp., and the flies were *Calotarsa insignis* Aldrich, a platypezid, or flat-footed fly. Laboratory reared adults first emerged 10 January 1974.

The principal speaker of the evening was Dr. William J. Hamilton, III, Professor of Animal Ethology, University of California, Davis. His illustrated talk was entitled, "Behavioral adaptations of the tenebrionid fauna of Africa's Namib Desert."

Coffee and other refreshments were served during a social hour held in the Trustees Room following the meeting.—F. ENNIK, *Secretary*.

THREE HUNDRED AND FIFTY-SEVENTH MEETING

The 357th meeting was held Friday, 15 March 1974 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Philip presiding.

Members present (30): F. G. Andrews, P. H. Arnaud, Jr., J. W. Bass, L. G. Bezart, R. W. Brown, R. J. Bushnell, H. V. Daly, M. R. Ebertz, J. G. Edwards, F. Ennik, W. E. Ferguson, B. W. Grushkowitz, R. W. Hall, R. M. Haradon, Jr., T. E. Hewton, Jr., C. Y. Kitayama, H. B. Leech, R. G. Locatelli, A. E. Michelbacher, R. L. Morrison, C. B. Philip, W. E. Savary, R. X. Schick, E. L. Smith, R. E. Somerby, R. E. Stecker, S. L. Szerlip, M. Wasbauer, C. Williams, and S. C. Williams.

Visitors present (21): A. Bush, M. Bush, T. L. Delgman, A. N. Ennik, A. V. Ennik, S. Ferguson, A. R. Gittins, R. Greek, D. S. Green, D. Grushkowitz, J. Hawkins, R. Lane, V. Maggi, G. Malleck, M. Michelbacher, Mr. & Mrs. J. J. Moran, E. Parker, E. J. Rogen, Jr., D. Veirs, and J. Wasbauer.

The minutes of the meeting held 18 January 1974 were summarized.

Two student members were elected to membership: Deborah S. Green and Donald W. Scott.

Dr. E. L. Smith exhibited an unidentified sawfly of the family Pamphiliidae, collected in Golden Gate Park, and summarized some of the biology of this primitive group of Hymenoptera.

The Executive Board decided that the social hour should be held before the next regular meeting at 7:45 p.m. in the Trustees Room, rather than after, to expedite meetings. The membership meeting will begin at 8:30 p.m. Dr. R. E. Stecker stated the opinion that students benefited greatly from exposure to the insect collections and wanted to know if access to the collections would be possible at future meetings. Both Dr. Arnaud and Dr. Smith replied that space in the insect rooms did not really allow study of the collections and socializing at the same time due to the large attendance of meetings. Access to the collections will be available before the regular meeting for those who wish, however.

The principal speaker of the evening was Dr. Arthur R. Gittins, Department of Entomology, University of Idaho. His illustrated talk was entitled, "A brief history of entomology at Idaho."

Coffee and other refreshments were served during a social hour held in the Trustees Room following the meeting.—F. Ennik, *Secretary.*

THREE HUNDRED AND FIFTY-EIGHTH MEETING

The 358th meeting was held Friday, 19 April 1974 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President-elect Daly presiding.

Members present (34): J. Anduiza, P. H. Arnaud, Jr., J. W. Bass, L. G. Bezart, D. Burdick, W. Carstens, P. S. Crane, H. V. Daly, D. G. Denning, M. Eastman, J. G. Edwards, F. Ennik, B. K. Eya, W. E. Ferguson, L. Green, K. S. Hagen, T. E. Hewton, Jr., A. I. Kaplan, C. Kitayama, D. H. Kavanaugh, R. L. Langston, V. F. Lee, K. L. Lipps, R. Morrison, H. G. Neal, R. W. Pemberton, R. L. Peterson, W. W. Pitcher and wife, M. V. Silveira, J. Spalding, E. L. Smith, D. Whitman, and S. C. Williams.

Visitors present (24): J. Bauer, C. Bera, A. Bush, E. J. Bynum, D. W. Caneto, L. Denning, J. T. Duncan, A. L. Edwards, A. V. Ennik, S. Ferguson, P. Grant, R. Hansen, N. Hays, A. Horning, C. A. Larrea, G. J. Mallick, M. Martin, G. Perrier, P. Phillip, R. G. Repke, C. Spencer, J. Stockton, S. Stockton and F. Wray.

The minutes of the meeting held 15 March 1974 were summarized.

The following persons were elected to membership. Student membership: John H. Benedict, Marion E. Buegler, Marli Eastman, Peter Goodall, Ronald J. McGinley, Carol Musgrave, Peggie Phillips, Tom Sparks, and James E. Tobler, I. Regular membership: David George, Donald S. Leson and W. F. Peregrin.

Dr. Arnaud announced that Memoir Series Volume 4, *Autobiography of an Entomologist* by R. L. Usinger is still available at $12.50 to members and $15 to non-members. Approximately 350 copies have been sold.

Dr. Arnaud announced that Dr. David H. Kavanaugh will replace Mr. Hugh B. Leech, on his retirement, as curator of Coleoptera at the California Academy of Sciences.

The following note was presented:

A New Record of Mantispid Reared from Spider.—On 24 March 1974, while collecting along the Kings River, near Piedra, Fresno County, California, a lycosid spider, *Tarantula* sp., was seen carrying an egg sac. The spider was captured and the egg sac opened. Within the sac a pupa of the mantispid *Climaciella brunnea* (Say) was found. The pupa was brought to the laboratory, wrapped in tissue and placed in a rearing cage in constant shade.

On 8 April at 11 a.m. the pupa was seen walking over the tissue, which had a hole chewed through it, and molted into the adult form by 5 p.m.

The spider and mantispid, with its pupal case, have been preserved and will be given to the California Academy of Sciences. A brief description of a study of a European mantispid, that develops within the egg sac of a lycosid spider, *Lycosa* sp., is given in Imms, "*A general textbook of entomology*" (O. W. Richards and R. G. Davies (Eds.), 9th Edition, 1957. pp. 498–9). The ambulatory behavior of mantispid pupae has been reported for *Plega banksi* (Werner and Butler, 1965, Ann. Entomol. Soc. Amer. 58: 66–68). Lloyd D. George and Nelda L. George.

The principal speaker of the evening was Dr. Karen L. Lipps, Department of Ecology and Systematics, California State University, San Francisco, whose illustrated talk was entitled, "The evolution of cleaning behavior in insects, particularly *Drosophila*."

Coffee and other refreshments were served during a social hour held in the Trustees Room prior to the meeting.—F. ENNIK, *Secretary*.

THREE HUNDRED AND FIFTY-NINTH MEETING

The 359th meeting was the annual field day and picnic held on Saturday, 18 May 1974 at Morton's Warm Springs, Kenwood, California.

Members present (15): E. Anderson, P. H. Arnaud, Jr., J. W. Bass, D. G. Denning, F. Ennik, W. C. Ferguson, R. L. Langston, K. L. Lipps, A. E. Michelbacher, W. W. Pitcher and wife, C. B. Philip, W. E. Savary, M. S. Wasbauer and son.

Visitors present (18): S. Anderson, N. Arnaud, P. H. Arnaud, S. Arnaud, J. M. Bass, L. Denning, T. Delgman, J. T. Duncan, A. N. Ennik, J. S. Ennik, A. V. Ennik, S. Ferguson, M. Michelbacher, G. Philip, P. Robaux, O. Robaux, C. Sinclair, and K. Taylor.

Although it was raining lightly at times, picnicking, swimming, and insect collecting were the main activities.—F. ENNIK, *Secretary*.

Three Hundred and Sixtieth Meeting

The 360th meeting was held Friday, 18 October 1974, in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Philip presiding.

Members present (35+): L. C. Armin, P. H. Arnaud, Jr., J. W. Bass, I. A. Boussy, T. Briggs, R. W. Brown, D. Durbin, J. G. Edwards, F. Ennik, D. S. Green, R. M. Haradon, Jr., L. Hawkins, T. E. Hewton, Jr., A. I. Kaplan, D. H. Kavanaugh, R. L. Langston, H. B. Leech, K. L. Lipps, G. J. Mallick, J. B. McCarthy, R. L. Morrison, D. W. Moss, Jr., G. M. Nishida, R. W. Pemberton, C. B. Phillip, W. W. Pitcher, J. A. Powell, H. G. Real, M. J. Robey, E. S. Ross, W. E. Savary, C. M. Sprenger, S. L. Szerlip, R. W. Thorp, and B. Villegas.

Visitors present (56+): K. Barth, J. M. Bass, R. X. Bettancourt, Jr., J. P. Boban, K. Brittan, J. Brown, K. W. Brown, P. Brown, B. & P. Buickerood, R. B. Chorf, J. Crane, C. M. Dixon, J. T. Duncan, A. Edwards, A. N. Ennik, A. V. Ennik, J. S. Ennik, R. French, T. Friebel, J. C. & K. L. Gerth, T. Gibson, R. D. Gunk, J. Hjelle, J. & Q. Illige, J. Jacobson, J. Johnson, B. A. Kavanaugh, B. Lasater, J. Locarnim, G. Low, D. McKay, D. McManus, P. Michelson, W. Moore, F. Murphey, J. Pang, D. L. Parker, J. B. Parker, P. Philip, P. & K. Pitcher, E. L. Rhe, G. Sahara, C. Sawley, P. & H. Sherman, P. F. Smith, A. Stephen, W. A. Sumner, J. T. Thorp, K. Uremorrie, N. Vandenberg, and K. R. Wahl.

The minutes of the annual field trip and picnic, held 18 May 1974, were summarized.

The following persons were elected to membership. Student membership: David L. Kulhavy, Ralph J. Michels, Wayne S. Moore, Lee C. Ryker, and D. Dee Wilder. Regular membership: Paul A. Collins, William E. Gavin, Dennis Groothuis, George J. Mallick, Dr. William L. Peters and Dr. Thomas J. Zavortink.

Dr. Arnaud announced that Dr. Thomas J. Zavortink has been appointed new curator of Hymenoptera and alcohol collections at the Academy.

Dr. Arnaud asked that Secretary Ennik send Mrs. Hawley a letter on behalf of the Society on her speedy recovery from recent surgery.

The following notes were presented:

A Remarkable New Brachypterous, Sand-Dune Moth.—Slides illustrating an undescribed genus and species of Scythridae from the coastal Santa Maria dunes in southern San Luis Obispo County, California were exhibited. Bizarre activities of the flightless, sand-colored moths, including behavioral thermoregulation and self-burial that occurs each evening, as well as the unique larval galleries which attach to buried parts of various plants in loose sands were shown. The species and its habits are being described elsewhere.—J. A. Powell, *University of California, Berkeley.*

New Record for a Nearctic Deerfly in Baja California.—Early last June Franklin Ennik and I made a collecting trip into Baja California Norte. Three females of *Chrysops coloradensis* Bigot were captured in a small Malaise trap, CO_2 baited, at midday, 5 June, on a dry lake bed one mile north of Laguna Hanson in the Sierra Juarez, 5500 ft. altitude. This must be a disjunct colony, as no previous records are known in Arizona or south of 3 montane localities in Ventura and San Bernardino Counties in California. The species extends on its southern boundary eastward through Utah into the Colorado Rocky Mountains, and northwest into southern British Columbia.

With more adequate collecting, it seems likely that *C. coloradensis* will also be taken farther south in the Sierra San Pedro Martir. In the latter mountains, rare specimens have been taken of other generalized tabanids: *Pilimas abaureur* (Phil.), *Silvius gigantulus* (Lw.), *C. coquilletti* Hine and *C. clavicornis* Bren., all similarly disjunct from the montane California fauna farther north. It appears not unlikely that these represent relicts from past, more verdent geologic times when biologic faunal interchange would have been more feasible than it is now.

Only one female of *Apatolestes comastes willistoni* Bren. was taken at Mike's Sky Ranch though we followed a route which Stan Williams and Kathy Blair had taken the year before about the same dates when they netted 16 specimens in 4 species of this generalized genus of tabanids. We were told by stock owners at Melling Ranch and elsewhere that the season was late and drier than usual, and that we appeared to be some two weeks too early for the expected horsefly pests of their livestock.

Expenses for this field trip were in part defrayed by a grant (no. 1071, Johnson Fund) from the American Philosophical Society, Philadelphia.—CORNELIUS B. PHILIP, *California Academy of Sciences, San Francisco, CA.*

The principal speaker of the evening was Dr. Edward S. Ross, Curator, Department of Entomology, California Academy of Sciences, San Francisco. His illustrated talk was entitled, "Insect photo trophies, 1974: a series of insect and arachnid slides with annotated biological notes."

Coffee and other refreshments were served during a social hour held in the Trustees Room following the meeting.—F. ENNIK, *Secretary.*

THREE HUNDRED AND SIXTY-FIRST MEETING

The 361st meeting was held Friday, 15 November 1974, in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Philip presiding.

Members present (34): P. H. Arnaud, Jr., F. R. Barnes, J. W. Bass, L. G. Bezart, K. Corwin, C. Dailey, J. G. Edwards, F. Ennik, K. S. Hagen, T. E. Hewton, Jr., A. I. Kaplan, D. H. Kavanaugh, R. L. Langston, H. B. Leech, K. L. Lipps, A. E. Michelbacher, R. L. Morrison, D. W. Moss, Jr., G. M. Nishida, R. W. Pemberton, C. B. Philip, P. Phillips, W. W. Pitcher, J. A. Powell, M. J. Robey, E. S. Ross, W. E. Savary, T. N. Seeno, C. M. Sprenger, R. E. Stecker, S. L. Szerlip, T. Toren, D. D. Wilder, and D. L. Wilson.

Visitors present (33): J. Alletts, R. X. Bettancourt, Jr., K. Brittan, B. P. Buickerood, A. Bush, D. Chase, S. Cohen, J. Cramer, C. E. Culley, C. Dailey, A. Edwards, W. J. Evans, T. Gibson, B. Kavanaugh, P. E. Kenmore, K. A. Kesketh, K. Nishida, P. Mason, D. McKay, M. Michelbacher, K. Neath, V. A. Nunez, B. C. Osborne, D. L. Parker, J. B. Parker, K. Pitcher, P. Pitcher, J. Redman, M. D. Smart, A. Stephen, L. Toren, P. Toren, and C. Wilson.

Two student members were elected to membership: George Erwin and Paul Mason.

President Philip appointed Hugh B. Leech Chairman of the 1975 Nominating Committee, to be assisted by Donald Denning and A. E. Michelbacher.

For the Auditing Committee, President Philip appointed H. V. Davis, Chairman, to be assisted by E. S. Ross.

President Philip appointed an ad hoc committee consisting of E. G. Linsley, Chairman, assisted by H. B. Leech, E. S. Ross and W. W. Middlekauff, to explore ways the Society could participate in the upcoming joint City of San Francisco-National Bicentennial celebration in 1976.

J. Gordon Edwards exhibited two live female beetles, *Pleocoma conjungens* and *P. hirticollis vandykei*, collected during recent rains in Quail Hollow, Santa Cruz Mountains and Coyote, California. The males are attracted to the flightless females, apparently by a non-species specific pheromone, as the females sit partially buried in the opening of their burrows. After mating, the female digs back into the ground and deposits her eggs. The larvae eat plant roots during their long period of development. Because the females do not move from their point of origin, *Pleocoma* species have limited geographic ranges.

H. B. Leech stated that *Pleocoma* beetles are also found at his home in Angwin, CA.

D. H. Kavanaugh reported on his field and laboratory observations on the carabid genus *Nebria*, which are restricted to snow melt trickles or cool mountain stream margins of the Sierra Nevada above the 11,500 ft. level.

S. L. Szerlip exhibited slides of two species of Diptera found living in the California pitcher-plant, *Darlingtonia californica* Torrey, in a Sphagnum bog near Willow Springs, Nevada County, California, in June, 1974. Larvae of *Metriocnemus edwardsi* Jones (Chironomidae) are apparently found only in *D. californica*, where they feed on detritus. Larvae of *Leptocera* sp. (Sphaeroceridae) as well as pupae and adults, were also found, and appear to be completely adapted to the living conditions in the pitcher-plants.

The main speaker of the evening was Dr. Ronald E. Stecker, Department of Entomology, San Jose State University. His illustrated talk was entitled, "Life in the 300 ft. giant Sequoia."

Coffee and other refreshments were served in a social hour, held in the Trustees Room following the meeting.—F. Ennik, *Secretary.*

Three Hundred and Sixty-Second Meeting

The 362nd meeting was held Friday, 20 December 1974 at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Philip presiding.

Members present (39): R. P. Allen, E. Anderson, L. C. Armin, P. H. Arnaud, Jr., F. R. Barnes, J. W. Bass, L. G. Bezart, R. M. Brown, P. A. Collins, K. Corwin, H. V. Daly, H. J. Denk, J. G. Edwards, B. Ehreth, F. Ennik, E. R. Gunderson, T. E. Hewton, Jr., D. Jamieson, W. Jamieson, A. I. Kaplan, D. H. Kavanaugh, A. Kitayama, H. B. Leech, K. L. Lipps, R. L. Morrison, C. B. Philip, P. Phillips, J. A. Powell, H. G. Real, E. S. Ross, T. N. Seeno, R. E. Somerby, R. E. Stecker, S. L. Szerlip, R. W. Thorp, J. W. Tilden, D. W. Whitman, D. D. Wilder, and D. L. Wilson.

Visitors present (16): S. Anderson, G. D. Barhe, P. Brown, A. Bush, D. Harms, P. Jamieson, R. Kimmick, D. L. Parker, J. B. Parker, D. Rodriguez, A. C. Stanet, G. Sweeny, J. Thorp, H. Tilden, N. Zackeroff, and G. Zefnah.

The minutes of the meeting held 15 November 1974 were summarized.

Richard A. Hinsdale was elected to membership into the Society.

E. S. Ross exhibited kodachrome slides of small insects mounted on microscope slides.

Allen Stephen displayed an unusual aberration of a checkerspot butterfly captured in flight in Alum Rock Park, San Jose. The specimen displayed the coloration of *Euphydryas chalcedona hemimelanica* on the dorsal wing surfaces and *E. c. fusimacula* on the ventral wing surfaces.

The following notes were presented:

Observations of the Mating Activities of Rhamphomyia Scaurissima Wheeler in Northern California.—*Rhamphomyia scaurissima* Wheeler was found in the oak-bay woodlands of northern Marin County, California. In March of 1974 a number of these empidids were observed swarming over Santa Fe Creek, located south of Novato. This mating swarm consisted of two groups; one larger group of males approximately three feet in diameter, and a smaller group, perhaps two feet in diameter, composed entirely of females. The two groups were separated by only an inch or two. The insects in both groups flew in an apparent circular or elliptical pattern giving the impression that the female group lay anterior to the male group. I observed no overlapping of the two groups.

Individual males would frequently fly into the female swarm, select a mate and fly up under her until they were touching. Together the pair zigzagged in tandem, in a direction more or less perpendicular to the main flow of the swarm. Moments later the pair separated, with the female returning to her swarm and the male immediately flying down to the water and skiing across the water's surface. On close inspection, I observed the male touching its modified middle tarsi to the water, which left a minute ripple on the surface. After this, the male returned to the swarming group.

Wheeler first described *R. scaurissima* (Entomol. News, 7:189–192, 1896) from specimens collected in Palo Alto, California. Since that time, this empidid has been largely unknown in collections and unmentioned in literature. When Wheeler first described the extraordinary, elaborate and large middle tarsi of the male, he thought perhaps their function was to vibrate in front of the female during courtship. However, this behavior was not observed in any of the mating swarms I studied. The only way in which the tarsi were used, were as boats or water skis. In fact the tarsi do resemble a tiller and rudder, with a flattened cup shaped tarsal segment as the "boat" or "water ski." The mating swarms have been found only during the latter part of March or the early part of April. No adult individuals have been collected at any other time of the year and the larva is unknown.—Peggie Phillips, San Francisco State University.

Massive Population Levels of the Cherry Tree Ugly-Nest Caterpillar.—Extensive silk tenting of *Prunus virginiana* var. *demissa* caused by gregarious larvae of the tortricid, *Archipa cerasivoranus* (Fitch) were observed in southern Siskiyou County. During California Insect Survey investigations in early June, 1974, large patches of defoliated *Prunus* were found along the railroad and roadsides from McCloud to Ash Creek, 9 miles to the east, and there were small nests at McBride Springs on the west slope of Mt. Shasta in late June. The largest colony, where all plants were defoliated in an area about 20 × 5–10 m, was observed on June 10; larvae were dying in large numbers in all but peripheral areas where some foliage remained. Two weeks later central portions had collapsed and dried, while new webbing on the expanding periphery had encompassed various low herbs and other shrubs, particularly *Ceanothus velutinus*, which was defoliated, *Arctostaphylos*, *Purshia* and *Eriogonum*. Four tents of larvae collected 7 and 9 miles east of McCloud and at McBride Springs showed no signs of disease in laboratory conditions. More than 550 moths emerged between July 2–29, but only 2 parasites, tachinids, were reared. These observations are in contrast to those made in 1957–58 in the same region, when only small colonies of *A. cerasivoranus* were found, and several parasites emerged, representing about 10% of some 40 individuals reared (Powell, 1964, U. Calif. Publ. Ent., 32: 147).—J. A. POWELL, *University of California, Berkeley.*

Confirmation of Occurrence in Amazonas of the Tabanid Tribe Rhinomyzini.—The third known specimen of the peculiar *Betraguia ocellata* Oldroyd previously described in 1970 from 2 (likewise) females from Para Dist., lower Amazon, Brazil is exhibited. It was taken by Dr. Richard W. Merritt while a pre-doctoral student at University of California and is labelled Leticia (Upper Amazonas) Columbia, "kilometer 8," 2–6 August 1973.

The Tribe Rhinomyzini is discussed by Oldroyd in a British Museum review of the Ethiopian tabanid fauna, 1957, as an assemblage of "bizarre forms" extending in the Old World as far as the Orient and related more on biological than on structural or even phylogenetic similarities. While he envisioned tabanid ancestry as radiating from a South American origin, no previous specialized members of the above peculiar tribe have been recorded in the New World. There are, however, other wasp mimics among Neotropical Tabaninae.

Note in the specimen passed among the audience the obvious resemblance to some shiny black wasp with elongated antennae and abdomen. The latter is spatulate and truncated behind, not constricted into a slender ovipositor as in many of its tree-hole breeding ethiopian relatives. Nevertheless, it appears not unlikely that this Amazon species also inhabits rot-holes in trees.

The well-developed ocelli and the hind-tibial spurs, though minute, relate this to the tribe, though the combination of sparsely hairy eyes, closed submarginal cells of the wings, and discal cells narrowed basally by apical extension of the 2nd basal cells, are unusual.

The discovery recently of only 3 widely-separated specimens in all the collecting in the Amazon region attests to some unusual habitats. But logical speculation on pathways and direction taken by progenitors is not possible at present.—CORNELIUS B. PHILIP, *California Academy of Sciences, San Francisco.*

The December meeting is traditionally the business meeting of the year and President Philip asked for reports of the standing committees.

In the treasurer's report Dr. Arnaud summarized the financial statement of the Society. Income is derived from dues and subscriptions, reprints and miscellaneous page charges, sales of memoirs, advertising, savings accounts interest and stock dividends. The financial statement is published here in order for all members to know the financial condition of the Society.

Dr. Arnaud stated that the treasurer's office is indebted to Mrs. V. Hawley, Office Manager of the Academy, for her dedicated attention to the Society's accounts, to Ms. Roxi Berlin, Entomology Secretary, for her attention to many letters and mailings of Society publications, and to Mr. H. Vannoy Davis, member of the firm of J. K. Lasser and Company (Certified Public Accountants), not only for his review of the Treasurer's records, but also for the completion of our Federal and State income tax forms.

Mr. Leech gave no report on behalf of the Historical Committee.

Dr. Williams, of the Membership Committee, reported there were 33 members (21 student and 12 regular) elected in 1974.

On behalf of the Publication Committee, Dr. Powell summarized results of the

Executive Board meetings regarding publication costs of the journal, which will increase in the future. A small memoir paper was published by M. R. Gardner.

President Philip announced his appointments to the Publication Committee for 1975 through 1977: R. W. Thorp and J. A. Powell.

Mr. Leech, Chairman of the Nominating Committee, presented the 1975 slate of candidates for office in the Society: President, Howell V. Daly; President-elect, Fred Andrews; Secretary, Franklin Ennik; Treasurer, Paul H. Arnaud, Jr. There were no nominations from the floor. The candidates were elected to office in the Society for 1975 by unanimous vote.

The principal speaker of the evening was Dr. Terry L. Erwin, Curator of Coleoptera, Smithsonian Institute. His illustrated talk was entitled, "The role of carabid beetles in the arboreal ecosystem in middle America."

Coffee and refreshments were served in the Trustees Room following the meeting.—F. ENNIK, *Secretary.*

HONORED MEMBERS OF THE PACIFIC COAST ENTOMOLOGICAL SOCIETY

C. P. Alexander
E. G. Linsley
A. E. Michelbacher
R. C. Miller

PACIFIC COAST ENTOMOLOGICAL SOCIETY

STATEMENT OF INCOME, EXPENDITURES AND CHANGES IN FUND BALANCES

Years Ended September 30, 1974 and 1973

	1974	1973
Income:		
Dues and subscriptions	$ 5,516	$ 5,526
Reprints and miscellaneous	7,349	2,999
Sales of memoirs	1,888	3,748
Advertising	28	333
Interest on savings accounts	744	601
Dividends, American Telephone & Telegraph Co.	241	224
Increase (decrease) in value of capital stock of American Telephone & Telegraph Co.	(880)	410
	14,886	13,841
Expenditures:		
Publication costs—Pan Pacific Entomologist	8,013	9,751
Memoirs	92	199
Reprints, postage and miscellaneous	1,977	2,075
	10,082	12,025
Increase (decrease) in fund balances	4,064	1,816
Fund balances October 1, 1973 and 1972	22,035	20,219
Fund balances September 30, 1974 and 1973	$26,839	$22,035

STATEMENT OF ASSETS

September 30, 1974 and 1973

	1974	1973
Cash in bank:		
Commercial account	$ 7,908	$ 3,366
Savings accounts:		
General fund	8,861	8,426
Memoir fund	2,457	2,189
Fall fund	2,404	2,173
Life membership fund	1,929	1,721
Total cash in bank	23,559	17,875
Investment in 80 shares of American Telephone & Telegraph Co. common stock (Life Membership and Fall Funds), at market value	3,280	4,160
Total	$26,839	$22,035

See accompanying notes to the financial statements.

NOTES TO THE FINANCIAL STATEMENTS

Year Ended September 30, 1974

SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Accounting Method

Income, expenditures and assets are recorded on the cash basis of accounting.

Marketable Securities

American Telephone & Telegraph Co. common stock is carried at market value. Increases and decreases in value are reflected in income.

Income Tax

The Company is exempt from Federal income and California franchise tax.

Accounts Receivable

As of September 30, 1974 accounts receivable aggregated $301 as follows:

August and September, 1974 billings	$211
July billings	9
January and February, 1974 (past due)	42
December, 1973 and prior (past due)	39
	$301

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 inaccuracy in the foregoing statements.

H. VANNOY DAVIS
Chairman of the Auditing Committee

THE PAN-PACIFIC ENTOMOLOGIST

Information for Contributors

Papers on the systematic and biological phases of entomology are favored, including articles up to *ten* printed pages on insect taxonomy, morphology, behavior, life history, and distribution. Excess pagination must be approved and may be charged to the author. Papers are published in approximately the order that they are received. Immediate publication may be arranged *after* acceptance by paying publication costs. Papers of less than a printed page may be published as space is available, in SCIENTIFIC NOTES.

Manuscripts for publication, proof, and all editorial matters should be addressed to the *Editor*, John T. Doyen, Division of Entomology & Parasitology, University of California, Berkeley, California 94720.

Typing.—*Two* copies of each manuscript must be submitted (original and one xerox copy are suitable). All parts of manuscripts must be typed on bond paper with double-spacing and ample margins. Carbon copies or copies on paper larger than 8½ × 11 inches are not accepted. Do not use all capitals for any purpose. Underscore only where italics are intended in the body of the text, not in headings. Number all pages consecutively and put author's name at the top right-hand corner of each sheet. References to footnotes in text should be numbered consecutively. Footnotes should be typed on a separate sheet.

First page.—The page preceding the text of the manuscript should 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, (6) 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.

References.—All citations in text, e.g., Essig (1926) or (Essig, 1958), should be listed alphabetically under LITERATURE CITED in the following format:

Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2:211–212.
1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York. 1050 pp.

Abbreviations for titles of journals should follow the list of *Biological Abstracts*, 1966, 47(21):8585–8601.

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.

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Biological Records and Descriptions of Some Little Known *Epiblema* in the Southwestern United States

(Lepidoptera: Tortricidae)

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The genus *Epiblema* Hübner is widespread in the northern Hemisphere, comprising nearly 100 described species in the Holarctic Region. The group extends into southern continents evidently by a depauperate representation, such as in South Africa, although the fauna of southern regions probably is largely unworked. Primarily on the basis of male genitalia Obraztsov (1965a) assigned the Palearctic species to three subgenera, *Epiblema s. str.*, *Cacochroea* Lederer, and *Notocelia* Hübner. These taxa had been treated at the generic level by some previous authors (e.g., Bradley, 1959). Larvae of the members of the first two of these subgenera feed in roots or stems of Compositae, sometimes creating a gall-forming reaction by the host, while larvae of *Notocelia* are leafrollers on Rosaceae (e.g., Ford, 1949).

MacKay (1959) placed Nearctic species currently assigned to *Epiblema* and a related genus, *Sonia* Heinrich, in three groups on the basis of larval structures and indicated that these are generic level categories. Her group 1 included *E. praesumptiosa* Heinrich and *Sonia canadana* McDunnough, and MacKay suggested on the basis of Heinrich's (1923) figures of male genitalia that *Epiblema abruptana, numerosana, grossbecki, praesumptiosa, deflexana, insidiosana* and *exerbatricana* should be combined with *Sonia* to form a single genus. Her group 2 corresponds to the remainder of Nearctic *Epiblema s. str.* for which larvae were available, that is *strenuana* Walker, *otiosana* Clemens, and in essence the species #7024–7032 of McDunnough's list (1939), nearly all of which are known to be stem borers and/or gall makers. Finally, group 3 of MacKay is equivalent to *Notocelia* including the introduced European species *suffusana* Zeller and the indigenous *culminana* Walsingham (probably = #7040–7043 of McDunnough).

I have reared the 3 species of *Sonia* that occur in California, each at a number of localities. All are root borers in woody Compositae (*vovana* Kearfott in *Gutierrezia*, *filiana* Busck and *comstocki* Clarke in *Haplopappus*). This suggests that the other members of MacKay's group 1 are root-borers and that biologies and larvae of this assemblage (#7015–7023 of McDunnough) have escaped discovery because American microlepidopterists have not much dug into this ecological horizon yet. This supposition may apply to the other biologically unknown *Epiblema* complex (#7033–7039 of McDunnough), as well as most *Eucosma*.

Whether larval characteristics ought to be weighted heavily enough to provide the basis for generic delineation is debatable, but MacKay's opinion should encourage a more comprehensive study of *Epiblema* and allies. In this group, as in many Microlepidoptera, too much emphasis has been placed on male genitalia and secondary male characters to the exclusion of other lines of evidence. The rainbow that was represented by the discovery of male genital characters led microlepidopterists out of the stormy taxonomic chaos of the turn of the century, but its pot of gold was so doggedly sought that many workers made the mistake of attempting to force male genitalia to serve a dual role as species diagnostic characters and as indicators of relationship in development of generic concepts. As a result some genera in groups such as Eucosmini are artificial groupings of convenience rather than taxa that reflect underlying evolutionary relationships. Probably a complete reshuffle of American *Phaneta*, *Eucosma*, *Epiblema*, *Suleima*, and *Sonia* will be warranted by a thorough investigation.

Several years ago I prepared a report treating an assortment of Eucosmini, including three previously undescribed species of *Epiblema*. However, after review of the manuscript, it seemed advisable to withhold the portion dealing with *Epiblema* until the work by Obraztsov on subgeneric relationships in Palearctic members of the genus was completed. Thus the rest of my study was published (Powell, 1963), and a review of Nearctic *Epiblema* in concordance with the European fauna was anticipated. Unfortunately types of the proposed new species were distributed to the appropriate museums, but the research was not resumed after the Palearctic classification appeared (Obraztsov, 1965a). The present descriptions are offered to rectify this situation and to make the names available for ecological work by C. D. MacNeill at the Oakland Museum and for more comprehensive taxonomic studies by Richard Brown who has completed a Master's degree thesis on *Epiblema* at the University of Arkansas.

Epiblema arizonana, new species
(Figs. 9, 10)

A large moth, resembling *E. carolinana* (Walsingham), having a mottled brownish forewing with a central whitish area followed by a darker terminal spot.

Male.—Length of forewing 9.1 to 10.2 mm (reared specimens). Head: labial palpus short, II segment length about 1.0 vertical eye diameter, slightly upcurved, thickly clothed with rather appressed scaling which forms a blunt, apical tuft obscuring III segment; latter about 0.33 the length of II, blunt; pale brownish exteriorly, whitish interiorly. Antenna slightly less than 0.5 forewing length; orange-brown, dorsal scaling brownish, darker toward base, scape white below. Scale tufts of crown dense, elongate, strongly directed mesad, brownish reflecting purplish; scaling of front short, appressed, whitish. Thorax: dorsum dark brown, the scales faintly tipped with whitish, more strongly so posteriorly; a tinge of red-brown in upraised tuft of scutellum; metanotum with dense, lateral hair brushes which do not entirely obscure scutellum; latter scaled brownish. Underside whitish, pro- and mesothoracic legs pale brownish exteriorly, excepting white apical bands of tarsi and tibiae. Forewing: length about 2.7 times width. A broad, appressed costal fold from base to beyond middle of costa; costal margin straight to end of fold, slightly convex beyond; termen slightly concave. Ground color grayish brown, mottled with darker, vertical strigulae. Costal fold of ground color with about seven darker bands; basal area heavily mottled with dark and light scales; a broad whitish area over middle one-third of dorsum, becoming diffuse above middle of wing, enclosing some pale grayish strigulae; a blackish spot immediately following pale area, just before tornus, with a black spot above it in apical area; outer costal and apical areas with some red-brown scaling. Fringe red-brown above middle, gray at tornus. Underside grayish brown, reflecting purplish; dorsal area white; latter with several rows of upraised, elongate scales. Hindwing: broader than forewing; costa with slight concavities before and following middle; termen very slightly concave, broadly curved to dorsum. Upperside dark brown, fringe broad, paler, the scales becoming white at apices. Underside dark brownish with paler streaks along veins and near margin; anal area whitish. Abdomen: (of holotype on slide) dorsal scaling dark brownish, underside paler, genital tuft shining pale brownish. Genitalia as in fig. 1 (drawn from holotype, "C. H. slide 1, 10 July, 1936;" two preparations examined); socii elongate, length equal to width of valva at neck (not evident in figure); valva moderately broad, cucullus length about two times its width, cornuti numerous, elongate, thin.

Female.—Essentially as described for male. Labial palpus apparently somewhat shorter. Forewing lacking costal fold and broader, length 2.5–2.6 times width; whitish areas more extensive and prominent, the markings, particularly the vertical strigulae, more distinct; tornal dark area as a nearly rectangular blackish spot crossed by two diagonal brown lines at veins. White areas of underside of hindwing more extensive. Genitalia as in fig. 5 (drawn from JAP prep. no. 3884, two preparations examined); anterior lobes of papillae anales produced ventrally; sterigma a simple, weakly sclerotized ring, ductus bursae with an ill-defined sclerotized patch above junction of ductus seminalis; signa large, smaller one as large as sterigma, subrectangular, larger one two times the smaller, distally broad and rounded; corpus bursae densely spinulate.

Holotype male: ARIZONA, OAK CREEK CAÑON, near FLAGSTAFF, COCONINO

COUNTY, emerged June 28, 1936, reared from *Rudbeckia laciniata* (G. P. Engelhardt); allotype female same data except June 26, 1936. Paratypes (18): 4 ♂♂, 14 ♀♀, same data except June 17 to June 30. One male bears a partially illegible handwritten label which appears to be: "root and stem borer Rudbeckia amplexicaulis." Seven females (June 24, 1936) are worn specimens and lack the host data and may be flown individuals. Holotype, allotype and 16 paratypes deposited in the U. S. National Museum of Natural History, two paratypes in the University of California, Berkeley collection.

There is little variation among the specimens in good condition. The species is similar to *E. carolinana* (Walsingham), which is known to range west to Illinois. *E. arizonana* differs only slightly in appearance, having more restricted whitish areas and more contrasting dark markings. The male genitalia differ, the valva being considerably broader in *arizonana.* In *E. carolinana* the cucullus distally is slightly narrower than the neck of the valva (fig. 2), whereas it is broader in the present species. The foodplant is the same for both, which suggests that they may be races of a single species; but until more information is available, the differences in male genitalia and the allopatry are bases for species designation.

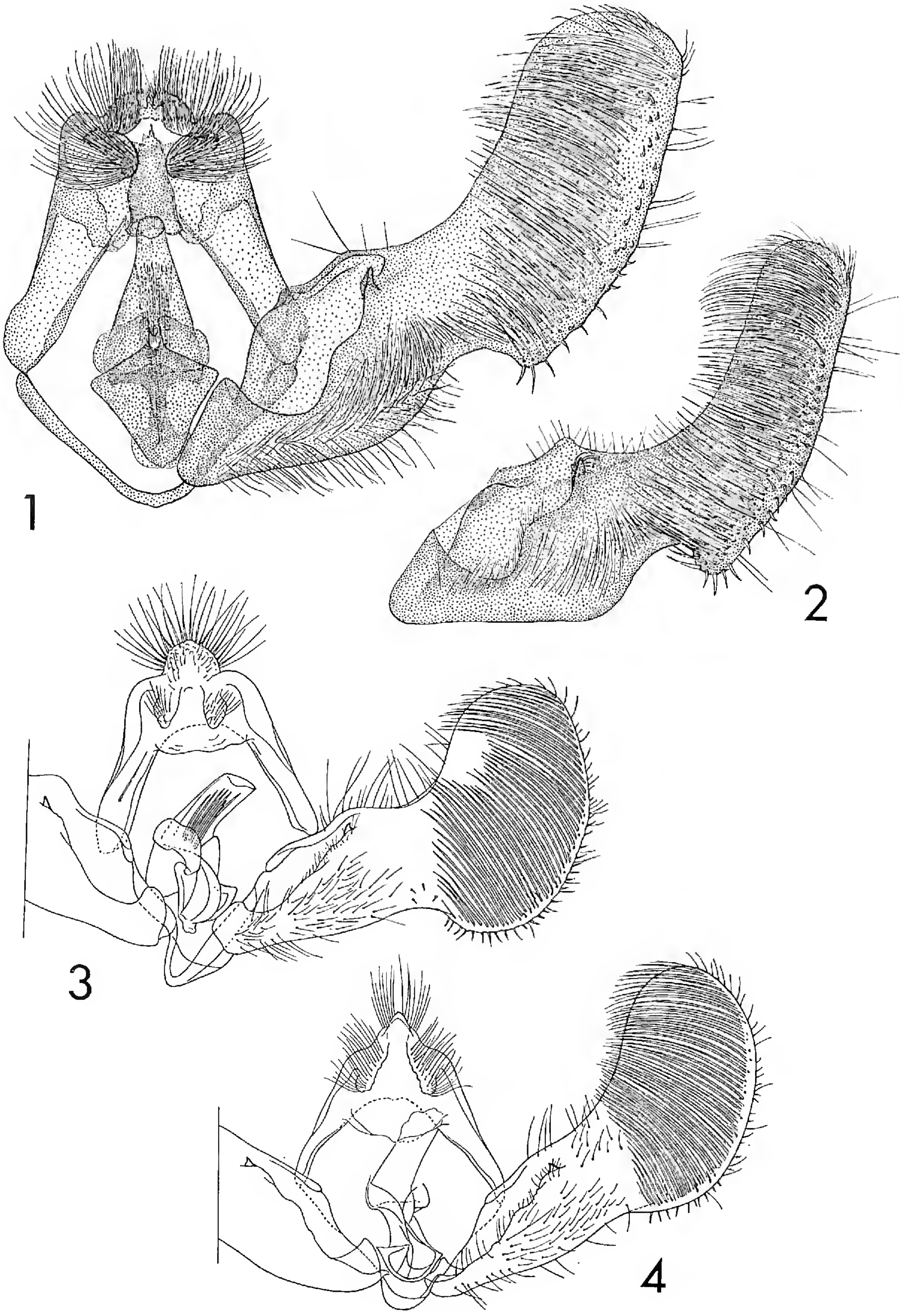
Superficially, the new species resembles *Eucosma williamsi* Powell (1963), and specimens of the two had been mixed in collections.

Epiblema macneilli, new species

(Figs. 11, 12)

A remarkably distinctive, elongate-winged moth, having a sordid white forewing marked by large blackish blotches.

Male.—Length of forewing 11.3–14.0 mm. Head: labial palpus large, II segment length about 1.7 times vertical eye diameter, greatly expanded by a broad scale brush ventrally, completely obscuring the short, appressed scaled, decumbent III segment; latter about .25 as long as II; scaling dark brown or blackish, reflecting purplish, narrowly tipped with whitish, paler basally and interiorly, scales of the ventral hair brush almost hairlike. Antenna about 0.4 forewing length, densely setate ventrally, the erect setae subequal to shaft diameter. Head scaling dense, elongate both on front and crown, the purplish, white tipped scales strongly directed mesad, exposing the conspicuous, red ocellus. Thorax: dorsal scaling concolorous with head, tegulae broadly tipped with white; metanotum posteriorly with short, broad, gray scales. Underside scaling dark gray, tibiae and tarsi distinctly banded with white. Forewing: elongate, narrow, not greatly broadened distally; length 2.9–3.1 times width; fold less than one-third costa length, rather narrow, costa beyond nearly straight, curved only slightly in outer third, termen slightly convex, steeply angled back. Ground color whitish, at times tinged with pale ochreous; markings dark brown or blackish, mostly distinct, as follows: basal one-fourth of wing including costal fold, enclosing a round costal spot of ground color, the patch angled outward at its middle; a rectangular spot on costa from end of fold to middle, extending to top of cell, followed by four triangulate



Figs. 1–4, male genital structures of *Epiblema*, ventral aspect: 1, *E. arizonana* Powell, holotype; 2, valva of *E. carolinana* (Walsingham); 3, *E. macneilli* Powell, holotype; 4, *E. rudei* Powell, paratype.

spots along costa, the last at apex joined to four smaller spots along termen by the dark fringe; a large, rectangular spot on dorsum, before tornus, extending into lower, outer corner of cell, its sides concave; an indistinct blotch in preapical area. Underside dark brown, reflecting purplish, paler towards dorsum; whitish costal interspaces of upperside reproduced. Hindwing: considerably shorter than forewing; costa concave in outer half; apex broad, termen strongly angled back, rather sharply angled with dorsum. Variably whitish basally, tending to brownish apically; fringe brownish basally, whitish dorsally. Underside whitish, the veins and fringe brownish. Abdomen: scaling blackish gray, genital scaling paler. Genitalia as in fig. 3 (drawn from holotype, JAP prep. no. 355, three preparations examined) ; uncus prominent, cucullus very broad, subangulate on distal curvature, its length about 1.6 times width; cornuti numerous, elongate, thin.

Female.—Length of forewing 10.6 to 11.7 mm. Essentially as described for male but smaller with more distinct, contrasting forewing markings and darker hindwings. Forewing slightly broader than in male, length 2.7–2.8 times width. Maculation of forewing generally more extensive so that subtornal blotch often joins median costal spot and nearly reaches subapical blotch, latter connected to apical marks. Hindwing dark brown. Sclerotized portion of VII sternite relatively narrow. Genitalia as in fig. 6 (drawn from paratype, Mono Pass, JAP prep. 3866, two preparations examined) ; sclerotization of VIII tergite elongated and enlarged to form a nearly tubular extension, sterigma broad, rounded; signa small, broad, the smaller one hardly pointed; surface of corpus bursae granulose.

Holotype male: CALIFORNIA, near MONO PASS, 12,000 feet elevation, INYO COUNTY, August 11, 1958 (C. D. MacNeill), deposited in the California Academy of Sciences; allotype female, same locality, 12,500′, Sept. 3, 1965 (J. Powell), deposited in California Academy of Sciences on indefinite loan from the Essig Museum of Entomology, University of California, Berkeley. Paratypes (26) : near Mono Pass, 12,600′, 6 ♂♂, 13 ♀♀, VIII-30, 31-65 (MacNeill, P. A. Opler, & H. G. Real), 1 ♂, same data except VIII-30-67 (Opler) ; same data as allotype, 1 ♂, 3 ♀♀ (Powell & P. A. Rude) ; Mt. Star, north of Mono Pass, 2 ♀♀, IX-3-65 (A. J. Slater) ; deposited in California Academy of Sciences, U. C. Berkeley and U. S. National Museum of Natural History.

One additional male in poor condition which appears to be conspecific, although it has a larger preapical blotch on the forewing, has been examined: "Summit Mt. Whitney, 14,500′, Inyo Co., Cal. VIII-15-53" (no collector given) (LACM).

With its narrow forewings and large blotched color pattern, *E. macneilli* is the most distinctive species of North American *Epiblema*. In genitalia form the species is most similar to the *walsinghami-infelix* complex, which contains more typical appearing members of the subgenus, smaller moths with broad, dark forewings having a white dorsal patch. Disregarding the pulvinus (or "clasper") the genitalia resemble certain *Eucosma* species (e.g., *subflavana* Walsingham) ; and *macneilli* would seem to be a more likely member of that genus, which is a much more heterogeneous assemblage, although even in American *Eucosma* it would not be closely approached in appearance. Superficially the female rather closely resembles that of the Asiatic species *Eucosma victoriana* (Kennel). Evidently the moths are diurnal, and at the type locality seemed to be associated with *Hulsea algida* (Compositae), but I was unable to locate any galls or other evidence of larval work on above ground parts of this plant in September, 1965.

I take pleasure in naming the species for Don MacNeill, who has collected many interesting Lepidoptera during his numerous visits to the arctic-alpine type locality.

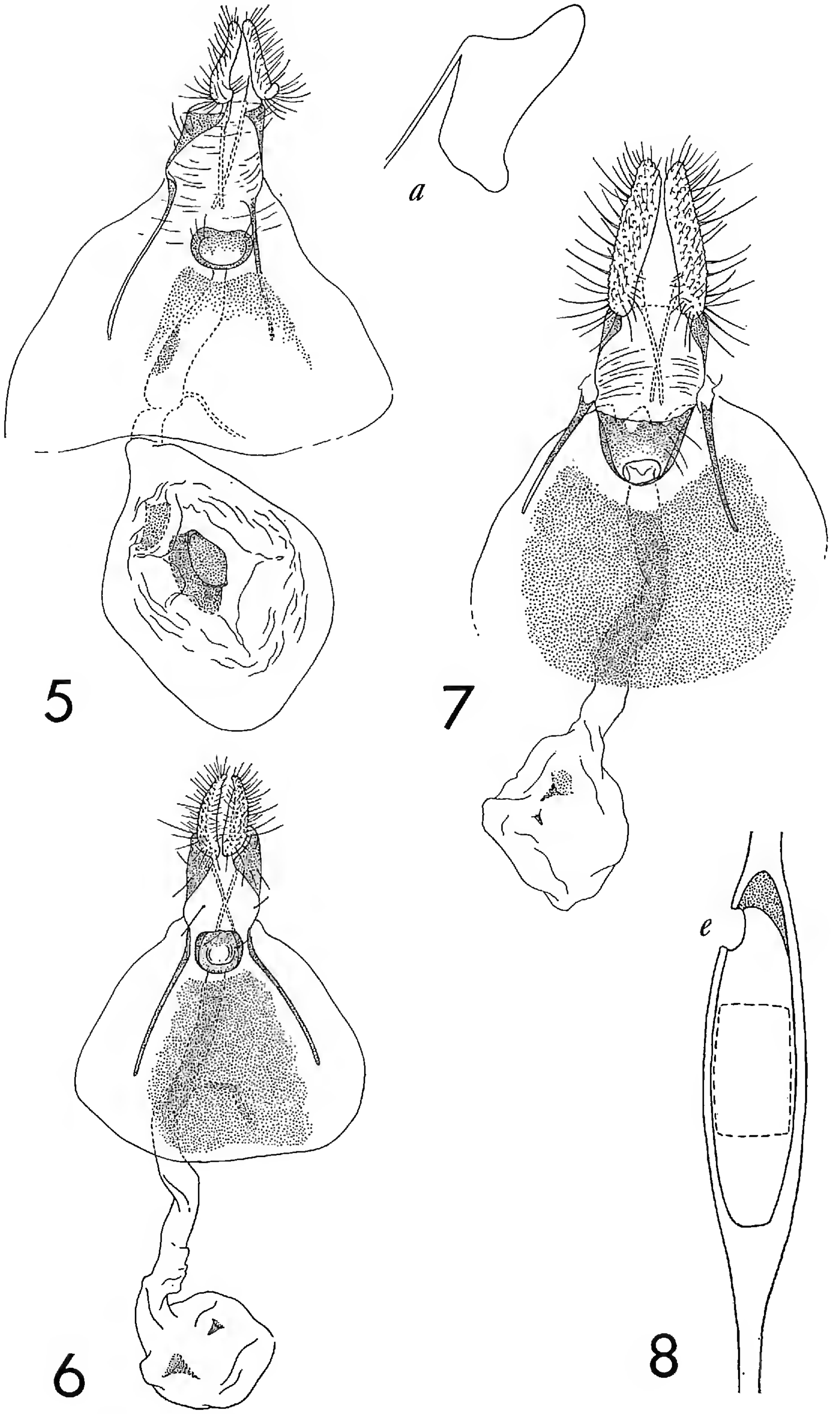
Epiblema rudei, new species

(Fig. 13)

A pale moth, resembling *E. obfuscana* and *E. desertana* in general appearance, the forewing having a narrow dark terminal band.

Male.—Length of forewing 8.4 to 10.6 mm (reared from field collected pupae). Head: labial palpus moderately elongate, appressed scaled (without a broad scale brush obscuring segment III), segment II length about 1.15–1.20 eye diameter; III .25–.30 as long as II, scaling dark brown, reflecting a purplish sheen. Head scaling concolorous, with some pale rust colored scaling intermixed. Thorax: dorsal scaling dark brown, becoming sordid whitish or gray posteriorly. Ventral scaling shining whitish gray, femora sordid whitish exteriorly, tibiae and tarsi dark gray, banded with whitish. Forewing: length 2.7–3.0 times width; narrow basally with a narrow costal fold extending nearly to mid costa, wing becoming broader distally, the apex produced; costa nearly straight, termen strongly angled back. Ground color sordid whitish or pale grayish, marked by two broad, transverse bands of pale bluish gray, the first covering basal one-third of wing, the second beyond middle, broad at costa where it encloses three pairs of white costal dashes, becoming narrower and rectangular across wing at end of cell, extending to dorsum just before tornus, obscured by ground color in costal one-third; both bands obscurely strigulate with indistinct, transverse pale lines. Subterminal area narrowly dark gray blending into the dark brown fringe which is tinged with red-brown. Underside gray, reflecting purplish, costa and subterminal areas narrowly cream-white; an indistinct whitish area at mid dorsum. Hindwing: broader than forewing, costal margin convex, apex rounded, terminal margin slightly convex. Ground color pale gray basally, irregularly streaked with darker gray-brown outwardly, becoming brownish on outer half of costal area and distal margins; fringe paler, gray. Underside white except veins on costal half gray. Abdomen: dorsal scaling dark gray, becoming sordid whitish on final 2 or 3 segments and laterally; ventral scaling mostly whitish. Genitalia as in fig. 4 (drawn from paratype, Colton, JAP prep. no. 233, 2 preparations examined); uncus 2 prominent triangular peaks, socii moderately elongate, valva broad, cucullus broadly rounded, its length about 1.75 width, sacculus only weakly emarginate before cucullus, cornuti apparently lacking.

Female.—Length of forewing 8.0 to 9.0 mm. Essentially as described for male, smaller with the forewing appearing broader due to absence of the costal fold. Fringe more richly rust-brown and hindwing slightly darker than in male. Genitalia as in fig. 7 (drawn from paratype, Colton, JAP prep. no. 2291, two preparations examined); papillae anales flat, unmodified; sclerotization of sterigma



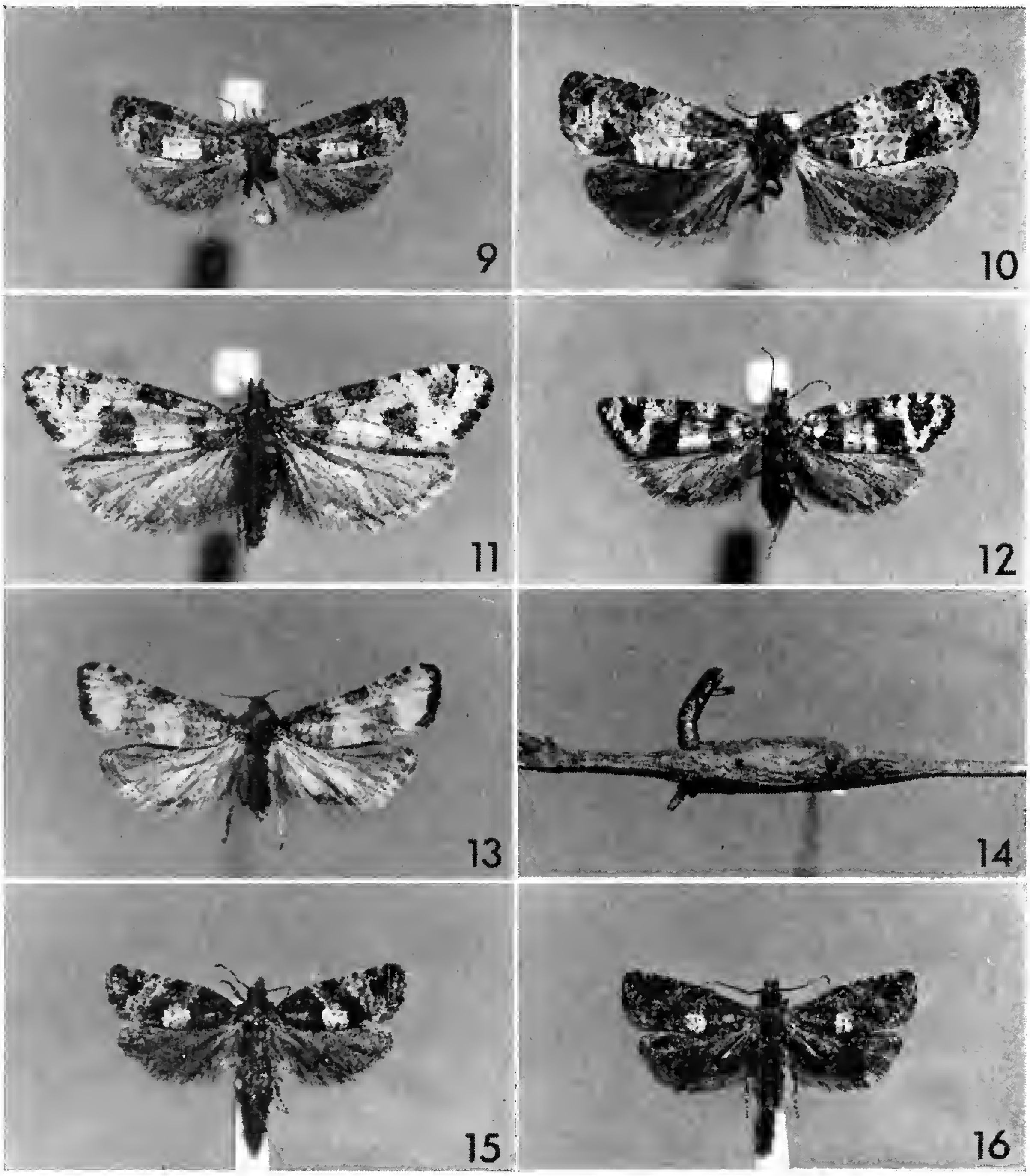
FIGS. 5–7, female genital structures of *Epiblema*, ventral aspect: 5, *E. arizonana* Powell, paratype (*a*, papillae anale, lateral outline); 6, *E. macneilli* Powell, paratype; 7, *E. rudei* Powell, paratype. Fig. 8, diagrammatic longitudinal section of gall caused by *E. rudei*: *e* = emergence hole; shaded area indicates zone of packed frass; approximate position of braconid cocoon indicated by dotted line.

irregularly emarginate posteriorly, signa small but acutely pointed, the smaller one sometimes very tiny; corpus bursae surface granulose.

Holotype male and allotype female: California, Big Panoche Creek, at Fresno-San Benito County line, March 4, 1968, reared from stem galls on *Gutierrezia californica*, emerged March 17–19, 1968, JAP 68C7 (J. Powell); deposited in the California Academy of Sciences on indefinite loan from the Essig Museum of Entomology, U. C. Berkeley. Paratypes (14): same data, 1 ♂, 3 ♀♀; same locality: 4 ♂♂, IV-21-67, r.f. *Gutierrezia*, emgd. IV-24-67, JAP 67D99 (P. A. Rude), 2 ♂♂, III-6-69, r.f. *Gutierrezia*, emgd. III-20, 29-69, JAP 69C1 (Powell), 2 ♂♂, II-5-70, emgd. II-23, 26-70, JAP 70B1 (Powell); Colton, San Bernardino Co., Calif., 1 ♂, 2 ♀♀, III-13, 17-1910 "ex composit gall" (G. R. Pilate); deposited in the California Academy of Sciences, U. S. National Museum of Natural History, and U. C. Berkeley.

In external appearance *Epiblema rudei* most closely resembles the Solidago-feeders, *E. desertana* (Zeller) and *obfuscana* (Dyar) of the eastern U. S., which differ from the present species by having the basal patch of the forewing darker than the outer transverse band, and by having more rectangular shaped forewings (termen less steeply angled back than in *rudei*). A ratio of base-to-apex: base-to-tornus distances is 1.30–1.35: 1 in *rudei* and 1.1–1.2: 1 in the two eastern species. *Epiblema obfuscana* also differs by having the terminal dark band short, ending above the tornus, which is white and by having dark brown hindwings. In male genitalia the new species is distinguished from the above two in many particulars and appears to be most similar to *abbreviatana* (Walsingham), a smaller moth of quite different external appearance that ranges across the northern U. S.

This new species is named for Paul A. Rude, who first called my attention to the galls at Panoche Creek, one of many interesting discoveries that he made during fieldwork as an assistant on my N.S.F. sponsored project on microlepidoptera biologies. Paul had originally observed the characteristic galls during a study of dipterous galls on *Gutierrezia* at La Mesa, San Diego County, several years previously. Reexamination of that site in October, 1967, revealed that plant succession was eliminating the *Gutierrezia* and there was no evidence of *Epiblema*. Other places where we have seen galls presumed to be of *Epiblema rudei* are: 2 miles north of Lancaster, L.A. County and 2 miles southeast of Pinon Hills, San Bernardino County (immature galls in October on *Gutierrezia microcephala*); Jacalitos Canyon near Coalinga, Fresno County; and the hills 2 miles southwest of Kettleman City, Kings County. A search in the vicinity of Colton to the La Sierra-Lake Matthews area, Riverside County, in August, 1968, failed to reveal work of this moth, as did extensive late season reconnaissance in other arid regions of southern California, southern Nevada, and Ari-



FIGS. 9–16, adults and gall of *Epiblema*: 9, 10, *E. arizonana* Powell, ♂, ♀ paratypes; 11, 12, *E. macneilli* Powell, ♂, ♀ paratypes; 13, *E. rudei* Powell, ♂ paratype (JAP 67D99); 14, *E. rudei*, gall and eclosed pupal shell (Colton, Calif.); 15, *E. radicana* (Walsingham), ♀, San Bruno Mts., Calif.; 16, *E. hirsutana* (Walsingham), ♂, Berkeley Hills, Calif.

zona during 1966–1968, in connection with a survey of root-boring Eucosmini inhabiting various woody Compositae.

Gutierrezia is a disclimax situation plant, and in most of the areas where we have examined it, colonies grow in sites that are overgrazed or otherwise affected by man's activities. By contrast, in the Mojave and Central Valley where we found populations of this moth, the host-plant thrives on naturally loose sand substrates.

Biology.—Adults of *Epiblema rudei* evidently are nocturnal. One male (70B1) was retained alive for several days and was inactive during day, moving only at night.

Presumably full grown larvae overwinter, and pupation occurs in early spring. Although emergences occurred within 2–3 weeks following collection of galls at various times in spring, the normal flight period probably is April. One gall dissected in early February, 4 days following collection, contained a pupa, while 1 larva and 2 pupae were excised in mid-March, 12 days after collection, and both pupae and already evacuated galls were taken on April 21.

The galls are elongate, thickened areas of 1.5–3 mm thick stems; usually mature galls are about 20–23 mm in length, with a maximum diameter of 6.0–6.5 mm. The silk-lined pupal chamber varies considerably in size from one gall to another, depending primarily on the thickness of the gall walls, in diameter from 1.8 to 3.3 mm and in length from 13–17 mm (figs. 8, 14). Emergence occurs via a 2.5–4 mm aperture which the larva prepares just prior to pupation, leaving a thin layer of bark for the pupa to dislodge. This covering is more strongly attached on its lower rim so that the pupal shell hangs over it. After emergence the pupal shell usually readily falls away and the hatch recloses, leaving the external appearance of abandoned galls nearly indistinguishable from occupied ones.

At the type locality there was a high rate of parasitism: 65% of a 1969 random sample consisting of 26 old and active galls had either braconid cocoons or emergence holes of chalcidoids, and 4 of 6 collected in 1970 were parasitized. The braconids mature after the caterpillar has spun its silk pupal chamber lining, while the chalcidoids were of two types. A larger species (not reared) caused the death of the *Epiblema* after construction of the emergence 'window' but prior to cocoon spinning, while a pteromalid affected younger larvae, judging by gall size, and cut its own emergence hole at varying places in the gall. At the Kettleman Hills, where the galls were abundant in 1974, a similar high proportion of parasite emergence holes was evident, while at Jacalitos Canyon galls were rare in February, 1970, and the two active ones collected both produced parasites.

EPIBLEMA RADICANA (Walsingham)

(Fig. 15)

Paedisca radicana Walsingham, 1879, Illus. Lep. Het. Brit. Mus., 4:53 (TL: Rogue River, Ore.).

Epiblema radicana; Obraztsov, 1965, Amer. Mus. Novitates, 2213:3 (synonymy).

Eucosma vomonana Kearfott, 1907, Trans. Amer. Ent. Soc., 33:90 (TL: Cisco, Calif.).
Eucosma serangias Meyrick, 1912, Ent. Mo. Mag., 48:35 (invalid repl. name).

The complex synonymy and taxonomic confusion involving this species and *Griselda radicana* Heinrich which was occasioned after Heinrich misinterpreted Walsingham's species was disentangled by Obraztsov (1964, 1965b). Fortunately Obraztsov elected to preserve the name *radicana* Walsingham rather than declare it a *nomen oblitum*, and in the process eliminated one of Kearfott's nonsense names and one of Meyrick's unnecessary substitution names.

We have discovered two colonies of *Epiblema radicana* in the San Francisco Bay area, but efforts to locate the larvae have failed. The moths fly in moderately early spring and appear to be diurnal, which probably have been major factors in the century-long preservation of anonymity of this species. Numerous adults were active during midday in the first week of April, 1962, below Radio Peak in the San Bruno Mountains, San Mateo County. In subsequent years a few have been taken there between mid-March and mid-April: IV-13-66, III-17-68, III-28-69, and III-10-72. The site is a rocky ridge featuring a rich coastal scrub chaparral, with several woody composites that might include a likely hostplant of *Epiblema*. The moths seemed to be associated with *Eriophyllum* (probably *E. staechadifolium* and *E. confertiflorum*), although no precise relationship was observed. No gall-like structures were discovered and several hours digging in early March, 1972, produced only larvae of *Hysterosia* (Cochylidae) in the crown and roots. One female of *radicana* caged in April, 1966, with *Eriophyllum* foliage lived only 4 days and produced no eggs.

The second colony was located at Raines Park, Del Puerto Canyon, 20 miles west of Patterson, Stanislaus County, where adults (3 ♂♂, 1 ♀) were flushed from *Ribes quercetorum* bushes during late afternoon on April 28, 1969. This site is in sparse digger pine (*Pinus sabinana*) woods, a quite different habitat than that of the San Bruno Mountains, and no woody composite was observed in the immediate area.

EPIBLEMA HIRSUTANA (Walsingham)
(Fig. 16)

Paedisca hirsutana Walsingham, 1879, Illus. Lep. Het. Brit. Mus., 4:50 (TL: Sonoma Co., Calif.).
Epiblema hirsutana; Heinrich, 1923, Bull. U.S. Natl. Mus., 123:149.

This is another species that remained in seclusion for many years following Walsingham's original collection in 1871. No specimens were known to Heinrich at the time of his 1923 revision. Later the National Museum received two from Walsingham's material via the Fernald collection (Heinrich, 1929), and these remained the only known specimens in American museum for another 30 years.

We rediscovered *E. hirsutana* when a colony turned up in the Berkeley Hills in northeast Oakland, Alameda County. A single male was taken April 3, 1959 (Chemsak and Powell), and males were common there, flying at midday April 17, 1962. In subsequent years only a few have been collected: V-16-63, IV-15-64, V-15-64, and V-16-67. This site, an east facing slope above the Caldecott Tunnel, used to be characterized by a mixture of native shrubs and herbs including *Lupinus arboreus, Phacelia californica, Symphoricarpos alba, Wyethia mollis, Artemisia californica,* and *A. douglasiana,* etc., but plant succession, especially invasion of alien grasses, encouraged by a fire in 1968, offroad motorbike traffic and fire suppression brush clearance, have greatly reduced the native vegetation. In 1962 *E. hirsutana* appeared to be flying in association with *Artemisia douglasiana,* but subsequent searches have failed to reveal any gall-like structures on this plant. Collections of overwintering larvae in the dry standing floral stalks produced only Pterophoridae and Mordellidae, and examination of roots in March, 1972, yielded only *Hysterosia* (Cochylidae). The *Artemisia* has been partly eliminated at this locality, and the colony of *E. hirsutana* also may be declining, although only one survey during the flight season has been conducted during the past 7 years.

Acknowledgements

Sincere thanks is made to collectors and authorities of institutional collections cited above for use of material they made available, and especially to J. F. G. Clarke of the Smithsonian Institution, who provided assistance on this project and the drawings of *E. arizonana* and *carolinana,* which had been prepared by a staff artist at the U. S. National Museum of Natural History. The rest of the drawings were done, in part from my pencil drafts, by Celeste Green, artist of the Department of Entomological Sciences, U. C. Berkeley. Field studies during 1965–1970, including assistance by P. A. Rude and A. J. Slater, was funded by N. S. F. grants GB-4014 and GB-6813X.

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Nest Descriptions and Associates of Three American Bees of the Genus "*Anthocopa*" Lepeletier

(Hymenoptera: Megachilidae)

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"*Anthocopa*" Lepeletier is a large group of megachilid bees found in North America, Eurasia, and Africa. This group has been treated as a genus in North America, but European authors have included *Anthocopa* in *Hoplitis* Klug. Recently Michener (1968) suggested that *Anthocopa* be synonymized with *Hoplitis*. For the purposes of this paper, I an using *Anthocopa* because of its familiarity and its current usage in the catalog of Hymenoptera of America (Muesebeck et al. 1951).

The North American species of *Anthocopa* are grouped into 4 subgenera containing 34 species. The nesting habits of the Nearctic species are undescribed, but Parker and Bohart (1966, 1968) recorded 2 species from trap stems. This paper describes nests of 3 species including the 2 from trap stems. Although these reared species belong to different subgenera and all have dissimilar nesting habits, I feel it is premature to propose that these behavior patterns are indicative of subgeneric categories because so few species are known biologically.

ANTHOCOPA (EREMOSMIA) HYPOSTOMALIS Michener

(Figs. 1–6)

Nesting Site: All nests (98 containing 305 cells) were recovered from prebored elderberry trap stems each with a bore diameter of 6–3mm (¼–⅛ in.); only the end holes were utilized though side holes with similar diameters were present on the same stems. The trap stems selected by these bees were placed in the following localities in southern California following the procedures of Parker and Bohart (1966): Deep Canyon and White Water Canyon, Riverside Co.; Kramer Hills, San Bernardino Co.; Palm Canyon (Anza-Borego State Park), San Diego Co.; and Glamis, Imperial Co. The best trapping site was White Water Canyon where 92% of the nests studied were recovered. In 1964, this species occupied 28% of the recovered trap stems; the next season it utilized 53%.

Nest Construction: Nests were made by building complete cells one on top of the other (Fig. 1); nests averaged 3.1 cells with a range of

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1–9. Each cylindrical cell was made by combining gravel and masticated plant parts and lining the burrow walls with this material. In smaller holes, the cells were long and narrow (5 × 13mm) and placed vertically. In larger borings, the cells were stout (8 × 9mm), and the cell series was oblique. Pith was removed from the sides of the burrow to accommodate the oblique cells. Also, because of the softness of the pith in the stems, the drilled holes were occasionally larger than the size stated earlier. The inner cell walls were smooth, polished, and composed of finely masticated plant parts combined with a salivary substance. The outer cell surface was roughened by protruding particles of sand and pieces of plant material (Figs. 2, 3). The cell cap was composed of a thin disc of masticated plant parts with a layer of sand appressed to the outer surface. The cap was concave and smooth initially; but later the concave area was filled with small pieces of gravel stuck together with masticated plant parts. The inside of the cell cap was rough and without any apparent design or openings. The nest entrance and burrow above the cells were plugged with fine gravel. The gravel in the entrance was held together with a salivary substance. One stem was plugged with a thin disc of resin, but this plug may have been applied by another species of bee.

Provisions: The size and shape of the pollen mass was not recorded. Hurd and Michener (1955) listed *Dalea* and *Cryptantha* as host plants for *A. hypostomalis*. Pollen found in the reared cells was Leguminosae, probably *Dalea*; but one sample contained pollen from a hydrophyllaceous flower.

Feces: The walls of the cells were lined with feces; those at the top were loose, but those on the sides were flattened against the cell walls. The dark, loose fecal particles were fairly uniform in length (0.5mm), tapered, and oblong; there was a faint linear depression on one surface.

Cocoons: The cocoons were formed by lining the cell walls from the bottom to nearly the top with finely spun silk. In shorter cells, the cocoon filled the cavity; in longer cells, it filled the lower ¾ of the cell (Fig. 4). The cocoon was thick, dark brown, and oval and had a nipple at the top (Fig. 4). The outer lateral surface of the cocoon below the nipple usually possessed several rings of loosely spun silk that in some cells extended to the cell walls. The nipple was loosely spun and of various shapes; but the inner cocoon surface opposite the nipple always had many strands of loose silk. The cocoon was tightly appressed to the cell walls.

Sex Ratio: More females than males emerged, and the ratio females to males was 1.2:1.0. The ratios of females to males in each cell

Fig. 1. Two cells of *A. hypostomalis* in a trap stem, bottom cell with larva.

Fig. 2. Cell of *A. hypostomalis* showing material used to construct the cell. The nest entrance plug is attached to the top of the cell.

Fig. 3. Female and cell of *A. hypostomalis.*

Fig. 4. Cell B in fig. 1 opened to illustrate the white nipple at the top of the cocoon. Note rings of silk at the top.

beginning with the first (bottom) cell was 1.6, 1.3, 1.0, 1.0, 0.5, 1.3, 1.0, 0.4, 0.0. Thus, the placement of the sexes in the cells followed the usual pattern of females at the bottom and males above; but in 7% of the nests, the sexes were intermixed, and in another 10% only males were present.

Nest Associates: The four insect species associated with nests of *A. hypostomalis* accounted for a 15% cell loss. An undescribed species of the parasitic bee, *Stelis* (Megachilidae) (Fig. 5), was the most common parasite, and it accounted for 62% of all parasitism. Like its host, more females than males (ratio 1.5:1) of this parasite emerged. Cocoons of *Stelis* also possess nipples (more elongate than the *Anthocopa*), but these cocoons are smaller and lack the rings of silk at the top (Fig. 6). A clerid beetle, *Cymatodera* sp., was the second most abundant nest associate. Larvae of these beetles destroyed 28% of the depredated cells, and as many as 3 cells in a series were entered and destroyed by one larva. *Leucospis affinis* Say, a common chalcid parasite of bees, was found in 2 cells, and a male mutillid, *Sphaeropthalma amphion amphion* (Fox), was reared from one cell. Two nests were destroyed by an unknown species of woodpecker, and cell losses due to unknown causes totalled 23.2% with 13.7% occurring in the precocoon stages and 9.5% in later stages.

ANTHOCOPA (HEXOSMIA) COPELANDICA (Cockerell)

(Figs. 7–9)

Two of the 3 recognized subspecies of *A. copelandica* were reared. The observations recorded below apply to both subspecies except where differences are noted.

Nesting Site: Nests of this species were collected from prebored elderberry stems set out at 6 western localities. At 3 locations, Boca and Carnelian Bay (Nevada Co.), California, and Craters of the Moon National Park (Butte Co.), Idaho, 32 nests of the subspecies *c. albomarginata* (Cockerell) were found. At 3 southern Californian localities, Brown Canyon, Kramer Hills (San Bernardino Co.), and Deep Canyon (Riverside Co.), 20 nests of the subspecies *c. arefacta* (Cockerell) were found. Three sizes, 6, 3, and 1.5mm (¼, ⅛, 1/16 in.) of end and side holes were utilized by these bees.

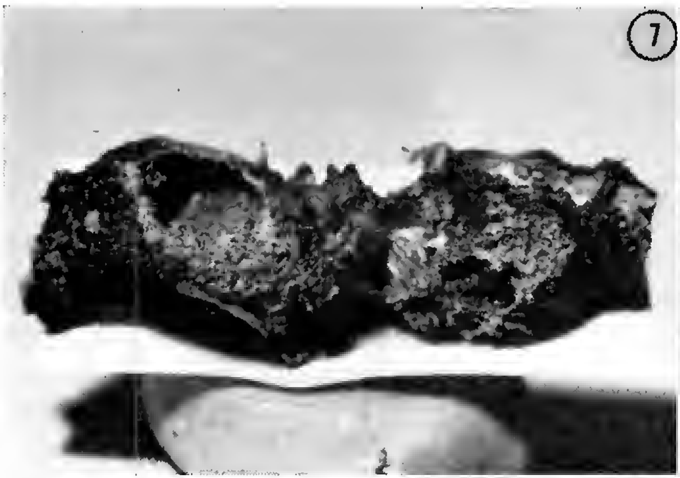
Nest Construction: The species was versatile in nest building. In wide burrows (6mm), cells were grouped with cell walls fashioned mostly from nest building material (Fig. 7); in narrow holes (2–4mm), only thin partitions (1–2mm) separated the cells. Cell size ranged from 4–9mm long and 3–4mm wide. The placement of cells in burrows

Fig. 5. A male of *Stelis* sp., a parasite of *A. hypostomalis.*
Fig. 6. Cocoon of *Stelis* sp. in cell of *A. hypostomalis.*

was highly variable, but there was often an empty space (avg length 28mm) between the last cell and the entrance plug, usually enough space for more cells. Nest building material was coarsely chewed plant parts; but in most nests of *c. arefacta,* sand and masticated plants were used in cell partitions and entrance plugs. Cell partitions were formed into thin discs, and the edge of some partitions were bent downward. In larger burrows, some of the upper partitions were partially constructed (except for the small entrance hole) prior to cell provisioning. The cell partitions were smooth above and roughened below. Nests were capped with discs of chewed plant parts, but occasionally some pith from the sides of the stem was incorporated into the plugs, which averaged 2–9mm long. Some plugs were composed of as many as 8 compact discs, and they were often situated below the nest entrance (avg 4.5mm). Thirty-two nests of the subspecies *albomarginata* were examined; they held 79 cells (1–10, avg 2.4/nest). Twenty nests of the subspecies *arefacta* were recovered; they held 87 cells (1–11, 4.3/nest).

Provisions: Shape and size of pollen masses were not recorded. Pollen samples in cells from Idaho were all Hydrophyllaceae.

Feces: The feces were light tan in cells of *c. arefacta* (Fig. 8) and dark brown in cells of *c. albomarginata* (Fig. 9). Neither had surface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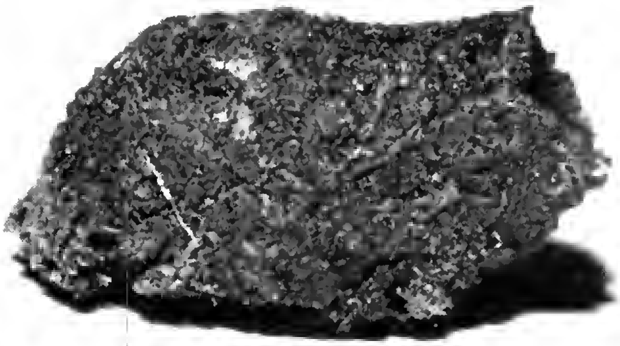
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depressions, and some particles were tapered and others were blunt. Most particles were deposited at the top of the cell or around the walls, but often they were flattened against the sides.

Cocoon: The cell wall was lined by thick layers of transparent silk that fit snugly against the wall. Inside this layer but closely attached to it a dark amber cocoon was spun. The amber cocoon was often smaller than the outer one in longer cells (⅔), but in shorter cells it filled the transparent cocoon. The cocoon did not have a protruding nipple, but at the top it was slightly raised with many strands of loose silk. The inner surface of the cocoon was shiny, but the silk strands were evident.

Sex Ratio: More females than males emerged, 2.4:1, and only 2 nests contained series with the sexes mixed. In all other nests, the females were at the bottom, and the male cells were above.

Nest Associates: Five species of parasites and predators were recovered from *A. copelandica* cells. Total parasitism was low, only 6.6%. The most common parasite was the chrysidid, *Chrysura sonorensis* Cameron, which occupied 6 cells of *c. albomarginata*; another wasp, *Sapyga pumila* Cresson, was found in 2 cells of this subspecies. The other 3 parasitized cells each contained one of the following species: a male leucospid wasp, *Leucospis affinis* Say, from a *c. arefacta* cell; a pteromalid, *Epistenia* sp., and a meloid beetle, *Nemognatha scutellaris* LeConte, each from a *c. albomarginata* cell. Three cells in one nest of *c. arefacta* were destroyed by a clerid larva belonging to the genus *Cymatodera*. Cell mortality due to unknown causes was 4.8%.

ANTHOCOPA (ATOPOSMIA) ABJECTA (Cresson)

(Figs. 10–13)

Nesting Site: Nests of *A. abjecta* were found attached to the under surface of flat stones at 2 locations above 8,000 ft in Cache County,

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Fig. 7. Nest of *A. c. albomarginata* showing composite cells. Some cells were almost completely lined with macerated plant parts.

Fig. 8. Cocoon of *A. c. albomarginata* from a wide burrow. The shape of the cocoon followed the walls of this irregular cell. Pith from the trap stems was incorporated into the plug at the top of the cell.

Fig. 9. Female and cell of *A. c. arefacta.*

Fig. 10. Leaf part cells of *A. abjecta.*

Fig. 11. Leaf part cells of *A. abjecta*, ventral view.

Fig. 12. Female and cell of *A. abjecta.*

Fig. 13. Top of cocoon of *A. abjecta*, showing the coarse silk strands.

TABLE 1. Comparative biology of *Anthocopa* species.

				Nesting material					
Species	Nesting site	Provisions	No. cells/nest	Entrance plug	Cell partitions	Cell walls	Cocoon	Associates	No. nests
hypostomalis	trap stems	Leguminosae Hydrophyllaceae	1–9 avg. 3.1	gravel and masticated plant parts	gravel and masticated plant parts	gravel and masticated plant parts	dark with nipple	*Stelis* sp. *Cymatodera* sp. *Leucospis affinis* *Sphaeropthalma amphion*	98
c. albomarginata	trap stems	Hydrophyllaceae	1–10 avg. 2.4	masticated plant parts	masticated plant parts	occasionally with masticated plant parts	amber w/o nipple	*Chrysura sonorensis* *Sapyga pumila* *Nemognatha scutellaris*	32
c. arefacta	trap stems		1–11 avg. 4.3	masticated plant parts and fine gravel	masticated plant parts and fine gravel	not lined	amber w/o nipple	*Leucospis affinis* *Cymatodera* sp.	20
abjecta	under stones	*Penstemon*	1–16	masticated plant parts	masticated plant parts	masticated plant parts	dark w/o nipple	*Stelis* sp.	5+

Utah. One habitat was near the summit of Wellsville Mountain, and the other was along Beaver Creek near the Idaho-Utah state line.

Nest Construction: Cell walls were constructed entirely from dark masticated plant material and shaped into domes about 9mm long and 8mm wide (Figs. 10, 11, 12). The rock surface was used as the base. Cells were capped with the same nest building material that was shaped into discs—smooth on the outside and roughened on the inside. The inside of the cell walls was slightly smoothed. When cells were adjacent, only one wall sometimes separated the cells. The number of cells found was not recorded because many were old and constructed during previous seasons. However, one nest contained 16 cells.

Provisions: Hurd and Michener (1955) listed species of *Penstemon* as the host plant for *A. abjecta*. Seven of the cells from which *A. abjecta* emerged contained traces of *Penstemon* pollen. One cell was partially filled with a white vile smelling liquid.

Feces: In most cells, feces were flattened against the walls, but in some they were at either end. The links were dark brown, of uniform length, and without surface markings.

Cocoon: The coarse matlike dark brown strands (Fig. 13) that formed the cocoon closely lined the cell walls. The strands were loosely spun on the outside, but inside the cocoon was polished with many strands visible. The top of the cocoon did not have a nipple.

Sex Ratio: Only females emerged from the cells examined. I did not find any parasitized cells at the Beaver Creek locality, but at Wellsville Mountain where only old cells were found, many had been parasitized by an unknown species of *Stelis*.

DISCUSSION

Nesting habits of *Anthocopa* species are indicative of the close relationship between these bees and other genera such as *Hoplitis* and *Osmia*. Some of the more important nesting patterns among *Anthocopa* and related North American genera are: (1) cells made entirely of masticated plant parts [*A. abjecta*, *Hoplitis biscutellae* (Cockerell)], (2) cells made primarily with fine gravel (*A. hypostomalis*, *Hoplitis anthocopoides* Schenck), (3) cell partition and plug of masticated plant parts (*A. copelandica*, *Osmia kincaidii* Cockerell), (4) cocoon with nipple (*A. hypostomalis*, most spp. of *Osmia*), (5) cocoon without nipple (most spp. of Osmiini except *Osmia*), (6) cocoons composed of 2 distinct layers (*A. copelandica*, *Osmia kincaidii* Cockerell), (7) nests in pre-existing holes (*A. hypostomalis*, *A. copelandica*, most species of *Ashmeadiella*, *Hoplitis*, *Heriades*, *Chelostoma*, *Proteriades*, and some *Osmia*), and (8) nests under stones [*A. abjecta*, *Osmia* spp. (*tanneri* Sandhouse, *longula* Cresson, *integra* Cresson)].

Table 1 summarizes the biology of the *Anthocopa* species considered in this paper.

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Thanks are due the persons who helped identify material reared from the trap stems. C. D. Michener (UK) determined the Apoidea, B. D. Burks (Systematic Entomology, ARS, USDA) Chalcidoidea, D. S. Horning (UCD) Chrysididae, and W. Enns (UM) Meloidae. H. Potter (ARS, Logan) made the pollen identifications. Appreciation is extended to those persons who reviewed this manuscript—Drs. K. V. Krombein (USNM), G. C. Eickwort (Cornell), and R. W. Thorp (UCD).

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The Genus *Limnia* in California

(Diptera: Sciomyzidae)

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The genus *Limnia* Robineau-Desvoidy (1830: 684) can be distinguished from other sciomyzid genera by the following characters: propleural bristle lacking; vallar (subalar) bristles present; arista with whitish hairs or pubescence; mid-frontal stripe approximately ⅓ width of frons; wings reticulated; black spot on medifacies lacking; tp (posterior crossvein) arcuate, only slightly sinuate.

As indicated by Steyskal (1965: 691), *Limnia* is in need of revision. Such a study is in progress jointly with G. C. Steyskal, L. V. Knutson (USNM), and the authors. Pursuant to compilation of a California Insect Survey Bulletin on the Sciomyzidae it has become necessary to clarify the status of the genus in this State. We recognize four species in California; *L. severa* Cresson (Cresson, 1920: 80), *L. inopa* (Adams) (Adams, 1904: 448), *L. pubescens* Day (Day, 1881: 86), and *L. boscii* (Robineau-Desvoidy) (R.-D., 1830: 690). The first three named are western North American in distribution. *Limnia boscii* is transcontinental between 35°–47°N Latitude. Both sexes of the species collected within California are easily separated by external characters. However, outside of California, examination of male terminalia is necessary for definitive determination of certain species. Structures such as the hypandrium, surstylus, and aedeagus are diagnostic for *L. inopa* and *L. severa* (Figs. 6–16).

The objectives of this paper are to (1) resurrect and redescribe *L. inopa* (Adams); (2) redescribe *L. severa* Cresson; (3) provide a key to the *Limnia* of California; and (4) summarize biological information for *Limnia* in California.

Limnia inopa (Adams)

Tetanocera inopa Adams, 1904: 448. Holotype ♂; Washington Territory; Repository, University of Kansas.

Limnia costalis var. *brevicostalis* Melander 1920: 323.
Limnia brevicostalis Melander, Steyskal 1965: 691.
Limnia boscii (Robineau-Desvoidy) 1830: 690, Steyskal 1965: 691.

Examination of the types of *L. inopa* (Adams) (Adams, 1904: 448) and *L. brevicostalis* Melander (Melander, 1920: 323) plus a series of 75 specimens in

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the UCR collection and 33 specimens from the collections of CAS, CU, CDA, KSU, KU, UCB, and USNM lead us to conclude a single taxon is involved.

Distribution: Alta., B.C., Calif., Idaho, Mont., Oreg., Wash.

Head.—Frons yellow, longer than wide, mid-frontal stripe ¼ to ⅓ width of frons, usually widest in females; two frontal-orbital bristles present, anterior socket surrounded by velvety black coloration; ocellars and post-ocellars prominent and of nearly equal length, longer than fronto-orbitals; velvety black patch present in anterior corners of frons. Single velvety black patch present on occiput immediately posterad of post-ocellars. Face and gulae whitish; medifacies bare; parafacies with fine black hairs; central portion of medifacies sometimes with brown discoloration; face deeply concave. Palpi yellow. Eyes large, oval, distinctly longer than high. Antennae with arista with dense white short hairs, basal segments yellow and hirsute; third antennal segment yellowish, usually tinged with black anteriorly, hirsute; second antennal segment approximately same length as third, longer than high from lateral aspect, inflated ventrally, compressed dorsally in cross-section, highly polished, ochraceus yellow, usually with brownish area on dorsal half, usually with two strong bristles on dorso-apical half. Thorax with notum with two narrow brown vittae centrally, a pair of broader brown vittae laterally and a pair of smaller vittae appearing posterad, all separated by dull pruinosity; scutellar bristles prominent; prescutellar bristles variable, generally vestigial to half length of scutellum. Pleura pruinose; pro- and mesopleura brown in upper half. Prosternum without hairs. Legs yellow, tarsal segments 3, 4, and 5 (and sometimes 2) may be dark brown. Wings hyaline, with brown reticulations; posterior crossvein curved outwardly, may be slightly sinuate; halter pale yellow. Wing lengths of 20 females 4.3 to 6.0 mm (average 5.2 mm), 20 males 3.3 to 5.3 (average 4.6 mm).

Abdomen pruinose with irregularly defined brown vittae laterally. Post-abdomen as in Fig. 3.

LIMNIA SEVERA Cresson

Limnia severa Cresson, 1920: 80. Holotype ♂; Cayton, Shasta County, California; Repository, California Academy of Science.

Limnia unguicornis var. *severa* Cresson 1920: 80.
Limnia saratogensis var. *severa*, Melander 1920: 324.
Limnia saratogensis var. *armipes* Melander 1920: 324.

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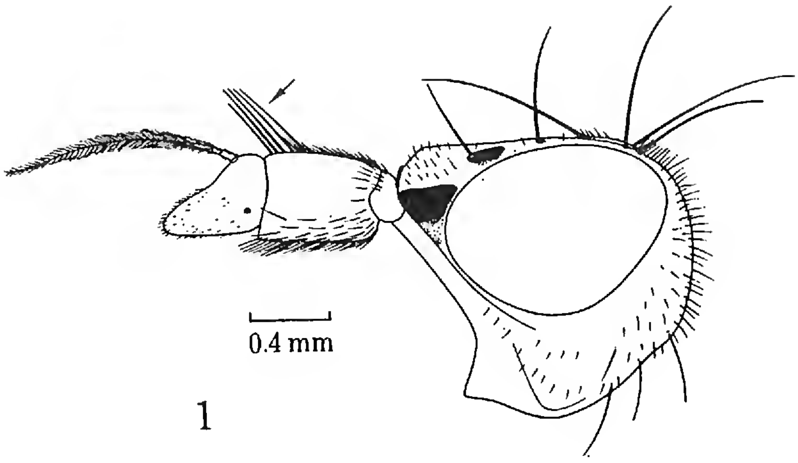
FIGS. 1–5. Fig. 1. *Limnia pubescens* (Day). Head, male. USA, Calif., Shasta Co., Cayton; Elev. 3,050 ft.; VII-25-1972; T. W. Fisher and R. E. Orth, collectors. Arrow indicates strong diagnostic bristles on the anterior dorsal edge on the second antennal segment. Figs. 2–5. Postabdomen, sinistral view; ae, aedeagus; ep, epandrium; hy, hypandrium; ss, surstylus; VI, ventral projection of 6th sternite or protandrium. Fig. 2. *Limnia boscii* (R.-D.). USA, Calif., Mono Co., Fish Slough; Elev. 4,250 ft.; IX-7-1967; T. W. Fisher and R. E. Orth. Fig. 3. *Limnia inopa* (Adams). USA, Calif., Modoc Co., East of Cedar Pass; Elev. 5,800



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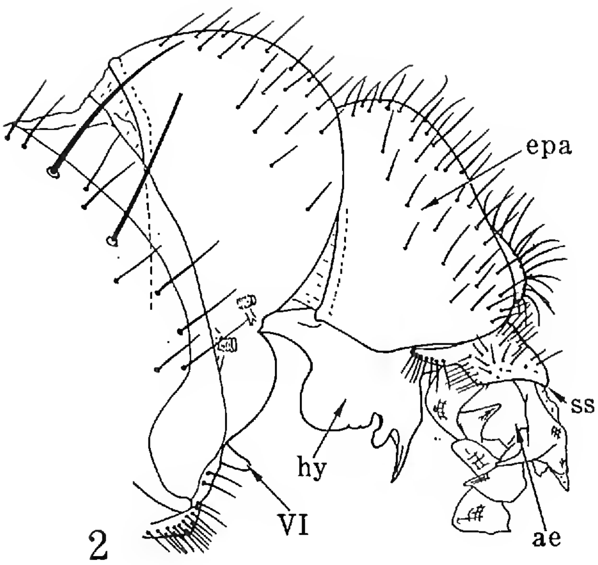

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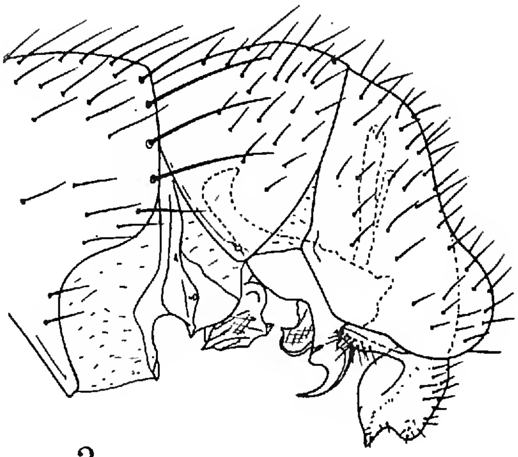

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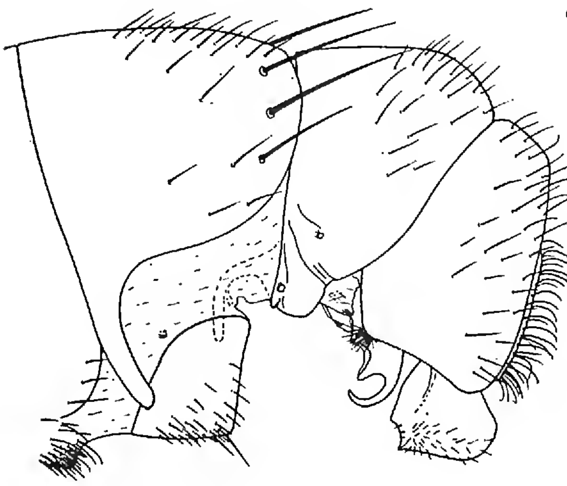

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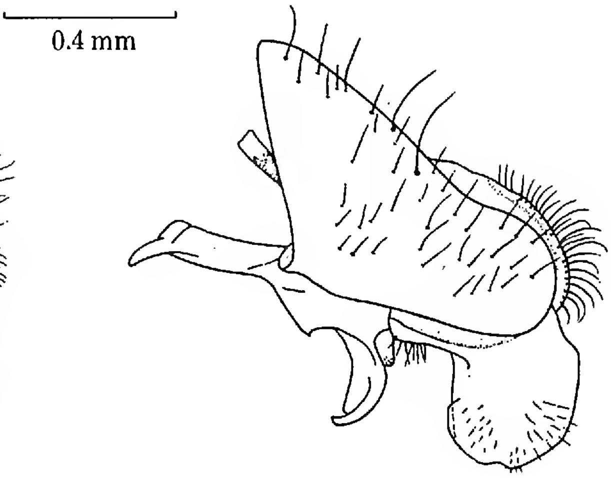

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ft.; VIII-24-1967; T. W. Fisher and R. E. Orth. Fig. 4. *Limnia severa* Cresson. USA, Calif., Alpine Co., south of Woodfords; Elev. 6,000 ft.; VII-11-1968; T. W. Fisher and R. E. Orth. Fig. 5. *Limnia pubescens* (Day). USA, Calif., Shasta Co., Cayton; Elev. 3,050 ft.; VII-25-1972; T. W. Fisher and R. E. Orth.

Limnia armipes, Steyskal 1965: 691.
Limnia severa, Steyskal 1965: 692; Fisher & Orth 1971: 164.

Distribution: B.C., Ariz., Calif., Colo., Oreg., Wash.

Head.—Frons yellow to testaceous, length and width nearly equal, mid-frontal stripe approximately ¼ width of frons; two fronto-orbital bristles present, anterior socket surrounded by velvety black coloration, posterior socket to a lesser degree; ocellars and post-ocellars prominent and of nearly equal length, longer than fronto-orbitals; velvety black patch present in anterior corners of frons; single velvety black patch present on occiput immediately posterad of post-ocellars. Face and gulae whitish; medifacies bare; parafacies with fine back hairs; central portion of medifacies sometimes with yellow to brownish discoloration; face moderately concave. Palpi yellow. Eyes large, oval, distinctly longer than high. Antennae with arista with moderately short and dense hairs, basal segments yellow and hirsute; third antennal segment yellowish, tinged with black anteriorly, hirsute; second antennal segment approximately same length as third; longer than high from lateral aspect; polished, ochraceus yellow, usually with brownish area on dorsal ⅓ to ½; usually with two strong bristles on dorso-apical half. Thorax with notum with two narrow brown vittae centrally, a pair of broader brown vittae laterad, and a pair of additional smaller vittae appearing posterad, all separated by dull pruinosity; scutellar bristles prominent; prescutellar bristles strong, as long as scutellum. Pleura pruinose; pro- and mesopleura brown in upper ¼ to ⅓. Prosternum usually without hairs. Legs yellow to testaceous, front tibae and tarsi brownish to black, mid and hind tibae and tarsi less darkly pigmented, usually only tarsal segments 4 and 5 blackish. Wings hyaline, with dark brown reticulations; posterior crossvein curved outwardly, usually sinuate; halter yellow, brownish at apex. Wing lengths of 20 females 4.6 to 6.0 mm (average 5.4 mm), 20 males 4.0 to 5.4 mm (average 4.9 mm).

Abdomen pruinose with two lateral brown vittae on each side. Postabdomen as in Fig. 4.

KEY TO THE SPECIES OF CALIFORNIA LIMNIA

1. Brown marginal cell of wing with clear spots extending to costal margin; prosternum with hairs; frons wider than long; second antennal segment with 2 strong bristles on the anterior dorsal edge; prescutellar bristles approximately as long as scutellum. (Male terminalia as in Fig. 2) .... *boscii* (Rob.-Desv.)
   Brown marginal cell of wing without clear spots extending to costal margin; prosternum without hairs 2
2. Second antennal segment with 4 or more strong bristles on the anterior dorsal edge (Fig. 1) frons approximately as wide as long; prescutellar

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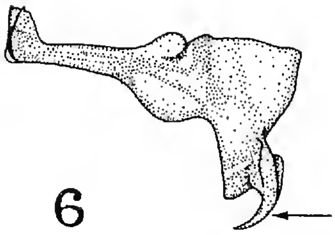
FIGS. 6–16. Figs 6–11. *Limnia inopa* (Adams). Diagnostic structures of postabdomen. USA, Calif.; Modoc Co.; Cedar Pass Campground; Elev. 5,800 ft.; VIII-8-1968; T. W. Fisher and R. E. Orth, collectors. Legend: aea, aedeagus;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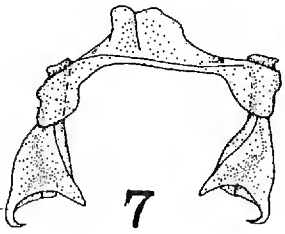
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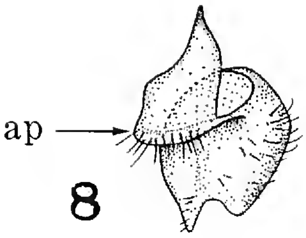
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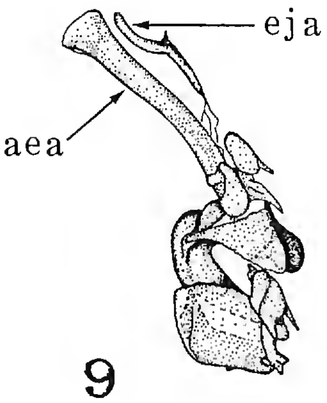
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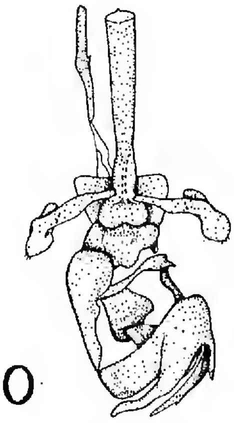
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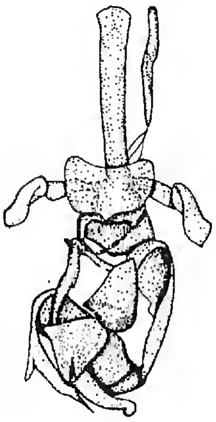
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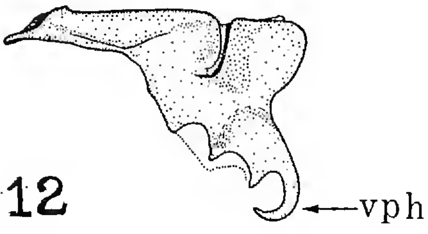
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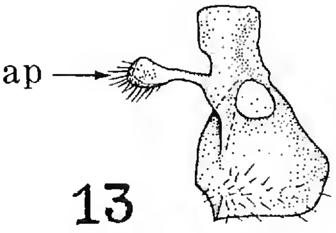
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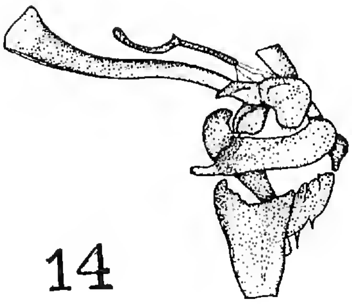
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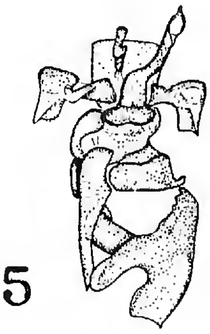
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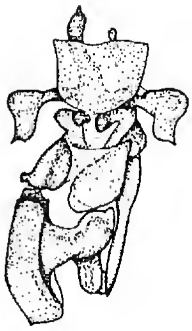
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ap, anterior process; eja, ejaculatory apodeme; vph, ventral process of hypandrium. Fig. 6. Hypandrium, sinistral view. Fig. 7. Hypandrium. Fig. 8. Surstylus (left), sinistral view. Fig. 9. Aedeagus, sinistral view. Fig. 10. Aedeagus, posterior view. Fig. 11. Aedeagus, anterior view. Figs. 12–16. *Limnia severa* Cresson. Diagnostic structures of post abdomen. USA, Calif.; Inyo Co.; Lake Sabrina; Elev. 9,000 ft.; IX-6-1967; T. W. Fisher and R. E. Orth, collectors. Fig. 12. Hypandrium, sinistral view. Fig. 13. Surstylus (left), sinistral view. Fig. 14. Aedeagus, sinistral view. Fig. 15. Aedeagus (looking posterad). Fig. 16. Aedeagus (looking anterad).

bristles approximately ½ to ⅔ as long as scutellum. (Male terminalia as in Fig. 5) .... *pubescens* (Day)

Second antennal segment with 2 strong bristles on the anterior dorsal edge.

3. Frons approximately as wide as long; pre-scutellar bristles as long as scutellum. (Male terminalia as in Fig. 4) .... *severa* Cresson

Frons distinctly longer than wide; prescutellar bristles variable, generally vestigial to ½ length of scutellum (Male terminalia as in Fig. 3) .... *inopa* (Adams)

DISCUSSION

Of the 440 *Limnia* specimens we collected within the State between VI-10-1965 and VI-26-1974, approximately 80% were *L. severa*, 11% *pubescens*, 8% *inopa*, and less than 1% *boscii*. In the 76 collections made in California which contained *Limnia*, *L. severa* occurred alone at 29 sites, *L. inopa* alone at 6, *L. pubescens* alone at 3, and *L. boscii* alone at one. *Limnia severa* and *L. inopa* co-habited 3 sites; *severa* and *pubescens* co-habited one site. Three species, *inopa*, *pubescens*, *severa*, co-habited two sites, Bartle in Siskiyou Co., and Cayton, in Shasta Co. In 1973–1974 at Bartle, a large diverse habitat, *L. severa*, *L. pubescens*, and *L. inopa* represented 9%, 4%, and 4%, respectively, of the 13 sciomyzid species collected. In 1972, 1973, and 1974 at Cayton, a very restricted habitat, *L. pubescens*, *severa*, and *inopa* represented 55%, 19%, and 1%, respectively, of the 10 sciomyzid species collected. *Limnia boscii* was the only species of *Limnia* we collected at Fish Slough in Mono Co., 10 miles north of Bishop, and our records indicate that it occurs only at that locality within California.

Over the nine year period of collecting in California we found *Limnia* co-existing with a rather diverse sciomyzid fauna, i.e., 21 species. Allowing for repeated collections at certain of the sites this summary does not reflect seasonal population trends but was derived from 76 isolated points in time. On-site separative mechanisms such as time, space, plant associations, or proximity to water, are discernible. Two examples are; (1) *L. inopa* does not appear before mid-summer, and (2) repeated visits to the Hat Creek and Cayton sites yielded *L. pubescens* only at restricted areas of several square meters within the larger boundaries of those sites. This observation suggests that *L. pubescens* requires a rather special set of ecological parameters to exist at all, but when those requirements are met *pubescens* can exist in relatively large numbers.

ACKNOWLEDGMENTS

Our thanks to G. W. Byers, (Snow Entomological Museum, University of Kansas) who provided the type of *L. inopa* Adams; to P. H.

Arnaud, Jr., (California Academy of Sciences) who provided the type of *L. severa* Cresson; and to L. V. Knutson (U. S. National Museum of Natural History) who provided the type of *L. costalis brevicostalis* Melander. Review of the manuscript by L. V. Knutson and G. C. Steyskal is greatly appreciated. The work was partly supported by U. C. Agric. Expt. Sta. Project 2037.

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Description of Two New Species of Diptera, Cyclorrhapha from the Ethiopian Zoogeographical Region

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From Dr. P. H. Arnaud, Jr., California Academy of Sciences, San Francisco, the Department of Entomology received a large number of Calliphoridae and Sarcophagidae. These flies had been collected recently in various parts of Africa and proved very interesting. Two new species are described here and more will be described in the future.

Phumosia rossi new species (Calliphoridae : Calliphorinae)

In the key to the *Phumosia* species of the Ethiopian zoogeographical region (Zumpt, 1956) this species runs down to the *P. stabulans*-group. It is well characterized by the male terminalia which show long inwardly curved paralobi terminating in a distinct knob (fig. 1).

Male—Frons at its narrowest point $\frac{1}{10}$–$\frac{1}{12}$ as wide as the eye is long. Parafacialia and -frontalia black or dark brown with silvery pollinosity, 5 to 8 irregularly arranged cruciate *paf*; *iv* and *oc* strong. First and second antennal segments brown, third segment darker, twice as long as second. Arista with long hairs. Bucca about $\frac{1}{3}$ as high as eye, black with greyish pollinosity, hairs black. Palpi yellow-brown, almost parallel, slightly curved.

Thorax black with dense olive pollinosity forming three longitudinal ill-defined and partly indistinct bands on the mesonotum. Chaetotaxy: *ac* = 0–1 + 1–2, *dc* = 2 + 3, *ia* = 0–1 + 2–3, *ph* = 1 (outer absent), *h* = 2, *prs* = 1, *n* = 2, *sa* = 2–3, *pa* = 2, *sc* = 2–3 + 0–1, *st* = 2:1. Pro- and poststigma red-brown to dark brown, propleuron and prosternum haired, alar-declivity bare. Wings hyaline or partly tinged especially towards the base. Veins yellow-brown, costal spine long, a few setae on the upper side of r_{4+5}, *r–m* clouded, R_5 open. Upper squama brown, lower squama yellowish. Legs with femora dark brown, tibiae and tarsi yellow-brown. Fore-tibia with several short *ad* and 1 long submedian *pv*; mid-tibia with 1 submedian *ad*, 0–1 *av* and 1–2 *pd*; hind-tibia with 2 *ad*, 2 *pd* and 1–2 submedian *av*; claws and pulvilli as long as last tarsal segment.

Abdomen slender, about $1\frac{1}{2}$ times as long as broad. Colour and pollinosity the same as that of the thorax, with a narrow median stripe, sometimes very weak. Last three segments with marginal bristles and a few lateral discals in some of the specimens.

Female—Frons at vertex about $\frac{1}{2}$ as wide as the eye is long, widening towards the antennal groove, frontal stripe subparallel, reddish-brown. Bucca about $\frac{3}{8}$ as high as the eye is long. Chaetotaxy of head consisting of *iv*, *ev*, *oc*, cruciate *paf* and 1 thick and 1 shorter and thinner *fo*.

Length: 5–6 mm.

THE PAN-PACIFIC ENTOMOLOGIST 51: 130–133. APRIL 1975

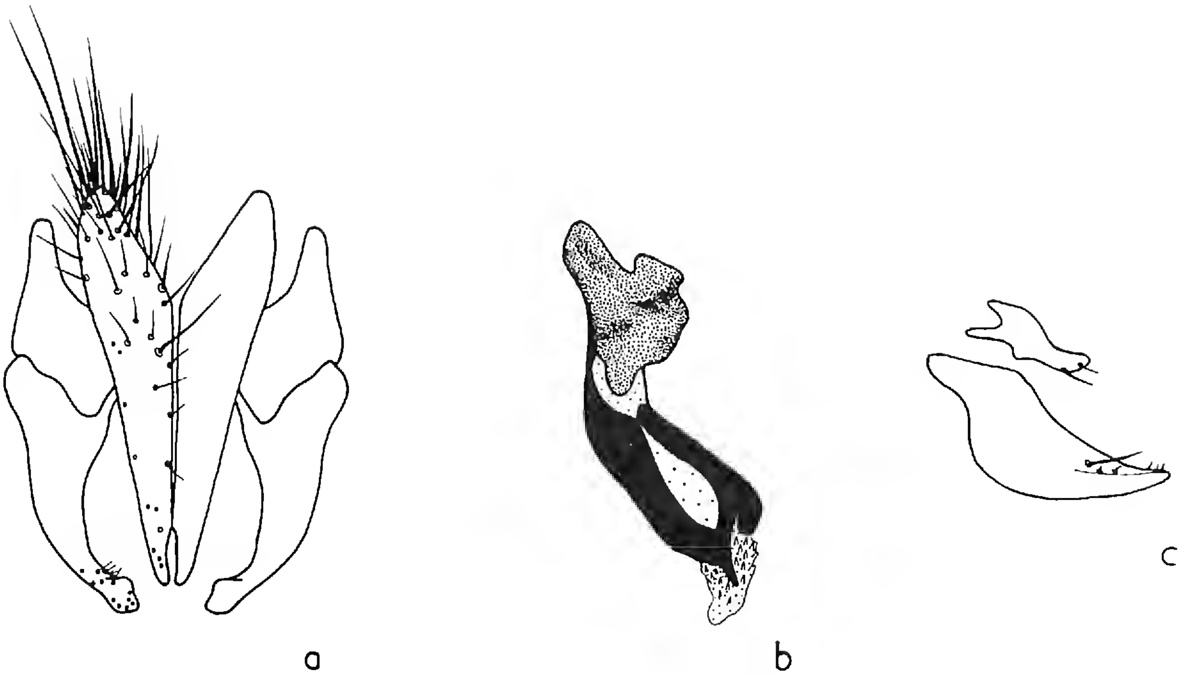

FIG. 1. *Phumosia rossi* n. sp. a) cerci and paralobi, b) phallosome laterally, c) parameres (Holotype).

There are 8 ♂♂ and 1 ♀ before me collected by E. S. Ross and R. E. Leech at the following localities:

1) NYASALAND (MALAWI), 16 MILES WEST OF DEDZA 24.II.1958 (*holotype* ♂ and 4 paratype ♂♂).
2) Northern Rhodesia (Zambia), Senga Hill, 40 miles south of Abercorn, 12.II. 1958 (2 paratype ♂♂ and an allotype ♀).
3) Angola, 12 miles south of Villa Teixiera de Silva, 28.V.1958 (1 ♂ paratype).

Holotype, allotype and 4 paratypes have been returned to the California Academy of Sciences, 3 paratypes have been kindly presented to the Department of Entomology of the South African Institute for Medical Research, Johannesburg.

Pterella kenyae new species (Sarcophagidae : Miltogramminae)

In the key to the species of *Pterella* (Zumpt, 1961) the new species runs down to *P. santosdiasi*, and on external features it falls within the "*obscurior*-complex." The males are easily distinguished by the hypopygia.

Male—Eyes bare, facets small. Frons at vertex measuring about ⅓ of eye-length. Frontal stripe yellow, darkening towards vertex, subparallel, at the tip of the ocellar triangle measuring about 1½ times as wide as the neighbouring parafrontalium. Parafrontalia with dense yellow pollinosity, becoming pale yellow with different light incidence. Ocellar triangle with *oc* accompanied by several bristly hairs; *iv*, *ev* and *f* well developed, 2 proclinate *fo* and several bristly hairs on the posterior parafrontalium; 10–12 *paf*. Face pale yellow, antennae yellow,

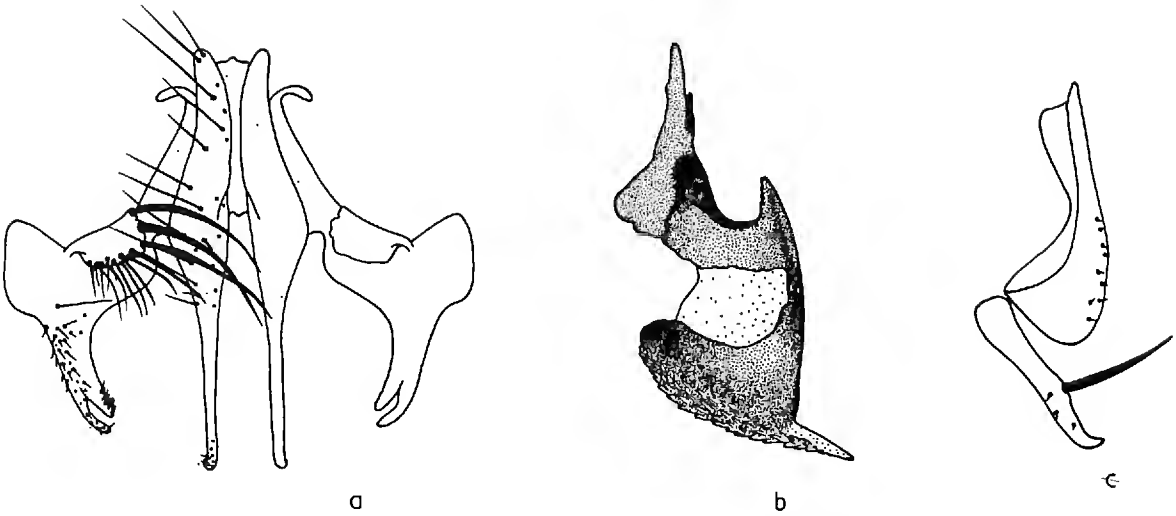

FIG. 2. *Pterella kenyae* n. sp. a) cerci and paralobi, b) phallosome laterally, c) parameres (Holotype).

third segment approximately 3 times as long as second, deep yellow; arista bare, basal half thickened, yellow, tip black. Posterior bucca and occiput black with short hairs, anterior bucca yellow. Height of bucca about 1/10 of eye-length. Palpi yellow, slender, proboscis black.

Thorax black with light grey pruinosity, narrow long undusted stripes visible. Chaetotaxy: *ac* = 0 + 1, 2 prescutellar *dc* and 1 weak presutural *dc*, *ia* = 0 + 1; 1 *prs*, 2 *sa*, 2 *n* and 3 *h* well developed. Pleura white pruinose, *pp* and *pst* long and thick, *st* = 1:1 or 1:2. Wings hyaline, epaulet black, basicosta yellow, veins yellow-brown, R_5 broadly open. Thoracic squama white, very broad, halter yellow. Legs black, fore-tibia with 1 submedial posterior bristle; mid-tibia with 1 *ad*, 1 *pv* and 3 weak *pd*; hind-tibia with a row of short *ad*, 3 or 4 *av* and 1 *pd*.

Abdomen longer than broad, black dorsally, reddish-brown laterally and ventrally. Anterior and posterior margins of tergites III, IV and V broadly but unevenly yellow pollinose. Hypopygium (fig. 2) with long slender cerci, shorter bifid paralobi with a row of long bristles; the first three anterior bristles are very well developed. Phallosome with the spinus protruding vertically as in the other species of the "*obscurior*-complex".

Female—not known.

Length: 6–8 mm.

Seven specimens have been received, collected by M. E. Irwin and E. S. Ross in KENYA, DIANI BEACH, KWALE DISTRICT, 4.I.1970 (*holotype* and 3 paratypes), and at Blue Lagoon, Kilifi District, 1.I.1970 (3 paratypes). Three specimens have been kindly presented to the South African Institute for Medical Research, Johannesburg.

ACKNOWLEDGEMENTS

I wish to thank Dr. F. Zumpt, head of the Department of Entomology, for supervising my studies on Higher Diptera and Professor J. F. Murray, Director of The South African Institute for Medical Research, who provided the necessary working facilities.

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A Description of the First Instar Larva of *Eupompha imperialis* and *E. edmundsi*

(Coleoptera: Meloidae)[1]

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The genus *Eupompha* (Lyttini: Eupomphina) consists of eight distinctive species, all confined to southwestern North America. The first instar larva of three of these, *E. elegans* (LeConte), *E. histrionica* (Horn) and *E. schwarzi* (Wellman) were described by MacSwain (1956, as *Calospasta*). Because background information on larval anatomy is needed for a forthcoming paper on the courtship behavior of *Eupompha*, descriptions of two additional species, *E. imperialis* and *E. edmundsi* are presented at this time.

To facilitate species comparisons, descriptions conform, insofar as possible, to the terminology employed by MacSwain (1956).

EUPOMPHA IMPERIALIS (Wellman)

(Fig. 1)

Body very light brown; heavy, spiniform setae on both dorsum and venter, some of those on thoracic and abdominal tergites curved upward at apex. Head wider than long, narrowing slightly to base; six setae between clypeus and frons (first row behind labrum) ; gula as long as wide, setae inserted on anterior margin. Eyes large, about 15% greater in diameter than mesothoracic spiracles. Antennae with segment I subrectangular, twice as wide as long; segment II 60% longer than wide, twice as long as I; segment III twice as long as wide, 30% shorter than II; sensory organ slightly wider than and subequal in length to III; terminal seta twice as long as III. Mandibles slender, gradually widened basally, entire to feebly crenulate; apical seta almost 4× as long as basal seta. Maxillae with about five weak setae at apex of mala; segment III of palpi 40% longer than wide, lateral margin 30% longer than medial margin, sensory area with about 20 papillae, two-segmented appendix not evident. Labium with setae of first prementum long, setae of second prementum minute; segment II of palpi longer than I, two-segmented appendix at apex of II very small. Thorax with line of dehiscence confined to pro- and mesonotum, and extreme apex of metanotum; 24 stout, elongate setae on pronotal disc. Abdomen with posterolateral margin of tergites abutting against pleurites; spiracles placed in membranous area between pleurites and anterolateral margin of tergites; first spiracle with diameter about 20% less than that of mesothoracic spiracle and twice the diameter of second spiracle, spiracles on segments II–VIII gradually decreasing in diameter; tergites with posterior marginal row of setae about ⅔ tergite length; sternum poorly sclerotized,

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[1] This study was supported by Grant GB-30907 from the National Science Foundation.

no evidence of sclerotization on segments I–VI, VII–IX each with a poorly defined medial sclerite. Legs slender, hind claw long, about ¾ as long as hind tibia; claws with their two setae separated at base by about 1/10 claw length, longer seta not approaching apex of claw (as in Fig. 3). Body length 1.30 mm; caudal setae .58 mm.[2]

Material Studied. Larvae from a mass of 180 eggs laid and hatching on 17 and 25 April, respectively (at 26°C). Adults collected 16 April 1974; Imperial County, California, ca. 12 mi W Calexico, adjacent to International Boundary; feeding on flowers of *Coldenia palmeri* Gray (Boraginaceae).

EUPOMPHA EDMUNDSI (Selander)

(Figs. 2, 3, 5–8)

Body very light brown, venter with normal, elongate, spiniform setae throughout; dorsum with both very short, stout setae, and highly modified, elongate, clavate, costate setae which are elliptical in cross-section; costae on thoracic and abdominal setae with apical projections; modified setae somewhat shorter than unmodified homologues in other species. Modified setae distributed as follows. Head capsule: widespread except on labrum, also, lateral-most seta on first setal row behind labrum, seta posteromedial to eye, and those on occiput normal; thorax: on lateral margin of pronotum only; and on lateral and posterior margin of meso- and metanotum; abdomen: on posterior margin of tergites only. Unmodified dorsal setae much shorter than homologues in other species.

Head wider than long, narrowing to base; six setae between clypeus and frons (first row behind labrum); gula as long as wide, setae inserted on anterior margin. Eyes subequal in diameter to mesothoracic spiracles. Antennae with segment I subrectangular, twice as wide as long; segment II as wide as long, 30–40% longer than I; segment III twice as long as wide, subequal in length to II; sensory organ slightly wider and shorter than III; terminal seta short, subequal in length to III. Mandibles slender apically, abruptly widened at base, entire to feebly crenulate; apical seta twice as long as basal seta. Maxillae with about 5 weak setae at apex of mala; segment III of palpi 50% longer than wide, lateral margin almost twice as long as medial margin, sensory area with about 25 papillae, two-segmented appendix not evident. Labium with setae of first prementum long, setae of second prementum minute; segments I and II of palpi subequal in length, two-segmented appendix at apex of II very small. Thorax with line of dehiscence confined to pro- and mesonotum, and extreme apex of metanotum; 26 setae on pronotal disc. Abdomen with posterolateral margin of tergites abutting against pleurites; spiracles placed in membranous area between pleurites and anterolateral margin of tergites; first spiracle subequal in size to mesothoracic spiracle and twice the diameter of second spiracle, spiracles on segments II–VIII gradually decreasing in diameter; tergites with posterior marginal row of setae less than ½ tergite length; sternum poorly sclerotized, no evidence of sclerotization on segments I–VI, VII–IX each with a poorly defined medial sclerite. Legs slender, hind claw long, about 7/10 as long as hind tibia; claws with their two setae basally adjacent, longer seta not approaching apex of claw. Body length 1.22 mm; caudal setae .60 mm.[2]

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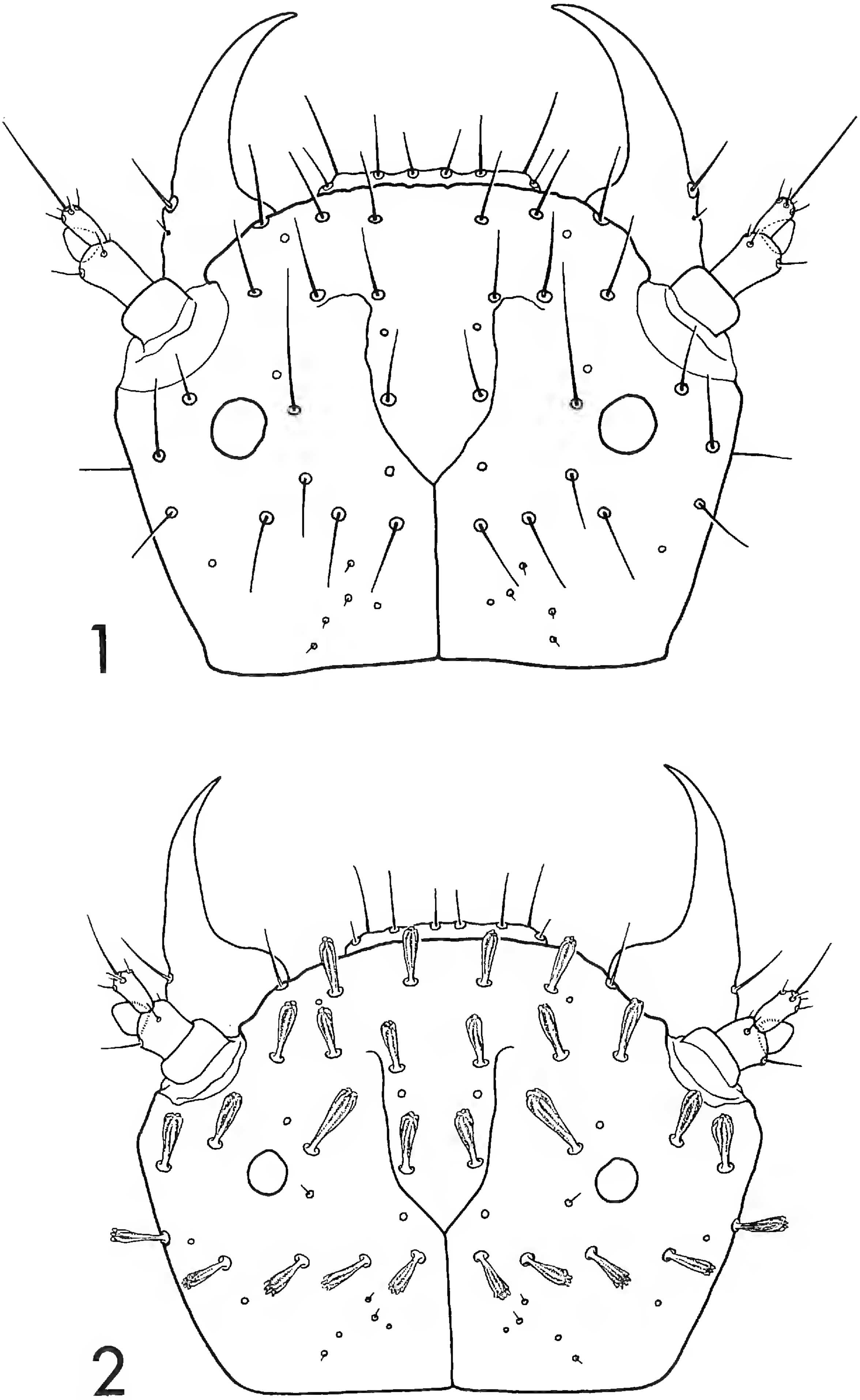
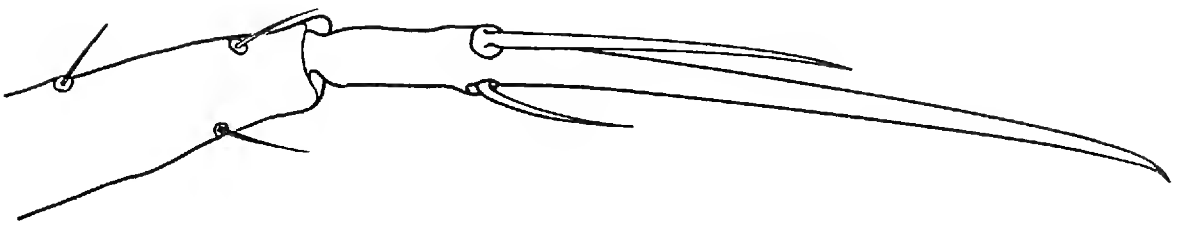
[2] Means based on the measurement of five slide-mounted specimens.



FIGS. 1–2. Head (dorsal view) of first instar larvae of *Eupompha*. 1. *E. imperialis*. 2. *E. edmundsi*. Illustrations of *E. elegans* are given by MacSwain (1956).



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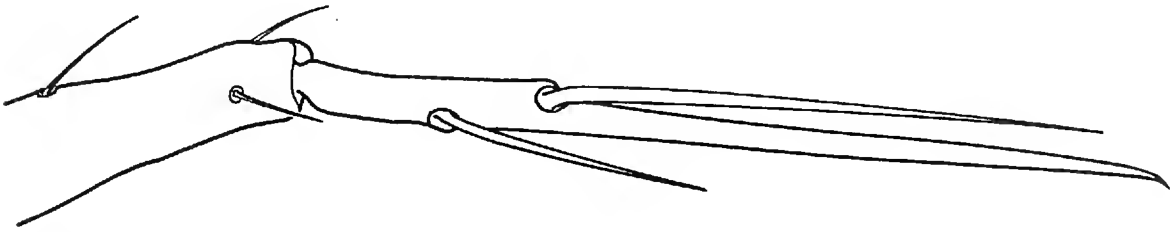

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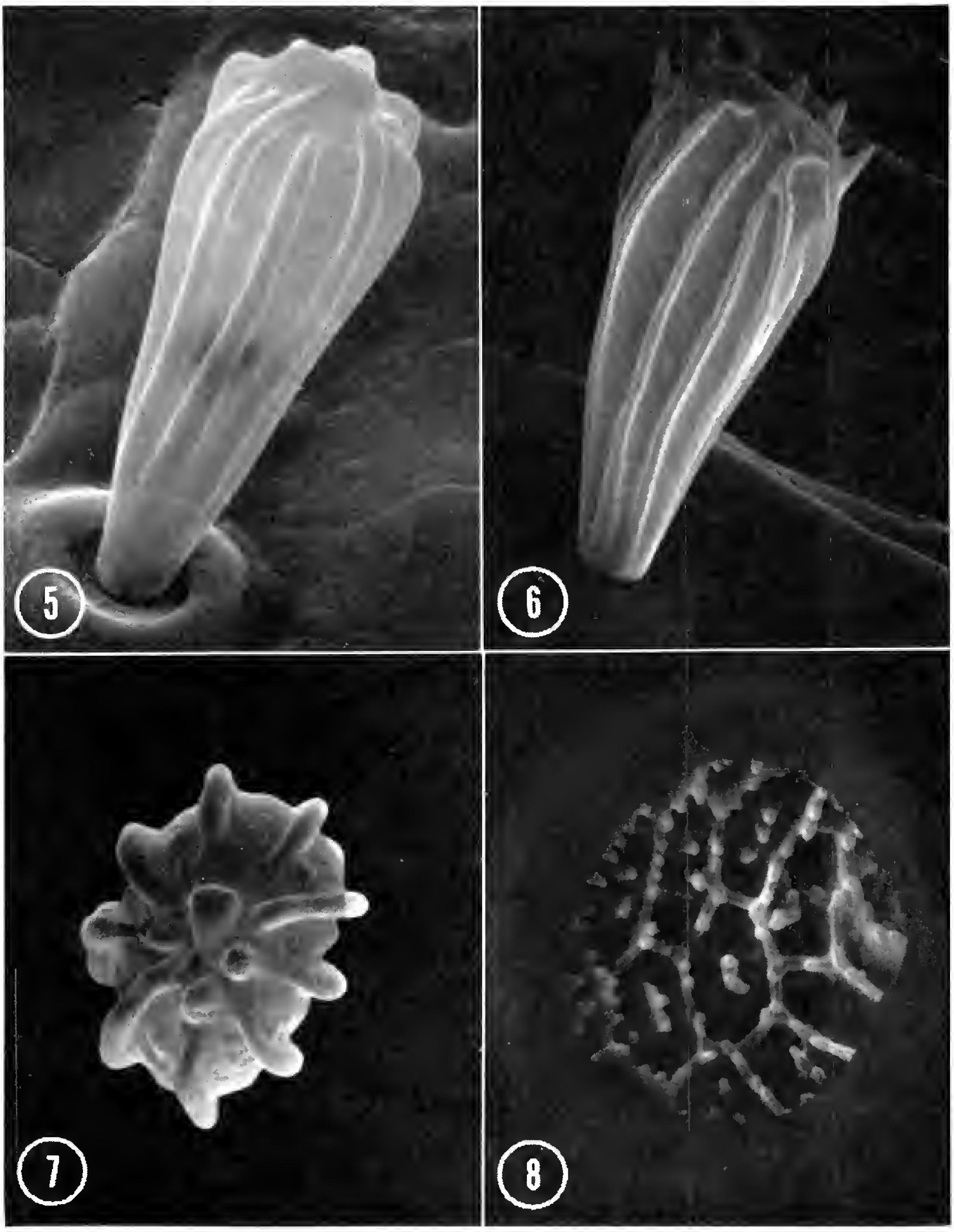
FIGS. 3–4. Hind claw of first instar larvae of *Eupompha* showing relative length and position of the two basal setae. 3. *E. edmundsi.* 4. *E. elegans.*

Material Studied. Larvae from masses of 142, 147, and 187 eggs, respectively. Respective oviposition and hatching dates as follows: 27 June–12 July; 28 June–13 July; 3–19 July (at 26°C). Adults collected 27 June 1972; Coconino County, Arizona, 2 mi W Page; feeding on inflorescences of *Helianthus anomalus* S. F. Blake and *Stephanomeria exigua* Nutt. (Compositae).

DISCUSSION

The traits of the two species described here agree with MacSwain's (1956) description of *Eupompha.* The clavate and costate setae on the dorsum of *E. edmundsi* are, so far as known, unique within the Meloidae. Their number, position and relative size correspond to their unmodified homologues in congeners (e.g., compare Figs. 1 and 2).

The larvae of the five species discovered so far fall into two groups with *E. histrionica* and *E. schwarzi* in one, and *E. elegans, E. imperialis* and *E. edmundsi* in the other. The latter three can be characterized as follows: six setae present between clypeus and frons, antennal segment II as long as wide or longer, line of dehiscence absent or incomplete on metanotum, and medial margin of maxillary palpal segment III distinctly shorter than lateral margin. In *E. histrionica* and *E. schwarzi* there are eight setae between the clypeus and frons, antennal segment II is wider than long, the line of dehiscence is complete on the metanotum, and the margins of segment III of the maxillary palpi are subequal.



FIGS. 5–8. Scanning electron micrographs of the first instar larvae of *E. edmundsi*. 5. Modified setae on dorsum of head capsule (5000×). 6. Modified seta on apical margin of abdominal tergite III (4000×). 7. Apical view of a modified seta on head capsule (6000×). 8. Spiracle on abdominal segment I (6000×).

The larvae of *E. elegans*, *E. imperialis* and *E. edmundsi* are similar, the highly modified setae of the latter notwithstanding. *E. imperialis* is phenetically intermediate. *E. elegans* is distinguished from both *E. edmundsi* and *E. imperialis* by its darker color and more strongly sclerotized abdominal sterna, the presence of the line of dehiscence in the basal half of the metanotum, the longer apical seta of the claws (Fig. 4), the placement of the gular setae anterior to the gular margin, the smaller eyes (smaller than the mesothoracic spiracles) and the inconspicuous basal mandibular seta. *E. elegans* and *E. imperialis*, on the other hand, are separated from *E. edmundsi* by the unmodified dorsal setae, the longer second segment and terminal seta of the antennae, the longer second segment of the labial palpi, and the less abrupt basal widening of the mandibles.

The phenetic relationships of larvae and adults correlate fairly well. Adults of *E. schwarzi* and *E. histrionica* are more similar to one another than to any other *Eupompha*. *E. imperialis* and *E. elegans* adults also correspond most closely with one another. Adults of *E. edmundsi* are most similar to those of *E. viridis* (Horn), whose larva is unknown. Males of both species lack certain head, antennal and foreleg modifications which are found in all other species. These modifications are epigamic in function (Pinto, MS). Because of their generalized adults, compelling evidence for including *E. edmundsi* and *E. viridis* in *Eupompha* was lacking. The close correspondence of the larva of *E. edmundsi* to those of other *Eupompha*, and to *E. imperialis* in particular, considerably strengthens its position within the genus.

ACKNOWLEDGMENTS

Host plants of *E. edmundsi* were identified by Mr. Oscar F. Clarke (U. C. Riverside Herbarium). Figures 1–4 were prepared by Mr. Carl T. Conley.

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MacSwain, J. W. 1956. A classification of the first instar larvae of the Meloidae (Coleoptera). Univ. Calif. Publ. Entomol., 12: 1–182.

The Larva of *Cafius sulcicollis* LeConte

(Coleoptera: Staphylinidae)

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James, Moore and Legner (1971) described larvae of four common west coast species of *Cafius* and presented a key to include two European species which were already known. *Cafius sulcicollis* LeConte is not common in southern California so could not be included in the study. Vincent D. Roth, Managing Director of the Southwest Research Station of the American Museum of Natural History at Portal, Arizona has given us a series of *Cafius sulcicollis* including larvae from Sonora, Mexico where it is apparently common. We are taking this opportunity to describe the larva. Among the west coast species of *Cafius*, this leaves only the larvae of *C. decipiens* LeConte, *C. femoralis* Mäklin and *C. opacus* LeConte unknown.

TABULAR KEY TO SOME LARVAE OF NEARCTIC *CAFIUS*

Statement of characters.
Shape and segmentation of urogomphus = SHAPE SEG UROG
  SPHER = Spherical, one-segmented.
  CYL = Cylindrical, two-segmented.
Length of urogomphus = LENG UROG
  LONG = longer than pseudopod.
  SHORT = shorter than pseudopod.
Length of first segment of maxilla = LENG ONE MAX
  LONG = as long as second segment.
  SHORT = shorter than second segment.
Length of fourth segment of maxilla = LENG FOUR MAX
  LONG = as long as penultimate segment.
  SHORT = shorter than penultimate segment.

Source
  James = James, Moore and Legner 1971.

SHAPE SEG MAX	LENG UROG	LENG ONE MAX	LENG FOUR MAX	SOURCE	NAME
CYL	LONG	SHORT	LONG	SPECIMEN	*sulcicollis* LeConte
CYL	LONG	SHORT	SHORT	JAMES	*luteipennis* Horn
CYL	LONG	LONG	SHORT	JAMES	*lithocharinus* LeConte
CYL	SHORT	SHORT	SHORT	JAMES	*canescens* Mäklin
SPHER	SHORT	SHORT	SHORT	JAMES	*seminitens* Horn

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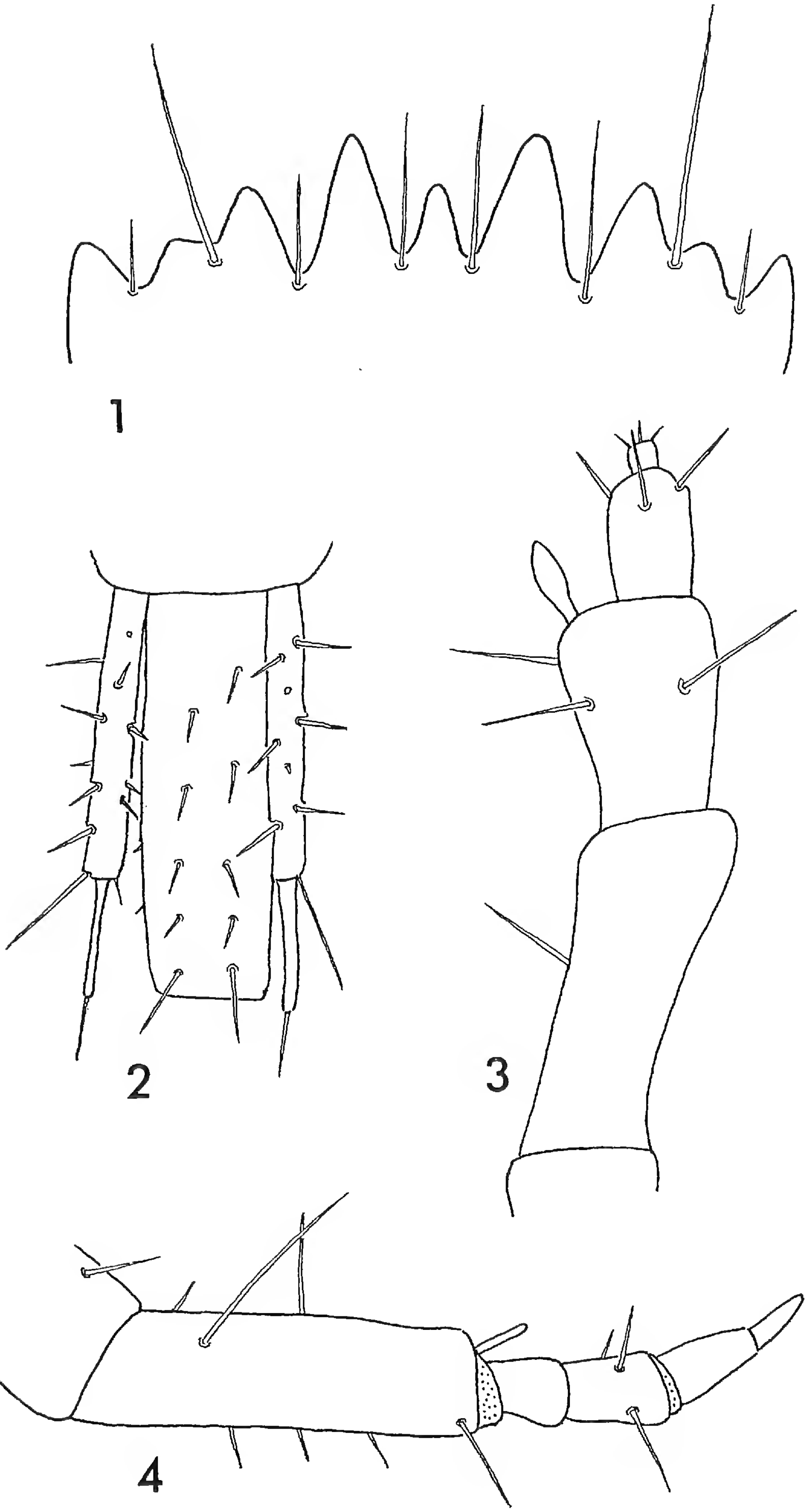

Figs. 1–4. Larva of *Cafius sulcicollis* LeConte. 1. Clypeus. 2. Pseudopod and urogomphi. 3. Antenna. 4. Maxilla.

LARVA OF *CAFIUS SULCICOLLIS* LECONTE

Color.—Head pale ferrugineous; thorax ferrugineous; abdomen, legs, antennae and mouthparts testaceous.

Head subquadrate, widest near base, very slightly narrowed to apical angles. Neck about three-fourths as wide as head. Ocelli lacking. Clypeus with nine teeth, the central tooth and the tooth adjacent to the outer tooth smallest. Antenna four-segmented; first segment about as long as wide; second segment about as wide as and about twice as long as first; third segment a little longer and about as wide at apex as first, tapered to base, with an ovid acorn-type seta at apex which is almost as long as fourth segment; fourth segment about one-third as wide and half as long as third, with an acorn-type seta at apex which is slightly smaller than the acorn-type seta of third segment. Maxilla with stipes as long as palpus; galea very small, slender; palpus four-segmented, first segment about as long as wide, second segment about as wide as and twice as long as first, third segment narrower and a little shorter than second, fourth segment only a little narrower and a little shorter than third. Ligula not quite as long as first segment of labial palpus. Labial palpus three-segmented, each segment narrower but about as long as preceding. Gular sutures united in basal three-fifths, thence diverging to apex.

Thorax.—Pronotum about one-eighth wider than long; widest at base; sides, apex and base gently arcuate; basal angles narrowly rounded; apical angles broadly rounded; surface polished. Mesonotum and metanotum each about as wide as and half as long as pronotum, with a few scattered fine setae, surface polished.

Abdomen gradually narrowed from near base to apex, the basal two segments shorter than the rest; with a few fine scattered setae; surface finely microreticulate. Pseudopod more than twice as long as wide. Urogomphus a little longer than pseudopod, two-segmented; first segment almost as long as urogomphus, very slender; second segment about half as wide and one-fourth as long as first.

Length 8.0 mm.

Material examined, seven specimens from Mexico, Sonora, Punta Cirio, 29.53–112.40, 20 March 1974, wrack on sandy beach, V. Roth & W. Brown collectors, in company with 93 adults.

Notes. This species is readily distinguished from all other known larvae of *Cafius* by the large apical segment of the maxillary palpus. The total lack of ocelli is similar to the condition in *C. seminitens* in which the ocelli are so pale as to be almost indiscernible.

LITERATURE CITED

JAMES, G., IAN MOORE AND E. F. LEGNER. 1971. The larval and pupal stages of four species of *Cafius* (Coleoptera: Staphylinidae) with notes on their biology and ecology. Trans. San Diego Soc. Natur. Hist., 16: 279–289, 8 figs.

A New Species of *Apanteles* from South America Being Introduced into California

(Hymenoptera: Braconidae)

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A new species of *Apanteles* is described to provide a name for studies being conducted at the University of California, Riverside. This species is being released in California against the potato tuberworm, *Phthorimaea operculella* (Zeller) and the tomato pinworm, *Keiferia lycopersicella* (Walsingham). It was collected in Colombia as a parasite of *Scrobipalpula absoluta* (Meyrick). The National Collection also contains specimens from Chile and Peru. Jack C. Hall, Division of Biological Control, University of California, Riverside, California, supplied the material from Colombia and has requested the name.

Apanteles gelechiidivoris, new species

Female. Length of body: 2.5 mm. Color: black except mandibles, palpi, apices of femora, tibiae and tarsi which are testaceous or dark brown; stigma translucent and margined on all sides by brown, wing veins brown. Head: shining, finely punctate, densely covered by short white pubescence; malar space about as long as clypeus; face only very slightly narrower at clypeus than at antennae, at its narrowest part about equal to eye height; antennae shorter than body. Thorax: stout; mesonotum flat, shiny, very finely punctate, punctures separated, densely and evenly covered with short white pubescence; disc of scutellum flat, shining, sparsely punctured, polished area on lateral face of scutellum semicircular, small; propodeum (fig. 1) smooth and shining on dorsal surface, slightly rugose laterally and strongly rugose medially at apex where rugae form lower part of an areola, costulae absent; meso- and metapleura smooth and polished. Legs: hind coxa smooth and polished, with a few scattered punctures dorsally at base; inner spur of hind tibia a little longer than outer and less than half as long as hind basitarsus. Wings (fig. 3): stigma short and broad, broader than length of first segment of radius, inner and outer sides nearly equal in length; metacarpus as long as stigma; first segment of radius slightly curved, longer and narrower than intercubitus; nervellus slightly curved at apex; vannal lobe evenly convex and with fringe of hair. Abdomen: short, often compressed laterally at apex in dead specimens; median plate of first tergum nearly parallel sided, only slightly narrower at apex than at base, longer than apical width, smooth at base and rugose at apex, no indication of median depression at apex (fig. 2); median plate of second tergum nearly four times as wide as long, apical width about two times basal width, weakly rugose at base (fig. 2); hypopygium acute at apex and extending slightly beyond apex of abdomen; ovipositor about as long as hind tibia, evenly curved downward.

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[1] Mail address: c/o U. S. National Museum, Washington, D. C. 20560.

The Pan-Pacific Entomologist 51: 143–146. April 1975

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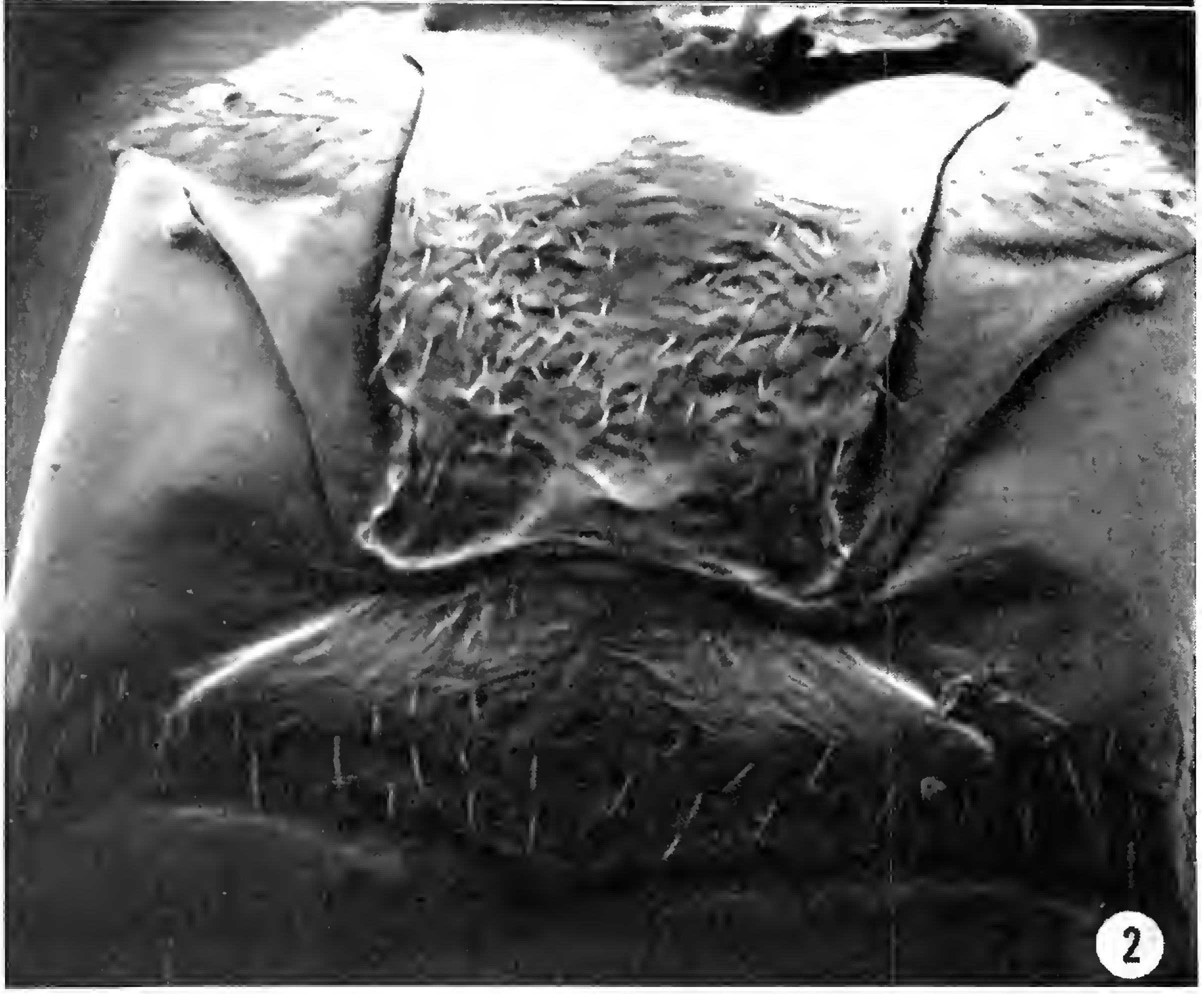

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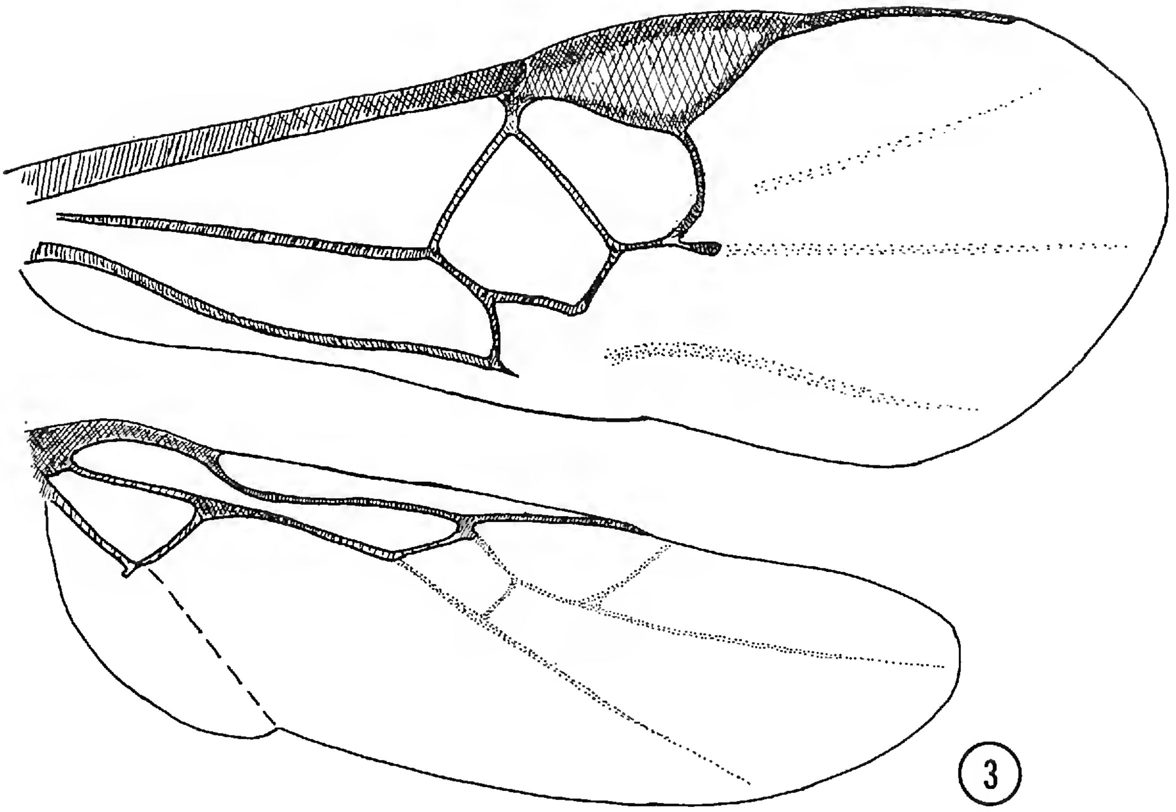

FIG. 3. *Apanteles gelechiidivoris,* n. sp.: fore and hind wings.

Male. Essentially as in female except antennae longer than body, median plate of first tergum slightly narrower at apex, and median plate of second tergum slightly longer.

Holotype female: COLOMBIA, PALMIRA, V-14-74, A. Sandarriaga, ex. *Scrobipalpula absoluta* on tomato. USNM type no. 73373. Paratypes: Chile: Arica, 7 ♀♀, XI-1965, H. Vargas, ex. *Gnorimoschema absoluta* on tomato; Arica, 11 ♀♀, 3 ♂♂, no date or collector, ex. *Gnorimoschema absoluta.* Colombia: 5 ♀♀, 3 ♂♂, same data as holotype; Garagoa, 4 ♀♀, 5 ♂♂, 4-30-73, E. R. Oatman, ex. gelechiid on tomato; Mosquera, 5 ♀♀, 5 ♂♂, 5-4-73, E. R. Oatman, ex. gelechiid on potato. Peru: LaMolina, 4 ♀♀, 1 ♂, XI-3-64, A. S. Guido and Silveira; Canete, 7 ♀♀, 5 ♂♂, XI-3, 6, 26-1964, A. S. Guido and Silveira; no locality, 2 ♀♀, 1966, ex. *Gnorimoschema operculella* on tomato. Paratypes deposited in U. S. National Museum, University of California, Riverside, and in the Introduced Beneficial Insects Voucher Collection, Beneficial Insects Introduction Laboratory, Beltsville, Maryland.

Apparently this species is widely distributed along the Andes in South America. It belongs to the *laevigatus* group as defined by Nixon (1965 Bull. Brit. Mus. (Nat. Hist.), Ent., Suppl. 2, p. 181). In South

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FIGS. 1–2. *Apanteles gelechiidivoris,* n. sp.: 1, propodeum, dorsal view, × 160 magnification; 2, abdominal terga 1 and 2, × 185 magnification. Scanning electron micrographs made at 5kv on a Cambridge II Scanning Electron Microscope.

America, it is similar to *subcristatus* Blanchard but can be distinguished by the smoother propodeum, sculptured median plate of the second tergum, and by the median plate of the first tergum being wider at the apex. In North America, *gelechiidivoris* is closest to *miantonomoi* Viereck but differs in the smoother propodeum and more slender hind tibia.

Scanning electron microscope time for this project was supported in part by the Electron Microscope Central Facility, Center of Materials Research, University of Maryland, College Park.

Host Records for Some Species of Pompilidae From the Southwestern United States and Mexico

(Hymenoptera)

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College of Environmental Science and Forestry, Syracuse, New York 13210

The nesting behaviors and host records of many species of Pompilidae from the southwestern United States and Mexico remain virtually unknown. This paper attempts to fill in some of the host record gaps. In addition to presenting first host records for *Priocnemioides angusticeps*, *P. aratus*, and *Anoplius percitus*, new host species of spiders are listed for *Ageniella* (*Ageniella*) *conflicta* Banks, *A.* (*A.*) *partita* Banks, *A.* (*Priophanes*) *arcuata* (Banks), *Anoplius* (*Lophopompilus*) *aethiops* (Cresson), *A.* (*Notiochares*) *lepidus atramentarius* (Dahlbom), *A.* (*Arachnophroctonus*) *relativus* (Fox), *A.* (*Anoplius*) *ithaca* (Banks), and *A.* (*A.*) *toluca* (Cameron). The host genus of *Dipogon* (*Deuteragenia*) *thoracicus* Townes and a host species of *Anoplius* (*Arachnophroctonus*) *americanus ambiguus* (Dahlbom) are verified.

All host records and associations are based upon specimens collected in Arizona, New Mexico, Texas, and Mexico by R. E. Acciavatti (REA), U. S. Forest Service, Albuquerque, N. M., R. C. Miller (RCM), Cornell University, Ithaca, N. Y. and V. D. Roth (VDR), The Southwestern Research Station, Portal, Arizona. H. E. Evans of Colorado State University, Fort Collins, Colo., determined *Priocnemioides aratus* and confirmed the identity of *Anoplius percitus*. The host spiders were identified by W. J. Gertsch, Portal, Arizona, V. D. Roth, and R. A. Norton, SUNY College of Environmental Science and Forestry, Syracuse, N. Y.

TRIBE PEPSINI

Priocnemioides angusticeps Townes.—Host: *Lycosa antelucana* Montgomery (Lycosidae), ad. ♀. TEXAS. Tarrant Co. Colleyville, June 7, 1972 (REA).

Priocnemioides aratus Townes.—Host: *Lycosa carolinensis* Walckenaer (Lycosidae), ad. ♀. MEXICO. Sonora. 30 mi. s.e. Agua Prieta on mesa nr. Cajon Bonito, August 24, 1972 (VDR). "Lycosa spider in burrow of spider."

Dipogon (*Deuteragenia*) *thoracicus* Townes.—Host: *Xysticus* sp. (Thomisidae), imm. ARIZ. Cochise Co. S.W.R.S. 5 mi. w. Portal. 5400′, September 18, 1964 (VDR).

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TRIBE AUPLOPODINI

Ageniella (*Ageniella*) *conflicta* Banks.—Hosts: (a) *Pardosa valens* Barnes (Lycosidae), ad. ♀, with all legs amputated at coxal-trochanter joints. ARIZ., Cochise County, S.W.R.S. 5 mi. w. Portal. 5400′, June 11, 1973 (RCM). (b) *P. valens* Barnes (Lycosidae), imm., with 3rd, 4th legs on both sides amputated. *Collection data*: Same as above. (c) *Trochosa gosiuta* Chamberlain (Lycosidae), imm., with all legs amputated at coxal-trochanter joints. *Collection data*: Same as above except June 14, 1973.

Ageniella (*Ageniella*) *partita* Banks.—Host: *Pardosa falcifera* F. Cambridge (Lycosidae), imm. ♂ with ? legs amputated. *Collection data*: Same as above except May 27, 1964 (VDR).

Ageniella (*Priophanes*) *arcuata* (Banks).—Host: *Sassacus papenhoei* Peckham (Salticidae), ad. ♀, with all legs amputated at coxal-trochanter joints. ARIZ. Cochise Co. Portal, July 31, 1973 (RCM).

TRIBE POMPILINI

Anoplius (*Lophopompilus*) *aethiops* (Cresson).—Hosts: (a) *Lycosa santrita* Chamberlain & Ivie (Lycosidae). ARIZ. Cochise Co. S.W.R.S. 5 mi. w. Portal. 5400′, October 14, 1965 (VDR). (b) *Lycosa carolinensis* Walckenaer (Lycosidae), ad. ♂. N. MEX. Catron Co. 0.7 mi. w. Quemado at Largo Creek. 6900′, October 2, 1973 (REA).

Anoplius (*Notiochares*) *lepidus atramentarius* (Dahlbom).—Host: *Lycosa antelucana* Montgomery (Lycosidae), imm. ♀. TEXAS. Tarrant Co. Colleyville, June 7, 1972 (REA).

Anoplius (*Arachnophroctonus*) *americanus ambiguus* (Dahlbom).—Host: *Arctosa littoralis* (Hentz) (Lycosidae), imm. ♀. N. MEX. Sandoval Co. 1 mi. s. San Ysidro at Rio Salado. 5500′, August 18, 1973 (REA).

Anoplius (*Arachnophroctonus*) *relativus* (Fox).—Host: *Arctosa littoralis* (Hentz) (Lycosidae), ad. ♀. (2 records). TEXAS. Cooke Co. 0.7 mi. e. Rosston at Clear Creek, October 10, 1973 (REA).

Anoplius (*Pompilinus*) *percitus* Evans.—Host: *Trochosa* sp., prob. *gosiuta* Chamberlain (Lycosidae), imm. N. MEX. Bernalillo Co. Albuquerque, 2 mi. n.e. Univ. of Albuquerque. 4980′, June 24, 1973 (REA).

Anoplius (*Anoplius*) *ithaca* (Banks).—Host: *Pardosa steva* Lowrie and Gertsch (Lycosidae), ad. ♀. N. MEX., Grant Co. 0.5 mi. w. Lake Roberts along Hwy. 35 6000′, July 11, 1972 (REA).

Anoplius (*Anoplius*) *toluca* (Cameron).—Hosts: (a) *Schizocosa avida* group (Lycosidae), ad. ♀. N. MEX., Hidalgo Co. 20 mi. n. Rodeo, June 13, 1973 (RCM). (b) *Trochosa gosiuta* Chamberlain (Lycosidae), ad. ♀. ARIZ., Cochise Co. S.W.R.S. 5 mi. w. Portal. 5400′, September 17, 1965 (VDR).

DISCUSSION

In the present paper, *Priocnemioides angusticeps* and *P. aratus* are recorded with prey for the first time. These records bring to five the number of Nearctic species and subspecies of *Priocnemioides* for which host records are now available, and they substantiate the fact that species of this pompilid genus, regardless of size, prefer wolf-spiders belonging to the genus *Lycosa.* The observation of *P. aratus* attacking *L. carolinensis* in its burrow and then leaving the spider there suggests that some species of *Priocnemioides* may utilize the spider's burrow as a nest. On the other hand, Janvier (1930) and Evans and Yoshimoto (1962) pointed out that other species of *Priocnemioides* do, in fact, construct their own burrow and transport the spider backwards on the ground to the nest.

The record of *Dipogon* (*Deuteragenia*) *thoracicus* preying on *Xysticus* sp. (Thomisidae) substantiates Evans' (1974) prey record for this species and, in addition, underlines the fact that species in this genus often utilize small thomisids and salticids as prey (see Medler and Koerber, 1957; Evans and Yoshimoto, 1962; Fye, 1965; Krombein, 1967; Kurczewski and Kurczewski, 1972).

Ageniella (*Ageniella*) *conflicta* has been reported to prey upon small lycosids of the genera *Arctosa, Lycosa,* and *Trochosa* (Hurd and Wasbauer, 1956; Townes, 1957; Evans and Yoshimoto, 1962; Kurczewski and Kurczewski, 1968a). The records of small, adult and immature *Pardosa valens* and immature *Trochosa gosiuta* for *A. conflicta* which are presented herein substantiate this preference.

Ageniella (*Ageniella*) *partita* has been recorded with prey several times and these hosts comprise wandering spiders belonging to the families Gnaphosidae and Lycosidae (summary in Kurczewski and Kurczewski, 1968b). The record included herein of *A. partita* preying upon *Pardosa falcifera* (Lycosidae) does not alter this host preference.

That of *Ageniella* (*Priophanes*) *arcuata* preying upon the salticid *Sassacus papenhoei* introduces a new host family for this pompilid species. Previously, *A. arcuata* had been reported to provision with Oxyopidae and Thomisidae (Evans and Yoshimoto, 1962; Evans, 1964). Although the first three host records for this pompilid have revealed three host families of spiders, *A. arcuata* is nevertheless selecting spiders with rather similar ecologies.

The records presented herein for *Anoplius* (*Lophopompilus*) *aethiops* bring to light two new host species which merely accentuate its preference for rather large wolf-spiders of the genus *Lycosa* (summary in Kurczewski and Kurczewski, 1973). The fact that one of these records is a male spider is noteworthy in view of the fact that the vast majority of records for this species of pompilid are for female spiders. Likewise, the record of *Anoplius* (*Notiochares*) *lepidus atramentarius* utilizing *Lycosa antelucana*, a new host species, for provisions underlines its preference for rather large wolf-spiders (see Evans, 1951; Evans and Yoshimoto, 1955, 1962).

That of *Arctosa littoralis* (Lycosidae) for *Anoplius* (*Arachnophroctonus*) *americanus ambiguus* substantiates earlier records for this host species of spider (see Evans, 1951). Additional host records for *A. americanus ambiguus* include species of Lycosidae and Oxyopidae (Evans and Yoshimoto, 1955, 1962; Hurd and Wasbauer, 1956; Wasbauer and Powell, 1962). The record of *Arctosa littoralis* as prey of *Anoplius* (*Arachnophroctonus*) *relativus* is, however, new. Previous records for this species of spider-wasp comprise the lycosid genera *Lycosa* and *Geolycosa* and the agelenid genus *Agelenopsis* (summary in Evans and Yoshimoto, 1962; Kurczewski and Kurczewski, 1968a, b, 1973).

Anoplius (*Pompilinus*) *percitus* has previously not been collected with prey and the record presented herein, therefore, indicates an initial preference for small Lycosidae (*Trochosa* sp.). Other species in this subgenus which utilize small Lycosidae exclusively as prey include *clystera* (Banks) (Wasbauer and Powell, 1962), *cylindricus* (Cresson) (Kurczewski and Kurczewski, 1968a, 1973), *estellina* (Banks) (Evans, 1964), *krombeini* Evans (Evans and Yoshimoto, 1962; Kurczewski and Kurczewski, 1973), *s. stenotus* (Banks) (Krombein and Evans, 1955; Kurczewski and Kurczewski, 1973), and *stenotus bequaerti* (Dreisbach) (Krombein, 1964). Two of the species, *cylindricus* and *estellina,* either utilize the spider's burrow for a nest or nest in a pre-existing burrow or depression in the soil.

The record of *Pardosa steva* as prey of *Anoplius* (*Anoplius*) *ithaca,* albeit new, emphasizes the fact that this species of pompilid prefers small lycosids of the genera *Pardosa* and *Arctosa* (Evans and Yoshimoto, 1962; Kurczewski and Kurczewski, 1968a, 1973). *Anoplius* (*Anoplius*) *toluca* has been previously collected with *Lycosa* sp. (Lycosidae) (Evans, 1964) and, therefore, our two records for the lycosid genera *Schizocosa* and *Trochosa* only narrowly extend the host selection parameters of this species of pompilid.

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A New Species of *Chersodromia* from Mexico
(Diptera: Empididae)

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In the Americas, the empidid genus *Chersodromia* Walker is known from one Neotropical species (from Panama; Smith, 1967) and eight Nearctic species (from the eastern, southern, and western shores of the United States; Melander, 1965). In the Palearctic, twenty-two species of *Chersodromia* are presently known (Chvála, 1970). Collin (1961: 61) considered the genus *Chersodromia* "an interesting natural genus of great antiquity in which, while many of the species have become particularly distinct as a result of evolution, practically all the connecting links between them have continued to exist." *Chersodromia* adults usually occur on sandy beaches (mostly marine) where they have the ability to run very rapidly over sand. Curran (1931: 11–12) described the Neotropical species—*longicornis*—from his collecting at Patilla Point, Panama. *Chersodromia longicornis* differed in its selection of habitat from other known species in that it occurred in holes and crevices in lava rocks that were several hundred feet from the shore line, but not wholly submerged at high tide.

The purpose of this paper is to report the discovery and to describe and compare a new species that is closely related to *C. longicornis*, both in structure and in habitat preference. This new species also occurs on rocks, but in this original collection it was taken from rocks along the shore line. The type series was swept during mid-day along with many Dolichopodidae and Canaceidae on the southwestern shore (fig. 10) of Bahía de Mismaloya, about 8 km southwest of Puerto Vallarta. The type locality is below the area where the movie "The Night of the Iguana" was filmed.

Chersodromia madelinae, new species
(Figs. 1, 3–6, 9–10)

Diagnosis.—Elongate, small (length about 1.75 mm. in male; 2.0 mm. in female), brownish-black species; thorax and abdomen thinly grayish-brown pollinose; 1 anterodorsal bristle on front tibiae at about basal third; a row of a dozen short anteroventral bristles on apical half of male mid-tibiae, lacking in female; hypopygium of male with right cercus broad and not attaining apices of dististyles and process of left basistyle with long bristles near apex.

Holotype male.—Length, about 1.75 mm., wing length about 2.1 mm. Head brownish-black, face, frons and back of head grayish pollinose, cheeks about

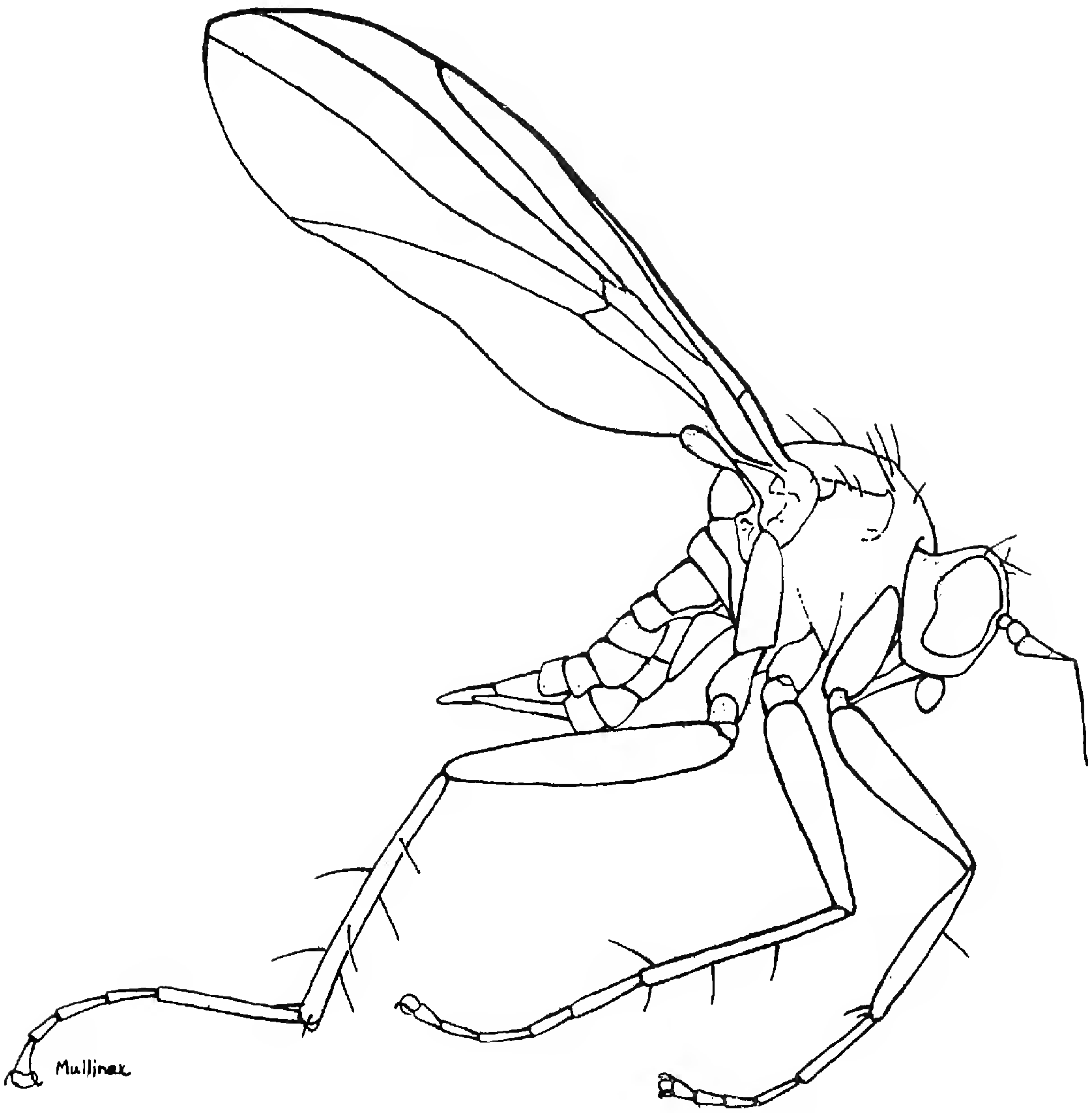
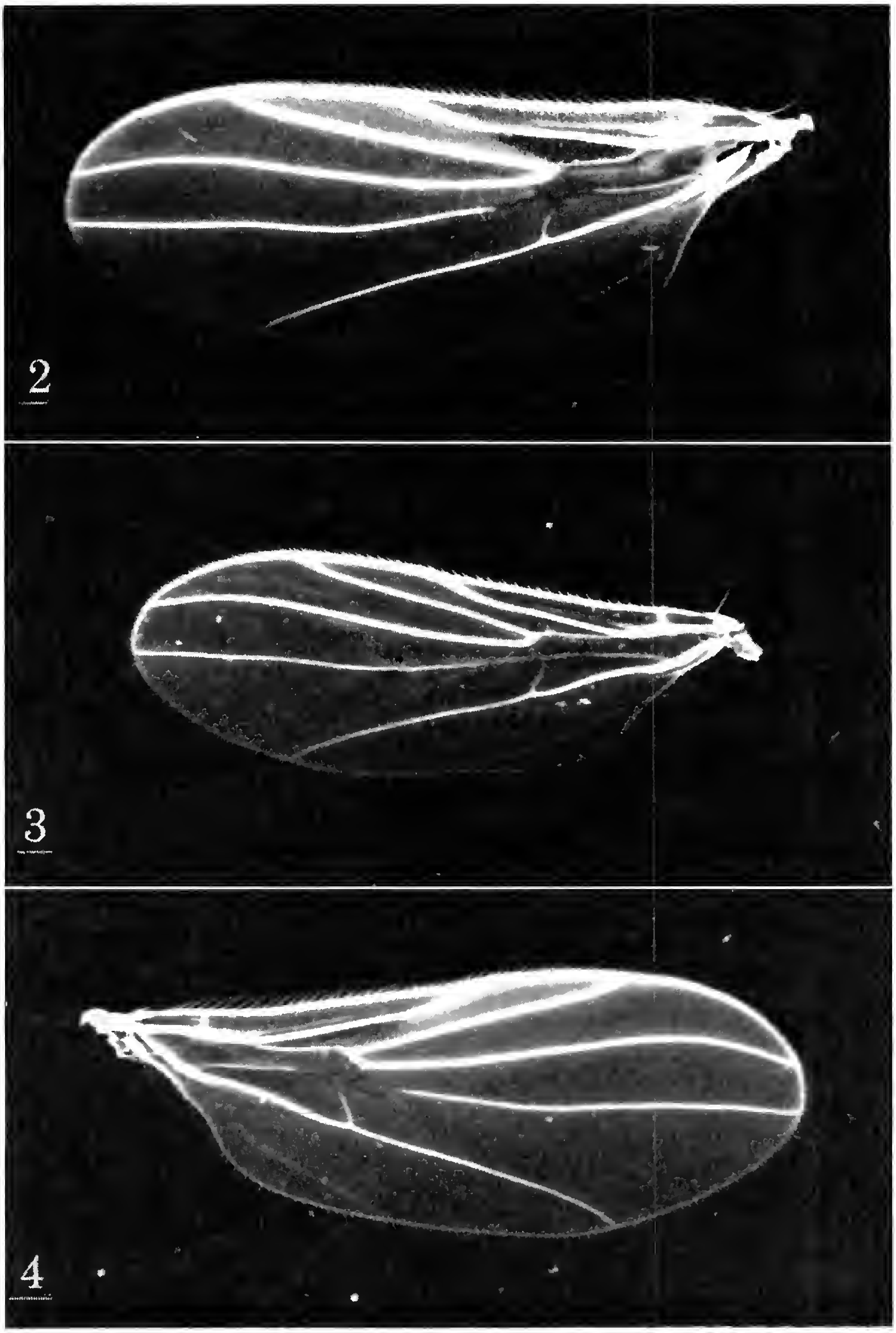


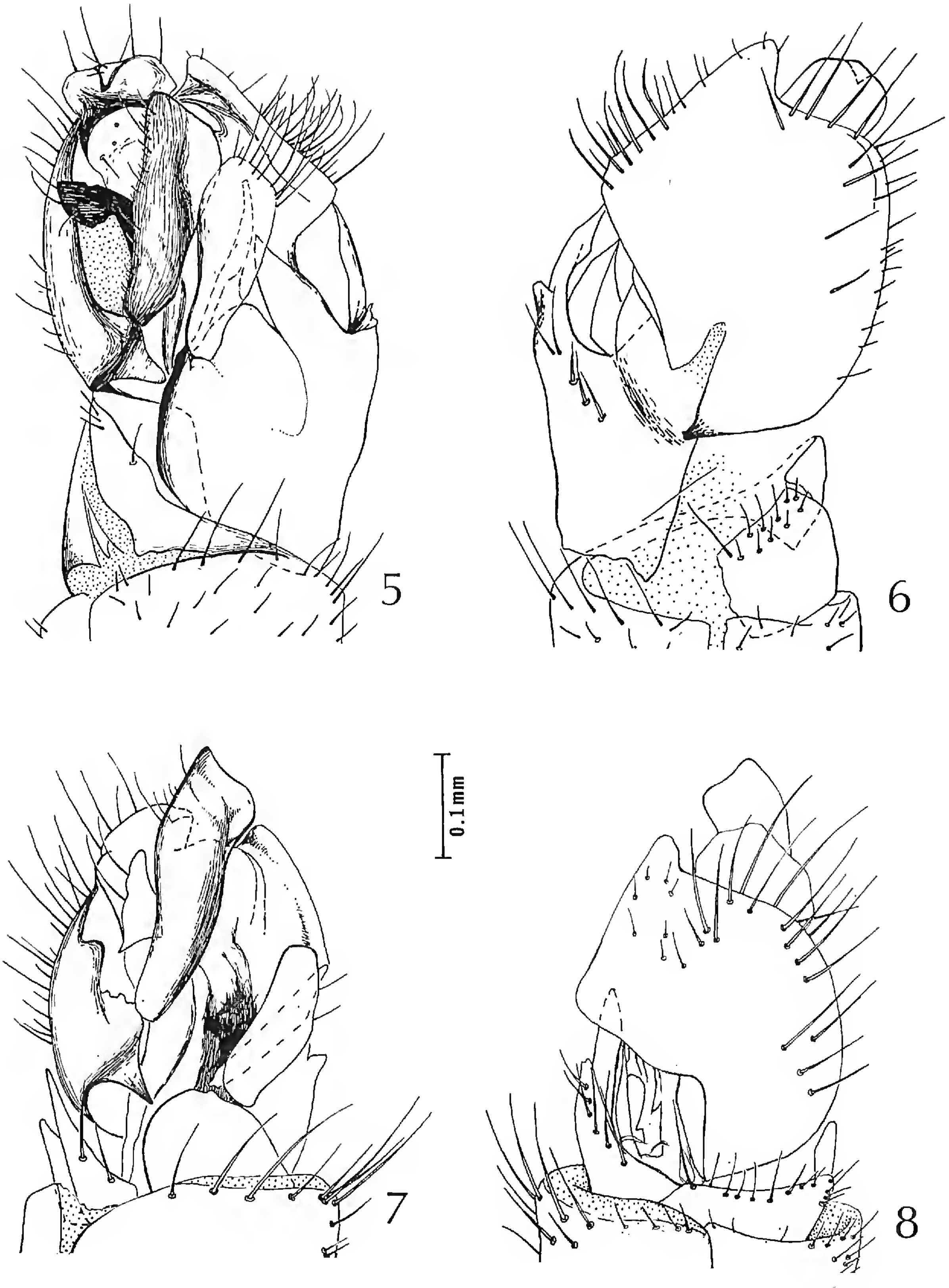
FIG. 1. *Chersodromia madelinae*, new species, right lateral view, paratype female.

one-fourth eye height, eyes with slight excisions opposite bases of antennae and concave on more than lower half of hind margin, face carinate, front at narrowest the width of ocellar protuberance, with a divergent pair of ocellar bristles and another convergent pair at edges of eyes at side of ocellar protuberance, two pairs of vertical bristles. Proboscis brown, exposed portion about half of head height. Palpi blackish, flattened, moderately long haired. Antennae dark brown, third segment elongate and tapered, with curved pubescence; aristae slender, about length of first three antennal segments, very short pubescent.

Thorax brownish-black, thinly grayish-brown pollinose; bristles and hairs of mesonotum black, acrostichals small, 4 pairs of dorsocentrals, scutellum with two pairs of marginal scutellar bristles, the apical long while the outer very small. Legs dark brown, front tibiae with 1 anterodorsal bristle at about basal third; mid-tibiae with 1 anterodorsal bristle at about basal third and with a row of a dozen short anteroventral bristles on apical half; hind tibiae with six bristles—2 dorsals, 2 anterodorsals, and 2 anteroventrals. Wings about 2.1 mm. long and 0.75 mm. wide; venation as illustrated (fig. 3), veins light brown, crossveins



FIGS. 2–4. *Chersodromia* species, wings, upper surfaces. Fig. 2, *C. longicornis* (Curran), left wing, paratype female. Fig. 3, *C. madelinae*, new species, left wing, holotype male. Fig. 4, *C. madelinae*, new species, right wing, allotype female. Illustrations made by projecting wing slide preparations through a B and L Tri-Simplex Microprojector onto a number 5 Azo single weight paper. Projected at same magnification.



FIGS. 5–8. *Chersodromia* species, holotype males, hypopygia. Figs. 5–6, *C. madelinae*, new species, ventrolateral and dorsolateral views. Figs. 7–8, *C. longicornis* (Curran), ventrolateral and dorsolateral views.

indistinct; membrane not clear, with dense microtrichia giving a light yellow-brown tinge. Halteres with knobs blackish-brown, stalks at bases yellow.

Abdomen brownish-black, minute hairs yellow otherwise black haired, thinly grayish-brown pollinose, lightly shining. Asymmetrical hypopygium (figs. 5–6)

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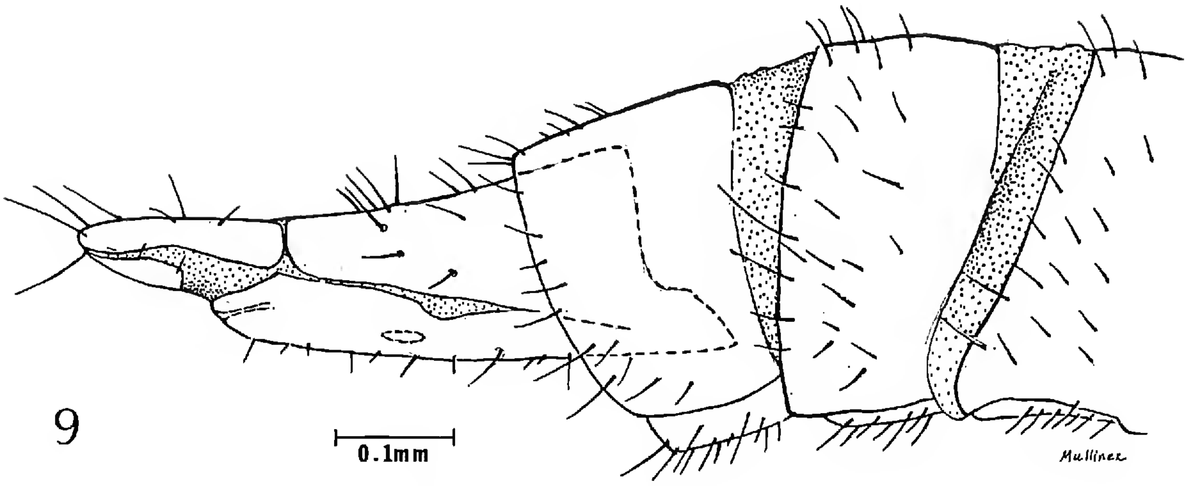

FIG. 9. *Chersodromia madelinae*, new species, allotype female, apical abdominal segments and ovipositor, lateral view.

rotated, brownish-black, yellow bristled; right cercus broad and not attaining apex of diststyles; process of left basistyle broader before apex, with long bristles near apex.

Allotype female.—Length, about 2.0 mm., wing length about 2.5 mm. by 0.9 mm. in width (fig. 4). Similar in coloration to male; mid-tibia lacks comb of short bristles on apical half; ovipositor elongate, tapering and as figured (fig. 9).

Type series.—Holotype male, MEXICO: JALISCO, BAHÍA DE MISMALOYA, 1-I-1971 (P. H. and M. Arnaud), PHA dissection no. 20IV71; mounted on minuten with postabdomen and hypopygium stored in microvial in glycerine and left wing on slide in balsam; deposited in the collection of the California Academy of Sciences, Entomology Type No. 12170. Allotype female, same collection data as holotype, except PHA dissection no. 7VIII71; mounted on minuten, with portion of abdomen and ovipositor stored in microvial in glycerine and right wing mounted on slide in balsam; Entomology Type No. 12170. Paratypes, 4 males and 6 females, same collection data as holotype; deposited in the following collections: 1 female, California Academy of Sciences; 1 male, 1 female, National Museum of Natural History; 1 male, 1 female, American Museum of Natural History (exchange); 1 male, 1 female, collection of Dr. Milan Chvála (exchange); 1 female, sent to Director General de la Fauna Silvestre, México, D. F., Mexico; and 1 male, 1 female, collection of author.

The paratypes are rather similar in size. The wing of one male paratype, which has been mounted in balsam on a slide, is 2 mm. in length. In working with such small creatures, when they are pinned and not mounted on microscope slides, measurements are difficult to make.

I take pleasure in naming this species for my wife, Madeline Milliet Arnaud, who enthusiastically participated in its collection.

Comparison between *Chersodromia madelinae* and *C. longicornis*.—The male of *C. madelinae* differs from *C. longicornis* by the following characters: (1) *madelinae* has tibial bristling with only 1 anterodorsal bristle (not 2) on the anterior tibiae and mid-tibiae with a row of

Fig. 10. Bahía de Mismaloya, Mexico, type locality of *Chersodromia madelinae*, new species. Type series swept from rocks in ocean along roadway, right of center.

about a dozen short anteroventral bristles on apical half (not with an elongate row of about two dozen shorter bristles, on more than apical two-thirds of tibiae); (2) the male hypopygium of *madelinae* (figs. 5–6) differs from that of *longicornis* (figs. 7–8) by its shorter, broader right cercus and the broad long bristled process of the left basistyle. Conversely *longicornis* differs from *madelinae* by its right cercus which is longer than the processes of the dististyles and the process of the left basistyle is narrower and without long bristles near apex and with 2 bristles on outer side of mid-region on the apical half. The female of *C. madelinae* differs from *C. longicornis* in tibial bristling of the anterior leg as there is only 1 anterodorsal bristle in *madelinae* while there are 2 in *longicornis*.

CHERSODROMIA LONGICORNIS (Curran)
(Figs. 2, 7–8)

Coloboneura longicornis Curran, 1931, pp. 11–12.

Chersodromia longicornis: Smith, 1967, p. 39.6.

As a supplement to Curran's description of *longicornis*, illustrations of the male hypopygium and a print of the female wing are included. Figures 7 and 8 illustrate the hypopygium of the male holotype which is deposited in the collection of the American Museum of Natural History. See comparison in description of hypopygium of *C. madelinae*, new species. Figure 2 illustrates the wing of the female, from the paratype which, through an exchange, is now deposited in the collection of the California Academy of Sciences. The wing is about 2.5 mm. in length and 0.9 mm. in width.

ACKNOWLEDGMENTS

The author would like to thank the following persons for their aid: Dr. Lloyd Knutson and Mr. George C. Steyskal, Agriculture Research Service, c/o National Museum of Natural History, for information concerning the holotype of *Chersodromia longicornis* (Curran), and to Mr. Steyskal also for terminology applied to the male hypopygium of this genus; Dr. Pedro W. Wygodzinsky, American Museum of Natural History, for the loan of type material of *C. longicornis* and for exchange of material; Miss Carolyn Mullinex, California Academy of Sciences, who prepared the line drawings of figures 1, 5–9; and Mr. Maurice C. Giles, California Academy of Sciences, for preparing the photographic print used in figure 10 which was made from a color transparency.

Collecting in Mexico was by permit number 45-70 from the Director General de la Fauna Silvestre, Departamento de Conservacion y Propagacion de la Fauna Silvestre.

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A New Species of *Indialis* from India

(Ephemeroptera: Leptophlebiidae)

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Peters and Edmunds (1970) established *Indialis* for the species *Indialis badia* Peters and Edmunds. The species description was based on one male subimago and 49 nymphs collected by me and my wife in Kerala and Andhra Pradesh States, India. Peters and Edmunds (1970) included the subimaginal description, as the one subimago was the only subadult or adult known for *Indialis*. Recently I studied a male imago from Kerala State which I describe herein as a new species of *Indialis*.

The new species is congeneric with *Indialis badia*; however, there are several differences between the species in the wings and eyes. In the fore wings of *Indialis rossi* veins R_S and MP are forked nearly equidistant from the base (Fig. 1); in *Indialis badia* vein MP is forked more basally than the fork of vein R_S. In the key to the imagos by Peters and Edmunds (1970) *Indialis* keys to the first part of couplet 17 based on the forks of veins R_S and MP. *Indialis rossi* keys to the second part of couplet 17, and will eventually key to couplet 25 and *Castanophlebia*. *Indialis* and *Castanophlebia* can be readily distinguished by the wing venation and male genitalia.

The Cu-A area (Fig. 1) of the fore wings of *Indialis rossi* is broader and more developed than that of *Indialis badia*. Also the costal projection (Figs. 2–3) of the hind wings of *Indialis rossi* is broader than that of *Indialis badia*.

The male eyes of *Indialis rossi* are separated on the meson of the head by a length 3½ times as long as the maximum width of a lateral ocellus (Fig. 4). Peters and Edmunds (1970) stated that the male eyes of *Indialis badia* meet on the meson of the head; however, the head of the subimaginal holotype is shriveled and the eyes of *Indialis badia* might be separated on the meson of the head. Thus, the generic limits of the eye character in *Indialis* have not yet been determined definitively.

I would like to thank Janice G. Peters for preparation of the illustrations, and Dr. George F. Edmunds, Jr., University of Utah, for bringing the specimen to my attention. This research was supported by grant no. 416-15-16 from the Cooperative State Research Service, United States Department of Agriculture.

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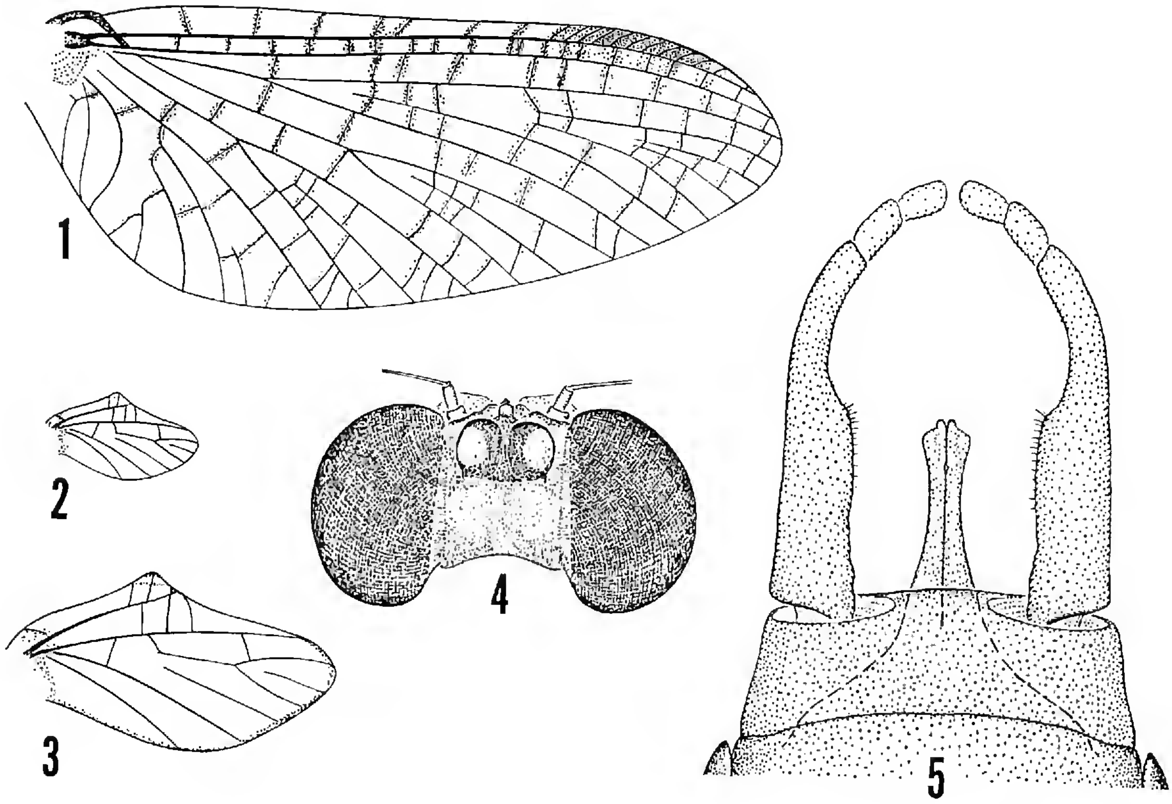

FIGS. 1–5. *Indialis rossi*, male imago. Fig. 1. Fore wing. Fig. 2. Hind wing. Fig. 3. Hind wing enlarged. Fig. 4. Dorsal view of head. Fig. 5. Ventral view of genitalia.

Indialis rossi, New Species

(Figs. 1–5)

Male imago (in alcohol).—Length: body, 7.1 mm; fore wings, 6.5 mm. Upper portion of eyes red-brown, lower portion black. Head brown, area around ocelli washed with black. Antennae brown, flagellum paler. Basal half of ocelli black, apical half brownish-white. Thorax: brown, carinae darker, sutures paler, carinae of pleurae and pronotum blackish. Coxae brown, trochanters pale. (Remainder of legs broken off and missing.) Wings (Figs. 1–3): longitudinal veins and cross veins of fore and hind wings yellowish-brown, cross veins in basal half of cells C and Sc of fore wings darker; membrane of fore and hind wings hyaline, except base of fore and hind wings yellowish-brown, all cross veins in fore wings surrounded with narrow, yellowish-brown clouds, apical ¼ of cells C and Sc of fore wings translucent, white. Abdomen: segments 1–7 translucent, washed with brown, segments 8–10 opaque, washed with brown; terga 1–9 with a narrow, darker brown, transverse band on posterior margin of each tergum, band darker and wider on terga 7 and 8, terga 1–9 with a narrow, lighter brown, longitudinal, median line extended entire length of each tergum; spiracles dark brown, tracheae washed lightly with dark brown; sterna 1–8 with a narrow, darker brown, transverse band on posterior margin of each sternum. Genitalia (Fig. 5): brown. Caudal filaments pale; wide, dark brown annulations at articulations.

Female imago and mature nymph.—Unknown.

Holotype male imago, INDIA, KERALA STATE, KOTTAYAM DISTRICT, KITTIKANAM, NR. PEERMADE, 1000 M, 22 March 1962, E. S. Ross and D. Q. Cavagnaro. Holotype is preserved in alcohol and deposited in the collections of California Academy of Sciences.

Etymology.—Species is named for Dr. E. S. Ross, California Academy of Sciences.

Discussion.—*Indialis rossi* can be distinguished from *Indialis badia* by the following combination of characters in the male imago, (1) all cross veins in fore wings are surrounded with narrow, yellowish-brown clouds (Fig. 1), (2) abdominal segments 1–7 are translucent and washed with brown, (3) caudal filaments are pale, with wide, dark brown annulations at articulations, and (4) the costal projection of the hind wings is well developed and broadly rounded at the apex (Figs. 2–3).

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A New *Acanthinus* from Panama

(Coleoptera: Anthicidae)

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In a recent series of ultraviolet light trap samples taken in the Canal Zone of Panama, there were present three species of *Acanthinus* which could be placed in the *aequinoctialis*-Group of Werner (1967). Two of the species were named, *aequinoctialis* (LaFerte) and *zeteki* Werner, while the third was undescribed. In several instances all three species were collected during the same night and so present a problem in species separation. The new species is more similar to *aequinoctialis* and *zeteki* than to any of the others in the group and actually combines certain of the characters which Werner used for the separation of these species in his key.

The shape of sternite 8 of the males is the best character for species separation. The emargination of this sternite in the new species is moderately deep and wide (Fig. 2). In *zeteki* the emargination is very deep and narrow (Fig. 3). Sternite 8 in *aequinoctialis* may be shallowly emarginate (Fig. 1). Werner notes in his key to the group that the sternite of *aequinoctialis* varies from truncate to gently convex. This description varies slightly from Figure 1, but examination of specimens from Brazil has convinced me that the Panama population is conspecific. The new species may be separated by rearrangement of Werner's key to the *aequinoctialis* group.

KEY TO ACANTHINUS OF THE AEQUINOCTIALIS GROUP

1. Dorsal portion of elytra subopaque due to extremely fine granulation on the surface between the punctures 2
   Dorsal portion of elytra smooth and shiny 3
2. Base of head shallowly, almost evenly curved between the distinct temporal angles. Elytra usually with an obscure, often interrupted, dark band across the middle .... *rugosus* (LaFerte)
   Base of head slightly produced at middle, the temporal angles feeble; therefore nearly evenly semicircular behind the eyes. Elytra not banded .... *tucumanensis* (Pic)
3. Male sternite 8 with deep notch at apex (Fig. 3); rugules on head apparently not oriented in a particular direction; antennae appearing heavy due to thickening of intermediate segments; usually with a dark midband .... *zeteki* Werner
   Male sternite with notch shallower (Fig. 2) or gently concave to convex

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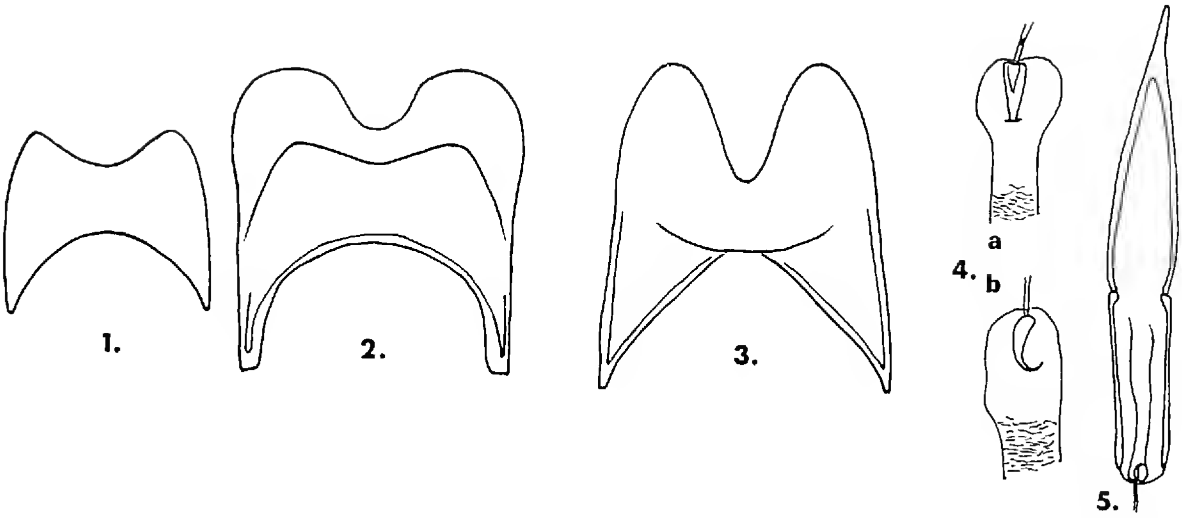

FIGS. 1–5. Terminal sternites and genitalia of *Acanthinus*. Fig. 1. Sternite 8, *aequinoctialis*. Fig. 2. Sternite 8, *umbilicatus*. Fig. 3. Sternite 8, *zeteki*. Fig. 4. Internal sac, showing gonopore armature; a, ventral view; b, lateral view. Fig. 5. Aedeagus.

(Fig. 1); rugules on head appearing to be at least slightly oriented longitudinally; elytra without midband 4

4. Male sternite 8 with a distinct notch; head often with longitudinal area at center of head without rugules and with sparse umblicate punctures, punctures may be obscured by definite longitudinal rugules; antennae appearing heavy due to thickening of intermediate segments .... *umbilicatus* n. sp.
Male sternite 8 gently concave to convex; head always with distinct rugules at center, no umbilicate punctures visible; antennae without thickening of intermediate segments .... *aequinoctialis* (LaFerte)

The format of Werner is used in presenting the species description.

Acanthinus umbilicatus, New Species

1.98–2.43 mm., rufescent with paler elytra, varying to dark brown with elytra brownish, coloration of elytra uniform. Similar in general appearance to *aequinoctialis*, but with "heavy" antennae, strigules distinctly longitudinally oriented and frequently with a longitudinal smooth central area on the head.

Holotype male: length 2.43 mm. Head 0.50 mm. long, 0.52 wide across eyes, 0.40 behind, tempora flat and nearly parallel, 0.07 long, temporal angles quite sharp and at ca. 120°, base evenly curved between them. Surface shiny, punctures small, umbilicate, smoothly strigose longitudinally, strigulations not dense, longitudinal smooth area at center. Setae inconspicuous, tactile setae erect and fairly stout, 0.08 mm. Eyes prominent, 0.25 × 0.18 mm., separated by 0.31, a line across their hind margins 0.15 from base. Last segment of maxillary palpi securiform, 0.17 × 0.09 mm. Antennae fairly stout, gradually thicker toward apex, with tactile setae 0.04 mm. long. Measurements in 0.01 mm.: 10/7, 7/5, 9/5, 7/5, 8/5, 7/5, 6/5, 7/7, 8/7, 9/8, 12/7. Segment 1 eccentrically pedunculate, 2–10 thickest near apex, 7–10 subtruncate at base, truncate at apex, 11 subtruncate at base, convexly tapered to a blunt point near base. Pronotum 0.50 mm. long, 0.34 wide at base, 0.31 at constriction, 0.43 maximum (0.46 including tubercles), 0.21 at collar, tubercles short, bluntly pointed. Disc slightly convex, shiny, covered with large, flat-bottomed punctures, sharply defined by a rugule between them, rugules with slight longitudinal orientation, no microreticulation in disc. Elytra 1.42 mm. long, 0.65 wide at the distinct humeri, 0.75 maximum, with a feeble, postbasal transverse depression. Punctures sharply defined, moderately deep in basal half, gradually smaller but distinct behind, 0.04 mm. from center to center. Setae appressed, 0.20 mm., barely clearing punctures; tactile setae erect, 0.07 mm., moderately stout. Mesosternum strigulose, longitudinal medially to oblique laterally, the strigules not anastamosing; 0.10 wide laterally, leaving 0.07 of mesepisterma exposed laterally. Fringe setae appressed, 0.07 mm. long anteriorly. Mesepisterna with deep punctures at anterior margin, smooth and shiny behind, fringe setae denser posterolaterally. Metasternum with longitudinal strigules, smoother medianly; metepisternum smooth next to sternum, longitudinally strigulate laterally. Abdominal sternum 1 with few longitudinal strigules, microreticulate, the rest with only microreticulation, setae appressed, sparse, 0.04 mm. Sternum 7 essentially as in *aequinoctialis.* Sternum 8 not down-curved, concave across base, with moderately deep U-shaped median notch, 0.28 mm. wide, 0.18 from one tip to the other, notch ca. 0.07 mm. deep. Ventral surface microreticulate, edges of notch with some long setae. Apex of tergum 8 with punctulate and pubescent zone, 0.26 mm. wide, 0.12 long, set off anteriorly by a sharp, transverse ridge. Front femur 0.48 × 0.15 mm., front tibia 0.37 × 0.07, hind femur 0.52 × 0.17. Aedeagus with tegmen gradually tapered (Fig. 5) ; gonopore armature essentially as in other species, with spines in the internal sac near the gonopore armature (Fig. 4).

FEMALE.—Similar to male, but with sternite 8 unmodified.

Holotype male: ALBROOK FOREST SITE, FORT CLAYTON, CANAL ZONE, PANAMA, 23/24 May 1968, black light trap, R. Hutton, Lot No. 200. 45 paratypes: 18 males, 25 females, same locality as holotype, 25 May, 1967 to 10 May, 1968, Hutton and Llaurado. Individuals were collected every month except July and October. 52 same locality; 2 males, 5 females, 25/26 May 1967, Hutton & Llaurado. 1 male, 1/2 June 1967, Hutton & Llaurado. 1 female, 3/4 August 1967, Hutton & Llaurado. 2 females, 7/8 September 1967, Hutton & Llaurado. 1 female, 28/29 September 1967, Hutton & Llaurado. 1 male, 2 females, 30 November/1 December 1967, Hutton & Llaurado. 1 female, 28/29 December 1967. 1 female, 19/20 January, Hutton & Llaurado. 2 males, 30/31 January 1968, R. Hutton. 1 male, 3 females, 23/24 February, R. Hutton. 1 female, 7/8 March 1968, R. Hutton. 2 males, 3 females, 21/22 March 1968, R. Hutton. 2 males, 1 female, 28/29 March 1968, R. Hutton. 3 males, 1 female, 4/5 April 1968, R. Hutton. 2 males, 10/11 April 1968, R. Hutton. 1 male, 2 females, 18/19 April 1968, R. Hutton. 1 male, 1 female, 9/10 May 1968, R. Hutton. 2 males, Las Cumbres, Canal Zone, 10 January/1 April 1974, H. Wolda. The holotype will be placed at the University of Arkansas with half the paratypes. Two paratypes will be placed at the United States National Museum and the remainder in the author's collection.

My thanks are given to C. A. Triplehorn for reviewing the paper.

LITERATURE CITED

WERNER, F. G. 1967. A revision of *Acanthinus* (Coleoptera: Anthicidae). IV. Ann. Amer. Entomol. Soc., 60: 255–273.

SCIENTIFIC NOTES

Additional Distribution Records for Nearctic Species of *Ptenus* Kirby (Hymenoptera: Argidae: Sterictiphorinae).[1]—Smith (1970. Trans. Amer. Entomol. Soc. 96: 79–101) revised the Nearctic species of *Ptenus* Kirby, recognizing 2 previously named species and describing 10 new species. The collection of the Department of Entomology at Texas A & M University (College Station) contains several specimens of *Ptenus* spp. collected in Texas and Mexico, some which extend the known distributions of several species into east-central and southeastern Mexico. The purpose of this paper is to redefine the distributions previously described by Smith, and to list additional collection records of some of the Nearctic species.

Ptenus bicolor Smith was described from eastern and southeastern Texas, and extreme northeastern Mexico (Matamoros). The known distribution of this species is extended to include eastern Mexico south to southeastern Vera Cruz. Additional records include: TEXAS: Cameron Co., Brownsville; San Patricio Co., Welder Wildlife Refuge. MEXICO: Nuevo Leon, 9 mi. s. Monterrey; San Luis Potosi, El Salto; Tamaulipas, 11.3 mi. n. Ciudad Victoria, and 8.5 mi. s. Soto La Marina; Vera Cruz, 7 mi. n. e. Mata Espino. Collection dates range from early June to mid-August.

Ptenus imus Smith was described from southern Texas (Laredo and Brownsville) and northeastern Mexico (Tampico). The known distribution of this species is extended north along the Gulf of Mexico coast to Corpus Christi. Additional records include: TEXAS: San Patricio Co., Corpus Christi St. Park, 25-VIII-1962.

Ptenus magnus Smith was described from western Texas, New Mexico and Arizona. Additional records include: TEXAS: Jeff Davis Co., Madera Canyon, w. of Ft. Davis, 9-VIII-1969.

Ptenus modestius Smith was described from Arizona, California, and Texas as far east as Brownsville and Austin. The known distribution of this species is extended north in Texas to Bosque Co., north along the Gulf of Mexico coast to San Patricio Co., and south into Mexico to southwestern Tamaulipas (16 mi. n. e. Jaumave). Additional records include: TEXAS: Bosque Co., 2 mi. w. Iredell; Cameron Co., 3 mi. w. Brownsville; Gonzales Co., Palmetto St. Park; Presidio Co., 2 mi. s. Shafter; Refugio Co., 8 mi. s. Woodsboro; San Patricio Co., 7 mi. n. Sinton, and Mathis. MEXICO: Tamaulipas, 11.3 mi. n. Ciudad Victoria and 16.3 mi. n. e. Jaumave. Collection dates range from mid-March to mid-July.

Ptenus nigropectus (Norton) was known previously from "eastern and northern Texas, east through Louisiana to Mississippi" (Smith, ibid.). Additional records extend the known distribution of this species to include Texas, from the panhandle south to San Antonio, southeast to Brownsville, east through Louisiana into Mississippi, and south into Mexico to northern Vera Cruz (18.6 mi. s. Tampico). Additional records include: TEXAS: Bosque Co., 3 mi. w. Laguna Park; Brazos Co., Minter Springs, and College Station; Burnet Co., Longhorn Cavern St. Park; Kerr Co., Kerrville; Refugio Co., 8 mi. s. Woodsboro. MEXICO: Nuevo Leon, 9 mi. s. Monterrey; Vera Cruz, 18.6 mi. s. Tampico. Collection dates in Texas range from mid-April to early June. The Mexican specimens were collected in mid-August.

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[1] Technical Article 11412, Texas Agricultural Experiment Station, College Station.

Ptenus parvus Smith was described from western Texas and Arizona. Additional records include: TEXAS: Brewster Co., 43 mi. s. Alpine, 7-VI-1972; Presidio Co., 3 mi. n. Presidio, 1-IX-1966.

Ptenus texanus (Norton) is known from Texas and Mexico. Additional records include: MEXICO: Coahuila, Puerta de la Goriona, el. 4900 ft., Sierra del Carmen, 13-VII-1938.

Ptenus vanus Smith was described from New Mexico, Arizona, and the bordering Sierra del Carmen mountains of Mexico (Coahuila). The known distribution of this species is extended south in Mexico to central Vera Cruz. Additional records include: MEXICO: Vera Cruz, 4 mi. w. Conejos, 29-VI-1971.

Ptenus vargus Smith was described from 2 females taken at "port of entry" from Mexico at Brownsville, Texas. The first specific records from Mexico are Nuevo Leon, 7.5 mi. s. Monterrey and 9 mi. s. Monterrey, and San Luis Potosi, 13.4 mi. w. El Naranjo. Collection dates range from mid-March to mid-August. The proximity of these localities to the Mexican-United States border suggests that *P. vargus* probably occurs also in southern Texas, as suggested by Smith (ibid.).

I wish to thank D. R. Smith (ARS, USDA, Washington, D. C.) for his suggestions and for his determinations of many of the specimens reported in this paper.—HAROLD N. GREENBAUM[2], *Department of Entomology, Texas A & M University, College Station, Texas 77843.*

A Mountain-top Swarm of the Hemipteran *Nysius raphanus* in New Mexico, with Notes on Other Insects.—Capulin Mountain National Monument, situated in extreme northeastern New Mexico, has as its central attraction an extinct volcanic cinder cone. This is thinly forested with pinyon pine and rises a thousand feet (summit is 8,215′) above the surrounding treeless plain. When Ray G. Martinez, Jr., Park Superintendent, kindly gave me a permit for collecting insects there (May 9, 1974), he said that visitors had complained for the past two weeks of vast swarms of small "flies" on the summit trail around the crater rim. Near midday, at the summit parking lot, hikers descending from the trail did indeed seem harassed. A short climb up the trail brought me into an area where the air was filled with flying, small, hard-bodied insects that pelted one's face like grains in a sandstorm. This situation extended for about a half-mile of the trail. The insects proved to be a species of lygaeid, identified as *Nysius raphanus* Howard by Jon L. Herring of the USDA Systematic Laboratory at Beltsville. Both females and males were present in about equal numbers. This species has long been regarded as a synonym of *N. ericae* (Schilling), the False chinch bug.

As the day progressed, the wind became brisk, and the *Nysius* sought shelter in the small pinyons. A blow with a net handle on a tree produced a thick gray cloud of insects that quickly drifted down wind; each pass of the net through such a cloud captured a few hundred of the insects. *Nysius* was not seen near the base of the mountain.

Near the highest point of the mountain, just down wind from the tip of a tall

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pine, was an aggregation of 10 to 20 oestrid flies, which easily kept its position in the wind. A specimen sent to R. J. Gagné (also of the Systematics Laboratory) proved to be *Cephenomyia pratti* Hunter.

At mid-morning of the same day the long-faced black bee *Andrena porterae* Cockerell was common on flowering bushes of *Ribes* at the base of the peak. This is, as far as I know, the easternmost record for this Rocky Mountain species.

Probably Mt. Capulin's chief claim to entomological fame is the satyrid butterfly *Oeneis alberta capulinensis* Brown 1970: 137 (J. New York Entomol. Soc.), which at the time of its description had status as an isolated eastern population of *alberta*. However, Brown predicted it would eventually be found in the highlands to the north and west. In order to reduce possible collecting pressure on the small Mt. Capulin colony, it would be well to point out here that I observed *alberta* on May 10 in numbers on Johnson's Mesa, about 10 mi. NNW of Mt. Capulin, at an altitude of 7,600′.—U. N. Lanham, *University of Colorado Museum, Boulder.*

Additional Notes on Chagas' Trypanosome in California and Arizona.—Wood (1975, Exptl. Parasitol. In Press) indicated 25 locations in California for recovery of *Triatoma protracta protracta* (Uhler) naturally infected with *Trypanosoma cruzi* Chagas. Further unreported California localities for recovery of Chagas' trypanosome in *T. p. protracta* include the following: from *Neotoma* houses in Garden Valley, El Dorado Co., 26 & 28 November 1963: 24 (4 ♂, 7 ♀, 8-5th and 5-4th instar nymphs) with 3 ♂ and 5 ♀ positive for *T. cruzi*, A. L. Gladwill; at black light in Lytle Creek, San Bernardino Co., 12 September 1964: 4 (2 ♂, 2 ♀), 1 ♀ positive, J. A. Robertson; 1 positive ♂ from a home in Yreka, Siskiyou Co., 21 July 1967, forwarded from the State Department of Agriculture by R. Hawthorne; 1 positive ♀ from the living room couch in a home in the Hollywood Hills, Hollywood, Los Angeles Co., 20 August 1967, R. DeRover, Jr.; and 8 (2 ♂, 3 ♀ and 3-5th instar nymphs), 2 ♀ and 3-5th positive 10 August and 2 September 1974 from *Neotoma* houses in Wildwood Park, Thousand Oaks, Ventura Co., S. F. Wood.

From 1964 through 1970, 28 *T. p. protracta* were reported to me from homes in Beverly Hills (Benedict Canyon), Los Angeles County. Microscopic examination of the feces of 3 ♂ and 11 ♀ revealed 1 ♀ positive for *T. cruzi* from inside a home 7 September 1968 and another ♀ positive from an outside screen 8 July 1969. Thus, there are numerous reservoir mammal carriers of Chagas' zoonosis in the southern end of the Santa Monica Mountains.

During the summer of 1965, A. L. Gladwill, caretaker at the Griffith Park Boys' Camp in Los Angeles, California, collected 13 *T. p. protracta* (6 ♂, 7 ♀) from the vicinity of his living quarters (Wood & Wood, 1967, Pacific Insects 9: 544, Fig. 5) from 26 August to 31 October and placed them, dead or alive, in his home refrigerator (1–2°C). These conenose bugs were transferred 6 June 1966 to the author's refrigerator and removed 6 July 1966 for examination of the rectal contents for trypanosomes. One ♀ with feeble leg movements when isolated by Gladwill 4 September 1965 revealed 3 trypo- and 16 epi-mastigotes of *T. cruzi* when examined 305 days after capture! One ♂ collected alive 30 August 1965 from inside the home (Fig. 5, above the garage, loc. cit.) revealed 1 trypo- and 8 epi-mastigotes when examined 310 days after capture. Another ♀ collected on 28 August 1965 showed 12 trypo- and 8 epi-mastigotes 312 days after capture. These are remarkably long survival times and show that freshly captured *Triatoma* can be stored in a household refrigerator to preserve *Trypanosoma cruzi* in the insect vector for at least 312 days.

Infection with *T. cruzi* for all California triatomes obtained by me through 1974 was 25.1% or 945 of 3,761 bugs. Most were alive when rectal contents were examined.

From Arizona, between 1966 and 1971, 24 (12 ♂, 12 ♀) *Triatoma rubida uhleri* Neiva were received. Two ♂ were positive for *T. cruzi* of 22 collected in Tucson, Pima Co., 14 June 1969 by G. Harwood. One of 2 ♀ was positive from Phoenix, Maricopa Co., collected 12 June 1970 by F. Plettenberg.

The infection rate for all Arizona triatomes examined through 1974 was 6.6% or 88 positive of 1,323 examined mostly from dead, dried specimens.—SHERWIN F. WOOD, *614 W. Shenandoah St., Thousand Oaks, CA 91360.*

Foraging Behavior of *Agapostemon* on *Oenathera caespitosa* in southeastern Wyoming (Hymenoptera: Halictidae).—Linsley, MacSwain and Raven (1963, Univ. Calif. Publs. Entomol. 33: 25–58) have provided information on the Apoideaen visitors to eleven species of *Oenothera* in and around the Great Basin. This note reports on a species previously unrecorded on *Oenothera caespitosa caespitosa* Munz and describes its foraging behavior on the blossom.

Observations were made on two small populations of *Oenothera caespitosa* on two consecutive mornings, May 26 and 27, 1974, from 5:30 to 9:30 a.m. The weather was clear, warm and without wind. The area, a slightly rocky sandstone patch surrounded by typical open short-grass prairie, is located about seven miles S. S. E. of Laramie, Wyoming. As reported previously, (ibid.) the flowers at this time of morning were devoid of nectar but did possess significant amounts of pollen.

The first activity was recorded at 8:30 on May 26 and 8:20 on May 27 when females of *Agapostemon texanus* began to appear on the flowers. A total of four bees were recorded on May 26 and ten on May 27. Typically, a bee would alight upon the proximal half of a petal and walk to the base of a filament. It would then ascend the filament to the anthers where pollen collected by the forelegs was transferred to the scopa. The pollen grains, which are large, triangular and inter-connected by viscin threads formed a rather loose and easily detachable mass on the scopa. When finished with one anther the bee flew to the next filament and repeated the process. Usually, two or three anthers were collected from on each flower. In no case did a bee forage on all four anthers of the same flower. Analysis of the pollen taken from the scopa of three bees revealed only *Oenothera* pollen. This flower constancy occurred despite the fact that several other species were in bloom and contained available pollen. Females of *Agapostemon texanus* carrying full pollen loads have been collected on these other species at other times. Of the fourteen recorded visitors none were seen contacting the stigma at any time. Thus, *Agapostemon texanus* does not seem to be an important pollinator of *Oenothera caespitosa* and may be regarded as a pollen thief.

Although evening observations were not conducted it is probable that this flower is pollinated by nocturnal hawkmoths as previously reported (ibid.). The stigmas of all plants examined contained noticeable amounts of pollen. The early-morning oligoleges of the genus *Andrena* (*Onagrandrena*) found by Linsley, et al. (ibid.) were not present on the study site.—V. J. TEPEDINO, *Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming* 82071.

Insect Associates (Diptera: Chironomidae, Sphaeroceridae) of *Darlingtonia californica* (Sarraceniaceae) in California.—In June, 1974, I had the opportunity to study specimens of *Darlingtonia californica* Torrey, the California pitcher-plant, in Nevada County, California, near Willow Springs. The plants were growing along the stream margins at 6500 feet elevation in a sphagnum bog surrounded by pine-fir forest. In view of the presumably digestive nature of the fluids contained in the pitchers (Street, H. E. and H. Opik. 1970. The Physiology of Flowering Plants: Their Growth and Development. American Elsevier Publishing Co.: New York, N. Y. 263 pp.), it was of interest to find two species of dipterous larvae living and developing in the upper layer of reddish fluid above the insect debris in the pitchers. One species was a chironomid midge, apparently *Metriocnemus edwardsi* Jones, the other a sphaerocerid in the genus *Leptocera.* I am indebted to Dr. E. I. Schlinger of the University of California, Berkeley, for his identification of the flies.

The chironomid larvae were abundant in 15–20 pitchers examined in the field. They appear to be detritus feeders, but may be herbivores. The larvae stayed near the top of the detritus. Jones found *M. edwardsi* larvae eating insect remains in plants in Siskiyou County, California, and reported that in captivity specimens pupated on the outside of the pitcher, on the basal portion of the leaf or on adjacent moss (Jones, F. M. 1916. Entomol. News 27: 385–392). Jones was convinced, by the presence of larvae in almost every suitable *Darlingtonia* leaf, that the larvae were habitually and possibly exclusively associated with it. To my knowledge, *M. edwardsi* has never been reported from any host other than *D. californica*, nor from outside California, although the plant occurs in Oregon. Because of the uniqueness of the habitat utilized, it seems quite unlikely that the same species of chironomid would be found in other aquatic situations in the same area. Although there are 17 described species of *Metriocnemus* in North America, *M. edwardsi* is the only one as yet described from California. The rest are northern in distribution.

The *Leptocera* larvae were more numerous than the chironomids. These crawl up the walls of the pitchers, and pupate among the retrorse hairs found in the lower portion of the tube. Adult *Leptocera* were also found in the pitchers. Some are probably caught by spiders, such as the eriogonids found in some of the atria at the tops of the plants, while others escape and colonize new pitchers. Various species of *Leptocera* are commonly found among low plants in this type of boggy area. This particular species has apparently been able to adapt completely to the conditions in the pitchers, and is probably limited to *Darlingtonia.*

It is interesting that the eastern genus of pitcher-plant, *Sarracenia*, has many recorded dipterous associates, while *Darlingtonia* has but three. It is also interesting that no mosquito larvae were found in any of the plants, since they are recorded from *Sarracenia*. This study was supported in part by the NIH Training Grant, Department of Entomological Sciences, University of California, Berkeley.—S. L. SZERLIP, *Division of Entomology and Parasitology, University of California, Berkeley, 94720.*

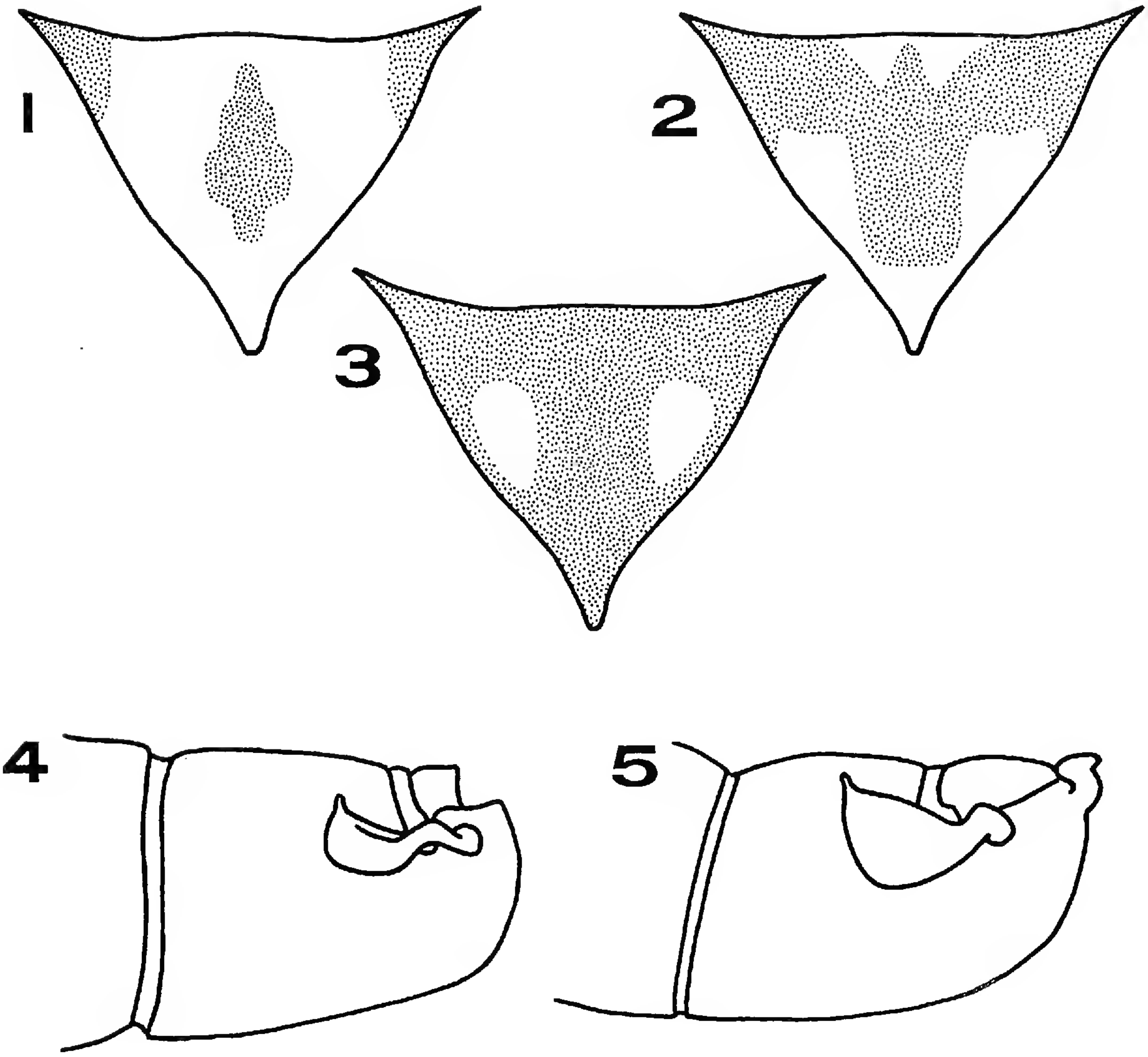
Identification of the damsel bugs, *Nabis alternatus* Parshley and *N. americoferus* Carayon (Heteroptera: Nabidae).—Harris (1928, Entomol. Am. 9: 1–97) records 6 species of Nabidae from California; 3 of these are extremely rare, and known from only a few specimens. Harris stated that of the 3 common species, *N. ferus* (L.) was European in origin and had been introduced and became widely distributed in the U.S. while *Pagasa fusca* (Stein) and *Nabis alternatus* Parshley were native. However, extensive genitalic studies of North American and European specimens of "*N. ferus*" (Carayon, 1961, Bull. Mus. Nat'l. Hist. Nat. Paris (2) 33: 183–96) have shown the American form, now *N. americoferus* Carayon, to be distinct from *N. ferus*, which is now thought not to occur in California.

Development of a couplet to separate the two species of *Nabis* resulted from difficulties encountered in rapidly identifying California Nabidae during studies on predatory Hemiptera in Sacramento Valley alfalfa hay fields. Identification using Harris's monograph or the keys of Werner and Butler (1957, Ariz. Agr. Exp. Sta. Tech. Bull. 133: 1–12) proved impractical due to the very similar overall appearance and variable color patterns in our 2 common species of *Nabis*. Also, we would point out that keys and descriptions of "*N. ferus*" in both taxonomic works apply to *N. americoferus* and not to the true European *N. ferus*. The following couplet was constructed using specimens of Nabidae subsampled from the predation study and identified by experienced Hemipterists. Its accuracy was then confirmed by testing it on identified museum specimens from a wide geographic range. The color pattern of the scutellum is best observed when the specimen is in alcohol. All characters used in the couplet refer to both sexes unless otherwise indicated.

Couplet to separate *Nabis alternatus* and *Nabis americoferus*.

—Scutellum dark brown with a pale yellow "V" shaped area extending to the posterior margin (Fig. 2) or scutellum yellow except for brownish areas centrally and at the anterior lateral margins (Fig. 1); male clasper (Fig. 5) wide (0.20–0.28 mm) and long (0.52–0.60 mm); body length 7.0–9 mm .... *N. americoferus* Carayon

—Scutellum dark brown with two oval yellowish areas, each located midlaterally (Fig. 3); male clasper (Fig. 4) narrow (0.11–0.16 mm) and short (0.40–0.44 mm); body length 6.4–8.1 mm .... *Nabis alternatus* Parshley



FIGS. 1–5. Structures used in separating species of *Nabis*; 1–3, scutellum; 4–5, lateral view of male genitalia, showing claspers. Figs. 1, 2, 5, *N. americoferus*. Figs. 3, 4, *N. alternatus*.

We are grateful to Drs. Peter Ashlock, Richard Bohart, Jon Herring, John Lattin and Mr. Tim Vargas for their assistance in various aspects of this project.—
J. H. BENEDICT AND W. R. COTHRAN, *Department of Entomology, University of California, Davis, California* 95616.

BOOK REVIEWS

THE INSECTS OF THE LOS ANGELES BASIN. Charles L. Hogue. x + 173 pp. incl. 2 color plates, 250 figs.; Los Angeles County Museum, Sci. Ser. 27, 1974. $6.00, 8 × 10″ paperback.

This fine little book is a pictoral guide to the common and conspicuous insects and related arthropods occurring in the greater Los Angeles area. Because these bugs are those most commonly seen in man's most heavily populated region of western North America, their numbers include many homodynamic kinds with a disproportionate representation of "weedy," introduced species and house and garden insects. Therefore, though the number of species treated is not large (about 200 are discussed and another 75 mentioned), most are widespread species, so that the book will prove useful throughout the Pacific States. Virtually all species discussed are illustrated, either by excellent photographs or shaded drawings, many taken from technical literature.

Taxonomically, the coverage is uneven, geared to a level of information that should answer questions of a layman. Thus orders or families of small insects are characterized by group only, while a few to many species are detailed for larger kinds like dragonflies and butterflies as well as for insects affecting man, such as lice and mosquitoes. The Lepidoptera are given top billing, with more than 60 species shown. Emphasis is also directed to household problems, with sections on pantry moths and beetles and to housing insects alive, with instructions for keeping mantids and ant colonies in captivity and raising caterpillars. A representative sample of scorpions, spiders, mites, ticks and other terrestrial arthropods is also discussed, again with emphasis on those of potential medical importance.

Introductory sections include discussions of structure and function, making a collection, insect classification, and habitats around Los Angeles. These parts and the text on individual orders and families are accompanied by literature references, and there is a general section referring the reader to other sources of information, both special topics and general ones, such as children's books.

Common names of each species are accompanied by parenthetical mention of the scientific names (without author), and the text is remarkably free from errors, both typographical and technical. The color plates add aesthetic value but are not essential, being habitat photographs of 16 species, most of which have been reproduced in black and white in the text.

Although the price seems high considering the audience, this is the best popular manual available to the public that deals with west coast insects, especially those of urban areas.—J. A. POWELL, *Division of Entomology and Parasitology, University of California, Berkeley* 94720.

THE MOTHS OF AMERICA NORTH OF MEXICO: PYRALOIDEA AND GELECHIOIDEA. This ambitious project which proposes to describe and illustrate all of the 10,000 + species in our fauna has now published the first two fascicles dealing with the so-called microlepidoptera. These follow a somewhat more formal format with less anecdotal digression of popular manual style that was characteristic of the several earlier issues treating sphingids, saturniids, and other bombycoids.

FASCICLE 13.1: PYRALOIDEA, PYRALIDAE (Part), by Eugene Munroe; published in 3 parts, A (Scopariinae and Nymphulinae) (1972), B (Odontiinae and Glaphyriinae) (1972), and C (Evergestiinae and plates to all 3 parts) (1973); 304 + xx pp., 13 color and 10 bl. & wh. plates [price about $82.00, non-subscription].

This is half of the first of 4 fascicles planned to cover the pyraloids, probably the second largest superfamily of Lepidoptera, with more than 1,500 species in North America. The introduction contains the first comprehensive review of higher classification in the superfamily and in the Pyralidae to have appeared in many years.

These 3 parts enumerate some 227 species of which nearly 20% are previously undescribed, despite the fact that the Odontiinae was monographed by Munroe in 1960 and various other taxa have been recently described. Virtually all species are illustrated in the superb color photographs, and genitalia of new species are shown by microphotographs. Most of the color plates are reproduced at twice natural size, while the somewhat larger moths of the Evergestiinae and some Scopariinae are shown at natural size.

The text is very thorough, more resembling a taxonomic revision than a general manual. It includes lengthy synonymies and rather detailed descriptions and full data citations for the new taxa, which in addition to the new species include 7 new genera and more than 20 new subspecies, encouraging nomenclatural recognition of geographical variation that American microlepidopterists have been relatively free from in the past.

This fascicle suffers from the paradox that the earlier macro-moth volumes instigated: a decision to treat the fauna as though these were taxonomic revisions, incorporating undescribed material, yet using mainly a few large eastern collections as sources of raw data. The former concept results in uneven treatment between taxa, greatly expanded text length, delays in completion and encourages high costs; while the latter attitude results in failure to incorporate all up to date knowledge, particularly that concerning western species. Munroe has used some western collections, in contrast to earlier fascicles where perhaps a convincing argument could be mustered supported by the much better fieldwork coverage by the industrious collectors of sphinges and bombyces. However, the use of western material in pyralids is sporadic both in taxonomic spectrum and in recency of solicitation, so that there are a number of statements concerning geographical distributions and lack of biological information that were out of date when written.

FASCICLE 6.2: GELECHIOIDEA, OECOPHORIDAE, by Ronald W. Hodges; 142 + x pp., 7 color and 1 bl. & wh. plates (1974) [price about $57.00, non-subscription].

This volume is of general interest in two ways. First it proposes a higher classification for Oecophoridae, based on review of the world fauna, and this is one of the largest families of microlepidoptera with more than 4,000 described species. Secondly, this is the first family of microlepidoptera to have been reviewed following an earlier taxonomic revision based on genital characters, namely Clarke's treatment in 1941. Thus this is our first chance to see whether an asymptote in faunal size is being approached in Nearctic microlepidoptera, and it appears that it is. Hodges defines some 147 species, and only about 10% are previously undescribed, while a like proportion of names are considered new synonyms. Therefore the size of this family is only slightly enlarged, and contemporary microlepidopterists can be encouraged to know that their present treatments are near the crest, at least in non leafminer taxa.

With the exception of new taxa, the oecophorid text is quite terse, with concise morphological and distributional summaries and abbreviated synonymies that often do not include previous generic assignments so that new combinations appear to revise the original combinations only. On the other hand, some superfluous items are incorporated, such as citation of plant common names, a lengthy quote from previous literature on page 44, and proposal of unique tribes (pp. 93, 136) in subfamilies that contain no other tribes. In general the coverage of biological, phenological, and geographical knowledge is excellent, although there are a few errors and omissions in biological information.

This is the first group in the series to include quite small moths, and the color plates are unbelievably good, showing the adults at twice natural size for all genera except a few like *Decantha* which are magnified 4 times. In addition there are excellent drawings by Elaine Hodges illustrating genitalia of new species and some previously described ones that were evidently deemed necessary for comparison purposes.

An innovation towards economy has been made without loss of clarity, with the use of smaller type organized in double column format, so that each page potentially carries about 17% more print than in predecessor volumes. However, the text incorporates 32 generously spaced, large figures which are more detailed than necessary so that greater reduction was not warranted in favor of details in non-taxonomic features such as shading and setae. The figures comprise about 18% of the text, much more than would have been necessary had they been less detailed drawings originally and were they aggregated as full page groups.

These two fine treatments will be musts for serious students of the pyralids and oecophorids, but considering the prices they are hardly manuals for the general lepidopterist. It is apparent that the dual goal of a hybrid monograph that will be useful and available to laymen, yet be comprehensive and prepared by meticulous professionals is impossible in the face of today's production costs.—J. A. POWELL, *Division of Entomology and Parasitology, University of California, Berkeley,* 94720.

RECENT LITERATURE

A REVISION OF THE SCARABAEINE DUNG BEETLES OF AUSTRALIA II. TRIBE SCARABAEINI. E. G. Matthews, Australian Journal of Zoology, Suppl. Ser. No. 24, pp. 1–211.

The highly specialized dung beetle fauna of Australia has received admirable monographic treatment in the first two parts of this work. Part II, dealing with the Canthonina, describes and keys 94 species in 16 genera, of which three genera and 52 species are considered new. Discussions of food, behavior, and biogeographic relationships, including the significance of wing reduction in many Australian species, supplement the keys and descriptions of genera and species. One species from each genus is portrayed in excellent half tone illustrations, and details of important taxonomic features are provided by over 300 line drawings.—*Editor.*

LOS TIPOS DE INSECTOS DE LA COLECCION LUIS E. PENA G. Luis E. Pena. Bol. Soc. Biol. Conception, 47:259–282. 1974.

The author lists 114 species for which he holds the holotypes. Of these, 84 species are Tenebrionidae, and 23 species are from other families of Coleoptera, especially Cerambycidae. The Pena collection also contains a few holotypes of Lepidoptera, Hemiptera and Orthoptera. Paratype material represents an additional 151 species, mostly Tenebrionidae, with moderate representation of other families of beetles and of Lepidoptera. Although small compared to the holdings of major museums, the Pena collection probably comprises one of the most important assemblages of insects, particularly Coleoptera, from southern South America.—*Editor.*

A SYSTEMATIC MONOGRAPH OF NEW WORLD ETHMIID MOTHS (Lepidoptera: Gelechioidea). J. A. Powell. Smithson. Contr. Zool., no. 120, iv + 302 pp. 1973. ($3.85, U. S. Government Printing Office, Washington, D. C. 20402.)

This exhaustive treatment of a previously confusing family of moths is truly monographic in scope. Both sexes, when available, of each of the 133 new world species are described. Clear line drawings of genitalia are provided for nearly all species, and 192 photographs arranged in 16 plates, illustrate the adult moths. Although genitalia, especially in males, provide excellent differentiating characters which were important in defining species groups, the keys to genera and species are based on external characteristics, making this work potentially useful to a much larger audience. Immatures are not described, but analysis of larval and pupal characters appears in tables and discussions. A large amount of biological information is integrated with the systematics portion of the text, with separate discussions on host plant relationships, phenological patterns, and biogeographic distribution. Taxonomic conclusions are derived in part from numerical analysis of 42 characters, with results expressed as phenograms and Primnets. The text is indexed by general subject, as well as host plant name.—*Editor.*

BUTTERFLIES OF THE WORLD. H. L. Lewis, with a Foreword by J. M. Chalmess-Hunt. Follett Publishing Company, Chicago, Illinois, 1973. XVI + 312 pp., 208 color plates.

Illustrates about 70 percent of the species of butterflies, representing nearly all genera. Organized by taxa within biogeographic regions.

THE ECOLOGY OF INSECT POPULATIONS IN THEORY AND PRACTICE. L. R. Clark, R. Hughes and R. F. Morris. Halstead Press, John Wiley and Sons, Inc., New York, New York, 1974. 248 pp., paper, $6.75.

INSECTS AND DISEASES. Keith Snow. Halstead Press, John Wiley and Sons, Inc., New York, New York, 1974. 208 pp., $9.50.

OBITUARY

Donald D. Penny was born September 22, 1894 at Los Gatos, California and died February 8, 1975 in Aptos, California at the age of 81. He entered the University of California in 1914 and received a B.S. degree in Entomology in 1917. While at the University, he was greatly influenced by Professors C. W. Woodworth and E. O. Essig. As a student, he conducted extensive investigations on Aleyrodidae, an interest which continued after graduation. His types were presented to the California Academy of Sciences.

On completing college, Penny went to Sacramento to work in the state insectary under the supervision of Harry S. Smith. His primary responsibility was the production of ladybird beetles. In 1919, at the urging of Smith, Penny took and passed the examination for Horticultural Commissioner for Santa Cruz County. While there he became very much interested in oil sprays. In cooperation with W. H. Volck he played an important role in the development and use of the new phytonomic summer oil sprays. These relatively safe oil sprays were rapidly accepted throughout the developed agricultural world and marked an important advancement in pest control.

In September 1923, Don, as he was known to friends and associates, joined Cal Spray Chemical (Ortho Division of Chevron Chemical Company) where he remained until he retired on October 1, 1959. He served the company in a number of capacities which included marketing, research and development, and formulation of products. He introduced Chevron products into Australia and New Zealand in 1927 and 1928 and into Hawaii in 1927. At the time of his retirement, he was Assistant to the Manager for Research of the company.

Penny served a term as President of the Entomological Society of Southern California and was an Emeritus member of the Entomological Society of America.

Don was a most friendly and cooperative person. His principal hobby during his active career revolved around applied entomology. After retirement he devoted much time to his garden. He is survived by his wife, Dorothy, who lives in Aptos, California, and a son, William, who resides in Oakland, California.—Leo R. Gardner, retired, *Chevron Chemical Co., Ortho Division* and A. E. Michelbacher, *Emeritus Professor of Entomology, University of California, Berkeley, 94720.*

ZOOLOGICAL NOMENCLATURE

Announcement A. (n.s.) 95

Required six months' notice is given of the possible use of plenary powers by the International Commission of Zoological Nomenclature in connection with the following names listed by case number: (see *Bull. zool. Nom.* 32, part 1, 27th March 1975).

1079. *Forcipomyia* Meigen, 1818 (Insecta, Diptera): designation of type-species.

1892. Ruling on the stem of the family-group name based on *Sphaerius* Waltl, 1838 (Insecta, Coleoptera).

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London SW7 5BD, England. Those received early enough will be published in the *Bulletin of Zoological Nomenclature.*—MARGARET GREEN, Scientific Assistant.

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Papers on the systematic and biological phases of entomology are favored, including articles up to *ten* printed pages on insect taxonomy, morphology, behavior, life history, and distribution. Excess pagination must be approved and may be charged to the author. Papers are published in approximately the order that they are received. Immediate publication may be arranged *after* acceptance by paying publication costs. Papers of less than a printed page may be published as space is available, in Scientific Notes.

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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.

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Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2:211–212.
1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York. 1050 pp.

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Nests of the Mason Bees *Osmia tanneri* Sandhouse and *O. longula* Cresson with a Description of the Female of *O. tanneri*

(Hymenoptera: Megachilidae)

FRANK D. PARKER
Bee Biology and Systematics Laboratory, Agr. Res. Serv., USDA
Logan, Utah 84322

The nesting habits of western mason bees are mostly unknown though Hicks (1926) stated that *O. integra* (Cresson) [reported as *novomexicana* (Cockerell)] made mason nests under flat stones and Stephen *et al.* (1969) described *Osmia* nests coated with mud that were constructed in cracks in split rocks. *O. nigrifrons* Cresson makes mason nests in a variety of situations (Rust *et al.*, 1974). Recently while I was searching under stones for nests of the pollen-collecting wasps, *Pseudomasaris* (Parker, 1967), I found nests of two species of mason bees, *Osmia tanneri* Sandhouse and *O. longula* Cresson.

OSMIA (*CENTROSMIA*?) *TANNERI* SANDHOUSE

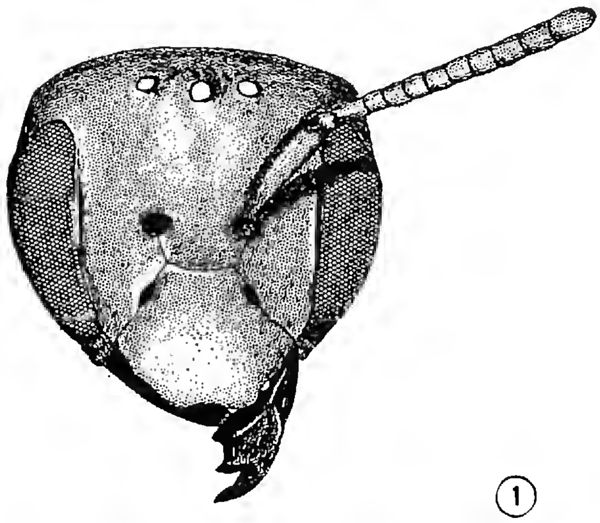
(Figs. 1–4)

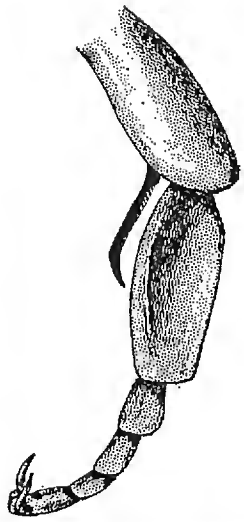
Sinha (1958) revised the subgenera of *Osmia* and placed *O. tanneri* in (*Centrosmia*). However, the female of *O. tanneri* will not key to this subgenus because it has a 3-toothed mandible (Fig. 1) instead of the 4-toothed condition found among known females of (*Centrosmia*). The need for a comprehensive revision of these important pollinators is evident when 28 of our Nearctic species cannot be placed to subgenus (Sinha, 1958)! Because sex association in this genus is quite difficult and is one of the factors limiting a better understanding of the classification, a description of *O. tanneri* females is given.

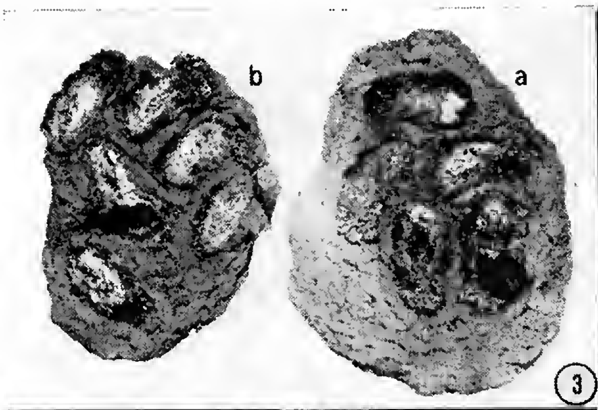
Females. Black, one specimen with bluish band across frons above base of antennae; wings lightly stained, darker posteriorly. Pubescence mostly dark brown, uniform length longer than last 2 flagellomeres; scutum, scutellum with dense off-white hair with narrow lateral border of dark hair; tergites I–II with off-white hair scattered across dorsal surface, rest of abdomen with black stiff setae except shorter, brownish, plumose setae apically on sixth tergite and sternite; legs with long brownish hair, inner surface of basitarsi with short dense pubescence, thinner on outer surface, setae longer, especially front basitarsus; tarsal spurs long, thin, slightly bent subapically with dense inner row of small teeth, spurs longer than half length of basitarsus; minute tufts of amber hair beneath lateral clypeal margin; labrum with apical bowed row of erect setae. Punctation of head coarse, contiguous, denser on clypeal margin, mandibles, above base of antennae, between lateral ocelli; smooth micropunctate below median ocellus, outer side of lateral ocellus; pits on thorax as on head but those on pleura shallow, pits on disc of scutum sparse; propodeum shallowly pitted, enclosure shagreen; pits on abdomen more obscure except scopal hair pits deep, round; abdominal terga, sterna I–V with apical impunctate shagreen band less than ⅕ width of segment. Scape cylindrical, ⅕ as wide as long, flagellomere I longer than II, III, IV, or V, ultimate flagellomere longest; clypeus produced below margin of compound eyes (Fig. 1), laterally clypeal margin sinuate, narrowing medially, clypeal margin medially subtruncate with slight median emargination; mandible 3-toothed (Fig. 1), apical tooth more slender, longer, farther apart than inner ones, inner margin of mandible between outer teeth deeply cleft, breadth of dentate margin 1.3 × basal width, lower mandibular carinae fading just more than half distance from dentate margin to base of mandible; interantennal distance shorter than antennocular distance; face as long as broad; ocellocular distance 1.6 × least interocular distance; distance between lateral ocelli equal to distance from one to edge of vertex; lateral ocelli above line drawn between apical ocular margins; head narrower than thorax (viewed from dorsum); face flat except for produced apical clypeal margin; narrow carina bordering inner ocular margin; declivity of tergite I without carina, with shallow longitudinal micropunctate depression; apical margin of tergite VI rimmed medially; legs stout, basitarsus longer than all other tarsomeres combined, hind basitarsus flattened (Fig. 2), dilated medially, 2.3 × as long as wide; length of body 10 mm, wings 7 mm. Two females are in the collection of the Bee Biology and Systematics Laboratory.

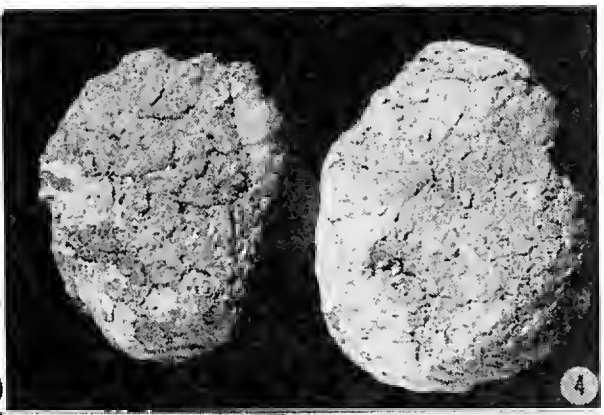
Nesting Site.—A barren ridge with scattered pieces of broken flat stones scattered among stunted sage near the summit of Wellsville Mt, 8,000 ft., Cache Co., Utah. Although many stones were turned over, only 2 nests were found—both beneath the same slab of rectangular slate; the underside of the stone was concave, and the nests were adjacent near the middle of the cavity.

Nest Construction.—Nests were made entirely from mud. The surface of the rock was the ceiling of the cells; the walls were built by making and extending rings of elongate fused pellets of mud, but individual loads of mud were distinguishable (Fig. 3). After one cell was completed, additional cells were attached to the first by using portions of its walls to form walls of adjacent cells (Fig. 3a, b). Thus, in one nest the oval cell walls of the first cell served as portions of the walls of three adjacent cells (Fig. 3a). In the other nest, all the cells were attached to the central cell (Fig. 3b). Additional rings of mud were added









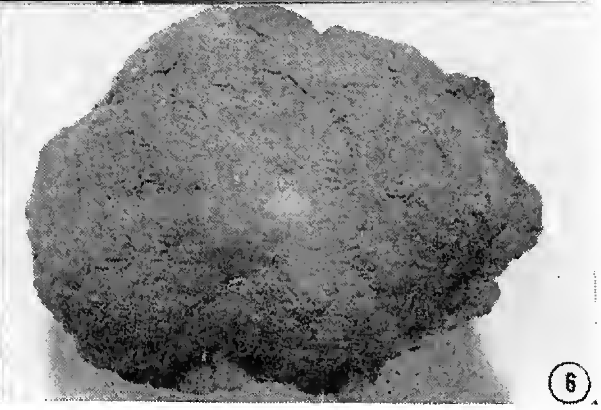


Fig. 1. Front view of female *Osmia tanneri.*

Fig. 2. Part of hind leg of female *O. tanneri.*

Fig. 3. Two mason nests of *O. tanneri.* Note size and color differences in mud pellets.

Fig. 4. Bottom view of 2 mason nests of *O. tanneri.* Note the patched appearance of the surface.

Fig. 5. Mason nest of *O. longula* with young larvae feeding on pollen provisions.

Fig. 6. Opposite view of nest in Fig. 5 illustrating contour and texture of surface.

around the cells, and the nest was covered with flat mud pellets that resulted in a surface covered with small patches (Fig. 4). In profile, the finished nests were flat beneath with round sides. The nests measured 24 × 35 mm and 29 × 38 mm. Maximum thickness was 10 mm.

The length of cells averaged 12 mm, width 6 mm, and depth 6 mm. The cell walls were smooth, but not polished; the inner surface of the cell cap was irregular.

Larval Habits.—In most cells the cocoon filled the entire cell. Cocoons were spun by attaching a loosely woven network of white silk to the walls. A thin sheet of silk was applied inside the network that enclosed the larva. Inside this layer thin longitudinal strips of fecal material were deposited on the inner walls from near the top to the bottom. Then, another layer of silk was added over the fecal material making the cocoon inside smooth and shiny. The apical nipple was small, flat, circular, white and spun beneath the first layer of silk. The nipple inside the cocoon was dark amber with loose strands of silk evident. Many fecal pellets covered the anterior end of the cocoon; they ranged in color from dark amber to light yellow. Their uniform shape was bowed medially, the top of the bow was flat with an impressed longitudinal line; the pellet ends were blunt with fine points. The pellets averaged 1 mm in length.

Nest Provisions.—Traces of pollen attached to the cocoons and exines in feces were an unknown species of Umbelliferae. All the cells contained cocoons when the nests were located so size and shape of the provision are unknown.

Overwintering.—The nests contained adults when found on May 27, 1972. It is likely that this species overwintered as an adult. Three of the cocoons contained dead larvae, but these were black and dried which indicated that they had died the previous summer.

Sex Ratio.—Two females and one male emerged.

Parasites.—Five of the six cells in one nest contained adults of the chrysid wasp, *Chrysura pacifica* (Say).

OSMIA (*ACANTHOSMOIDES*) *LONGULA* CRESSON

(Figs. 5, 6)

Nesting Site.—A sparsely timbered slope facing west with abundant broken rock scattered among many species of annual and perennial plants. The site was located above Beaver Creek, Cache Co., Utah, at an elevation of 8,000 ft. One completed nest was attached to the side of a stone beneath a slight overhang.

Nest Construction.—The nest was initiated in a small indentation on the east side of a rock. The first cell was started by making an oval ring around the indentation from 1 mm thick mud pellets, then arching the walls inward forming the cell. The inside diameter of the cell was 16 mm long, 9 mm wide, and 7 mm deep; its inner walls were smooth but not polished. The cell was capped by mud pellets. Next, a layer of masticated leaf material was applied over the cell walls; this material was tightly appressed to the mud walls and covered the outer surface of the cell. This layer of plant material is visible in Fig. 5. Three additional cells were attached to the side and above the first. Thus, portions of the first cell became the base for additional cells (Fig. 5). Additional cells were also coated with plant material. The outer surface of the nest was plastered with mud, but some plant parts were also incorporated. The outline of the underlying compartments was evident (Fig. 6) after the nest was plastered and in profile the nest outline was crenulate. The dimensions of the nest were 34 × 24 mm.

Larval Habits.—The cocoon was formed as in *O. tanneri* with the same pattern and number of layers of silk. In cocoons of *O. longula*, the initial layer of silk adhered more closely to the cell walls and was thicker. The striped fecal material between the layers of silk was darker as was the inner shiny, polished cocoon. The nipple was larger, flat, white, and covered by a layer of attached darker silk. The entire cocoon was larger (14 mm) and barrel shaped.

Sex Ratio.—All the cell contents died except for one male.

Nest Provisions.—Pollen remaining in the cells was identified as belonging to the plant family Leguminosae.

Overwintering.—When the nest was collected on June 1, 1972, it contained 4 early instar feeding larvae, Fig. 5. During that summer one larva molted to an adult and entered diapause.

ACKNOWLEDGMENTS

I am thankful to Dr. A. S. Menke, Systematic Entomology, ARS, USDA, Washington, D. C., for comparing specimens with the holotype of *O. tanneri.* Thanks are due to Mr. M. M. Montgomery who turned over many a stone in a vain attempt to locate more nests of *O. tanneri.*

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Observations on the Life Cycle and Flight Dispersal of a Water Beetle, *Tropisternus ellipticus* LeConte, in Western Oregon

(Coleoptera: Hydrophilidae)

LEE C. RYKER
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Species of the genus *Tropisternus* Solier are well known for their vagility (Spangler, 1960), but no detailed studies of flight dispersal have been made. In western Oregon, *Tropisternus ellipticus* LeConte can be collected from pond edges in the spring and fall, but disappears from ponds during summer. In 1972, I first collected this species from temporary rock pools along the Illinois River in southwestern Oregon. Since then I have found them in similar habitats along the Umpqua, South Santiam, and Willamette Rivers. This report describes the flight movements of *T. ellipticus* within and between habitats and relates dispersal movements to changes in reproductive state.

Beetles of the genus *Tropisternus* occur throughout the Western Hemisphere, generally in quiet water habitats. *T. ellipticus* is a dark green, broadly ovate, vertically elliptical beetle 8–11 mm long with a metasternal keel extended posteriad into a sharp point below the abdomen. As with other members of the genus, this species stridulates when seized (Ryker, 1972). Females fasten silken egg cases onto objects below the water surface, and the larvae are predaceous on small aquatic insects. Pupation occurs in moist soil. Adults graze and scavenge under water, consuming algae, detritus, and animal remains (Young, 1958).

Flight dispersal of Hydrophilidae has been simply summarized as spring dispersal flights, with the development of the next generation being completed in the summer, and a fall dispersal flight of newly emerged adults (Leech, 1956; Miller, 1963). Landin (1968) and Landin and Stark (1973) reported daily summer flights of *Helophorus brevipalpus*, a small hydrophilid in Sweden, and suggested that this species has both migratory and non-migratory flights.

Johnson (1970) hypothesized that insect migratory flight generally occurs in reproductively immature adult insects. He defined "migrations" as insect flights characterized by an exodus from one habitat, by undistracted or persistent flight, and by the location of a new acceptable habitat. Shorter flights resulting from the stimuli of changing micro-environmental conditions are "trivial" flights (Southwood, 1962).

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Following Chapman (1969), a period of adult reproductive delay or quiescence is referred to here as reproductive diapause.

FIELD STUDY LOCATIONS AND METHODS

Dispersal movements were followed by marking and releasing adult beetles inhabiting a series of rock pools at Waterloo Falls, South Santiam River, Linn County, Oregon and by year-round collecting from ponds in the Willamette Valley. Rock pools form in late spring (May, 1973 and June, 1974) as the summer dry period begins and the river recedes. They are covered again by the rising river when the winter rains begin in October. Pools that form in low spots during the winter rainy season and dry up in the spring will be referred to as winter pools.

The Waterloo rock pools were mapped and the number and location of each beetle captured was recorded. Using a No. 2 insect pin and a stereomicroscope, a number was scratched into the right elytron. Beetles marked and held in the laboratory showed no increase in mortality. The marks were permanent and did not become obscured, even after several months. Marked beetles were released within a few feet of their capture location. Beetles were collected either by netting swimming individuals or by removing floating *Spirogyra* mats and feeling for the beetles. All pools were sampled on each visit.

Beetle age was estimated as they were marked. In newly emerged, teneral beetles, a scratch would puncture the elytron and draw blood. Punctured beetles survived, however, and many were recaptured. Beetles about one week old could withstand a light scratch; beetles two and three weeks old were hard enough for careful marking; and beetles four weeks and older were quite hard and durable. Older beetles have a darker cuticle, scars, worn claws, and often have missing appendages and *Ceratomyces* fungi (Laboulbeniaceae) (Spangler, 1960) on the abdomen or between the claws.

To observe the movement of adult *T. ellipticus* to ponds in the fall, a small pond located at Peavy Arboretum near Corvallis, Oregon (20 miles west of the Waterloo site), was sampled regularly from September to December, 1973. Beetles were collected with an aquatic net from the pond perimeter for one hour per sampling day. Peavy pond was also sampled intermittently during winter and spring (1973–74) and summer (1972).

RESULTS

Observations on the movements and reproductive state of *T. ellipticus* will be presented seasonally, starting with winter. No beetles were found when Peavy pond was sampled in December, 1973. When next sampled, on March 20, 1974, four specimens were collected. On March 21, 34 specimens were collected from the edge of the pond. This was following a period of five sunny days. Beetles were also collected from this and other permanent ponds in succeeding days in March and April. By May, 1974, adults were appearing in temporary pools at the Waterloo site and were becoming scarce in Peavy and other local, permanent ponds.

Overwintered adults were found breeding in the spring before the river had fallen enough for rock pools to form. On May 10, 1973, egg cases, third instars, and some very dark, scarred and parasitized adults were collected in two temporary winter pools just above the Waterloo rock pool area. Overwintered adults did not appear in rock pools in 1973 and were not found in ponds after the end of May, which suggests that they died after spring breeding. In 1974, overwintering adults were seen flying between April 29 and June 16 and collected at Waterloo from temporary winter pools and several high rock pools that formed in April and were dry by June. A female, marked in a rock pool August 12, 1973 and about 10 months old, was collected in a winter pool at Waterloo on May 8. Egg cases were present at this time, and four overwintered females dissected had developing eggs in their ovaries.

Beetles that immigrated into newly formed river rock pools at Waterloo in May, 1973 (Fig. 1) were of the spring generation (bright green, not fully hardened, undamaged, not parasitized) and not of the overwintered generation. In 1974, spring rains delayed the formation of the Waterloo rock pools until June. New generation beetles that appeared then were already hardened, and four of five females dissected June 10 had small, partially developed eggs, and the abdomen full of fat body. The fifth female had about one-fourth of her eggs fully developed, and much less fat body. About half of the beetles collected on June 10 ($n = 48$) were new generation adults, and by June 29 adults of the overwintering generation were no longer found.

Teneral adults (< 2 weeks old) appearing in the Waterloo rock pools in 1973 were counted, and the number captured per sampling day is shown in Fig. 1. A large influx of teneral beetles occurred in mid-May, but the percentage (of beetles collected per sampling day) that was teneral dropped to zero on May 28 ($n = 37$). Subsequently, teneral adults appeared in samples throughout the summer.

Four teneral beetles collected from rock pools were dissected August 1–4, 1974, to see if they were reproductively mature. They were found to have undeveloped ovaries and no noticeable fat body. Six hardened

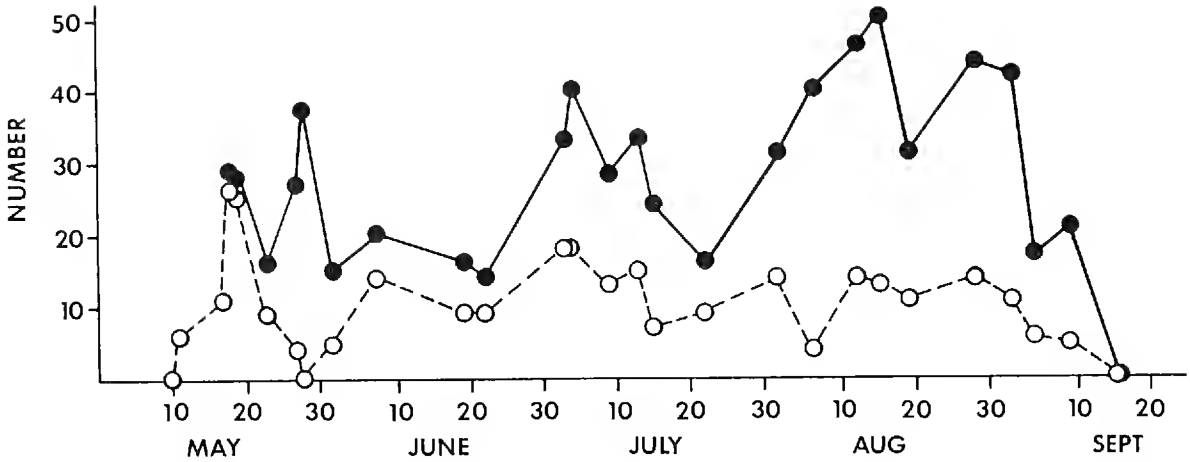

Fig. 1. Number of teneral adults (dashes) and total number of *Tropisternus ellipticus* adults captured at Waterloo, Oregon in rock pools during summer, 1973.

adult females collected from rock pools at the same time were dissected and found to contain eggs. The eggs were fully developed, filling the abdominal cavity, and very little fat body was present.

Twenty-two beetles were observed flying and entering pools in 1974. These flights were observed on warm, cloudless days between 11 AM and 3 PM. Of these flights, two overwintered adults were taken entering a sandy pool on April 29. Ten beetles on June 10, one on June 12, and nine on June 29 were taken entering rock pools. The beetles flew slowly into the breeze at one to two meters height and often circled back after crossing a pool, sometimes hovered briefly, and then closed their elytra and fell. Beetles observed flying at midday across small pools fell at the north edge of the pool, sometimes hitting on the rock edge and scrambling for the water.

Both sexes moved in and out of the Waterloo rock pools throughout the summer. Of 487 beetles marked and released, 140 (29%) were recaptured. Recaptured individuals were captured an average of 2.5 times. Thus the beetles tended to fall into two classes—those that were captured only once (71%) and those that settled into the pools and moved short distances only. Some of these were captured five or six times over a period of several months. Of the beetles recaptured, 26% had changed pools. However, of 28 beetles recaptured within two days, 27 (96%) were still in the same pool, but often at a different location within the pool. Beetles were often captured in the same pool several times over a period of several weeks if the pool did not dry up or become flooded with cold river water.

Pools containing beetles between July 9 and August 1, 1973 had a temperature range of 23° to 33° C ($\bar{x} = 28.7 \pm 0.24°$ C; n = 114 beetles). Unselected pools had temperatures ranging from 14° to 35° C.

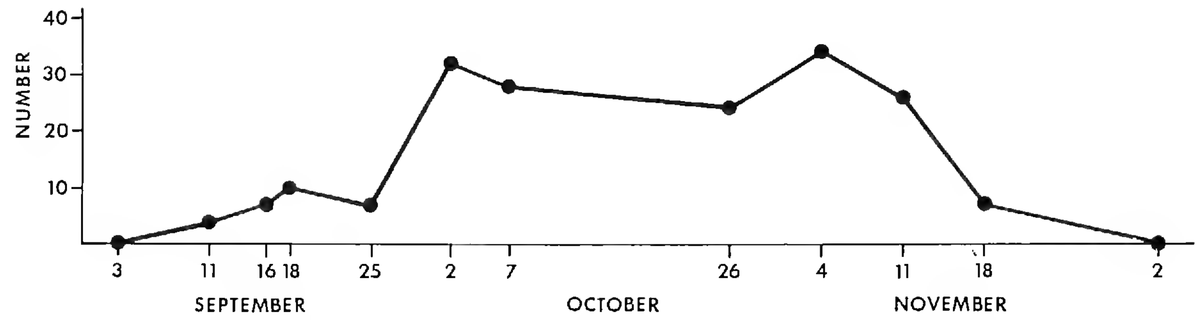

FIG. 2. Destructive sampling for *Tropisternus ellipticus* from a small pond at Peavy Arboretum, Corvallis, Oregon, 1973. Each sampling period was one hour.

One pool, which never yielded specimens, consistently had cool temperatures (14°–20° C). In June and July, 1973, beetles left pools that were drying up and therefore very warm (> 33° C), or pools with water temperatures below 21° C for several days. However, after August 5, the river level rose and all pool temperatures fell below 22° C. Beetles were found in this colder water until mid-September.

Adult females collected in early summer and held in the laboratory usually laid eggs within three days, but females collected at Waterloo August 15, 1973 and held with males in an observation pool for three weeks did not produce eggs. Egg cases had been observed at Waterloo throughout the summer, but by August 28 no cases containing eggs could be found. However, third instars (> 2 weeks old) were still present in some pools, and the adult population was present (Fig. 1).

In early October, 1972 and in mid-September, 1973, the number of adult *T. ellipticus* collected at the Waterloo site fell to zero (Fig. 1), suggesting that the adults had begun migrating. Concurrent with this decrease, adults began to appear in samples at Peavy pond (Fig. 2), presumably migrating from rock pools nearby. I have found *T. ellipticus* in rock pools but not in permanent ponds from June through August in nine years of collecting *Tropisternus* in western Oregon. Other species are present in ponds during the summer, however. Data from museum specimens at Oregon State University also indicates that *T. ellipticus* is found in ponds from September through November and from February through May, but no specimen labels (except mine) have summer collection dates.

Six females collected from ponds and dissected in October had undeveloped ovaries, and the abdomen was full of fat body. Beetles collected from ponds in the fall were paired in pint jars under conditions found to be favorable for laboratory rearing in the summer, and observed for indications of reproductive diapause. With one exception, 30 male-female pairs held under several sets of light and temperature conditions for a minimum of 25 days did not breed. One female produced a single egg case, and she had been paired with a male under long days and temperatures fluctuating between 20° C at night and 27° C during the daytime. This pair, however, produced no more eggs in the concluding 30 days of the trial.

To see if diapausing adults lose their ability to fly after reaching the ponds in the fall, males and females collected in September and held at 16° C for five months were tested for flight ability. All ten males and eight of ten females flew up out of a Petri dish in response to a 250 W lamp. These beetles were paired subsequently under favorable rearing conditions to be certain that they were diapausing, and none of the pairs produced eggs.

Tropisternus adults are difficult to find in winter. Fig. 2 shows that *T. ellipticus* disapeared from the edge habitat in Peavy pond in late November, 1973. Spangler (1960) suggested that they may overwinter buried in the bottom mud or in pond edge soil. Accordingly, a habitat choice test was set up to see if these beetles will bury themselves in moist sand or in bottom mud. Seventeen beetles collected in September from Peavy pond were held at 16° C (8L/16D) in an aquarium that had sand extending from the bottom to 15 cm above the water level at one end, flat rocks on bottom mud, and floating aquatic vegetation. After 30 days, two beetles were still in the aquatic vegetation, six were buried in sand above the water level, and nine were buried beneath the flat rocks on the mud bottom. I have collected occasional specimens from pond bottoms in winter, and a few from beneath flat rocks at pond edges, but have not excavated pond edges to see if they burrow into the soil there.

Discussion

Adults of *T. ellipticus* disappeared from the edge habitat of permanent ponds in western Oregon in late November, 1973, and reappeared in March, 1974. Overwintered beetles were dispersing into temporary winter pools in early spring before the rock pool complexes along the S. Santiam River were uncovered. The appearance of overwintered adults, eggs, and larvae in winter pools and recently-formed pools at Waterloo by late April and early May in both years indicates that they had resumed breeding.

Teneral progeny of the overwintered beetles appeared in May, 1973, and hardened progeny in June, 1974, migrating into the newly-formed rock pools. Although no specimens were dissected in May, teneral adult females dissected in early August, 1974, had undeveloped ovaries.

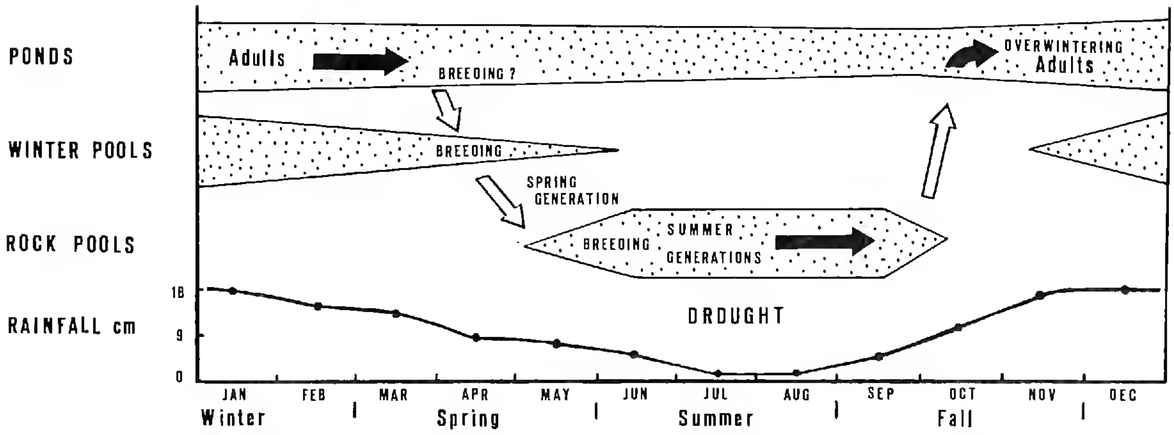

FIG. 3. Aquatic habitats used by *Tropisternus ellipticus* in western Oregon and normal precipitation for Waterloo, Oregon (Climatological Data, Oregon Annual Summary, 1973, U.S. Dept. Commerce).

Ovaries were beginning to develop in the June, 1974 individuals, but the eggs only partially filled the abdomen. Hardened females dissected in mid-summer had abdomens filled and distended with eggs. It seems probable, then, that the spring migration into rock pools primarily consists of reproductively immature adults.

Overwintered individuals were no longer found after mid-May in 1973 and late June in 1974. The new generation bred in the rock pools until mid-August, 1973, producing teneral individuals continuously until September. Continuous breeding, immigration, and inter-pool movements obscured the distinction between one or more summer generations. The laboratory rearing time for this species is about 45 days (unpublished data). This, theoretically, gave *T. ellipticus* time to produce a second generation by July in 1973, and by August in 1974, with both generations reproducing until mid-August. Third generation adults did not have time to breed during their first summer because they could not have eclosed before late August or September, after breeding had ceased.

All adults left the rock pools in the fall, but it is not known whether only the second and third, or both the summer generations and the spring generation migrate and survive the winter to resume breeding the following spring. The only marked beetle recaptured after overwintering probably had eclosed in late July as a second generation beetle.

Adults ceased breeding in the rock pools in mid-August, 1973, although they did not emigrate for another month. The female abdominal cavity, filled with eggs in the summer, was packed with fat body in the fall. Because efforts to induce adults to breed in the fall and early winter failed, in contrast to successful maintenance of breeding pairs in the summer, I feel that they are in a state of reproductive diapause.

Coincidence of the phenomena of emigration from rock pools and the appearance of *T. ellipticus* in ponds is good circumstantial evidence that this species migrates from rock pools to ponds in the fall in western Oregon. The beetles disappear from pond edges in early winter. The laboratory habitat choice test indicated that the beetles are capable of burying themselves in the bottom mud or in soil, and may do so in the pond habitat, as was suggested by Richmond (1920) and Spangler (1960). Occasional collection of specimens from pond bottom mud also supports this idea.

Besides spring and fall migratory flights and the dispersal movements of overwintered adults in April and May, intermittent trivial flights of individuals occurred in the river rock pool habitat during the summer. These movements apparently were responses to ponds either drying up and becoming too warm, or being flooded by cold river water. The most frequented pools were close to 29° C in midafternoon, about 10° C warmer than the river.

Observations of flights of *T. ellipticus* are similar to those mentioned by Zimmerman (1959) for *Tropisternus lateralis nimbatus* and those of *Helophorus* (Landin, 1968; Landin and Stark, 1973; Fernando, 1958) in that they occur during the daytime. However, these observations differ in that *T. ellipticus* was observed flying upwind, whereas the smaller *Helophorus* may be wind-borne. *T. ellipticus* often fell to the north edge of small pools at midday, and may have been responding to the image of the sun reflected from the still water surface.

T. ellipticus has three of the types of flight dispersal mentioned by Johnson (1970): 1) migration of teneral adults from one habitat to another; 2) trivial dispersal flights by individuals from one place to another within a habitat in response to fluctuations of microenvironment; and 3) migration of diapausing adults from one habitat to another. Previous generalizations about Hydrophilidae (Leech and Chandler, 1956; Miller, 1963) suggest that spring dispersal flights are of overwintered individuals and that fall flights are of "newly emerged" individuals. However, although the overwintered generation of *T. ellipticus* disperses in early spring and can be found breeding in winter pools, the late spring migration is of new generation, often teneral adults, and the fall migration is of non-teneral, diapausing adults.

Pajunen and Jansson (1969) showed that rock pool Corixidae in Finland have physiological and behavioral adaptations, similar to *T. ellipticus*, which allow them to breed in summer in temporary pools and to overwinter as diapausing adults in deeper pools. Ova of overwintering

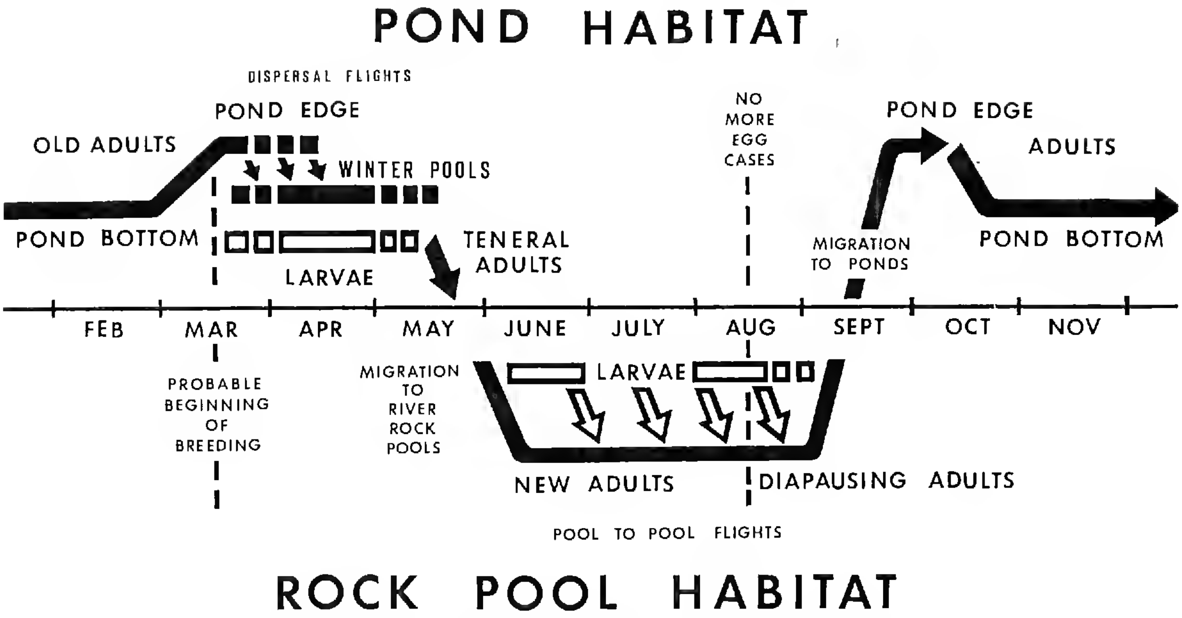

FIG. 4. Life cycle, flight dispersal, and habitat selection of *Tropisternus ellipticus* in western Oregon.

adults do not mature until after spring migration. These corixids fly to shallower rock pools for spring breeding, as does *T. ellipticus* for summer breeding, and they have a similar pattern of summer dispersal flights of breeding adults between temporary pools. Migratory flights of both Corixidae and Hydrophilidae into and out of temporary rock pools are of teneral, immature, or partly mature adults (late spring), or of reproductively diapausing adults (fall). These observations agree with Johnson's concept that migratory flight characteristically occurs in reproductively immature adult insects.

Because old generation adults were seen flying on sunny days in early May and entering temporary winter pools and rock pools, an alternative description of habitat selection behavior by *T. ellipticus* is also plausible. These species may select pond habitats after entering reproductive diapause in fall, and select rock pools or the best substitute (winter pools) when reproductive maturity ensues. In this view, overwintered adults reassuming breeding condition in the spring tend to seek the rock pool habitat, except that rock pools are not available. When river levels drop, rock pools form, this event generally coinciding with eclosion of the new generation and demise of the old.

Wiggins, Mackay and Smith (1974) presented a concept of community organization for animals inhabiting annual temporary pools, making a distinction between vernal and autumnal pools. River rock pools are neither vernal nor autumnal pools because they appear during the summer drought. Winter pools in western Oregon are pools that are "temporary" from October to May during the winter rains, and are functionally similar to vernal pools in the spring (Fig. 3). In the scheme of Wiggins et al., *T. ellipticus* is a Group II animal, a pool stage arrival adapted to temporary pools by evolution of dispersal behavior.

The main features of the life cycle of *T. ellipticus* in western Oregon are summarized in Figs. 3 and 4. Adults overwinter apparently in the soil or under bottom rocks of ponds. In early spring they move to the pond edge habitat, subsequently dispersing on warm days to other ponds and winter pools, where they breed in April and May. Their offspring, the spring generation, migrate (sensu Johnson) into the newly formed river rock pools and begin breeding. Offspring of spring generation adults, the second, or summer, generation, may have time to mature and breed in dry years like 1973, in which case their offspring would eclose in time to migrate to ponds before the rivers flood the rock pools. Adult female beetles stop producing eggs (reproductive diapause) in mid-August, and their abdomens fill with fat body. About a month later the surviving adults of spring and summer generations migrate from rock pools to the edge habitat of permanent ponds, and then move to the pond bottom or edge soil for the winter.

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Notes on the Behavior of Three Argentine Sphecids (*Microbembex uruguayensis, Tachytes fraternus* and *T. amazonus*)

(Hymenoptera: Sphecidae)

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I report here new information on the behavior of three species of digger wasps based on observations made in two Argentine localities during December and January 1974–1975. Studies of *Microbembex uruguayensis* (Holmberg) took place on 30–31 December in an area of sand dunes situated in pasture, marshes, and woodlands 2 km south of Estación Paranacita, Prov. Entre Rios. Nests were found in a sandy roadside scrape by the edge of a reed-filled swamp. *Tachytes fraternus* Taschenberg and *T. amazonus* F. Smith nested on the edge of a dirt road 4 km east of Benavidez, Prov. Bs. Aires. The road bordered a drainage canal and ran through an area of pasture and marshy woodlands.

MICROBEMBEX URUGUAYENSIS

This species has been studied previously in Argentina by Llano (1959). In work that extended over several summers Llano found cells provisioned solely with one species of carabid beetle. He implied that the wasp captures living carabids in the morning when these beetles are prone to move about. Of the numerous species of *Microbembex* that have been studied subsequently, all have proved to be scavengers, taking dead and disabled arthropods (Matthews and Evans, 1974).

I excavated four nests (12–23 cm long; 8–13 cm deep) finding two that contained an egg laid upright in the single cell along with a number of ants (five in one case, seven in the other). Many of the ants were in poor condition, missing most or all of their legs, indicating that they had been picked up when already dead. In addition, I observed a perched female as she manipulated a dead wasp before dropping it and flying off. Moreover, twice I watched females as they foraged over open sandy areas; each collected an immobile object from the sand, presumably a dead insect of some sort, which they then manipulated in flight while hovering 2–4 cm above the ground. The wasp curved its abdomen strongly and touched the prey, as though stinging it. It is conceivable that this action misled Llano into believing that the wasp

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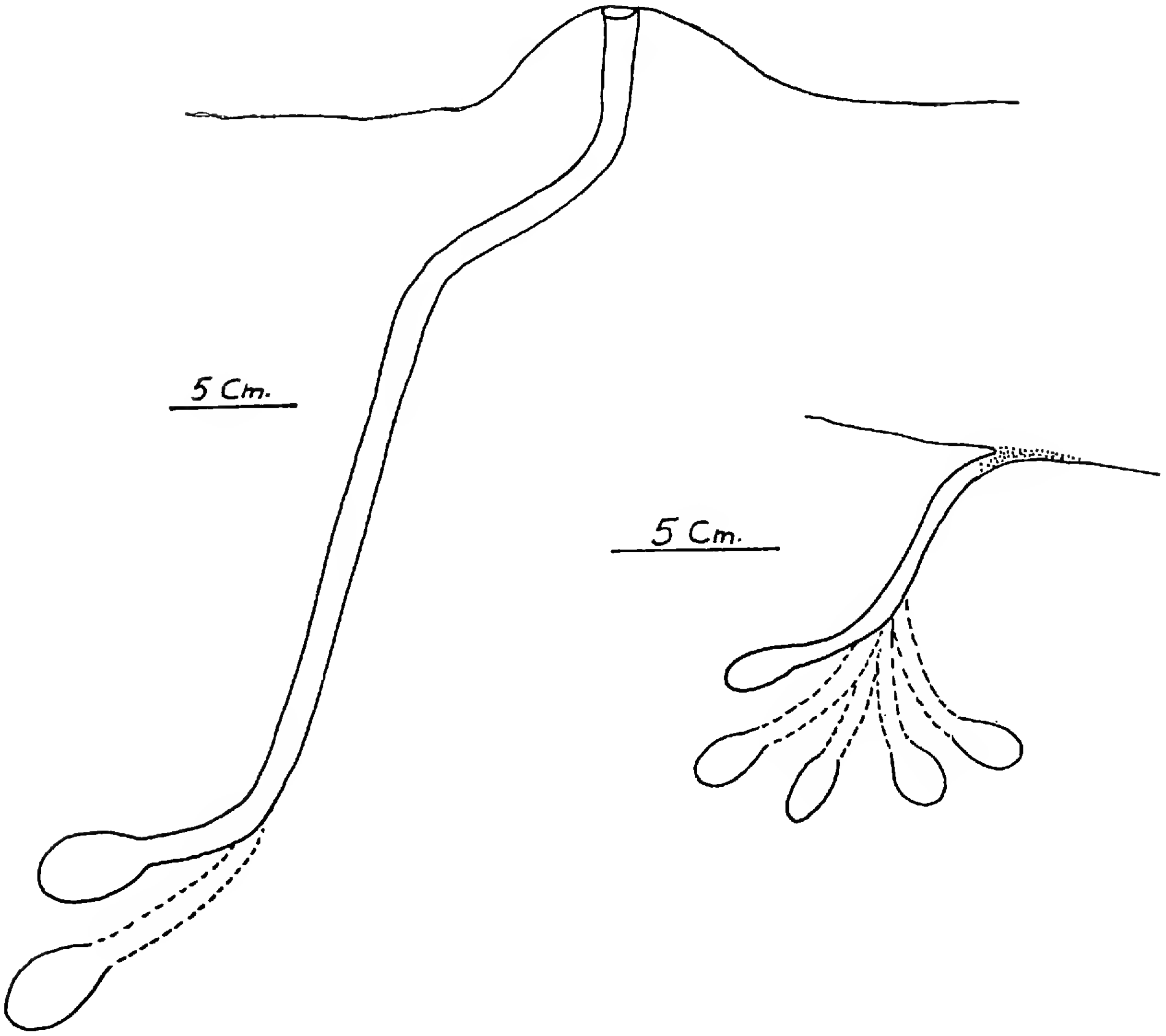

FIG. 1. Lateral views of the burrows of *T. fraternus* (left) and *T. amazonus* (right). Both were dug into moist firm sandy clay. The dotted lines indicate hypothetical side burrows leading to discovered cells.

was paralyzing living prey. I have, however, seen known scavengers, *M. nigrifrons* and *M. argyropleura*, do exactly the same thing and believe this "stinging movement" to be a vestigial behavior pattern. The evidence suggests that some individuals in the population of *M. uruguayensis* I studied do scavenge.

If Llano were mistaken about the capture of living prey, the only moderately distinctive behavioral trait of *M. uruguayensis* would be the rapid provisioning of the cell immediately following egg-laying. Although occasionally a female of other species of *Microbembex* will bring one or a few prey to the brood chamber prior to egg-hatching (Evans, 1966), none bring large numbers of food items to the cell before this event. On the whole, however, it would appear that *M. uruguayensis* is a typical member of a genus that is characterized by extreme behavioral uniformity.

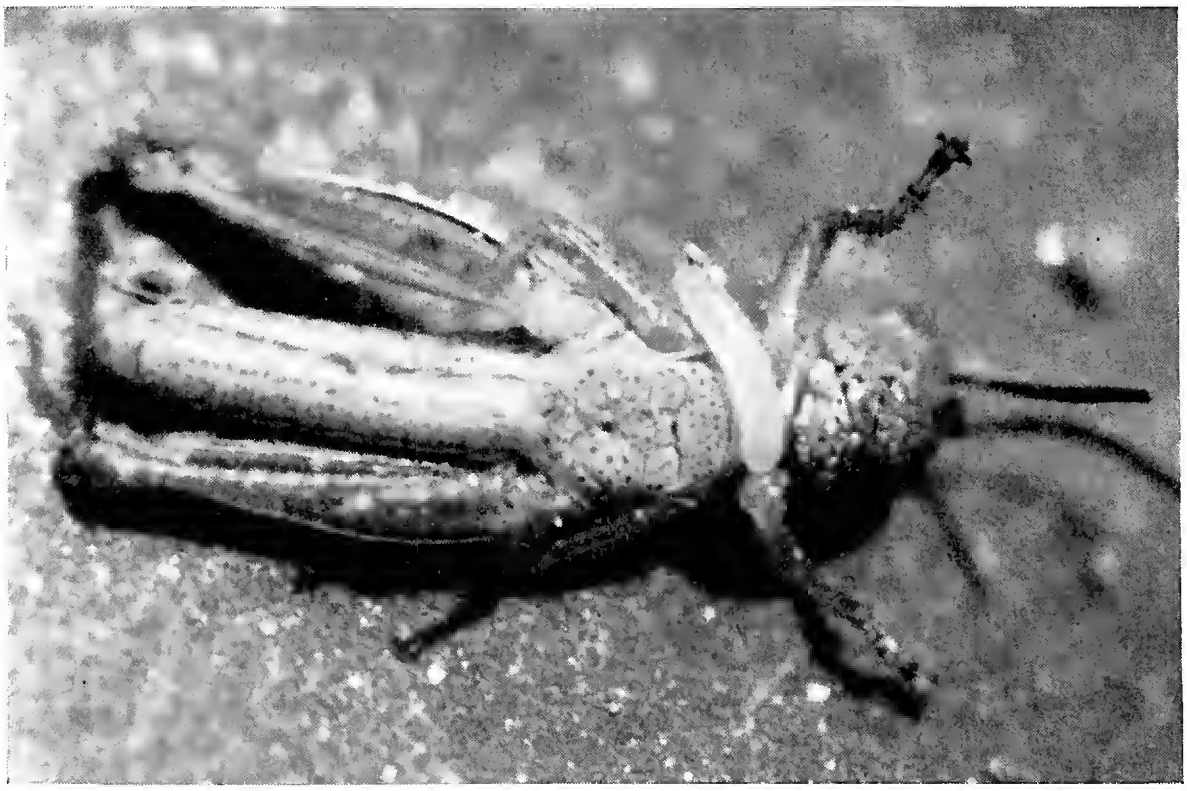

FIG. 2. The egg of *T. fraternus* is attached to the base of a foreleg and extends transversely across the thorax.

TACHYTES FRATERNUS

A single nest of this species was discovered on 2 January 1975 when a prey-laden female was spotted as she dashed along the ground and into a small clump of weeds. The open nest entrance was hidden by the surrounding weeds and was located in the center of a large, 6 cm high, mound of soil. The design of the long and deep burrow is shown in fig. 1. There were two cells, one with five immature acridids and the other with three. All the hoppers (ranging from 16–21 mm in length) were positioned head first into the cells. In the chamber with five prey, the last individual placed in the cell (venter-up, on top of the others) carried an egg (fig. 2). Egg placement is very different in some other species of *Tachytes* that prey on tettigoniids (Evans and Kurczewski, 1966).

TACHYTES AMAZONUS

Nesting in the same area but in much greater numbers, the behavior of this small species differs in many respects from *T. fraternus*. Its burrows (fig. 1) were short and shallow (11.5–18 cm long; 5–9 cm deep; $N = 4$). They were placed in open areas and the entrance was kept closed at all times except when the wasp had just entered the nest with prey. *T. amazonus* performed a strikingly elaborate closure in

FIG. 3. A male *T. amazonus* resting on alert in his territory.

the early morning usually between 0800–0900. The female walked toward the nest entrance, kicking soil behind her as she moved along. Upon reaching the vicinity of the entrance, the wasp would fly out to a point as much as 15 cm from the burrow and would repeat the march toward the entrance. This activity commonly lasted as long as 20 min. As a result, much of the area from 5–15 cm about the entrance would be covered with loose soil kicked about in the wasp's maneuvers.

Provisioning females flew quickly to the closed nest entrance with their prey, acridid hoppers smaller than those taken by *T. fraternus* (0.9–1.5 cm in length; $N = 13$). Upon landing the wasp would walk a few cm forward straddling the prey and holding it by an antenna before dropping its victim by the concealed burrow. The female would then open the nest, and enter the burrow briefly before exiting to fly about the apron of raked soil. She would relocate her prey, straddle it, drag it right up to the nest opening, drop the hopper, reenter the nest, turn around, and finally pull the prey in by an antenna. The grasshoppers were placed head first into the cell with the egg laid on the *first* hopper introduced into the brood chamber. The position of the egg was the same as that of *T. fraternus*. In eight cells with complete complements of prey, seven held 3–4 acridids (for male offspring?) while one contained 8 (for a female offspring?).

This wasp, with its shallow nests, complex nest closure, and manner of carrying prey into the burrow, behaves rather more like a *Tachysphex* (e.g. Kurczewski, 1966) than a typical *Tachytes* (H. E. Evans, pers. communication). The differences between *T. amazonus* and *T. fraternus* may have ecological significance (as in the different sizes of preferred prey) and phylogenetic implications (the differences in nest design, especially the prominent mound of *T. fraternus*). Reviews of Evans and Kurczewski (1966) and by Lin (1967) have revealed important variation in prey taken and burrow structure in the very few species of North American *Tachytes* that have been studied. Much more comparative work is needed on the nesting behavior of Neotropical *Tachytes*.

Male *T. amazonus* were common in and along the nesting area. They often rested on the ground or on a pebble or stick with their front legs drawn up (fig. 3). The approach of another insect generally stimulated the male to fly up and pursue the intruder. In addition, males regularly cruised low over the ground following a consistent route. Male *T. distinctus* behave in similar way when guarding mating territories early in the nesting season of this species (Lin and Michener, 1972).

Two male *T. amazonus* were marked with a dot of paint on their thorax. One was recaptured two days after it had been marked; at the time it was within ½ m of the point where it had been taken previously. The other, marked on 19 December, was seen again in the same spot on 24 and 26 December and on 2 January (when it was collected). This male patrolled a strip of open roadside about 7 m long and ½ m wide for consecutive periods of up to at least 3 hrs. between 0900–1600. It often clashed with males on adjacent territories and would drive them away in a swirling pursuit flight.

The territorial behavior of this species closely resembles that of *Sphecius speciosus* (Lin, 1963) and *S. grandis* (Alcock, 1975a). (For a review of territorial behavior by male sphecids, see Alcock, 1975b.) By guarding elongate zones through or by nesting area, male *T. amazonus* may gain exclusive rights to virgin females that emerge in or near their territory and to receptive females that must pass through the male's territory in search of nectar or prey in the vegetation away from the barren nesting site.

ACKNOWLEDGMENTS

My father, John P. Alcock, introduced me to the nesting sites and generously assisted me in a variety of ways, for which I thank him. Dr. Manfredo Fritz identified the *Microbembex* and Dr. R. M. Bohart identified the *Tachytes*. Dr. Howard E. Evans read a draft of the manuscript and made a number of helpful suggestions for its improvement. This study was supported in part by NSF grant GB-42865.

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New Species of the Genus *Aneflomorpha* from Mexico
(Coleoptera: Cerambycidae)

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The tribe Elaphidionini is represented in Mexico by a large number of species, many as yet undescribed. More intensive and sophisticated collecting methods have accounted for the discovery of many of these and increased knowledge of the previously described species has greatly facilitated their recognition. Although extensive revisionary work is necessary to more fully understand the relationships among the large and diverse Mexican elaphidionines, the following species of *Aneflomorpha* are described at this time to make the names available for use in other studies, particularly those supported by the National Science Foundation (Grant GB-BM574) for a monograph of North American Cerambycidae.

The Canadian National Collection, Field Museum of Natural History, Chicago, University of Michigan, E. Giesbert, and H. F. Howden are gratefully acknowledged for the loan of material.

Aneflomorpha giesberti, new species

Male: Form elongate, sides subparallel; integument shining reddish black, appendages reddish; pubescence short, pale, directed back. Head with front rather coarsely, irregularly punctate except for median glabrous area, vertex coarsely, densely punctate, neck minutely punctate; interantennal line shallow, barely extending beyond antennal tubercles; palpi unequal, apical segments moderately dilated; eyes prominent, as broad across as width of pronotum; antennae extending about one segment beyond elytra, third segment with a short spine at apex, fourth segment minutely spined, remaining segments unarmed, segments from third opaque, densely clothed with minute appressed pubescence, basal segments with a few long hairs beneath, segments 3 to about 6 carinate above, third segment longer than first, fourth shorter than third, fifth slightly longer than fourth, eleventh vaguely appendiculate. Pronotum longer than broad, sides broadly rounded; disk moderately coarsely, irregularly punctate, middle narrowly glabrous, each side with two vague calluses; pubescence sparse, long, suberect; prosternum impressed, rugose before coxae, minutely pubescent, coxal cavities wide open behind; mesosternum minutely punctate, densely pubescent, metasternum scabrous at sides, subglabrous at middle, densely pubescent at sides. Elytra more than 3 times as long as broad; punctures dense, separated, becoming finer toward apex; pubescence rather sparse, short, suberect, with a few longer erect hairs interspersed near base and along suture; apices obliquely emarginate, outer angles prominently toothed, inner angles dentate. Legs slender; all tibiae strongly carinate. Abdomen shining, rather finely, sparsely punctate, pubescence sparse, depressed; last sternite notched at apex. Length, 13–15 mm.

Female: Form similar. Antennae about as long as body. Abdomen with last sternite subtruncate at apex. Length, 15 mm.

Holotype male (California Academy of Sciences) and three paratypes (2 male, 1 female) from 5 MILES N MAZATLAN, SINALOA, MEXICO, 1 August 1973, 28 July 1973 (E. Giesbert), 27 July 1964, at black and white lights (J. A. Chemsak, J. A. Powell).

This species is similar in appearance to *A. rufipes* Chemsak and Linsley from the same locality. However, it may be distinguished by the shining integument, the sparser pubescence and the coarser punctation of the elytra.

As is the case for several other described species of *Aneflomorpha*, the generic status of *giesberti* is not certain. In its overall aspect and in some external characteristics the species resembles members of the genus *Psyrassa* and provides another example in support of the merging of the tribes Elaphidionini and Sphaerionini.

We are pleased to dedicate this species to Edmund Giesbert for his avid interest in the Cerambycidae.

Aneflomorpha crinita, new species

Male: Form elongate, subparallel; integument reddish testaceous, elytra yellowish; pubescence dense, pale, appressed and recurved with numerous long erect hairs interspersed. Head with front finely, densely punctate except for impressed glabrous median triangle, vertex finely, densely punctate, impressed at upper eye lobes; pubescences dense, short, appressed; palpi unequal, apical segments broadly dilated; eyes about as broad across as width of pronotum; antennae longer than body, outer segments subopaque, third segment moderately spined, fourth with a short spine, segments five and six with minute spines, segments three to six carinate, segments moderately densely clothed with minute pubescence, segments to about ninth densely fringed beneath with long erect hairs, third segment longer than first, fourth or fifth, fifth slightly longer than fourth, eleventh vaguely appendiculate. Pronotum longer than broad, sides broadly rounded; disk densely, irregularly punctate except for a median linear glabrous callus behind middle; pubescence dense, appressed, obscuring surface, with numerous long erect hairs interspersed; prosternum impressed, densely, finely punctate, densely pubescent, coxal cavities open behind; meso- and metasternum minutely, densely punctate, densely clothed with short appressed pubescence. Elytra more than 3½ times as long as broad; punctures rather fine, very dense; each elytron vaguely bicarinate; pubescence dense, short, depressed, with numerous long, erect hairs interspersed; apices truncate to shallowly emarginate-truncate. Legs slender, densely clothed with long flying hairs. Abdomen very finely, densely punctate, densely clothed with short recumbent pubescence and long suberect hairs; last sternite emarginate at apex. Length, 11–16 mm.

Holotype male (California Academy of Sciences) from 60 MILES E ZAMORA, MICHOACAN, MEXICO, 24 June 1957, at light (J. A. Chemsak, B. J. Rannells).

Paratypes include, 1 male, same data as type; 2 males, 25 km E Morelia, Michoacan, 14 June 1955, at light (R. B. & J. M. Selander); 1 male, Real de Arriba, Mexico, 2 June 1954 (R. Selander).

The yellowish elytra, the dense, appressed pubescence of the pronotum and the dilated apical segments of the palpi make this species distinctive among the known Mexican *Aneflomorpha.*

Aneflomorpha preclara, new species

Female: Form elongate, subparallel, moderately robust; integument shining, orange testaceous, elytra yellowish, antennae from apex of scape, tarsi, tibiae and apices of femora black; pubescence moderately dense, very short, recurved. Head finely, densely, punctate; median frontal triangle deeply impressed: vertex minutely, irregularly punctate; pubescence fine, appressed; median line deep, extending onto vertex; palpi unequal, apical segments moderately dilated; antennae shorter than elytra, segments from third carinate, finely, densly punctate along outside one half, pubescence sparse, short and depressed on outside segments, basal segments moderately fringed beneath with long erect hairs, spine of third segment short, segments four and five with shorter spines, segment six dentate; scape cylindrical, shorter than third segment, fourth and fifth subequal, shorter than third. Pronotum broader than long, sides subparallel, base constricted; disk shallowly, irregularly punctate except for median glabrous area behind middle; each side with two vague calluses; pubescence minute, dense at sides, absent at middle, long erect hairs numerous; prosternum impressed, minutely punctate and pubescent before coxae, coxal cavities open behind; meso- and metasternum minutely densely punctate and pubescent, metasternum glabrous medially. Elytra more than three times as long as broad, each elytron medially costate; punctures fine, dense, contiguous, subconfluent at middle; pubescence very short, recurved, longer erect hairs sparse; apices truncate, inner angles dentate. Legs slender, finely punctate; all tibiae bicarinate. Abdomen minutely, densely punctate and pubescent, sternites glabrous medially toward apices; last sternite broadly truncate at apex. Length, 17 mm.

Holotype female (Canadian National Collection) from 10 MILES SE TEOPISCA, RT. 24, CHIAPAS, MEXICO, 2–4 June, 1969 (H. Howden).

This attractive species is distinct by the black appendages, the fine, dense punctation, and the very short, recurved and appressed pubescence.

Aneflomorpha ruficollis, new species

Male: Form slender, elongate, subparallel; integument shining, testaceous, head and pronotum reddish, antennae basally and apical halves of femora brownish testaceous; pubescence moderate, mostly short, depressed. Head finely, confluently punctate, median triangle deeply impressed; vertex confluently punctate; median line shallow; pubescence sparse, very short; palpi unequal, apical segments slender; antennae extending about two segments beyond elytra, basal segments shining, sparsely pubescent, rather densely fringed beneath with long erect hairs, segments from fifth moderately densely clothed, with short erect pubescence, segments three to about seven carinate, spine of third segment short, segments four and five with decreasingly smaller spines, sixth segment spiculate, third segment much longer than first, fourth shorter than third, fifth slightly shorter than third. Pronotum longer than broad, sides rounded; disk coarsely almost reticulately punctate, impressed each side of middle; pubescence sparse, short, recurved, long erect hairs numerously interspersed; prosternum impressed, rugulose, sparsely pubescent, coxal cavities narrowly open behind; meso- and metasternum faintly scabrous, finely pubescent, metasternum subglabrous medially. Elytra over 3 ½ times as long as broad, slightly tapering posteriorly; basal punctures rather fine, well separated, becoming finer toward apex; pubescence sparse, short, depressed, with a few long erect hairs interspersed; each elytron vaguely bicostate; apices truncate to vaguely emarginate. Legs slender, densely, shallowly punctate; all tibiae bicarinate. Abdomen finely, densely punctate at sides, pubescence fine, dense, sternites medially subglabrous; last sternite truncate at apex. Length, 10–14 mm.

Female: Form similar. Antennae about as long as body. Abdomen with last sternite broadly rounded at apex. Length, 12–14 mm.

Holotype male, allotype (Canadian National Collection) and 12 paratypes (10 males, 2 females) from 25 MILES W DURANGO, DURANGO, MEXICO, 10 June 1964, 20 June 1964, 23 June 1964, 29 June 1964, at lights (H. F. Howden, J. Martin, J. A. Chemsak, J. A. Powell). Additional paratypes include: 1 male, 23 miles W Durango, 29 June 1964 (L. A. Kelton) ; 1 female, 20 miles E El Salto, Navajos, Durango, 23 July 1964 (Kelton) ; 1 male, 25 miles E El Salto, 17 July 1964, on *Quercus* (Howden) ; 1 male, 28 miles E El Salto, 22 July 1964, on *Quercus* (Howden) ; 1 male, Tepalcates, 30 miles W Durango, 4 to 8 August 1972 (Powell, Veirs, MacNeill) ; 1 female, 8 miles W El Palmito, Sinaloa, 9 August 1972 (Powell).

The slender form, distinctive coloration, and very coarse punctation of the pronotum will separate this species from other *Aneflomorpha*. There is very little variation in color in the type series.

Natural History of *Veromessor pergandei*
I. The Nest[1]

(Hymenoptera: Formicidae)

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An interesting feature of the Hot Desert landscape is the craters made by the black desert harvesters *Veromessor pergandei* (Mayr) (see Fig. 1). We studied these ants intensively in the north end of Death Valley National Monument, California, near Grapevine Ranger Station where this species is near the northern limit of its range. The area is in a side canyon off the main valley at an elevation of 800 meters. The living-trailer belonging to the Laboratory of Desert Biology of the Desert Research Institute was stationed here. All nests in the intensive study were in the compacted sand, gravel and boulders deposited in the bottom of the canyon by flood waters and were in an area 75 by 250 m (18,750 m^2). The duration of the study was 19 May to 22 June, with a re-check 7–9 July, 1973. Less intensive studies were carried on during 1968–1970 in the Philip L. Boyd Deep Canyon Desert Research Area of the University of California, Riverside (near Palm Desert, California) and in Death Valley National Monument from 1968–1974.

The dominant vegetation of our study area is *Larrea divaricata* Cav. Smaller shrubs are abundant, including *Atriplex hymenelytra* (Torr.) Wats., *Franseria dumosa* Gray, *Hymenoclea salsola* T. & G., and *Lygodesmia spinosa* Nutt. Prior to the study period, the winter annuals (mainly *Chaenactis carphoclinea* Gray, *Chorizanthe brevicornu* Torr., *C. rigida* (Torr.) T. & G., *Cryptantha angustifolia* (Torr.) Greene, *Mohavea breviflora* Cov., *Oenothera clavaeformis* Torr. & Frém., *Phacelia calthifolia* Brand. and *P. crenulata* (Torr.) had bloomed in profusion. In the winter of 1972–1973 rains fell at the proper times and in the correct amounts to produce an impressive display of winter ephemerals in Death Valley National Monument.

The daily air temperature and amount of cloud cover during the study period are shown in Fig. 2. Precipitation usually occurs during late autumn, winter and early spring, with rare summer rains. On 31 May

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[1] The second portion of this study will contain our report on: "Behavior" and "Literature."

[2] The authors gratefully acknowledge the financial support by the National Science Foundation, Grants GB 17731X and GB 37241, Dr. Frits W. Went, Principal Investigator.

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The Pan-Pacific Entomologist 51: 205–216. July 1975

FIG. 1. Worker of *Veromessor pergandei*, × 15. Photograph of living worker by Kenneth Middleham (Wheeler and Wheeler 1973).

there was 0.25 mm of rain and on 1 June 3.0 mm; on 14 June there was a trace both morning and afternoon. The average annual precipitation at the nearest weather station (Furnace Creek, 80 km south and 48.8 m below sea level) is 42 mm, but the extremes are 0.00–115.7 mm.

THE NEST

Incipient Colonies.—On 7 June 1973 in the study area, we saw a small crater about 65 mm in outside diameter at the smoothed edge of a gravel road. Very small black ants were harvesting at 0800 Pacific Standard Time; each worked alone and moved very quickly. We excavated the nest, and at a depth of 15 cm we found 9 queens, 40 nanitics (dwarfed first workers produced by founding queens), and a packet of

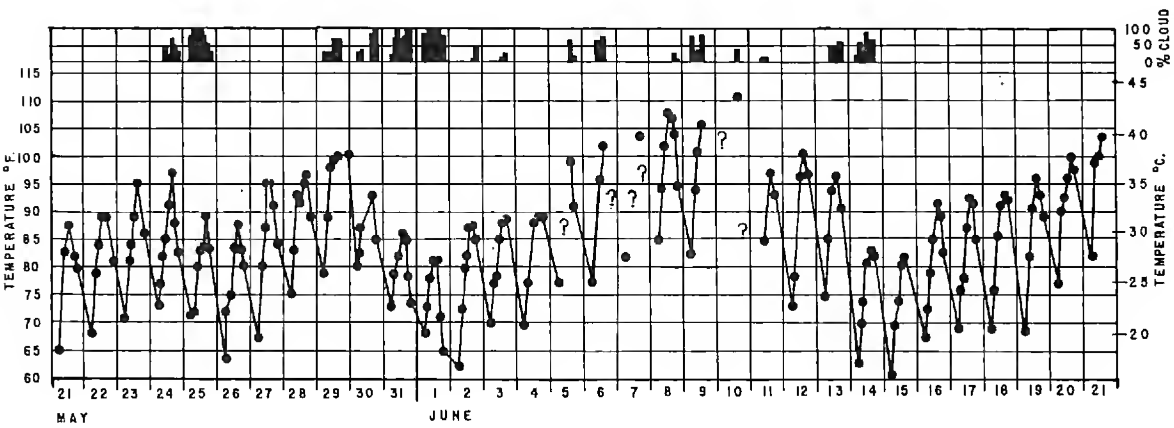

FIG. 2. Daily air temperatures and approximate percentage of cloud cover at the study area, 21 May to 21 June 1973.

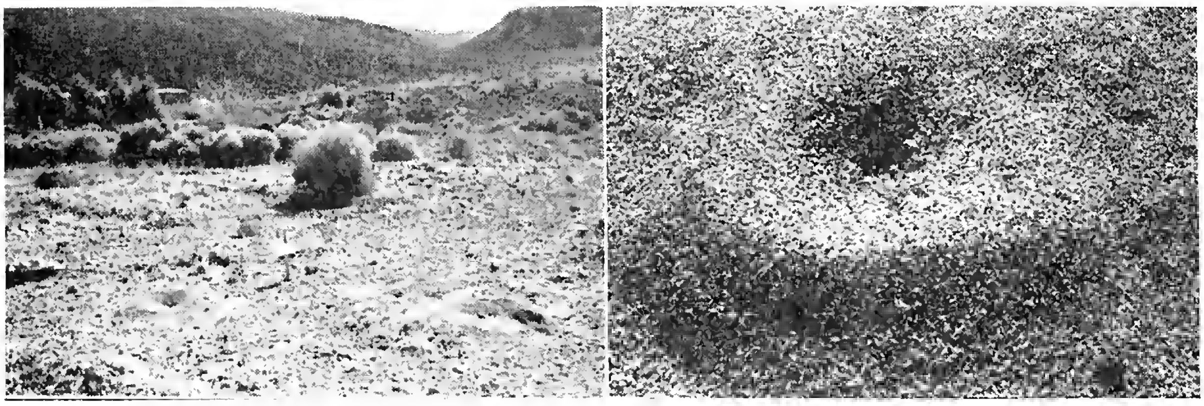

FIG. 3. Left, nest of *Veromessor pergandei* in Death Valley National Monument. There are 3 craters in front of the stake bearing the 3 by 5 card. Right, close-up of one of the craters. Refuse is piled in the foreground and to the left of the crater.

brood. We transported the colony to Reno and placed it in an artificial nest. The nest had wet paper toweling in the bottom chamber, ants and brood in the middle chamber, and numerous seeds collected by mature colonies of *V. pergandei* in the top chamber. The queens behaved as workers, moving soil in the chamber, opening their jaws as if they would attack a disturbing hand or forceps, and tending the brood packet.

The nanitic workers collected seeds of *Chenopodium pumilio* R. Br. and *Calycoseris parryi* Gray and placed them in the brood packet. The packet consisted of eggs, larvae, and pupae and seeds. We did not see the queens or workers eating the seeds or paying much attention to them at any time. One larva had its mouth parts on a seed of *Calycoseris*; another had a seed of *Chenopodium* on its belly. On 7 July nanitics harvested seeds of *Cryptantha* sp. and *Phacelia calthifolia* from the top chamber.

Although we continued to observe and water the colony, the queens and workers began dying. Since no new workers were produced, we preserved the remnants of the colony on 28 July. Later, about 100 more nanitics were found at the excavation. Therefore, we judged that our captive colony failed because there were too few workers.

On 21 June in the study area, we examined numerous craters of about the same size as the first nest, excavating several. One nest had no queen that we could find and only a few nanitics. We found 1 or 2 queens in each of the others, and the workers were more numerous. None of these nests seemed as prosperous as the colony with 9 queens which we had excavated on 10 June. On 5 September 1968, in Death Valley, we found nanitics using an entrance 3 mm by 6 mm beside a rock. In 1970 we found two incipient nests in Clark County, Nevada. At Mesquite, 2 March (490 m), we excavated 2 queens beneath a small pile of gravel

Table 1. Data on nests studied in Death Valley National Monument.

Nest number	Abandoned craters	Active craters	Length & width (cm)	Chaff pile location	Chaff pile size (cm)	Entrances	Entrance size (mm)	Location in crater
1	3	1	45 × 60	E	13 × 30	A	19 × 25	W
						B	13 × 63	E
		2	30 × 45	E	10 × 15	C	13 × 13	SE
						D	15 × 18	NW
		3	23 × 33	N	8 × 20	E	30 × 31	NW
				S	13 × 20			
		4	35 × 48	N	18 × 33	G	15 × 31	center
						H	15 × 18	center
						I	8 × 8	NW
2		1	40 × 48	SW	33 × 33	A	13 × 13	E
			Became inactive during study			B	30 × 50	NW
		none				C	13 × 13	
		2	15 × 18	S	6 × 15	D	25 × 25	N
		3	23 × 28	S	8 × 15	E	15 × 63	N
3	3	1	40 × 45	NE	30 × 45	A	40 × 50	center
		2	55 × 70	N	8 × 75	B	19 × 195	N
				S	5 × 45	C	25 × 25	center
						D	18 × 18	S
		3	40 × 43	N	5 × 75	F	25 × 30	S
		4	29 × 35	N	16 × 21	G	35 × 38	center
				E	25 × 5	H	18 × 25	N
				SW	12 × 17			
5	none	1	85 × 65	E	5 × 90	A	31 × 81	E
						B	31 × 31	center
						C	13 × 19	N
						D	13 × 38	N
						E	38 × 75	N
						F	5 × 5	N
8	none	1	45 × 45	SW	1 × 40	A	19 × 241	N
		2	31 × 43	SW	6 × 9	B	20 × 35	N
10	5	1	58 × 48	NW to SE	10 × 90	A	19 × 25	W

on a road shoulder; the entrance was closed. Nearby at Cactus Springs, 4 March (100 m), in *Larrea*, *Franseria*, *Atriplex* and scattered *Prosopis*, we found a 25 mm crater which we excavated, finding a few nanitics only.

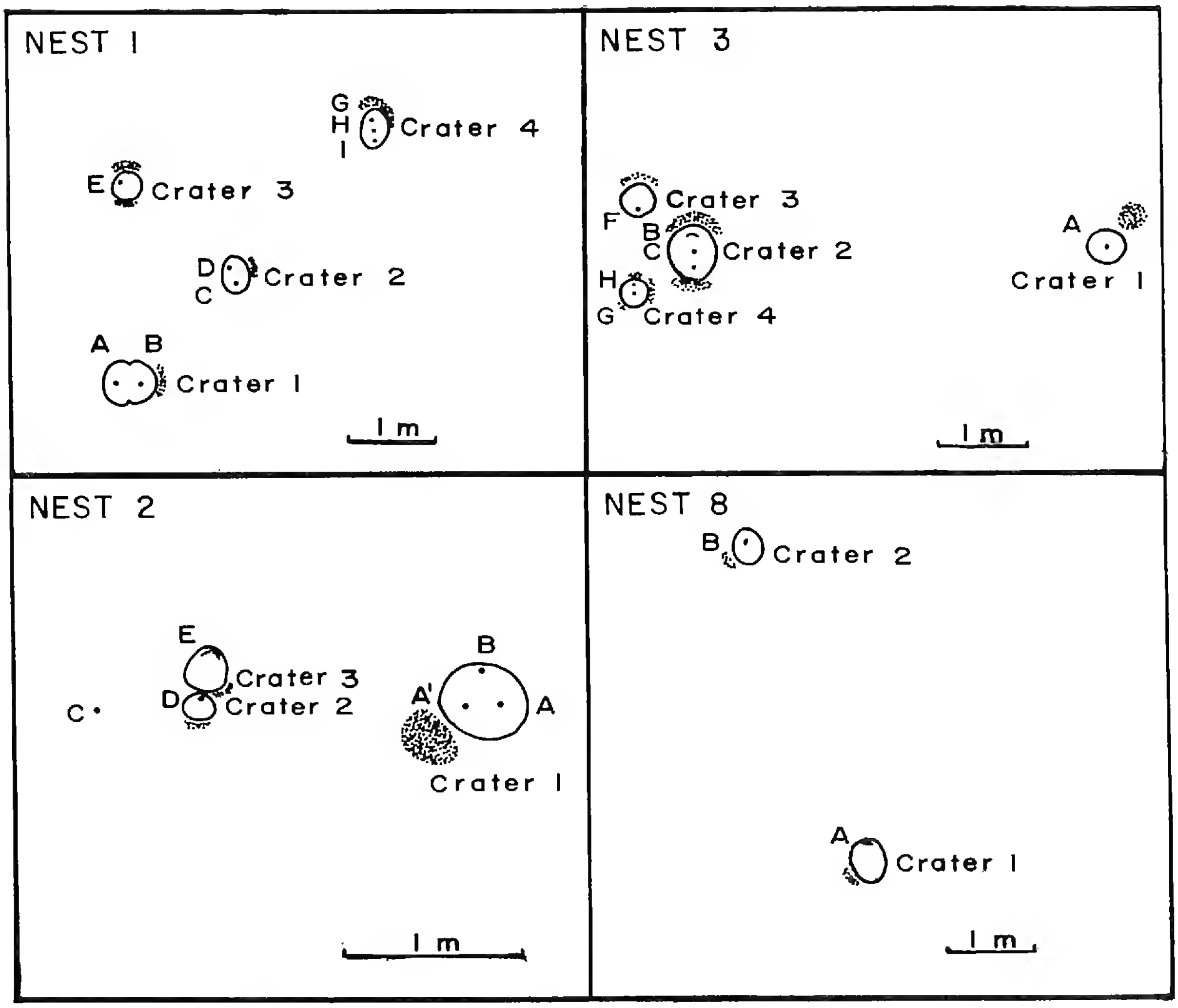

FIG. 4. Maps of active craters (outline), refuse piles (stippled), and entrances (solid spots or lines within crater) which are lettered. Nest 2, entrance C lacked a crater.

Winged males and females were found at the entrances of Nest 2 (Table 1), 20 March 1974, by Dr. F. W. Went. Females were more numerous than males and scurried back into the nests when approached. In Deep Canyon on 9 March 1970 at 914 m elevation, we found 72 winged females and 18 males with over 2000 workers in a nest with 2 craters about a meter apart. We could not find any brood (Wheeler and Wheeler 1973: 171). Therefore we judge that mating flights take place in April and that our captive colony was about 2 months old when excavated.

Craters.—The portion of the mature nest (Fig. 3) above ground consists of one or more craters within an area of several square meters. Active craters, entrances and refuse piles of 4 of the intensively studied nests are shown in Fig. 4. Table 1 gives the dimensions of the craters; locations and dimensions of the refuse piles; numbers, dimensions and locations of the entrances within each crater for all intensively studied nests. The crater of Nest 5 has remained about the same size since about 1968. Its entrance is through the asphalt in a service road.

A typical nest has 2 or 3 active craters, each 35 by 43 cm in outside diameter, with a refuse pile on the northern periphery, 11 cm wide and in a 37-cm arc adjacent to the crater. The craters are made of sand and fine gravel removed from the underground excavation. The typical crater has 2 entrances 20 by 40 mm. The sand nearest the entrance—on both the upper and lower surfaces—is held together by a yellowish cement. This same material is apparently used as a coating on the walls of the galleries and chambers, for we found a stain here also. This cement seems to be fecal material of workers. It dissoves readily in water and has a distinctly foul odor, similar to that of urine. Drops of what appeared to be the same material were found in the refuse pile in the shape of miniature (about ½ mm) discs. Ants were picked up in a teaspoon to induce them to drop their seeds. When annoyed thus, they smeared the spoon with a drop of greenish-yellow material from the anal region; it hardened to a varnish-like finish. This substance might also play a role in defense, in navigation or in marking territory.

On 23 May, Nest 9 was partially excavated, leaving a trench 45 cm wide and 45 cm deep. New entrances were opened by the workers in both walls and excavated material and organic refuse dropped into the trench. The trench was then lined with cellophane. From 29 May to 10 June, about 570 g of sand and organic refuse were dropped into the trench by the workers; 10–17 June, 790 g; 17–21 June, 275 g. Hence, at this one entrance an average of 80 g per day of refuse and excavated material were removed from the nest. Two factors decreased accuracy in these measurements: (1) wind blew some of the material away; (2) it was impossible to distinguish between what the ants had carried out of the nest and what had been blown into the trench.

Underground Nest Structure.—Our earlier attempts to excavate nests of *V. pergandei* were unsuccessful. Even with the enthusiastic help of a class of students we have never been able to dig quickly enough to find a large concentration of ants. We have also tried to make molds of the underground nest structure with roofing cement, aerosol foam, liquid plastic, and other substances. On 4 June 1973, about 4½ liters of maximally thinned casting resin (Fiberglas Evercoat) was poured into one large entrance of Nest 12. The plastic was allowed to set for 2 days before excavation. A trench was dug beside the entrance and the cast carefully excavated. Pictures were taken with a Polaroid-Land camera at various stages to facilitate reconstruction.

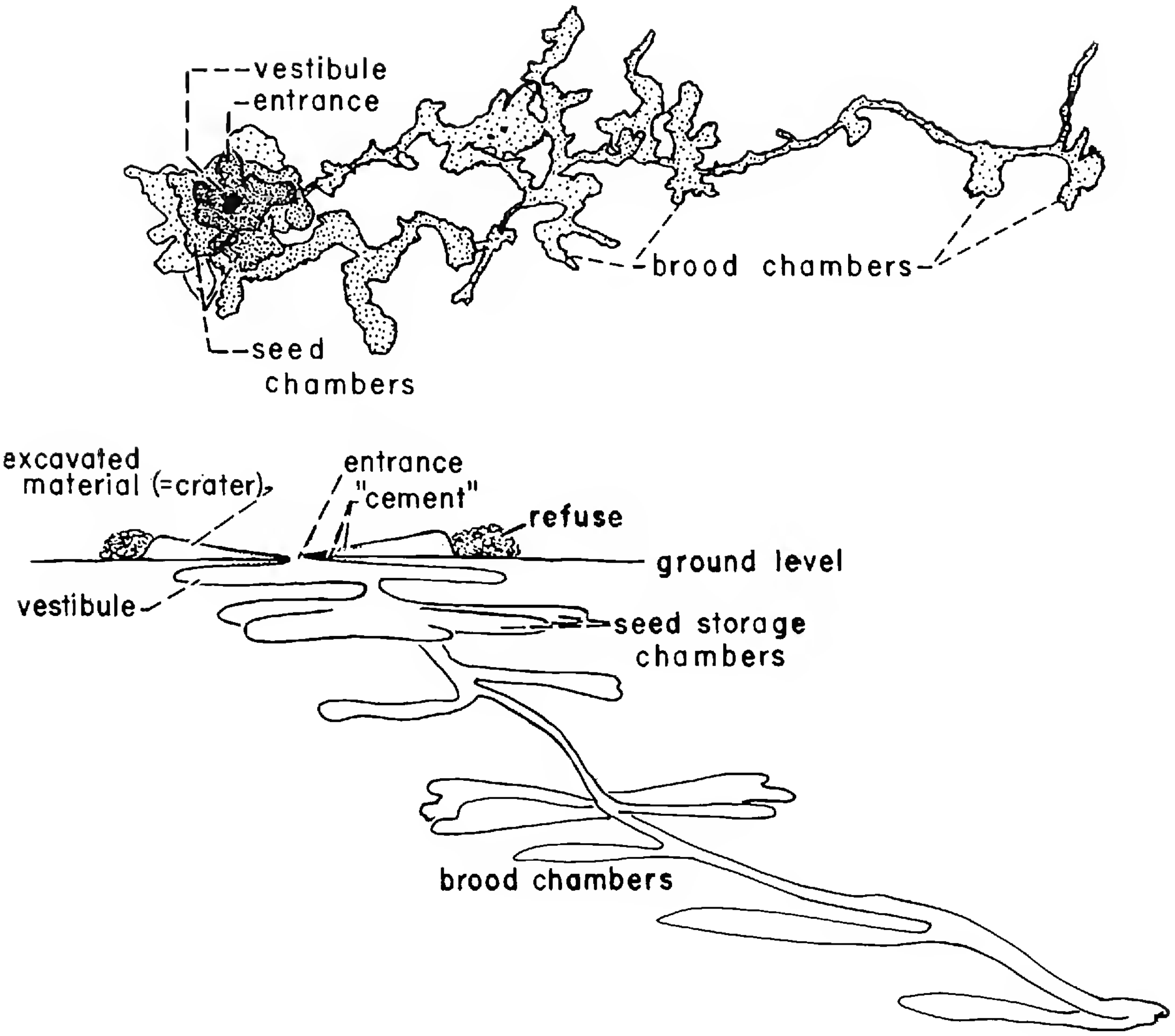

Fig. 5. Structure of excavated nest. Tracing of reconstruction, with labels on most important structures is shown above. Darkest stipples indicate structures nearest surface. Highly diagrammatic side view of nest structure under one entrance is shown below.

In one place the plastic had followed the lower of 2 intersecting galleries, and it also left a chamber 75 by 125 by 19 mm completely empty. Other chambers in the excavated nest showed bevelled edges where the plastic had failed to fill the complete depth of the chamber. The plastic flowed to a depth of 104 cm and to a distance of 250 cm horizontally from the entrance. (See Fig. 5.)

The cast was taken in pieces to the Laboratory of Desert Biology in Reno. There, each piece was cleaned of as much of the adhering debris as possible. When larvae, fruits or seeds were in the chamber the pieces were cleaned under a stereomicroscope. After each piece had been cleaned and examined and the interesting structures photographed the cast was reassembled.

Just below the entrance was a large chamber (hereafter called the vestibule) in which there was chaff but only a few seeds. This seemed to be the seed-cleaning chamber. The entrances to each lower series of chambers were offset horizontally from the entrance above. The vestibule opened into a series of anastomosing chambers which covered an area about 38 cm in diameter. Seeds were on the floor of these chambers, 4 cm below the soil surface. All seeds had been husked, but all seed coats were entire. We could germinate these seeds in the laboratory. Seeds were not sorted but were mixed.

At a depth of about 53 cm was another series of chambers which were low-ceilinged (up to 10 mm) and covered an area 40 by 48 cm. Each chamber ranged from 5 cm by 5 cm to 15 cm by 19 cm; the largest had what looked like two supporting columns near the middle. These columns were of gravel and were easily cleaned out after the piece had been soaked. Brood was present from this level to the lowest chamber (104 cm). Larvae and pupae were mixed. We did not find the queen nor any young larvae. This did not surprise us, because we had excavated only about a fifth or sixth of the nest. The other entrances for this colony were all to the north and west, while our excavation extended to the south and east.

There was no concentration of workers with the brood, therefore we concluded that the workers had not attempted to remove the brood in front of the advancing plastic. In the upper chambers the ants were imbedded near the edges of the plastic, as if pushed aside, but in the lower chambers the larvae were found across the entire floor. They were piled as we have seen them in the nests of many other species when we uncovered brood-chambers by turning over a stone or lifting a piece of wood lying on the soil surface. Since we had not previously found brood, we concluded that the workers of *V. pergandei* behave as do other species and that the plastic had trapped the brood and workers *in situ.* Some of the seeds which the larvae had next to their mouths had had the seed coats removed. We did not find any workers near seeds.

Colony-duration.—Figure 6 gives the summaries of the nest counts on the grids in Deep Canyon and in Death Valley. [Each grid is marked with stakes every 15¼ m and there are 14 stakes on a side (= 3.9 hectares)]. Well established colonies lasted longer than our 3 (Deep Canyon) or 5 (Death Valley) years of surveys. A quarter of the Deep Canyon nests that were present on our first survey (1968) were still present on our latest (1970), while half of the Death Valley colonies that were counted in 1968 were still present in 1973.

The fact that a colony was the same from one survey to the next did not mean that the same entrances were used. We recognized a colony

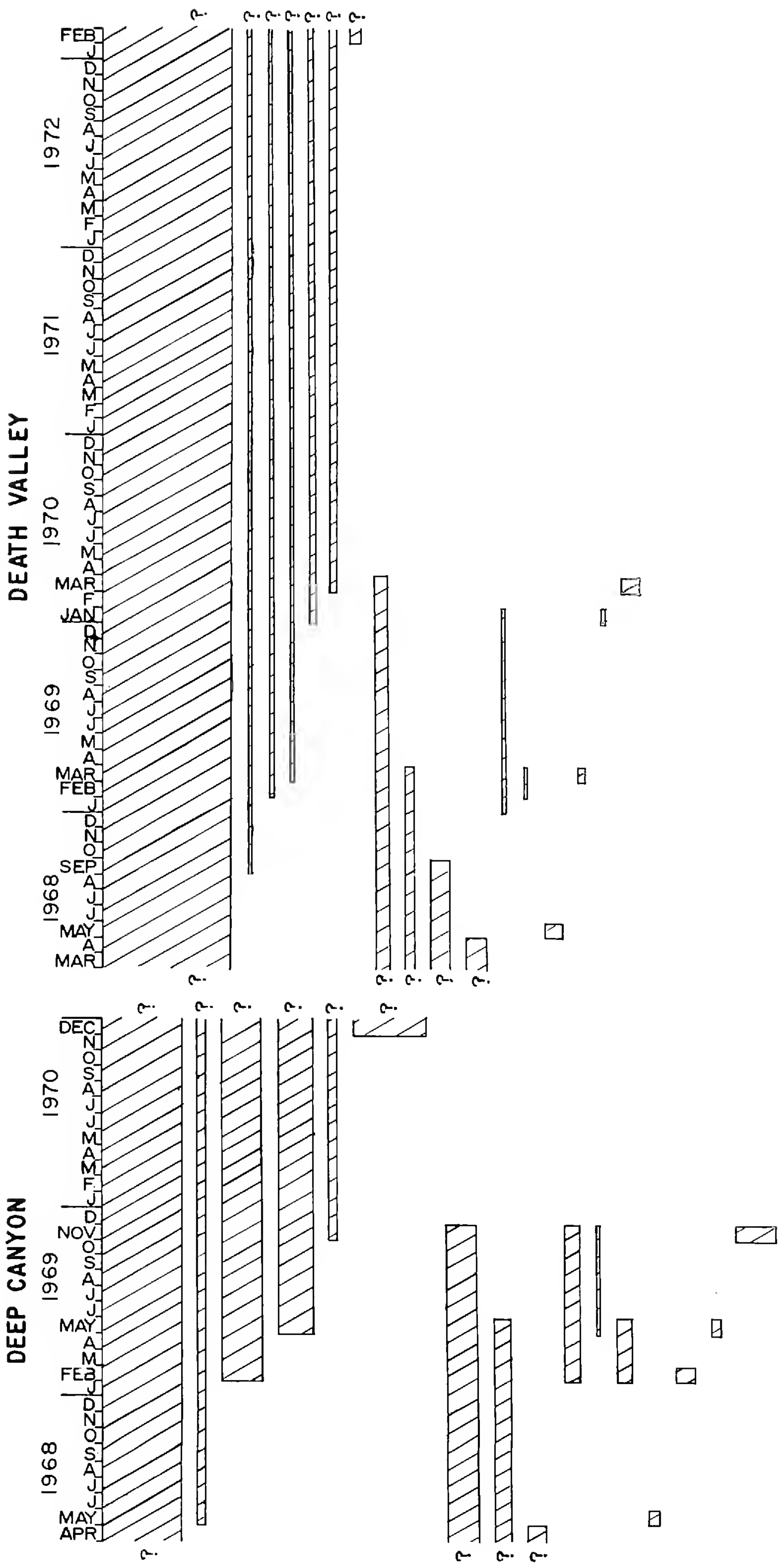

FIG. 6. Survival of colonies on the grids in Deep Canyon and Death Valley. Width of column indicates number of colonies; narrowest column represents one colony. Question marks indicate the colony was already established on our first survey or still thriving on our latest. Spelled-out abbreviations indicate months when surveys were made.

as still active if a crater or craters were found within, or adjacent to, the area of craters observed during the previous survey. A well established colony had numerous abandoned craters. An abandoned crater had no entrance, the rim was lower, the refuse pile was dull grey and and matted and could be picked up in large patches. A new crater was started almost as soon as an entrance was opened from below. A mature colony under favorable weather conditions had several entrances active at the same time; they appeared as described above under "Craters."

In Deep Canyon, April 1969, we made a survey of the grid. About a third of the nests were inactive and apparently extinct. However, a half-inch rain fell during the next night. On the following afternoon in the warm sunshine, workers were active at nearly all the colonies rebuilding entrances and craters.

DISCUSSION

All records for winged sexual forms of *V. pergandei* are for March and April. In June in Death Valley in 1973, we found numerous craters 25 mm in diameter, which we judged to be incipient colonies. At this stage these contained only the founding queen, nanitics, and a small packet of brood. Creighton (1953: 16) reported that the nest-founding queens made their first nests under covering rocks. In 1968 we found one incipient nest under a covering rock; all others have been in the open with small craters.

Mature colonies were reported by both Creighton (1953) and Tevis (1958) to have only one entrance active at any one time. We have found that this species may have as many as 8 entrances active simultaneously; 2 or 3 would be the average.

Tevis (1958) followed the spiralling main gallery of a mature nest to a depth of 4 m in the nearly pure sand of the Whitewater River terrace. He found shallow seed chambers, but no brood. In 1968–1970 we worked 16–32 km south of his area at elevations of 75–1220 m in Deep Canyon. Most of our nests were in outwash channels in sand, gravel and boulders (Wheeler and Wheeler 1973). Whereas Tevis was able to follow his gallery for nearly 4 m, we lost ours at about 1. The chambers and galleries were next to large boulders; when we moved them, we destroyed the structure of the nests. In Deep Canyon and Death Valley we tried slicing off the top or digging in from the side toward the center of the nest; even with the enthusiastic assistance of several students, we were never able to dig quickly enough to find any large concentration of workers. We did find superficial seed chambers, but never any brood.

We had tried several times with different substances to make a cast of a nest of *V. pergandei.* The cast reported in this paper is not that of an entire colony: To make such an extensive cast and excavate it would require energy similar to that involved in digging out an archeological site; and it would take the same kind of careful uncovering and mapping. The underground area of a single mature nest was estimated by Tevis (1958: 697) as about 15½ m (50 ft) in diameter, which he calculated from the area in which he found the entrances of a nest during one year. As is shown in Fig. 4, the entrances of the intensively studied nests in Death Valley do not cover such a large area. On the other hand, both Creighton (1953) and Tevis (1958) said that only one entrance was in use by each nest at one time. Perhaps the area in use in one nest is the same at any one time. We would like to see an entire mature nest excavated.

The underground structure of the portion of a nest of which we made a cast is an intricate system of anastomosing chambers and galleries. We had not expected to find the vestibule, thinking that the uppermost chamber was a seed-storage chamber. Tevis (1958: 697) said: "An inch or two under the surface, there was a store of unhusked seeds [= fruits], probably to be transported below by the ants after the removal of the chaff, and, at the seven-foot level, a small granary (90 × 50 × 4 mm) filled with seeds of Amaranthus." We had not realized that he was talking about two different stages in seed-handling. Now, with several casts of the upper portions of the nests, we can corroborate his statement. We also found the unhusked seeds in the topmost chamber, while the seed storage chambers are lower and are filled with cleaned seeds. We disagree on the kinds of seeds in a chamber. We found that seeds of several genera were mixed in each chamber and that the seeds were piled together in the seed chambers without any sorting. The plastic certainly reached these shallow chambers before the ants had a chance to carry the seeds away or mix them.

In the lower chambers, containing brood, the position of the larvae with seeds adjacent to their mouths certainly looked as if both larvae and seeds were in normal positions for feeding by the larvae. We have observed in artificial nests living larvae of *Veromessor* spp. and *Pogonomyrmex* spp. with seeds in similar positions. The further observation that the nanitic workers in the incipient colony placed seeds in the brood packet served to strengthen our hypothesis that larvae behave as a digesting link in the feeding of these harvester ants (Went, *et al.* 1972). This suggests that in *V. pergandei* the larvae are used as Wüst (1973) reported for *Monomorium pharaonis* Linnaeus, and as Ishay and Ikan (1968) reported for the Oriental wasp *Vespa orientalis* F.; the larvae digest foods and feed the mature workers with products of digestion. Wüst found that in *M. pharaonis*, the secretions from the larval labial glands which the workers imbibed contained amino acids, traces of proteins, and showed protease activity; the proctodeal secretions from the rectal bladder had a high water content and contained amino acids with traces of proteins. She found no trace of carbohydrates nor fats in either secretion.

Colonies near the northern limit of the range apparently last longer than those near the center: such would be the implication of our nest counts on the Deep Canyon and Death Valley grids. Roger Mauer (unpublished Master's thesis) found that the same species of desert rodents lived longer in Death Valley than in Deep Canyon. There is more cover and the variety of seeds is greater in Deep Canyon than Death Valley; so this observation is also peculiar. Why an organism (if one considers an ant colony as such) should live longer at the edge of its range than near the center is an intriguing problem.

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Sciomyzidae of Oregon

(Diptera)

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INTRODUCTION AND BACKGROUND[1]

Sciomyzid flies, commonly referred to as swale or marsh flies, are found world-wide and most of the more than 500 named species occur in the northern hemisphere. The family Sciomyzidae is separated from other acalyptrate Diptera by the following characters: oral vibrissae absent, post vertical bristles diverging, costa entire, subcosta complete, one or more tibiae with preapical bristles. Body length within the family ranges from 2 to 12 mm and may be pale yellowish-brown to brown to gray to black in color. At rest marsh flies impart a grasshopper-like appearance because of the well developed hind legs and the head held higher than the abdomen. The more hygrophilous species of these rather slow flying Diptera are often seen resting head end directed downward on emergent rushes or grasses along the margins of ponds, lakes, and sluggish streams. However, genera such as *Limnia* and *Tetanocera* are commonly taken well removed from free standing or flowing water in rather typical mesic habitats.

Subsequent to the discovery by Berg (1953) that larvae of sciomyzid flies kill and consume aquatic snails, extensive biologies of nearly 200 species have been studied, mainly at Cornell University. It is now established that larvae of all species studied are obligate mollusk feeders. Some develop only on slugs or terrestrial snails, but most feed on freshwater snails. Certain species feed specifically on fingernail clams, and an eastern U.S. seaboard species is associated with a strandline marine snail. Host association or feeding habit of sciomyzid larvae varies among the species from saprophagous to overt predation to parasitoid. Certain species, mainly among the Sciomyzini are highly host specific. Certain species of *Antichaeta* (Tetanocerini) oviposit on the egg mass of the host snail, and the first-instar larvae feed obligatorily on snail embryos. Instars II and III require more food and in addition attack snails such as *Physa* directly. Biologies of nearctic Sciomyzidae include those published by Bratt, et al. (1969), Fisher and Orth (1964), Foote and Knutson (1970), and Neff and Berg (1962, 1966).

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Applied interest in sciomyzid flies relates to the fact that certain fresh water snails serve as intermediate hosts of digenetic trematode diseases of higher vertebrates. Lymnaeid snails infest most wet pasture areas and are the intermediate hosts of liver flukes, *Fasciola* spp., which cause "liver rot" or "red water" in ungulates. Pregnant females may abort, infected animals become weak, and may die. Those which make it to the slaughter house produce inferior carcasses, and the infested livers cannot be sold as human food. Now that control of mosquito-borne diseases of man, such as malaria, filariasis, etc., has been greatly improved, Bilharzia, or schistosomiasis, has become the disease of prime importance in tropical climates of the world. The causative organisms, *Schistosoma* spp., must complete part of the life cycle in an aquatic snail and, as reported by Malek (1961), several species of snails may serve as the intermediate hosts. Swarms of cercariae issue from infested snails and swim to and penetrate the derm of man, the definitive host. Repeated exposure adds to the blood fluke population within the human body and severe debilitation and often death from secondary factors follows.

Although formal documentation is meager, there is no dispute from an academic view that sciomyzid flies are potential tools for the control of the snail vectors of trematodes. However, Boray (1964, 227) "... considered it unlikely that (in Australia) sciomyzid flies will prove to be of value as a means of biological control of *Lymnaea tomentosa*" (host of *Fasciola hepatica*). Boray's statement appears to apply equally to our field experience with *F. hepatica* in western U.S. during the past 15 years. Earlier, Chock, *et al.* (1961) reported on the introduction into Hawaii of *Sepedon macropus* for biological control of *Lymnaea ollula* a host of *Fasciola gigantica*. The senior author collected a few adult *S. macropus* during a survey trip to Hawaii in 1965 and was informed by local entomologists and ranchers that the snail population was lower than it was when *S. macropus* (plus other sciomyzid species) were first introduced. However, animal industry people were of the opinion that no reduction in the incidence of fluke-infested livers was evident from slaughter house records.

There have been no publications to our knowledge attesting to the successful utilization of sciomyzid flies for the biological control of the snail intermediate hosts of human schistosomes.

Thus, with present evaluation criteria, the few attempts to utilize sciomyzid flies either by introduction or manipulation of native species for biological control of vector snails of trematodes have not resulted in significant clinical or economic reduction of the incidence of disease either in man or animals. The presumed explanation is that (1) snail populations cannot be eradicated, i.e. totally destroyed, by their natural enemies, and (2) the trematode population remains viable in a very low snail population. To date the only methods known which can effectively eliminate flukes even from localized areas are to separate snails and vertebrates either mechanically by drainage or fencing, or to kill the snails with chemical molluscicides. It is beyond the purpose of this paper to discuss parameters such as (1) the effect of molluscicides on non-target organisms, (2) the rapid rate of reinvasion by the highly ecologically diverse snails, and (3) ecological factors operating for and against successful colonization of natural enemies in an aquatic habitat.

SOURCES OF MATERIAL

During the course of a field survey in progress since 1962, the authors have developed a catalogue of sciomyzid flies of western North America. The data herein constitute an annotated checklist of Sciomyzidae known to occur in Oregon. It is primarily a qualitative presentation of species based on approximately 2,000 specimens seen by the authors from fifteen sources. It also includes records published by Bratt, *et al.* (1969), Foote (1961), Steyskal (1965), and Neff and Berg (1966) as well as unpublished records (correspondence) of L. V. Knutson and G. C. Steyskal (USNM), the leading American specialists on sciomyzid taxonomy.

Sources of material or information are indicated by the following codes, and the assistance and cooperation of all persons mentioned are gratefully acknowledged:

BAF* = B. A. Foote (1961)
CAS = California Academy of Sciences (P. H. Arnaud, Jr.)
CU* = Cornell University, det. by L. V. Knutson
GCS* = G. C. Steyskal (1965)
OSDA = Oregon State Department of Agriculture (R. L. Westcott)
OSU = Oregon State University (P. Oman)
OSU* = Oregon State University, det. by L. V. Knutson
UCB = University of California, Berkeley (E. I. Schlinger)
UCD = University of California, Davis (R. O. Schuster)
UCR = University of California, Riverside (T. W. Fisher and R. E. Orth)
UI = University of Idaho (W. Barr)

UK = University of Kansas (G. W. Byers)
USNM = U.S. National Museum (P. Hurd, L. V. Knutson, G. C. Steyskal)
WSU = Washington State University (W. J. Turner)
WSU* = Washington State University, det. by L. V. Knutson

Codes without asterisk indicate source of material seen by the authors.

Codes with asterisk indicate material as reported by Knutson, Steyskal, Foote, or Bratt mainly from USNM and CU records, or reported in correspondence with the authors.

No code indicates material collected by either or both authors (UCR) during 52 collections made on four trips into Oregon—6–8 August 1968, 17–21 June 1969, 9–12 July 1970, and 19–20 June 1972.

FORMAT

For each species is cited the original description, type locality, type depository if known, and an abbreviated synonymy. State or province records only are used to indicate distribution outside of Oregon.

OREGON RECORDS: In order to simplify the checklist, collection data have been summarized to indicate only the earliest and latest collection dates in the calendar year, the years spanned, and the lowest and highest elevations as stated on labels. Details can be provided by the authors upon request.

ANTICHAETA ROBIGINOSA Melander

Melander, A. L. 1920. Ann. Entomol. Soc. Amer. 13(3): 317. Holotype ♀; Three Forks, Gallatin Co., Montana; USNM; Redescribed—Fisher, T. W. and R. E. Orth. 1969a. Pan-Pac Entomol. 45(1):32–43. Neallotype, Alturas, Modoc Co., California; USNM.

DISTRIBUTION: Calif., Mont., Oreg., Wash.

OREGON RECORDS: 18 June to 8 August; 1968 to 1970; 400 to 4750 feet elev.

LAKE CO.: Drews Valley; 9 mi. south of Lakeview. LANE CO.: Eugene. WASCO CO.: 13 mi. north of Warm Springs.

ANTICHAETA TESTACEA Melander

Melander, A. L. 1920. Ann. Entomol. Soc. Amer. 13(3): 318. Holotype ♂; Gallatin Co., Montana; USNM.

DISTRIBUTION: Calif., Idaho, Mont., N. Mex., Oreg., S. Dak., Utah.

OREGON RECORDS: 21 July 1969; 1250 feet elev.

JOSEPHINE CO.: 0.5 mi. south of Cave Junction.

ANTICHAETA VERNALIS Fisher and Orth

Fisher, T. W. and R. E. Orth. 1971. Pan-Pac. Entomol. 47(1): 38–40. Holotype ♂, Allotype; Willits, Mendocino Co., California; CAS no. 10208. [Prior to 1971 conspecific with *A. robiginosa.*]

DISTRIBUTION: Calif., Idaho, Oreg., Wash.

OREGON RECORDS: 5 to 27 March; 1919 to 1942; 160 feet elev.

MARION CO.: Turner (OSU); Roberts (OSU). WASHINGTON CO.: Forest Grove (UCB).

ATRICHOMELINA PUBERA (Loew)

Loew, H. 1862. (Sciomyza) Smithsn. Misc. Collect. 6(1[= Pub. 141]): 106–107. Holotype ♂; Middle states.

DISTRIBUTION: Alta. to Ont., continental United States excluding Alaska, south to Mexico (D. F.).

OREGON RECORDS: 17 June to 20 October; 1917 to 1970; 224 to 4400 feet elev.

BENTON CO.: Corvallis (BAF*); Philomath (BAF*). CLACKAMAS CO.: Colton (OSDA). CROOK CO.: 19 mi. south of Prineville. HARNEY CO.: 45 mi. east of Burns (OSDA). HOOD RIVER CO.: Hood River. JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: 4 mi. east of Sprague River; 20 mi. north of Klamath Falls; Klamath Falls (BAF*). LANE CO.: Eugene; 15 mi. west of Oakridge. LINCOLN CO.: 4 mi. south of Newport (OSDA); Newport (BAF*). MARION CO.: 0.5 mi. west of Mill City; Salem-Albany (BAF*). YAMHILL CO.: 5 mi. south of Dayton. WASCO CO.: 13 mi. north of Warm Springs.

DICTYA EXPANSA Steyskal

Steyskal, G. C. 1938. Occas. Pap. Mus. Zool. Univ. Michigan 386: 9. Holotype ♂; Detroit, Michigan.

DISTRIBUTION: B. C. to Que., Wash. to N. Y., s. from Ariz. to Ga.

OREGON RECORDS: 17 August to 22 September; 1963 to 1968.

MALHEUR CO.: 12 mi. southwest of Nyssa (OSDA). UMATILLA CO.: Hermiston (OSDA); Cold Springs (BAF*). UNION CO.: 8 mi. southeast La Grande (OSDA).

DICTYA FONTINALIS Fisher & Orth

Fisher, T. W. and R. E. Orth. 1969. Pan-Pac. Entomol. 45(3): 222–228. Holotype ♂, allotype; Boca Spring, Nevada Co., California; CAS no. 10207.

DISTRIBUTION: Calif., Oreg.

OREGON RECORD: 24 May 1964.

JOSEPHINE CO.: 4 mi. west of Selma (OSDA).

DICTYA MONTANA Steyskal

Steyskal, G. C. 1954. Ent. Soc. Amer. Ann. 47: 534. Holotype ♂, allotype; Paradise Cove, Marin Co., California; USNM. [We recognize four clinal forms, all of which occur in Oregon.]

DISTRIBUTION: B. C. to Sask., s. to Calif., Ariz., Colo.

OREGON RECORDS: 27 May to 25 August; 1944 to 1972; 150 to 5000 feet elev.

> BENTON CO.: Corvallis (BAF*); 10 mi. south of Corvallis, Winkle Lake (OSU). CLACKAMAS CO.: 0.5 mi. west of Government Camp. CROOK CO: 10 mi. southeast of Prineville (BAF*); 19 mi. south of Prineville. CURRY CO.: Floras Lake, 12 mi. north of Port Orford (OSDA). DESCHUTES CO.: 6 mi. southwest of Bend (OSDA); Redmond, Deschutes River (BAF*). GRANT CO.: 10 mi. north of Seneca (BAF*). HOOD RIVER CO.: 1 mi. south of Hood River; 15 mi. southeast of Hood River (OSDA), 0.5 mi. south of Sherwood Campground. JACKSON CO.: 9 mi. north of Butte Falls (OSDA); Jenny Creek, Hwy. 66; 1.3 mi. southwest of Prospect; Medford (BAF*); Butte Falls (BAF*). JOSEPHINE CO.: 0.5 mi. south of Cave Junction; Merlin (OSDA). KLAMATH CO.: Klamath Game Refuge; 4 mi. east of Sprague River; Odell Lake (BAF*). LAKE CO.: Drews Valley; 9 mi. south of Lakeview; 12 mi. east of Lakeview (OSDA); south end of Summer Lake (OSDA). LANE CO.: 4 mi. east of Belknap Springs (USNM); 5 mi. south of Cottage Grove (OSDA); Eugene; 7 mi. west of Eugene. MALHEUR CO.: Juntura (OSDA). MARION CO.: 0.5 mi. west of Mill City. MULTNOMAH CO.: Portland (OSDA). WASCO CO.: Mt. Hood National Forest; 13 mi. north of Warm Springs. YAMHILL CO.: 5 mi. south of Dayton.

ELGIVA CONNEXA (Steyskal)

Steyskal, G. C. 1954. (*Hedroneura*) Ent. Soc. Wash. Proc. 56(2): 60. Holotype ♂, Allotype; Matanuska Valley, Alaska, USNM no. 51609. [We recognize a separate distinct clinal form in parts of northern Oregon and Washington.]

DISTRIBUTION: Alaska to Ont., s. to Calif., N. Mex., Nebr.

OREGON RECORDS: 1 July to 13 September; 1918 to 1970; 150 to 5000 feet elev.

> BENTON CO.: Corvallis (UCB), 10 mi. south of Corvallis (BAF*). CLACKAMAS CO.: 0.5 mi. west of Government Camp. GRANT CO.: 10 mi. north of Seneca (BAF*). LAKE CO.: Drews Valley; 9 mi. south of Lakeview. MARION CO.: 0.5 mi. west of Mill City. WASHINGTON CO.: Forest Grove (UCB). YAMHILL CO.: 5 mi. south of Dayton.

ELGIVA SUNDEWALLI Kloet and Hincks

Kloet, G. S., and W. D. Hincks. 1945.

Synonymy: *Hedroneura* Hendel; *rufa* Panzer, *lineata* Day.

DISTRIBUTION: Alaska to N. S., s. to Calif., N. Mex., N. Y.

OREGON RECORDS: 17 June to 7 August; 1964 to 1972; 150 to 5000 feet elev.

JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: 20 mi. north of Klamath Falls; Klamath Game Refuge. LAKE CO.: Drews Valley. LANE CO.: Eugene airport. UNION CO.: North Powder (OSDA). YAMHILL CO.: 5 mi. south of Dayton.

HOPLODICTYA ACUTICORNIS (v. d. Wulp)

Wulp, F. M. van der. 1897. (*Tetanocera*) Biologia Centrali-Americana. Diptera. II, 358. April 1888–May 1903. Holotype ♂' Mexico, Northern Sonora (Morrison). [Separated from *Hoplodictya spinicornis* (Loew) and redescribed by Fisher and Orth (1972a).] Lectotype ♂, Paralectotypes; Brit. Mus. Natl. Hist.

DISTRIBUTION: B. C., Ont., Ariz., Calif., Ill., Kans., Okla., Oreg., Nebr., N. Mex., Utah, Wash.

OREGON RECORDS: 19 June to 8 August; 1968 to 1972; 1250 to 4750 feet elev.

JACKSON CO.: Eagle Point. JOSEPHINE CO.: 0.5 mi. south of Cave Junction. LAKE CO.: 9 mi. south of Lakeview.

LIMNIA BOSCII (Robineau-Desvoidy) *

Robineau-Desvoidy, J. B. 1830. (*Pherbina*). Inst. de France, Sci. Math. et Phys., Acad. Roy. des Sci., Mem. presentes par divers Savans [ser. 2], 2: 690. Holotype ♀; The Carolinas.

DISTRIBUTION: Alaska to Nfld., s. to Calif. and N. C.

OREGON RECORDS: 17 June to 9 July; 1949 to 1972. 1200 to 4440 feet elev.

BAKER CO.: Baker (USNM). CLACKMAS CO.: 0.5 mi. west of Government Camp. JEFFERSON CO.: 8 mi. north of Camp Sherman (OSDA). JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: 6 mi. south of La Pine; Crescent, Deschutes Rd. WASCO.: Mt. Hood National Forest; 13 mi. north of Warm Springs.

LIMNIA INOPA (Adams) †

Adams, C. F. 1904. (*Tetanocera*). Kans. Univ. Sci. Bul. 2 [= whole ser., 12]: 448 (= Kans. Univ. Bul. (6)). Holotype ♂; Washington Territory.

DISTRIBUTION: Alta., B. C., Calif., Idaho, Mont., Oreg., Wash.

OREGON RECORDS: 3 July to 26 July; 1931 to 1970; 400 to 4750 feet elev.

BAKER CO.: Spring Creek (WSU). HOOD RIVER CO.: Hood River (UK); Mt. Hood (UK); 0.5 mi. south of Sherwood Campground. JACKSON CO.: 5 mi. southwest of Sams Valley (WSU). WASCO CO.: Hwy. 26, 1.5 mi. south of junction Hwy. 216.

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* We feel *L. boscii* is a composite of 3 species. In a generic revision of North American species of *Limnia* by Steyskal, Fisher, Knutson and Orth, (ms. in prep.), *L. sandovalensis* Fisher & Orth will be the name applied to all the Oregon "*boscii*" we have seen.

† *Limnia inopa* (Adams) 1904 resurrected. Synonymy: *Limnia brevicostalis* Melander, 1920. Revision in press. Fisher & Orth (1975).

LIMNIA PUBESCENS (Day)

Day, L. T. 1881. (*Tetanocera*). Canad. Entom. 13: 86. Types ♂ and ♀; Washington Territory.

DISTRIBUTION: B. C., Calif., Idaho, Oreg., Wash.

OREGON RECORDS: 21 May to 29 August; 1935 to 1960; 1350 to 1540 feet elev.

> BENTON CO.: Corvallis (BAF*); Monroe (BAF*). HOOD RIVER CO.: Mt. Hood (UK). JACKSON CO.: Tou Velle State Park, 8 mi. north of Medford (OSU); Phoenix (BAF*). MULTNOMAH CO.: Portland (BAF*). YAMHILL CO.: McMinnville (CAS).

LIMNIA SARATOGENSIS (Fitch)

Fitch, A. 1855. (*Tetanocera*). N. Y. State Agr. Soc. Trans. (1854) 14: 772. Holotype ♀; New York.

[We no longer recognize *Limnia saratogensis.* The description is vague and letter correspondence (16 August 1972) from L. V. Knutson USNM, reads "The type of *L. saratogensis* Fitch is in the USNM and is a badly molded, unrecognizable female. . . ." We feel locality references for *L. saratogensis* in Oregon made by B. A. Foote (1961) probably should be assigned to *L. severa* Cresson.]

LIMNIA SEVERA Cresson

Cresson, E. T., Jr 1920. Trans. Amer. Ent. Soc. 46: 80. Holotype ♂; Cayton, Shasta County, California; CAS. Synonymy: *Limnia unguicornis* var. *severa* Cresson; *Limnia saratogensis* var. *severa* Cresson; *Limnia saratogensis* var. *armipes* Melander; *Limnia armipes* Melander; [For complete details see Fisher and Orth (1971).]

DISTRIBUTION: B. C., Ariz., Calif., Colo., Oreg., Wash.

OREGON RECORDS: 15 June to 13 August; 1945 to 1972; 50 to 4750 feet elev.

> COOS CO.: Bandon (OSDA). DOUGLAS CO.: 3.8 mi. northeast of Jackson Co. line; Tenmile (OSDA). JACKSON CO.: Eagle Point; Jenny creek; 6 mi. north of Medford; 1.3 mi. southwest of Prospect; 2 mi. south of Willow Lake, Indian Glade (OSDA). JOSEPHINE CO.: 0.5 mi. south of Cave Junction; Lake Selmac (UCB). KLAMATH CO.: 15 mi. southwest of Keno (WSU). LANE CO.: 2 mi. south of Florence (USNM). WASCO CO.: Mt. Hood National Forest; 13 mi. north of Warm Springs. WASHINGTON CO.: Timber (OSDA).

PHERBELLIA GRISEOLA (Fallén)

Fallén, C. F. 1820. (*Sciomyza*). Sciomyzides Sveciae, 14. Type; Europe.

DISTRIBUTION: Europe; Ont., Queb.; Calif., Idaho, Mich., Mont., N. Y., Oreg., Utah, Wash.

OREGON RECORDS: 20 June to 7 August; 1968 to 1972; 390 to 4540 feet elev.

> KLAMATH CO.: Klamath Game Refuge; Silver Creek State Park. LANE CO.: Eugene airport.

PHERBELLIA HUMILIS (Loew)

Loew, H. 1876. (Sciomyza). Ztschr. f. die Gesam. Naturw. 48–330. Types ♂ and ♀: Texas. Synonymy: *Pherbellia grisescens* (Meigen), palaearctic, see Steyskal (1963).

DISTRIBUTION: Throughout s. Canada and U. S., south to Costa Rica, see Bratt, *et al.*, (1969).

OREGON RECORDS: 17 June to 7 August; 1963 to 1972; 150 to 5200 feet elev.

> CROOK CO.: 19 mi. south of Prineville. DOUGLAS CO.: Diamond Lake. HARNEY CO.: 45 mi. east of Burns (OSDA). JACKSON CO.: Eagle Point, Hwy. 62; 6 mi. north of Medford; northwest of Tou Velle St. Park; Butte Falls (BAF*). KLAMATH CO.: Klamath Game Refuge; 20 mi. north of Klamath Falls. LANE CO.: Eugene. WASCO CO.: 13 mi. north of Warm Springs. YAMHILL CO.: 5 mi. south of Dayton.

PHERBELLIA IDAHOENSIS Steyskal

Steyskal, G. C. 1961. Papers Mich. Acad. Sci., Arts, Letters. 46: 411. Holotype ♂; Moscow, Latah Co., Idaho; UI.

DISTRIBUTION: Calif., Idaho, Oreg., Wash.

OREGON RECORDS: 20 June 1972 and 3 July 1954; 4105 and 4200 feet elev.

> KLAMATH CO.: Klamath Falls (UI); Silver Creek State Park.

PHERBELLIA MELANDERI Steyskal

Steyskal, G. C. 1963. Papers Mich. Acad. Sci., Arts, and Letters. 48: 117. Holotype ♂; Three Forks, Gallatin Co., Montana; USNM.

DISTRIBUTION: Calif., Colo., Mont., Oreg., Utah.

OREGON RECORDS: 5 June to 17 June; 1963 to 1972; 4160 feet elev.

> HARNEY CO.: 9 mi. north of Andrews (OSDA). KLAMATH CO.: 20 mi. north of Klamath Falls.

PHERBELLIA NANA (Fallén)

Fallén, C. F. 1820. (*Sciomyza*). Sciomyzides Sveciae. 15. Lund. Types ♂ and ♀; Europe.

DISTRIBUTION: Europe; Alaska, Canada, U. S., s. to Mexico (D. F.).

OREGON RECORDS: 27 March to 5 September; 1918 to 1972.

> BENTON CO.: 12 mi. south of Corvallis (BAF). CROOK CO.: Prineville (BAF); 19 mi. south of Prineville. CURRY CO.: 12 mi. north of Port Orford, Flores Lake (OSDA). DESCHUTES CO.: 20 mi. south of Bend (BAF); Pringle Falls, west of La Pine (BAF). HARNEY CO.: 9 mi. north of Andrews, Alvord Hot Springs (OSDA). HOOD RIVER CO.: Parkdale. JACKSON CO.: 6 mi. north of Medford; northwest of Tou Velle State Park; Prospect (BAF). JEFFERSON CO.: 8 mi. north of Camp Sherman (OSDA). JOSEPHINE CO.:

0.5 mi. south of Cave Junction. KLAMATH CO.: Crescent, Deschutes Rd.; 7 mi. south of Klamath Falls; 20 mi. north of Klamath Falls; Klamath Game Refuge; 6 mi. south of La Pine; Silver Creek State Park; 4 mi. east of Sprague River. LAKE CO.: 12 mi. south of Lakeview (OSDA); south end Summer Lake (OSDA). WASCO CO.: 13 mi. north of Warm Springs. WASHINGTON CO.: Forest Grove (UCB). UMATILLA CO.: Ukiah (BAF*). COLUMBIA CO.: Scrappoose (BAF*).

PHERBELLIA OBSCURA Ringdahl

Ringdahl, O. 1948. Opuscula Entomologica 13: 52. Synonymy: Separated from *Pherbellia ventralis* (Fallén), palearctic; see Bratt, *et al.*, (1969:73).

DISTRIBUTION: Europe; Alaska, Canada, U. S.

OREGON RECORD: 160 feet elev.

MARION CO.: Salem (CU*).

PHERBELLIA OREGONA Steyskal

Steyskal, G. C. 1961. Papers Mich. Acad. Sci., Arts, Letters 46: 411–412. Holotype ♂; Forest Grove, Washington Co., Oregon; UI.

DISTRIBUTION: Calif., Oreg.

OREGON RECORDS: 5 July 1963, 40 feet elev.; 11 July 1970, 900 feet elev.

LINCOLN CO.: 4 mi. south of Newport (OSDA). MARION CO.: 0.5 mi. west of mill City.

PHERBELLIA PROPAGES Steyskal

Steyskal, G. C. 1966. Papers Mich. Acad. Sci., Arts, Letters 51: 37–38. Holotype ♂; Aweme, Manitoba; USNM no. 67877.

DISTRIBUTION: Alaska throughout Canada s. to northern Calif. to Ohio.

OREGON RECORDS: 1 April to 26 September; 1919 to 1969; 400 to 4750 feet elev.

BENTON CO.: Parker Creek, Mary's Peak (OSDA). HOOD RIVER CO.: 0.5 mi. south of Sherwood Campground. MARION CO.: Breitenbush (OSDA). WASCO CO.: Mt. Hood National Forest. WASHINGTON CO.: Hillsboro (OSDA).

PHERBELLIA SCHOENHERRI MACULATA (Cresson)

Cresson, E. T., Jr. 1920. (*Melina*). Trans. Amer. Entom. Soc. 46: 48. Holotype ♂; Illinois; ANSP no. 6222.

DISTRIBUTION: Alaska to Nfld. s. to Calif., Colo., Ill., N. Y.

OREGON RECORDS: 12 July to 8 August; 1967 to 1970; 3500 to 5000 feet elev.

CROOK CO.: 27 mi. east of Prineville (BAF). JACKSON CO.: Jenny Cr., Hwy. 66. KLAMATH CO.: 8 mi. east of Chemult (UCB); 4 mi. east of Sprague

River. LAKE CO.: Drews Valley; 9 mi. south of Lakeview. UNION CO.: 8 mi. southeast of La Grande (OSDA).

Pherbellia vitalis (Cresson)

Cresson, E. T., Jr. 1920. (*Melina*). Trans. Amer. Entom. Soc. 46: 43–44. Holotype ♂; Berkeley Hills, Alameda Co., California; ANSP no. 6221.

Distribution: Alaska e. to northern Que. s. to Calif., N. Mex., Kans., Ind., N. Y.

Oregon Records: 5 May to 26 September; 1918 to 1972; 400 to 4400 feet elev.

COLUMBIA CO.: St. Helens (BAF). BENTON CO.: Parker Creek, Mary's Peak (OSDA). HARNEY CO.: 45 mi. east of Burns (OSDA). JACKSON CO.: Butte Falls (BAF*); southwest of Prospect. KLAMATH CO.: Crescent, Deschutes Rd.; 7 mi. south of Klamath Falls; 20 mi. north of Klamath Falls; 4 mi. east of Sprague River. LAKE CO.: 12 mi. south of Lakeview (OSDA). LANE CO.: Eugene. WASCO CO.: 13 mi. north of Warm Springs. WASHINGTON CO.: Forest Grove (UCB). UMATILLA CO.: Cold Springs (BAF).

Pteromicra siskiyouensis Fisher & Orth

Fisher, T. W. and R. E. Orth. 1966. Pan-Pac. Entom. 42(4): 307–318. Holotype ♂, Allotype; Grass Lake, Siskiyou Co., California; CAS no. 10168. [Specimens may be labeled as *Pteromicra nigrimana* (Meigen) prior to separation by Fisher and Orth (1966).]

Distribution: Alta., B. C.; Calif., Idaho, Mont., Oreg., Wash., Wyo.

Oregon Records: 20 June to 7 August; 1968 to 1972; 4160 to 5100 feet elev.

KLAMATH CO.: Klamath Game Refuge; 20 mi. north of Klamath Falls; Odell Creek; Silver Creek State Park; east of Willamette Pass.

Renocera cyathiformis Melander

Melander, A. L. 1920. Ann. Ent. Soc. Amer. 13: 319. Type; Mount Constitution, Orcas Island, Washington.

Distribution: Alaska, Calif., Colo., Idaho, Oreg., Mich., N. Mex.

Oregon Records: 18 June to 9 July; 1963 to 1970; 3380 to 3750 feet elev.

CLACKAMAS CO.: 0.5 mi. west of Government Camp; 1 mi. north of Government Camp; Mt. Hood Natl. Forest. UNION CO.: 10 mi. south of Tollgate Pass, Hwy. 204 (OSDA).

Renocera pacifica Curran

Curran, C. H. 1933. Amer. Mus. Nat. Hist., Amer. Mus. Novitates 682: 9. Holotype ♀; Boiler Bay, Oregon.

Distribution: Oregon.

Oregon Records: 18 May 1930.

LINCOLN CO.: Boiler Bay. This species is known only from the Holotype ♀. [We have not seen the type, hence we must reserve judgement regarding the taxonomic affiliation of this specimen. Because species separation in many sciomyzid genera is more easily definitive on the basis of male characters, we would not be surprised if *R. pacifica* and *R. cyathiformis* are conspecific.]

SCIOMYZA SIMPLEX Fallén

Fallén, C. F. 1820. Sciomyzides Sveciae.: 12. Types ♂ and ♀: Europe.

DISTRIBUTION: Europe; Alaska to Manitoba, s. to Calif., Ariz., Wyo., Mich.

OREGON RECORDS: 20 June to 8 August; 1968 to 1972; 4160 to 5000 feet elev.

KLAMATH CO.: 4 mi. south of Fort Klamath; Klamath Falls (BAF*); 7 mi. south of Klamath Falls; 20 mi. north of Klamath Falls; Silver Creek State Park; 4 mi. east of Sprague River; LAKE CO.: Drews Valley; 9 mi. south of Lakeview.

SEPEDON ARMIPES Loew

Loew, H. 1859. Wien. Ent. Monatschr. 3: 298. Type: Middle States. [Not yet discovered in Oregon but approaches to within 50 miles of the Oregon border in Idaho. Oregon specimens labeled *Sepedon armipes* are probably *Sepedon capellei*. See Fisher and Orth (1969b).]

SEPEDON BOREALIS Steyskal

Steyskal, G. C. 1951 (1950). Wasmann Jour. Biology 8(3): 283. Holotype ♂, Allotype; Yale, Idaho; USNM no. 60906.

DISTRIBUTION: Alaska, B. C. to Nfld., s. to Calif., N. Mex., Ill., Pa., N. Y.

OREGON RECORDS: 18 June to 7 August; 1952 to 1972; 2450 to 4250 feet elev.

BENTON CO.: Corvallis (BAF*). CLACKAMAS CO.: 0.5 mi. west of Government Camp; Mt. Hood National Forest. HOOD RIVER CO.: 1.7 mi. north of Barlow Pass; 0.5 mi. south of Sherwood Campground. JACKSON CO.: Jenny Creek, Hwy. 166; 1.3 mi. southwest of Prospect; 2 mi. south of Willow Lake, Indian Glade (OSDA). KLAMATH CO.: Crescent, Deschutes Rd.; 8 mi. east of Chemult, Skookum Butte; 4 mi. south of Fort Klamath; 6 mi. south of La Pine. LAKE CO.: 11 mi. east of Lakeview (UCB). LANE CO.: 3 mi. west of Willamette Pass (OSDA). WASCO CO.: Mt. Hood National Forest.

SEPEDON CAPELLEI Fisher & Orth

Fisher, T. W. and R. E. Orth. 1969. Pan-Pac. Entom. 45(2): 157. Holotype ♂, Allotype; Bishop, Inyo Co., California; CAS no. 10166. [Separated from *Sepedon armipes* by Fisher and Orth (1969).]

DISTRIBUTION: Calif., Idaho, Oreg., Nev., Utah.

OREGON RECORDS: 19 May to 18 September; 1917 to 1972; 1200 to 4750 feet elev.

CROOK CO.: Ochoco Creek (OSU*); Prineville (OSDA); 19 mi. south of Prineville. DESCHUTES CO.: Bend (OSU*); 20 mi. south of Bend (WSU*).

GRANT CO.: 10 mi. south of Seneca (OSU*, BAF*). HOOD RIVER CO.: Hood River (UCB). JACKSON CO.: Butte Falls (BAF*); nr. Prospect (BAF*); 2 mi. south of Willow Lake, Indian Glade (OSDA). JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: Crescent, Deschutes Rd.; Fort Klamath, Crooked Creek (WSU*); 4 mi. south of Fort Klamath; Harpold Dam (WSU*); Klamath Game Refuge; 6 mi. south of La Pine; 4 mi. east of Sprague River. LAKE CO.: 9 mi. south of Lakeview. MALHEUR CO.: Malheur River Canyon (OSU*). UNION CO.: North Powder (CU*, UK); Anthony Lake (UK). WALLOWA CO.: Enterprise (WSU*); Minam (WSU*, BAF*). WASCO CO.: 13 mi. north of Warm Springs. WHEELER CO.: Richmond (WSU*).

SEPEDON CASCADENSIS Fisher & Orth

Fisher, T. W. and R. E. Orth. 1974. Pan-Pac. Entomol. 50(3): 291–297. Holotype ♂, Allotype; 0.5 mi. south of Sherwood Campground, Hood River Co., Oregon; CAS no. 12038.

DISTRIBUTION: Known only from the Cascade Mts. of Oregon.

OREGON RECORDS: 22 May to 12 July; 1954 to 1972; 2400 to 3180 feet elev.

HOOD RIVER CO.: Barlow Pass; 0.5 mi. south of Sherwood Campground. JACKSON CO.: 1.3 mi. southwest of Prospect. MARION CO.: Breitenbush.

SEPEDON FUSCIPENNIS FUSCIPENNIS Loew

Loew, H. 1859. Wien. Ent. Monatschr. 3: 299. Types ♂ and ♀; Middle States.

DISTRIBUTION: Alaska to Nfld., s. to Calif., N. Mex., Tex., Fla.

OREGON RECORDS: 20 June to 24 October; 1924 to 1969; 50 to 4540 feet elev.

BENTON CO.: 10 mi. south of Corvallis, Winkle Lake (OSU); 12 mi. south of Corvallis (BAF*). JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: 4 mi. north of Fort Klamath; Klamath Falls (BAF*); 10 mi. north of Klamath Falls (UCB). LANE CO.: Eugene; Eugene airport; 7 mi. west of Eugene; 0.5 mi. east of Florence. MARION CO.: 0.5 mi. west of Mill City. YAMHILL CO.: 5 mi. south of Dayton.

SEPEDON PACIFICA Cresson

Cresson, E. T., Jr. 1914. Ent. News. 25: 457. Holotype ♂; Redwood Canyon, Marin Co., California; ANSP no. 6076. [Material labeled prior to Fisher and Orth (1972b) may appear as *Sepedon praemiosa* Giglio-Tos. *S. praemiosa* does not occur in the Pacific northwest.]

DISTRIBUTION: B. C. to Sask. s. to Baja Calif. north to Nev., Colo., S. Dak.

OREGON RECORDS: 17 June to 30 September; 1918 to 1972; 400 to 5000 feet elev.

CROOK CO.: 19 mi. south of Prineville. DOUGLAS CO.: Diamond Lake. HARNEY CO.: Fields (OSDA). JACKSON CO.: Eagle Point, Hwy. 62; northwest of Tou Velle State Park. KLAMATH CO.: Bly; Klamath County Fish Hatchery (BAF*, USNM); Klamath Game Refuge; 10 mi. north of Klamath Falls (UCB); Klamath Lake, Eagle Ridge (CAS); Silver Creek

State Park; 4 mi. east of Sprague River. LAKE CO.: Drews Valley. LANE CO.: Eugene. MARION CO.: 0.5 mi. west of Mill City. UMATILLA CO.: Hermiston (USNM); Cold Springs (BAF*). UNION CO.: Hot Lake (UK); North Powder (OSDA, UK). WASCO CO.: 13 mi. north of Warm Springs. WASHINGTON CO.: Forest Grove (UCB). YAMHILL CO.: 5 mi. south of Dayton.

SEPEDON PSEUDARMIPES Fisher & Orth

Fisher, T. W. and R. E. Orth. 1969. Pan-Pac. Entomol. 45(2): 159–160. Holotype ♂; O'Sullivan Dam, Grant Co., Washington; CAS no. 10167. [Separated from *Sepedon armipes* by Fisher & Orth. (1969).]

DISTRIBUTION: B. C., Idaho, Oreg., Wash.

OREGON RECORDS: 11 April 1954.

UMATILLA CO.: Cold Springs (WSU).

SEPEDON SPINIPES AMERICANA Steyskal

Steyskal, G. S. 1951. Wasmann Jour. Biology. 8(3): 277 (1950). Holotype ♂; Hamburg, Livingston Co., Michigan; USNM.

DISTRIBUTION: Alaska, B. C. to Que., s. to Calif., Utah, Wyo., Ohio, Pa., N. Y.

OREGON RECORDS: 6 May to 22 September; 1924 to 1972; 2560 to 4540 feet elev.

BAKER CO.: Hereford (CAS). BENTON CO.: Corvallis (BAF*). JACKSON CO.: southwest of Prospect, Hwy. 62; KLAMATH CO.: Crescent, Deschutes Rd.; Klamath Game Refuge; Klamath Lake, Eagle Ridge (CAS); Silver Creek State Park. UNION CO.: 8 mi. southeast of La Grande (OSDA).

TETANOCERA BERGI Steyskal

Steyskal, G. C. 1954. Ent. Soc. Wash. Proc. 56: 66. Holotype ♂, Allotype; Matanuska Valley, Alaska; USNM no. 61791.

DISTRIBUTION: Alaska, B. C., Alta., Manit., Oreg.

OREGON RECORD: 6 August 1968; 20 feet elev.

DOUGLAS CO.: 7 mi. east of Reedsport.

TETANOCERA FERRUGINEA Fallén

Fallén, C. F. 1820. Sciomyzides Sveciae p: 9. Lundae [= Lund]. Types ♂ and ♀; Europe. Synonymy: *Tetanocera triangularis* Loew, *Tetanocera huronensis* Steyskal.

DISTRIBUTION: Europe; Alaska, B. C. to Nfld., s. to Calif., Colo., S. Dak., Ill., N. Y.

OREGON RECORDS: 20 June to 7 August; 1968 to 1972; 4200 to 4540 feet elev.

HARNEY CO.: 19 mi. south of Frenchglen (BAF*). KLAMATH CO.: Eagle Ridge, Klamath Lake (GCS*); Klamath Game Refuge; Silver Creek State Park; 4 mi. east of Sprague River. POLK CO.: Buena Vista (BAF*).

TETANOCERA LATIFIBULA Frey

Frey, R. 1924. Notulae Ent. 4: 51. Holotype ♂; Europe. Synonymy: *Tetanocera hespera* Steyskal.

DISTRIBUTION: Europe; Alaska, Alta, Wash., S. Dak., s. to Calif., Utah, N. Mex.

OREGON RECORDS: 30 June to 25 August; 1951 to 1970; 4160 to 5000 feet elev.

> BENTON CO.: 10 mi. south of Corvallis, Winkle Lake (OSU). KLAMATH CO.: Klamath Game Refuge; 7 mi. south of Klamath Falls; 4 mi. east of Sprague River. LAKE CO.: Chandler State Park (CAS); Drews Valley; 5 mi. south of Lakeview (OSDA); 12 mi. south of Lakeview (OSDA).

TETANOCERA LOEWI Steyskal

Steyskal, G. S. 1959. Mich. Acad. Sci., Arts, and Letters, Papers. 44: 68 (1958). Holotype ♂, Allotype; Deerfield Township, Lapeer Co., Michigan; G. C. Steyskal, USNM.

DISTRIBUTION: B. C., Ont.; Calif., Ind., Mich., N. Y., Ohio, Oreg., Wash., Wis.

OREGON RECORDS: 20 June to 30 September; 1918 to 1969; 360 to 390 feet elev.

> LANE CO.: Eugene airport; 3 mi. north of Junction City. WASHINGTON CO.: Forest Grove (UCB).

TETANOCERA MESOPORA Steyskal

Steyskal, G. C. 1959. Mich. Acad. Sci., Arts and Letters, Papers. 44: 70 (1958). Holotype ♂, Allotype; Walden, Colorado; G. C. Steyskal, USNM.

DISTRIBUTION: N. W. T., B. C. to Nfld., s. to Calif., Nev., N. Mex., S. Dak., Mich., N. Y.

OREGON RECORDS: 20 June to 7 August; 1932 to 1972; 4160 to 5200 feet elev.

> DOUGLAS CO.: Diamond Lake; KLAMATH CO.: 4 mi. south of Fort Klamath; Klamath Falls (OSU); 7 mi. south of Klamath Falls; Klamath Game Refuge; 4 mi. east of Sprague River.

TETANOCERA PLUMOSA Loew

Loew, H. 1847. Stettin. Entom. Zeitung 8: 201. Holotype ♀; Sitka, Alaska; MCZ. Synonymy: *Tetanocera nanciae* Brimley; *Tetanocera plumifera* Wulp.

DISTRIBUTION: Alaska, B. C. to N. S. s. to Calif., Ariz., N. Mex., Mo., Ill., Pa., N. Y.

OREGON RECORDS: 18 May to 10 October; 1949 to 1972; 1300 to 5000 feet elev.

> CROOK CO.: Powell Butte (BAF*). DESCHUTES CO.: 20 mi. south of Bend (BAF*); 10 mi. northeast of La Pine (BAF*); Redmond (BAF*); Tumalo Reservoir (BAF*). GRANT CO.: 3 mi. east of Prairie City (OSDA). HARNEY CO.: Hines (OSDA); Indian Creek southeast of Frenchglen (OSDA). JACKSON CO.: 23 mi. southeast of Eagle Point, Upper Dead Indian Soda Springs (OSU); Jenny Creek, Hwy. 66; nr. Prospect (BAF*); Tou Velle

State Park, Rogue River (OSU). JOSEPHINE CO.: 0.5 mi. south of Cave Junction; 4 mi. north of Selma (OSU); 4 mi. west of Selma (OSDA). KLAMATH CO.: 4 mi. north of Fort Klamath; 4 mi. south of Fort Klamath; Klamath Falls (BAF*); 20 mi. north of Klamath Falls; Klamath Game Refuge; 6 mi. south of La Pine; 4 mi. east of Sprague River. LAKE CO.: Chandler State Park (CAS); Drews Valley; 9 mi. south of Lakeview; 12 mi. south of Lakeview. LANE CO.: 8 mi. south of Florence (USNM). MARION CO.: Breitenbush (OSDA). UNION CO.: 8 mi. south of Union, Catherine Creek State Park (OSU). WALLOWA CO.: Enterprise (BAF*); Minam (BAF*); 6 mi. west of Wallowa. WASCO CO.: 13 mi. north of Warm Springs.

TETANOCERA OBTUSIFIBULA Melander

Melander, A. L. 1920. Ann. Entom. Soc. Amer. 13 (3): 328. Cotypes, thirty-seven specimens; Pullman and Mount Constitution, Washington; Worley, Idaho; Stanford, California; USNM.

DISTRIBUTION: B. C., Calif., Idaho, Oreg., Wash.

OREGON RECORDS: 25 May to 18 September; 1918 to 1972; 20 to 3500 feet elev.

BENTON CO.: 10 mi. south of Corvallis (BAF*). DOUGLAS CO.: 7 mi. east of Reedsport. HARNEY CO.: Alvord (OSDA). JACKSON CO.: Jenny Creek, Hwy. 66; 6 mi. north of Medford; 9 mi. north of Prospect. Woodruff Meadows (OSDA). JOSEPHINE CO.: 0.5 mi. south of Cave Junction; Redwood Hwy., mile post 19 (OSDA). LANE CO.: 3 mi. north of Junction City. LINN CO.: 9 mi. north of Brownsville (BAF*). WASCO CO.: MT. Hood National Forest; 13 mi. north of Warm Springs; Hwy. 26, 1.5 mi. south of Jct. with Hwy. 216. WASHINGTON CO.: Forest Grove (UCB).

TETANOCERA PLEBEIA Loew

Loew, H. 1862. Smithsn. Inst., Smithsn. Misc. Collect. 6(1): 120. Types ♂ and ♀; Middle States.

DISTRIBUTION: Alaska, Yukon Terr., B. C. to Nfld. s. to Calif., Ariz., N. Mex., Iowa, Ill., Ind., Ohio, W. Va., N. Car.

OREGON RECORDS: 2 June to 7 August; 1917 to 1972; 2450 to 5240 feet elev.

CLACKAMAS CO.: Mt. Hood National Forest; 0.5 mi. west of Government Camp. DESCHUTES CO.: Sisters (BAF*). DOUGLAS CO.: Diamond Lake (CAS); 3 mi. southwest of Diamond Lake; 3.8 mi. northeast of Jackson Co. line, Hwy. 230. HOOD RIVER CO.: Hood River (UCB); Mt. Hood; 0.5 mi. south of Sherwood Campground. JACKSON CO.: Jenny Creek, Hwy. 66; 1.3 mi. southwest of Prospect; nr. Prospect (BAF*). KLAMATH CO.: 4 mi. north of Fort Klamath; 6 mi. south of La Pine; Odell Lake (BAF*); east of Willamette Pass. WALLOWA CO.: Enterprise (BAF*); 6 mi. west of Wallowa (OSDA).

TETANOCERA ROBUSTA Loew

Loew, H. 1847. Stettiner Ent. Stg., 8: 197. Types ♂ and ♀: Europe. Synonymy: *Tetanocera papillifera* Melander.

DISTRIBUTION: Europe; Alaska to Nfld., s. to Calif., N. Mex., S. Dak., Wis., Mich.

OREGON RECORDS: 18 June to 8 August; 1951 to 1972; 150 to 5100 feet elev.

BENTON CO.: 10 mi. south of Corvallis (BAF*). CLACKAMAS CO.: 1 mi. north of Government Camp; Mt. Hood National Forest. CROOK CO.: 1 mi. north of Prineville. GRANT CO.: nr. Strawberry Lake (BAF*). HARNEY CO.: Fish Lake, Steens Mts. (CAS). HOOD RIVER CO.: 0.5 mi. south of Sherwood Campground. KLAMATH CO.: Klamath Falls (BAF*); Odell Creek; east of Willamette Pass. LAKE CO.: Drews Valley; 9 mi. south of Lakeview. WALLOWA CO.: Enterprise (BAF*). WASCO CO.: 13 mi. north of Warm Springs. YAMHILL CO.: 5 mi. south of Dayton.

TETANOCERA ROTUNDICORNIS Loew

Loew, H. 1861. Berlin. Ent. Ztschr. 5: 344. Types ♂ and ♀. English River, Ontario.

DISTRIBUTION: Alaska to Nfld., s. to Oreg., Ill., N. Y.

OREGON RECORD: No dates available; 4105 feet elev.

Oregon (GSC*). KLAMATH CO.: Klamath Falls (BAF*).

TETANOCERA SOROR Melander

Melander, A. L. 1920. Ann. Entom. Soc. Amer. 13: 328. Type; Mica, Washington; USNM.

DISTRIBUTION: Calif., Idaho, Mont., Nev., Oreg., Wash.

OREGON RECORDS: 25 May to 30 September; 1918 to 1972; 1300 to 5000 feet elev.

BENTON CO.: Corvallis (BAF*); 10 mi. south of Corvallis. JACKSON CO.: 6 mi. north of Medford. LAKE CO.: Drews Valley. KLAMATH CO.: Snookum Meadow (UCB). WASCO CO.: Mt. Hood National Forest; Hwy. 26, 1.5 mi. south of Jct, with Hwy. 216; 15 mi. west of Pine Grove. WASHINGTON CO.: Forest Grove (UCD).

TETANOCERA UNICOLOR Loew

Loew, H. 1847. Stettin Ent. Ztg. 8: 199. Types ♂ and ♀: Europe.

DISTRIBUTION: Europe; Alaska to Nfld., s. to Oreg., Ariz., Iowa, Wis., Mich., N. Y.

OREGON RECORDS: 12 June to 9 July; 1965 to 1970; 2450 to 4100 feet elev.

CLACKAMAS CO.: Mt. Hood National Forest; 0.5 mi. west of Government Camp. HOOD RIVER CO.: Barlow Pass; 1.7 mi. north of Barlow Pass; 0.5 mi. south of Sherwood Campground. JACKSON CO.: 1.3 mi. southwest of Prospect. JEFFERSON CO.: 8 mi. north of Camp Sherman (OSDA).

TETANOCERA VICINA Macquart

Macquart, J. 1843. Soc. Roy. des Sci., de l'Agr. et des Arts, Lille, Mem. (1842): 337 or Dipt. Exot. (1843) 2(3): 180. Type; Philadelphia.

DISTRIBUTION: B. C. to Nfld., s. to Calif., Ariz., N. Mex., Iowa, Ill., Ind., Ohio, W. Va., N. Car.

OREGON RECORDS: 3 May to 7 August; 1917 to 1972; 20 to 5000 feet elev.

BENTON CO.: Corvallis (BAF*); Corvallis, Oak Creek (OSDA). DESCHUTES CO.: north of La Pine (BAF*). DOUGLAS CO.: 7 mi. east of Reedsport. HOOD RIVER CO.: Hood River (UCB). JACKSON CO.: Butte Falls (BAF*); nr. Prospect (BAF*); 1.3 mi. southwest of Prospect; northwest of Tou Velle State Park; 2 mi. south of Willow Lake, Indian Glade (OSDA). JOSEPHINE CO.: 0.5 mi. south of Cave Junction. KLAMATH CO.: 4 mi. north of Fort Klamath; 4 mi. south of Fort Klamath. LAKE CO.: Drews Valley. LANE CO.: Eugene airport; 3 mi. north of Junction City. WALLOWA CO.: Minam (BAF*). WASCO CO.: 13 mi. north of Warm Springs.

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ERRATA

A Correction in Notation of Sex of Type Specimens of *Pseudatrichia melanderi* Kelsey.—While checking the Diptera types on deposit in the California Academy of Sciences, preparatory to publishing a list of types held by them, it was discovered that there was a discrepancy in the material at hand and that published with the description of *P. melanderi* in Kelsey, L. P., 1969, A Revision of the Scenopinidae (Diptera) of the World. U. S. Nat. Mus. Bul. 277, p. 256 and I was asked to clarify the situation.

On checking my original drawings and notes I find that there was indeed an error in the designated sex of the Holotype and Allotype which should be corrected to read as follows:

Holotype: *Female* (USNM) 67465
Allotype: *Male* etc. (CAS) 8925

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Host Plants, Behavior, and Distribution of the Eucerine Bees *Idiomelissodes duplocincta* (Cockerell) and *Syntrichalonia exquisita* (Cresson)

(Hymenoptera: Anthophoridae)

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The monotypic eucerine bee genera *Idiomelissodes* and *Syntrichalonia* are limited to the arid portions of southwestern United States and northern Mexico. According to LaBerge (1957), *Idiomelissodes* is related to the more widespread genera *Svastra* and *Anthedonia*, and *Syntrichalonia* is perhaps related to the widespread genus *Synhalonia* (as *Tetralonia*). The species of *Idiomelissodes* and *Syntrichalonia*, *duplocincta* (Cockerell) and *exquisita* (Cresson), respectively, have been collected rarely, and very little is known about their flower preferences or behavior. The purposes of the present paper are to briefly summarize my observations on the host plants and behavior of these bees, and to extend their known distributions.

Most specimens reported here are in the collection of the California Academy of Sciences or in my private collection. Other specimens reported are in the following collections: Arizona State University; Instituto de Biologia, Universidad Nacional Autonoma, Mexico City; Natural History Museum of Los Angeles County; United States National Museum of Natural History; and University of California at Berkeley. I thank F. F. Hasbrouck, P. D. Hurd, Jr., E. G. Linsley, and R. R. Snelling for permission to examine the specimens in their care, E. G. Linsley and R. R. Snelling for criticizing the manuscript, and Roxi Berlin for typing the manuscript and preparing the tables.

IDIOMELISSODES DUPLOCINCTA (COCKERELL)

In southeastern Arizona and southwestern New Mexico, *duplocincta* occurs in the Sonoran and Chihuahuan deserts, where females gather pollen from flowers of barrel cactus, *Ferocactus wislizenii* (Engelm.) Britt. & Rose, throughout the hottest part of the day in the late summer. Both sexes of *duplocincta* visit other flowers for nectar, and in southwestern New Mexico I have collected specimens at the flowers of the following additional plants: *Cevallia sinuata* Lag. (Loasaceae), *Hoffmannseggia densiflora* Benth. (Leguminosae), and *Lippia wrightii*

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Table 1. Diurnal activity of *Idiomelissodes duplocincta* on *Ferocactus wislizenii*, Rock Hound State Park, Luna County, New Mexico, on several dates in 1973 and 1974. Time periods are in Mountain Standard Time. Time periods during which no collecting was done are marked "NC."

	Time periods															
	0900–1000		1000–1100		1100–1200		1200–1300		1300–1400		1400–1500		1500–1600		1600–1700	
Dates	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
16 Aug. 1973	NC		1		4	1	1	14	1	7	2		NC		NC	
17 Aug. 1973				7	2	3	NC		NC		3	2	2		1	
25 Aug. 1973		6	3	11		13	2	20		11	1	7	2	1	NC	
26 Aug. 1973		2		11		14	2	14	2	14		5	2	5	NC	
28 Aug. 1974						1		4		8		5		4		
29 Aug. 1974				1		3		15		4		3				
Totals		8	4	30	6	35	5	67	3	44	6	22	6	10	1	

Gray (Verbenaceae). Males from Baja California Sur that I have examined were collected at the flowers of *Asclepias* sp. (Asclepiadaceae), *Melochia tomentosa* L. (Sterculiaceae), and *Wislizenia refracta* Engelm. var. *mamillata* (Rose) Wiggins (Capparidaceae).

At Rock Hound State Park in southwestern New Mexico, *duplocincta* started arriving at *Ferocactus wislizenii* at 0900–1015 Mountain Standard Time (MST) on several mornings in 1973, and at 1045–1145 MST on two mornings in 1974, and continued to forage until 1500–1615 MST in the afternoon (Table 1). The air temperature varied from 24–31° C during my observations of the bees in 1974; the temperature was not recorded in 1973, but it was much higher, and this may account for the earlier arrival of the bees at the barrel cacti that year. At a site near Continental in southeastern Arizona, *duplocincta* was active on *Ferocactus wislizenii* from 1000–1015 MST until 1600 MST in both 1973 and 1974 (Table 2). At both localities, the daily foraging period of *duplocincta* appears to be well synchronized with the presentation of pollen by the barrel cacti. Individual flowers of these plants last three days. On the second and third mornings of their existence, the flowers open from 0830–0930 MST in bright sunlight, and pollen is available immediately. On all three afternoons, the flowers close from 1500–1700 MST in bright sunlight.

Females of *duplocincta* may approach a barrel cactus and fly directly into a flower, or they may approach and hover at a height of about 10–30 centimeters over the plant for several seconds before either landing or flying away. During this hovering, a female may drop to within a few centimeters of a flower, or strike it, or even alight on it momentarily, and then rise again one or more times. Once a female has settled on a flower, it crawls into the space between the style and innermost stamens and disappears from sight while it gathers pollen; after gathering pollen, it backs from this space and flies from the flower. At this time, it may again hover over the cactus for several seconds before departing or re-entering the same flower. Males of *duplocincta* fly rapidly around the barrel cacti, and sometimes hover over them, but they rarely land in the flowers. At Rock Hound State Park in 1973, they were frequently seen perching on twigs of mesquite, *Prosopis glandulosa* Torr. var. *torreyana* (L. Benson) M. C. Jtn., that extended over or near barrel cactus plants, and a single mating pair of *duplocincta* was observed on such a twig. The foraging activity of females and the patrolling activity of males are greatly reduced when the sun is obscured by clouds. Both sexes of *duplocincta* produce a char-

Table 2. Diurnal activity of *Idiomelissodes duplocincta* on *Ferocactus wislizenii*, 3.1–4.2 miles southeast of Continental, Pima County, Arizona, on two dates in 1973 and 1974. Time periods are in Mountain Standard Time.

	Time periods															
	0900–1000		1000–1100		1100–1200		1200–1300		1300–1400		1400–1500		1500–1600		1600–1700	
Dates	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
31 Aug. 1973				3		2		4		6	2	8	3	4		
21 Aug. 1974				2		2		2		1		1		3		
Totals				5		4		6		7	2	9	3	7		

acteristic odor, similar to that of species of *Svastra* (*Epimelissodes*), which, depending upon its strength, may be pleasant or unpleasant.

The seasonal flight period of *duplocincta* is known to extend from June 15 (LaBerge, 1956:1031) to 6 October; all my collections of this species have been made in August.

The distribution of *duplocincta* is summarized by LaBerge (1956: 1031), who records the species from Arizona, California, Chihuahua, and Coahuila. The species is recorded below for the first time from New Mexico and Baja California Sur.

Since *duplocincta* occurs in areas west of the range of *Ferocactus wislizenii* and sometimes flies in the early summer, before this cactus blooms, it obviously cannot be an oligolege of this species. However, since *duplocincta* is such a close and constant associate of this plant in southeastern Arizona and southwestern New Mexico, it probably is an oligolege of the genus *Ferocactus*, or, at least, of the family Cactaceae.

Specimens examined: 67 males, 264 females, from: UNITED STATES. *Arizona*: Continental (3.1–4.2 mi. SE); Graham Mts. (Stockton Pass); Mesa; Sahuarita (1.9 mi. SW); Sentinel; Tucson (16–18 mi. S). *New Mexico*: Deming (7.0 mi. ESE); Rock Hound State Park. MEXICO. *Baja California Sur*: La Paz (7 mi. SW, 24 mi. W, 10 mi. NW); Penjamo (22 mi. NW); Santa Rita (31 mi. S).

SYNTRICHALONIA EXQUISITA (CRESSON)

In southeastern Arizona, *exquisita* occurs most commonly in montane, forested regions, where it visits the flower heads of several species of Compositae for both nectar and pollen during the warmest part of the day in the late summer and early fall. All my records of this species are from composites with large, showy, yellow, radiate heads in the related, predominantly American tribes Helenieae and Heliantheae, namely: *Helenium hoopesii* Gray, *Helianthus annuus* L., *Heliopsis parvifolia* Gray, *Verbesina encelioides* (Cav.) Benth. & Hook., and *Viguiera dentata* (Cav.) Spreng. Other specimens of *exquisita* that I have examined were collected on *Asclepias* sp. (Asclepiadaceae), *Chrysopsis* sp. (Compositae, Astereae), *Encelia* sp. (Compositae, Heliantheae), *Helianthus annuus*, and *Verbesina oreophila* Woot. & Standl.

At Rucker Canyon, Chiricahua Mountains, in 1974, *exquisita* was active between 0930 and 1615 MST (Table 3). The air temperature in the upper, narrow part of the canyon, where *exquisita* visited flowers of *Viguiera dentata*, varied from 20–24° C during this time interval; the air temperature in the lower, broad part of the canyon, where it visited *Verbesina encelioides*, was 27° C at the time specimens were collected in the afternoon. At Rodeo, New Mexico, a male *exquisita* was collected

Table 3. Diurnal activity of *Syntrichalonia exquisita* on *Viguiera dentata* and *Verbesina encelioides*, Rucker Canyon, Chiricahua Mountains, Cochise County, Arizona, on several dates in 1974. Time periods are in Mountain Standard Time. Time periods during which no collecting was done are marked "NC."

	Time periods															
	0900–1000		1000–1100		1100–1200		1200–1300		1300–1400		1400–1500		1500–1600		1600–1700	
Dates	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
31 Aug. 1974	NC		NC		NC		NC		NC		NC		3	1	NC	
5 Sept. 1974	1		8	1	2		NC		NC		2	1	1	2		1
6 Sept. 1974		1		1	5	1	6	1	3	1	2	1	2		NC	
7 Sept. 1974	7	6	NC		NC		NC		NC		NC		NC		NC	
Totals	8	7	8	2	7	1	6	1	3	1	4	2	6	3		1

from *Helianthus annuus* by E. G. and J. M. Linsley between 1630 and 1659 MST when the temperature was 34° C.

Females of *exquisita* alight on the disks of the composite heads and gather the fine pollen grains characteristic of these plants in their dense, highly plumose scopal hairs. Males fly rapidly around and over the flower-bearing plants and alight occasionally to drink nectar. The foraging of females and the patrolling of males continue, but at reduced levels, when the sun is obscured by clouds for either short or long intervals.

The seasonal flight period of *exquisita* in southwestern United States is during and after the summer rainy season. The earliest and latest collection dates are 10 August and 4 October, and the greatest number of specimens has been collected in September. The seasonal flight period in Mexico is known to extend from 27 July to December.

Syntrichalonia exquisita has been previously reported only from Mexico (Cresson, 1878) and New Mexico (Cockerell, 1905). In the following list, it is recorded for the first time from Arizona and Texas in the United States, and Distrito Federal, Durango, Jalisco, and Zacatecas in Mexico.

Specimens examined: 61 males, 29 females, from: UNITED STATES. *Arizona*: Chiricahua Mts. (Barfoot Camp, Cave Creek Canyon, Rucker Canyon, Rustler Park); Huachuca Mts. (Miller Canyon, Yaqui Canyon Area); Mt. Graham; Patagonia (2.0 mi. SW); Santa Rita Mts. (Madera Canyon). *New Mexico*: Rodeo; Three Rivers (2 mi. S). *Texas*: The Basin, Big Bend National Park; Van Horn Mts. MEXICO. *Distrito Federal*: Pedregal de San Angel. *Durango*: Nombre de Dios. *Jalisco*: Mt. Colima (SE slope); San Juan Lagos. *Zacatecas*: Sombrerete (15 km. E).

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New Estuarine and Intertidal Water Striders from Mexico and Costa Rica

(Hemiptera: Gerridae, Mesoveliidae)

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The water striders described here are from localities having a marine influence, and are published so that the names will be available for a forthcoming work on marine insects. I am indebted to Dr. Paul Arnaud, Jr. and Vincent Lee of the California Academy of Sciences for making material available for study, to Lanna Cheng for calling my attention to the *Speovelia* from Baja California, and to Dr. Charles Hogue for suggesting that I investigate the Boca de Barranca area in Costa Rica.

For all measurements 60 units = 1 mm, except where given in mm. Types held in the Polhemus collection are irrevocably committed to later placement in a designated type repository.

FAMILY GERRIDAE

Rheumatobates prostatus, n. sp.

Length, apterous male, 2.5 mm; macropterous forms unknown. Color; deep brown to black; dorsum of thorax and abdomen mostly frosted; connexiva, postero-lateral portion of thorax, head except median longitudinal stripe, orange brown; broad medial area of pronotum, propleura, venter of head and thorax yellowish to leucine. Antenna brown, lighter ventrally and on base of segment I. Fore femur and acetabula yellowish brown, remainder of legs brown, lighter ventrally. Rostrum infuscated.

Structural characteristics. Antenna, hind legs and abdominal segments of male modified. Antennal formula I–IV: male, 34:4:32:26; female, 25:5:24:22. Male antennal segment I swollen, thickest at middle (7), thickly set with anteriorly directed bristles longer than width of segment where they arise; segment III slender, slightly curved and thinned distally with about 14–16 anteriorly and ventrally directed long bristles on basal third, one long anteriorly directed bristle near distal end; segment IV curved, with 9 long (7) ventrally directed bristles set in a regular row on the inside of the curvature. Head of male long (32), broad (28 across antennal tubercles), shorter (26) and narrower (25) in female; vertex moderately convex in male, less so in female. Male abdominal dorsum broadly, transversely depressed, tergite II lowest. Venter of abdomen modified so that ventrite IV is produced into an anteriorly directed protuberance, flanked by a raised portion of ventrite III; ventrites II–VI converging on this protuberance; entire median venter deeply excavate cephalad of ventrite VII; anterior margin of

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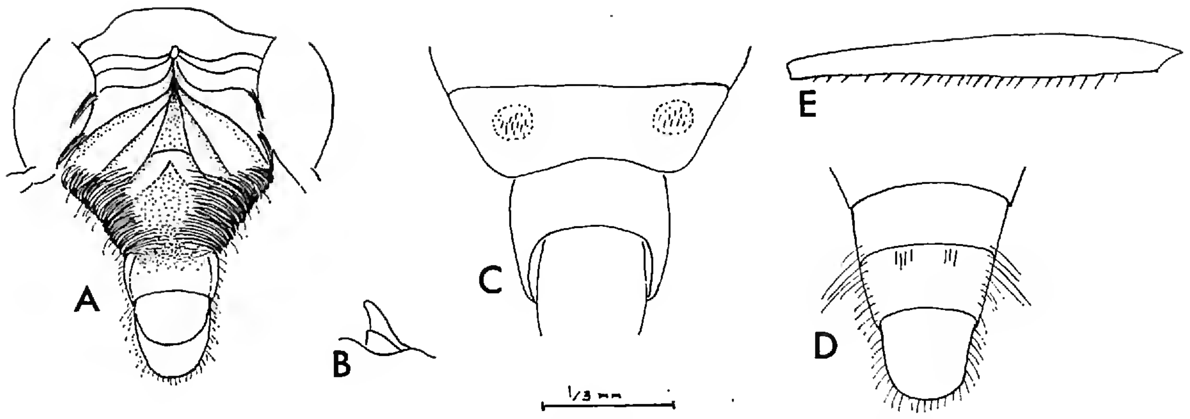

FIG. 1. A–B. *Rheumatobates prostatus* n. sp. A. Male abdominal venter. B. Side view, ventral projection, male. C. *Speovelia mexicana* n. sp., male abdominal venter. D–E. *Mesovelia halirrhyta* n. sp. D. Male ventral genital segments. E. Male middle femur.

ventrite VII broadly raised, then deeply excavate caudad; ventrites III and IV laterally with long ventrally directed tufts of hair; ventrites V and VI laterally with enormous brushes of very long curved hairs arising from lateral margins, curving inward and almost touching over midline of venter (Figure 1 A,B). Connexiva of male almost vertical, flatter in female. Male genital segments turned down slightly. Fore femur with an anterior basal knob, set with a few spines along posterior margin. Anterior tarsal claws slightly spatulate, otherwise unmodified. Posterior trochanter set with four long spines beneath; posterior femur slightly curved and set with long, slender decumbent hairs.

Material: *Holotype* (♂), and paratypes, 22 ♂♂, 37 ♀♀ (all apterous) and 53 nymphs, COSTA RICA, BOCA DE BARRANCA, CL1305, 1-7-1970, J. T. Polhemus (in J. T. Polhemus collection).

Discussion: This species is the third in a complex comprising *prostatus*, *R. aestuarius* Polhemus and *R. carvalhoi* Drake and Harris, but is easily separated from the others by the highly modified ventrites which form a protuberance. For a discussion of *aestuarius* and *carvalhoi*, see Polhemus (1969). All of these species have long brushes of abdominal ventral hairs forming an arch over the venter. Cheng and Lewin (1971) discussed the possibility that these were pheromone dispersal structures, but I am convinced that they and the depressed venter form a tunnel into which the female abdomen fits during copulation.

Ecology: Specimens of this insect were collected from an estuary where a large river enters the Pacific Ocean. They were not seen in the broad area just inside the bar near the ocean, but were taken perhaps ½ mile inland from the sea. Specimens were also collected in a shaded pond full of sticks and heavy vegetation that is apparently connected to the estuary at high tide. *Limnogonus* and *Mesovelia* also inhabited this pond, which is in a lowland tropical jungle and must experience rather large changes of salinity, as another pond only slightly deeper in the forest showed no evidence of marine influence but indicated an abundance of fresh groundwater.

FAMILY MESOVELIIDAE

Mesovelia halirrhyta, n. sp.

Ground color yellowish brown; legs and two basal antennal segments luteous; distal two antennal segments brown; venter yellowish, embrowned laterally. Thorax frosted on sides. Pronotum short, posterior margin straight; midline lengths of pronotum:mesonotum:metanotum/13:13:8. Body, legs and antenna set with very short decumbent pubescence. First antennal segment with 1 long (8) anteriorly directed thin setae at distal three fourths; antennal segments II, III and IV set with many long, thin setae. Legs with numerous longer thin hairs, hind tibia with scattered stiff brown setae. Male fore femur armed beneath with 14 black spines, their lengths ¼ to ½ of the width of the femur where they arise; middle femora armed beneath with 25 black spines of similar proportional lengths. Female fore and middle femora similarly armed with 9 and 16 spines, respectively. Head long (30), broadened anteriorly to antennal tubercles, wide across tubercles (22); with median sulcus posteriorly, reaching caudal margin, becoming evanescent anteriorly between eyes; eyes large (width of eye/interocular space: 9/14) with many ommatidia, converging anteriorly; length 15; width of eye:interocular space/10:13. Antenna long, slender, segment I stoutest; proportions I–IV, 33:25:47:48. Abdominal tergites I–VI subequal in length, with II and VI slightly longer (8–9) than the others (each 7). Median pore at anterior ¼ of tergite IV.

All femora stout, tibia and tarsi slender; proportions of legs:

	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	51	43	2	6	6
Middle	59	57	2	8	6
Posterior	76	97	3	13	10

First genital segment of male armed at anterior margin with two groups (1 + 1) of 3 or 4 posteriorly directed thin brown spines. Male parameres small, curved, elongate.

Male (holotype) length 2.50 mm, width (across abdomen) 0.7 mm; female length 2.75 mm, width (across abdomen) 1 mm.

Material examined: *Holotype* (apterous ♂) and paratypes, 3 ♂♂, 5 ♀♀, all apterous, COSTA RICA, BOCA DE BARRANCA, CL 1305, 1-7-1970, J. T. Polhemus (in J. T. Polhemus collection).

Discussion: *Mesovelia halirrhyta* may be easily separated from its congeners by the placement, nature and number of thin spines on the first genital segment, and by the armature of the fore and middle femora. In genital armature, it most closely resembles *Mesovelia horvathi* Lundblad, but the legs are greatly different in the two species. Other American species have armed femora, but at most 8–10 spines on any male femur (e.g. *M. mulsanti* White, *M. hambletoni* Drake and Harris).

Ecology: These specimens were taken in a pond beside an estuary.

For a discussion of this site, and the associated fauna, see the notes under *Rheumatabates prostatus* n. sp. in this paper.

Speovelia mexicana, new species

Ground color light brown; femora and antenna luteous; femora distally, first two antennal segments, genital segments lightly embrowned; venter orange brown. Pronotum with posterior margin sinuate, midline lengths of pronotum:mesonotum: metanotum 15:8:9. All three segments with broad areas laterally set with fine pits visible in alcohol. Body, legs and antenna covered with very short pubescence. Anterior and posterior femora each with one black spine on dorsal surface at distal three fourths; posterior tibia with six black spines; first and second antennal segments with scattered longer setae. Head long (32), broadened anteriorly to antennal tubercles, wide (24) across tubercles; dorsum with median double parallel lines, joining posteriorly, nearly reaching posterior margin; width of an eye:interocular space/4:20; eyes small compared to *Mesovelia*, roughly faceted, with about 30 to 35 ommatidia. Antennal segment I moderately stout, II slender, III–IV very long and slender; ratio I–IV, 33:28:54:73. Abdominal tergites II–VI subequal in length (10), tergite I shorter (8), tergite VII longer (16); genital segments I and II subequal in length dorsally (12). Median pore at anterior ⅓ of tergite 4.

All femora stout, tibia and tarsi slender. Proportions of legs:

	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	50	47	3	7	10
Middle	55	58	3	8	12
Posterior	60	80	3	11	13

Male parameres symmetrical, spatulate. Eighth abdominal sternite with two (1 + 1) lateral callosities, each with a small central tubercle embrowned posteriorly.

Length 2.6 mm, width 1 mm (across abdomen). Winged form and female unknown.

Material examined: *Holotype* (apterous ♂), MEXICO, BAJA CALIFORNIA, BAHIA CONCEPCION, BEACH N. OF BAHIA COYOTE, 2 April 1974, #137(2), Vincent F. Lee; 3 nymphs, same data. All specimens are in the California Academy of Sciences, in alcohol.[1]

Discussion: This species is clearly a *Speovelia*, being closely allied to *Speovelia maritima* Esaki, but easily distinguished by the processes on the eighth abdominal ventrite. The parameres of *mexicana* are

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[1] After this paper went to press, I collected a female of *Speovelia mexicana* new species on the opposite side of the Gulf of California (paratype, apterous ♀, MEXICO, SONORA, SAN CARLOS, CL715, VI-4-1975, J. T. Polhemus; in Polhemus collection). The female is very similar to the male in most respects, except all femora are armed with 1 spine at distal ¾, and the posterior tibia has only 3 spines; slightly longer (3.2 mm) and wider (1.4 mm) than male. Ovipositor sheath similar to *Speovelia maritima* Esaki.

The San Carlos specimen was found at midnight skating in a protected tide pool, at low tide, in the same locality frequented by *Enalosalda mexicana* (Van Duzee). Many sea caves and protected coves occur near San Carlos, and a search of these at low tides should result in further collections of this interesting insect.

rather long and slender, spatulate, while those of *maritima* are rather broadly expanded distally.

Habitat notes: Vincent Lee has kindly furnished some notes concerning the habitat of this unusual bug, which I paraphrase here. He stated that the specimens were collected from under rocks atop a gently sloping reef-like area, with a rocky overhang having a 6–8′ ceiling height covering the intertidal area. The insects were skimming on the surface of the water that was trapped by the reef after the tide receded.

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Bee and Wasp Visitors to *Kallstroemia grandiflora* After Two Years of Drought

M. A. CAZIER AND E. G. LINSLEY[1]

In August, 1971, at a site along the Portal Road, two miles north of Rodeo, Hidalgo County, New Mexico, between the Arizona-New Mexico state line and U. S. highway 80, *Kallstroemia grandiflora* (Torrey) Gray was blooming profusely in large patches on each side of the road. At that time, the flowers were being visited by 15 species of bees (representing 11 genera and six families) and three species of wasps (representing three genera and two families) (Cazier and Linsley, 1974). Females of seven species of bees were gathering pollen and nectar from a position on top of the stamens, females, and/or males of seven species of bees and one of wasps were taking nectar only from the same position, females and/or males of three species of bees and one of wasps were taking nectar from beneath the stamens, and females and/or males of three species of bees and one of wasps were taking nectar from the underside of the flower (for a description and discussion of these various processes, see Cazier and Linsley, 1974).

During the summers of 1970 and 1973 no *Kallstroemia* seeds germinated within 10 miles of this site, but in 1974 the seeds germinated and the plants grew and again bloomed profusely in the same areas occupied in 1971. During the flowering period, other plants which compete with *Kallstroemia* for bee and wasp visitors, all of which are polylectic but often as individuals or local populations constant to particular pollen sources (bees), were scarcer than usual. This may account in part, at least, for the fact that half hour samples throughout a diurnal blooming cycle in mid-August (0800–1400 hours) yielded 951 bees of 25 species representing 15 genera and five families and 63 wasps of 12 species representing 10 genera and four families. The principal species of bees and wasps, those represented in the samples by five or more individuals, are listed by half hour (actually 29 minute) periods and kind of activity at the flowers in tables 1 and 2.

NOTES AND COMMENTS

As in 1971, the oxaeid *Protoxaea gloriosa* (Fox) was the largest and dominant species of bee visiting *Kallstroemia* flowers. However, indi-

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Table 1. Half hour samples of principal species of bees visiting *Kallstroemia grandiflora* during a diurnal blooming cycle in mid-August, 1974, two miles north of Rodeo, Hidalgo County, New Mexico. (PN = taking pollen and nectar from top of stamens, NS = taking nectar only from top of stamens, NBS = taking nectar only from beneath stamens, NUF = taking nectar only from underside of flower)*

Species			0800 0829	0830 0859	0900 0929	0930 0959	1000 1029	1030 1059	1100 1129	1130 1159	1200 1229	1230 1259	1300 1329	1330 1359	Totals
P. gloriosa	♀	PN	29	27	25	19	12	11	6	1					130
	♂	NS	5	12	7	4	5	13	4	15	13	13	5	6	102
P. sumichrasti	♀	PN	4	14	18	19	17	4	5	4	2	4	4	2	97
	♀	NS							1	9	6	3	2	4	25
	♂	NS									4	3	6	10	23
E. solani	♀	PN			2										2
	♀	NUF			1	6	5	7	5	5	13	13	9	7	71
	♂	NUF		2	1	4	1	2	11	9	5	6	4	5	50
M. limbus	♀	PN		1	1		2	1	3			2			10
	♀	NS			1		1		1						3
	♂	NS			2	1	2	7	3	23	21	14	8	8	89
Triepeolus spp.	♀	NS		1	1		1		4	2	2	3	7	7	28
	♂	NS		1	1	2		1	1	1	4	4	6	7	28
S. sabinensis	♀	PN		1				2		1	5	4			13
	♀	NS			1							4			5
	♂	NS										3	9	6	18

* Bee species referred to in Table 1 are *Protoxaea gloriosa* (Fox), *Ptilothrix sumichrasti* (Cresson), *Exomalopsis solani* Cockerell, *Melissodes limbus* LaBerge, *Triepeolus* spp., *Svastra sabinensis sabinensis* (Cockerell), *Diadasia ochracea* (Cockerell), *Melissodes thelypodii thelypodii* Cockerell, *Melissodes tristis* Cockerell, *Melissodes paroselae* Cockerell, *Agapostemon angelicus* Cockerell, *Psaenythia mexicanorum mexicanorum* (Cockerell), *Melissodes verbesinarum* Cockerell, *Nomia tetrazonata tetrazonata* Cockerell, *Svastra sila* (LaBerge), *Melissodes vernalis* LaBerge, and *Apis mellifera* Linnaeus.

Table 1. (Cont.)

Species			0800 0829	0830 0859	0900 0929	0930 0959	1000 1029	1030 1059	1100 1129	1130 1159	1200 1229	1230 1259	1300 1329	1330 1359	Totals
D. ochracea	♀	PN		1	1	1		1	1						5
	♀	NS								1					1
	♂	NS								1		1	2		4
M. thelypodii	♀	PN		2	1	1	1	1			2				8
	♀	NS								1					1
M. tristis	♀	PN		1				1							2
	♀	NS							1		2			1	4
M. paroselae	♀	PN										1			1
	♀	NS		1				1		1		1			4
A. angelicus	♀	NS		3	2										5
P. mexicanorum	♀	NS			1	1	1				1			1	5
M. verbesinarum	♀	PN							1	1					2
	♂	NS							2	2	6	2		3	15
N. tetrazonata	♂	NBS			2				3		1			1	7
S. sila	♀	PN					1				1	3	3		8
M. vernalis	♂	NS									1		5	10	16
A. mellifera	♀	PN								2	1				3
	♀	NUF		4	2	7	16	21	26	22	16	20	9	7	150
Totals			38	71	68	65	65	73	78	101	106	104	79	85	935

viduals of both sexes were even more numerous in 1974. Females with their remarkably developed pollen collecting scopae loaded with the bright red pollen were very conspicuous as they flew rapidly from flower to flower, alighting on and grasping the stamens as they rotated around to each of the five nectaries. Males were even more numerous and more conspicuous as they established territories throughout the fields of *Kallstroemia*, darting at other bees and insects and pausing periodically for rapid visits to several flowers for the nectar necessary for them to maintain their constant flight. During these flower visits the males became almost completely covered with pollen which adhered to their appendages and ventral surfaces in particular but also to the head and thoracic dorsum and abdominal apex. In this condition, the brightly colored pollen is very noticeable in the poising, darting bee. However, the males, which mass by the hundreds and "sleep" gregariously, remove the pollen from their bodies at or near the aggregation site before settling in for the evening. In 1974, the males formed their aggregations in the *Kallstroemia* fields, utilizing both the stiff branches of *Ephedra trifurca* Torrey and the comparatively flimsy stems of *Amaranthus palmeri* Watson. Mating pairs were found in the morning (e.g. 1047, 1050, 1109, 1115 hrs.) hanging from the petals beneath the *Kallstroemia* flowers.

In 1974, *Ptilothrix* sp. nr. *sumichrasti* (Cresson) was only slightly less abundant than *Protoxaea gloriosa* (122♀, 23♂: 130♀, 102♂), judging from our samples, the largest discrepancy being among males. Mating was not observed. This species was not found at the Rodeo *Kallstroemia* site in 1971, but in 1972, 3 females were taken while gathering pollen from flowers near Apache, Cochise County, Arizona, about 11 miles to the south.

Other bees well represented in 1974 that were absent or poorly represented in 1971, were *Triepeolus* spp. (one of these presumably parasitic in the nests of *Protoxaea gloriosa*), *Melissodes limbus* LaBerge, *Svastra sabinensis sabinensis* (Cockerell), *Melissodes verbesinarum* Cockerell, and *Melissodes vernalis* LaBerge. *Melissodes verbesinarum*, although represented by both sexes, did not appear until 1100 hrs., past the peak of activity of female *Protoxaea* and *Ptilothrix*.

Among the species of bees excluded from the table because they were represented in the samples by less than five individuals were *Pseudopanurgus verbesinae* Timberlake (♂), *Xenoglossodes eriocarpi* (Cockerell) (♂), *Psaenythia bancrofti* Dunning (♀, ♂), *Paranomada velutina* Linsley (♀) and *Triopasites micheneri* Linsley (♀). Each of these extract nectar from a position beneath the stamens, and each had

Table 2. Half hour samples of principal species of wasps visiting *Kallstroemia grandiflora* during a diurnal blooming cycle in mid-August 1974, two miles north of Rodeo, Hidalgo County, New Mexico. (NS = taking nectar from top of stamens, NBS = taking nectar from beneath stamens, NUHF = taking nectar from underside of flower)*

Species			0800 0829	0830 0859	0900 0929	0930 0959	1000 1029	1030 1059	1100 1129	1130 1159	1200 1229	1230 1259	1300 1329	1330 1359	Totals
B. u-scripta	♀	NUF	1	2									1		4
	♂	NUF	3	1	1										5
C. octomaculata	♀	NS				2	1		1	3		2	1	1	11
M. navajo	♀	NBS				2	1			2		1	2	1	9
M. frontale	♀	NBS					1			1		2	1		5
Myzinum sp.	♀	NUF				2				1	1	1		1	6
P. arizonicus	♀	NUF						1	1		2	1			5
A. occidentalis	♂	NBS							1	2		1		1	5
S. nobilitata	♂	NBS							1		2		1	1	5
Totals			4	3	1	6	3	1	4	9	5	8	6	5	55

* Wasp species in Table 2 are *Bembix u-scripta* (Fox), *Campsoscolia octomaculata texensis* (Saussure), *Myzinum navajo* Krombein, *Myzinum frontale* Cresson, *Myzinum* sp., *Pterocheilus arizonicus* Bohart, *Astata occidentalis* Cresson and *Scolia nobilitata fulviventris* Bart.

scattered pollen grains attached to the dorsum and appendages and parts of the ventral surface, the former presumably resulting from lightly brushing the stamens as they crawl beneath them, the latter presumably picked up accidentally from loose pollen in the base of the flower. (The pollen of *Kallstroemia* is so adhesive that it adheres to the body and appendages of such relatively naked parasitic bees as *Triepeolus* and *Nomada* which extract nectar from astride the anthers, and are thus capable of pollination.)

Excluded bees which take nectar from a position on top of the stamens include: *Svastra helianthar*um (Cockerell) (♀), *Melissodes subagilis* Cockerell (♂), *Melissodes brevipyga* LaBerge (♀), *Xenoglossodes* sp. (♀), and *Nomia micheneri* Cross (♂).

The principal species of bee taking nectar from beneath the flowers in 1974, as in 1971, was *Apis mellifera* Linnaeus. However, although in 1971 no individual worker was observed gathering *Kallstroemia* pollen, in 1974 three individuals were captured inside the flower and each was carrying *Kallstroemia* pollen. *Centris* spp., especially *C. atripes* Mocsary and *c. atriventris* Fox, frequently visit the underside of the flower for nectar, but they are readily disturbed at a distance of 5 to 10 ft. and are extremely difficult to sample without disturbing other flower visitors in the area.

Wasps excluded from the table were mostly individuals of species not taken previously at either the Rodeo or Apache sites and have not been identified.

ACKNOWLEDGMENTS

We are especially indebted to Dr. Wallace E. LaBerge of the Illinois Natural History Survey for identification of most of the bees obtained in our samples. Appreciation is also expressed to Juanita M. (Mrs. E.G.) Linsley and Marjorie Statham Favreau for assistance in field collections.

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Dahmsia, a New Genus of Mymaridae

(Hymenoptera: Chalcidoidea)

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Australia has a remarkably rich Mymarid fauna to which this paper adds the following element:

Dahmsia, new genus

Female.—Body length 0.86 to 1.16 mm. Dark brown, legs light brown, eyes red. Abdomen petiolate, Figs. 1 and 3. Tarsi 4-segmented, Fig. 7. Head, lateral view, Figs. 3 and 6, peculiarly shaped with upper face including toruli projected forward from elongate vertex; lower face slanted posteriorly. Longest axis of compound eye horizontal. Mandibles elongate, Fig. 5. Antennal club a single, large,

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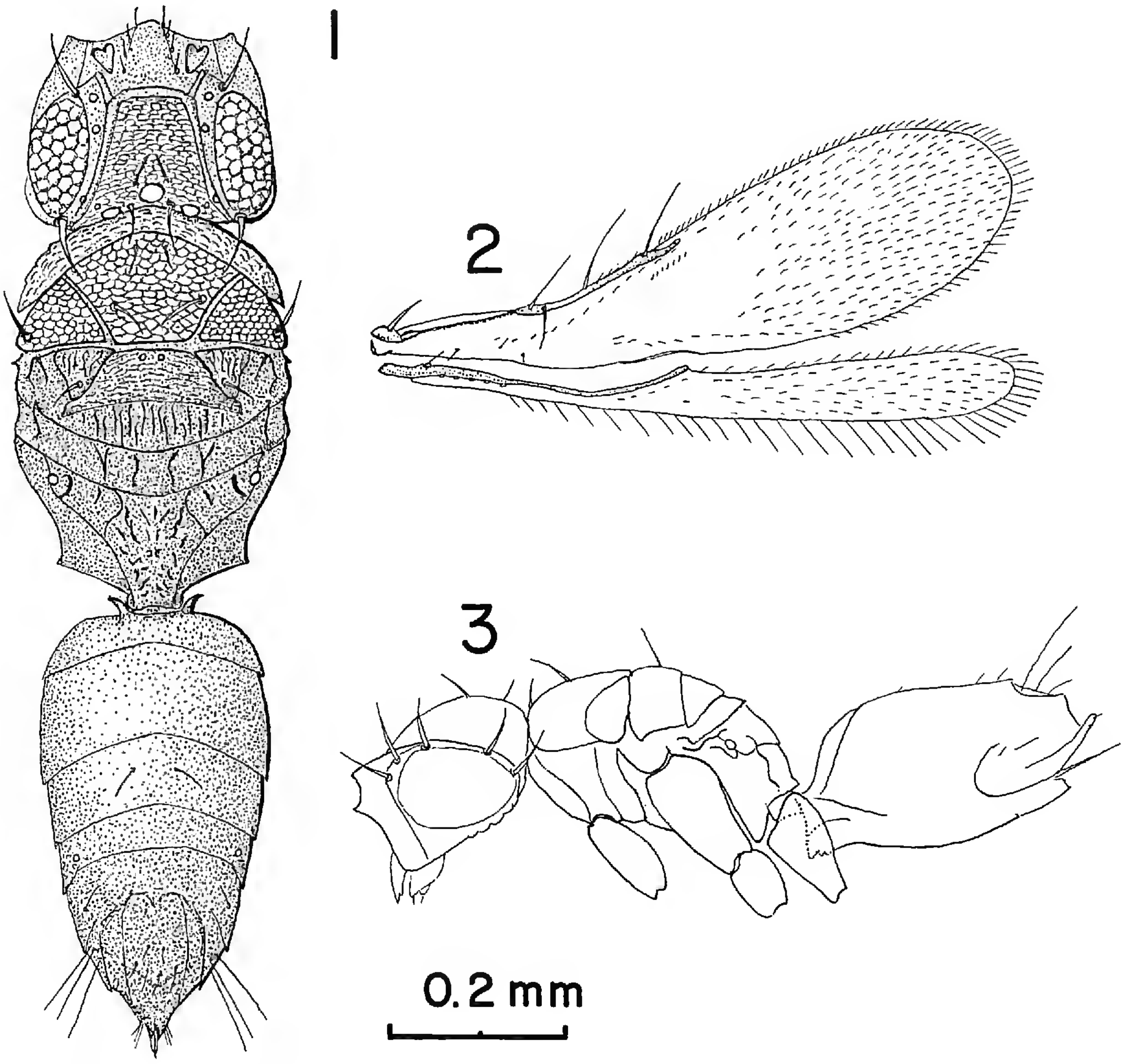

FIGS. 1–3. *Dahmsia australiensis.* Fig. 1. Body, dorsal view. Fig. 2. Wings. Fig. 3. Body, dorsal view.

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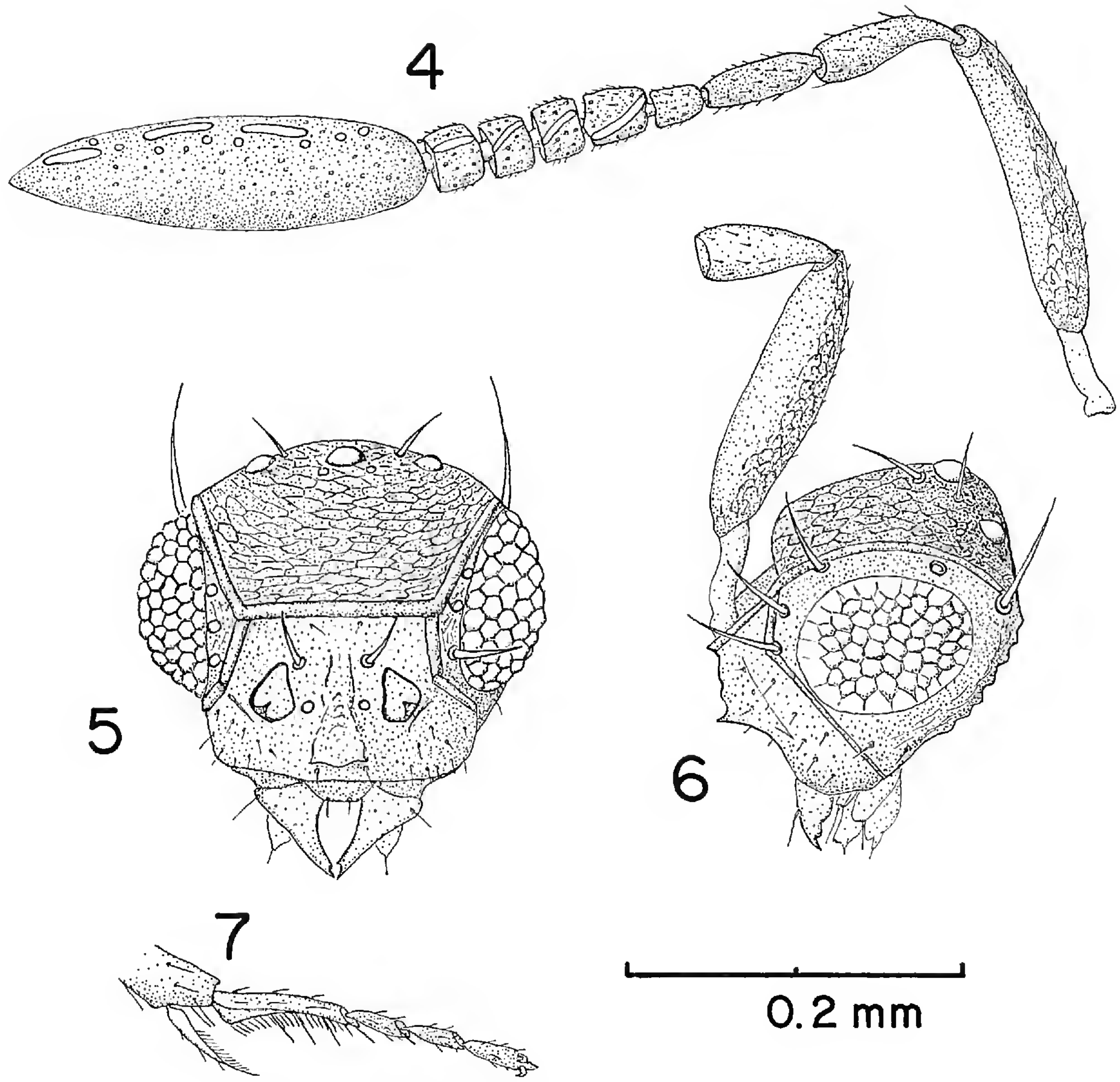

FIGS. 4–7. *Dahmsia australiensis.* Fig. 4. Antenna. Fig. 5. Face. Fig. 6. Head, lateral view. Fig. 7. Foretarsus.

elongate segment; funicle 6-segmented with funicle segment 1 elongate, equal to pedicel; funicle segments 2 to 6 short, 3 to 6 broad, Fig. 4. Forewings hyaline, marginal vein elongate with distinct radius, Fig. 2. Marginal cilia of hindwing longer than those of forewing. Thorax with distinct sculpturing, abdomen smooth, ovipositor short.

Male.—Unknown.

Certain features of this genus resemble those characteristic of the subfamily Eubrocinae proposed by Yoshimoto, *et al.*, (1972). These are the elongate mandibles, petiolate abdomen, 4-segmented tarsi, and 9-segmented antennae. The genus *Dahmsia* differs significantly in having a short pronotum, differently shaped forewings, and in lacking the acute angle between the planes of fronto-vertex and lower face characteristic of the genera in Eubrocinae, namely *Eubroncus* and *Stomarotrum.*

This genus is named for E. C. Dahms, Curator of Entomology, Queensland Museum. The type species is described as follows:

Dahmsia australiensis, new species

Female.—Antenna, Fig. 4, with massive elongate club equal to combined lengths of scape and radicle. Funicle segment 1 twice length of any other segment; segments 1 and 2 distinctly more slender than following segments; funicle segments 3 to 6 short and wide, each with linear sensoria; these obliquely oriented on segments 3 to 5. Antennal setae very short. Pedicel slightly longer than funicle segment 1. Scape and radicle elongate, scape with reticulate sculpturing on dorsal surface.

Fronto-vertex produced well forward of ocelli; upper face including toruli a shelf-like anterior projection of fronto-vertex. From toruli the face abruptly angles ventrally, then slants posteriorly to clypeus. Compound eyes bordered dorsally and anteriorly by large, prominent spines. Fronto-vertex reticulate. Mandibles elongate. Hind wings broadened apically.

Male.—Unknown.

Holotype female. MINYON FALLS, N. S. W., AUSTRALIA, by sweeping native vegetation, September 9, 1965, R. L. Doutt. Six paratypes, same data.

Holotype to be deposited at Queensland Museum. Paratypes to be distributed to California Academy of Sciences, U.S.N.M., and Division of Biological Control, University of California, Berkeley.

LITERATURE CITED

YOSHIMOTO, K. M., M. A. KOZLOV, and V. A. TRJAPITZIN. 1972. A new subfamily of Mymaridae (Hymenoptera, Chalcidoidea). Rev. Entomol. U.S.S.R., 51(4): 878–885. (In Russian).

SCIENTIFIC NOTE

Cage for observing and rearing small arthropods.—In studying the biology of the anystid mite, *Anystis agilis* (Banks) a need arose for a positive restraining cage to contain this hyperactive species. Existing cage designs which utilize both barrier and totally enclosed systems were examined (McMurtry and Scriven 1965, J. Econ. Entomol., 58: 282–4; Hughes *et al.* 1966, J. Econ. Entomol., 59: 1024–5; Horsburgh and Asquith 1968, J. Econ. Entomol., 61: 572–3; Medved and Fleschner 1971, J. Econ. Entomol., 64: 342; Osborn and Laing 1972, J. Econ. Entomol., 65: 1175–6) but all proved unsatisfactory due to one or more of the following reasons: escape; cage complexity or expense; poor observability or access; mortalities associated with desiccation, condensation or barriers. To circumvent these disadvantages, a cage was developed that is constructed of readily available and inexpensive prefabricated components (Fig. 1). The design encompasses a confinement area and a water reservoir, and appears well suited for observing and rearing predatory mites and small insects. Its practicality is enhanced by a reusable main body and easily replaceable, expendable components.

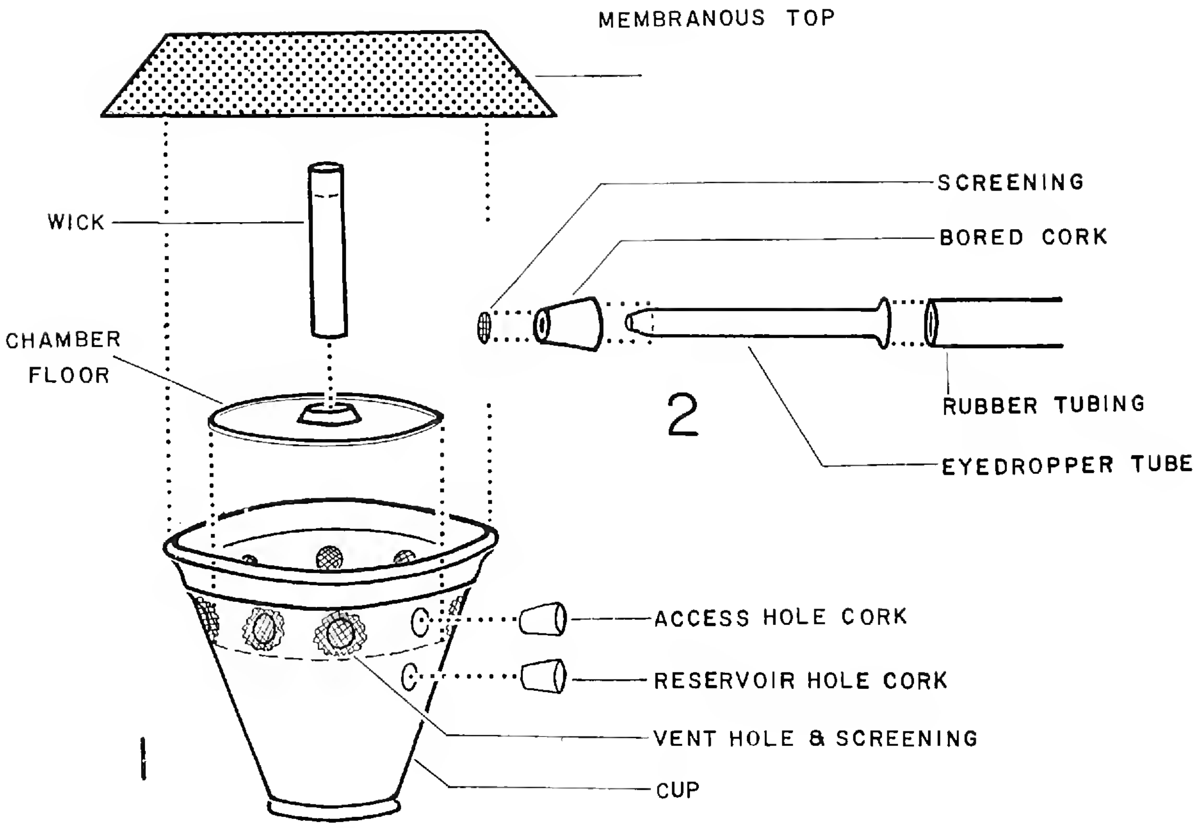

FIG. 1. Cage, exploded view.
FIG. 2. Aspirator, cxploded view.

The materials were: plastic food wrap (Stretch & Seal®, Colgate-Palmolive Co., New York, N. Y. 10022); plastic disposable coffee cup refills (Solo Cozy Cup®, 7 oz, No. 806 RC; Solo Cup Corp., Chicago, Ill. 60649); 7 cm dia. plastic cup lids (Dixie® No. 907 S; American Can Co., Easton, Pa. 18042); plastic glue (Weldit Cement®, Weldit Corp., New York, N. Y. 10011); Silicone Seal® (General Electric, Silicone Dept., Waterford, N. Y. 12188); rubber cement; fine weave nylon cloth; dental wicks; and 0.25 in corks.

In construction, 8 holes were punched with a standard paper punch 1.25 cm below the rim of the cup. One of these served as a corked access, with the remaining 7 as screened vent holes. A 9th hole was punched 3.5 cm below the cup rim and served as a reservoir fill hole. The cup lid served as the floor of the confinement chamber, and was trimmed of its central, circular straw hole cover to create a perfectly round opening without nicks. Silicone Seal was applied to the outer edge of the lid, which was inverted and placed into the cup to a depth of ca. 2 cm, thus creating the confinement chamber's vertical depth. This depth placed the lid below the upper 8 vent holes but above the reservoir hole. Nylon cloth, fastened to the cup with plastic glue, was used to cover the vent holes. A 6 cm long dental wick, used as a capillary moisture source, was inserted through the lid's straw hole leaving ca. 1 cm protruding up into the confinement chamber. When wetted, the wick swelled slightly forming a tight seal against the lid. A light, even coat of rubber cement was applied to the cup rim which was then covered with plastic food wrap to form a tight, yet removable and resealable, top.

Cage durability was attested to by survival through several uses and subsequent washings. Expendable components (the wick, the plastic food wrap top and the rubber cement) were replaced when fouled. Damage to the cage's reservoir seal was quickly repaired by removal of the confinement chamber floor and reapplication of Silicone Seal. Cost per cage was ca. 5 cents (excluding labor), while construction time for each unit was ca. 7 minutes.

A convenient method of introducing specimens through the access hole was achieved by an aspirator modified from a design by Laing and Osborn (1974, Entomophaga, 19: 267–77). The aspirator consisted of a rubber tube, an eyedropper glass tube, a small cork with a center hole, and a small piece of 200 mesh per inch screen (Fig. 2). The animal was sucked up lightly and held against the screening, then expelled into the chamber after the modified cork was maneuvered through the access hole.

If the cage is to be used for rearing only, one modification is the substitution of a snap-on plastic top (Dixie® half pint container top No. 2568) for the plastic food wrap top and rubber cement seal. When inverted, this top snaps over the cups' rim. Disadvantages of this modification are: it does not guarantee an absolutely positive seal thereby limiting its use with very small predators; the container top has a poor optical clarity; access is somewhat hampered because of the tight fit of the top.

The only possible disadvantage noted in the cage, as originally described, was a relatively high internal humidity. If undesirable, this might be alleviated by: shortening the evaporative area of the wick, subjecting the cage to external air movement or increasing the number of vent holes. It should also be mentioned that various plastics have been noted to cause some degree of toxicity or behavioral modification with certain insects (Chada 1962, J. Econ. Entomol., 55: 970–2; Hutt and White 1972, J. Econ. Entomol., 63: 615; Osgood 1974, Can. Entomol., 106: 1039–42).

This work was supported by National Science Foundation Grant GB-20961-A1 and California Wine Advisory Board Contract V-45. The mention of a product does not constitute its endorsement by either the authors or the University of California.
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Surface Molting Behavior and its Possible Respiratory Significance for a Giant Water Bug *Abedus herberti* Hidalgo

(Hemiptera: Belostomatidae)

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Relatively little attention has been given insect molting behavior. Entomological textbooks (*e.g.* Borror and DeLong 1971, Romoser 1973, Ross 1965) usually accompany their discussion of the protective qualities of the integument with assertions of the vulnerability of insects during their molts. These discussions invariably neglect to suggest how insects behave in ways to minimize risks and to meet other challenges presented by the necessity to molt. Wigglesworth (1972) reviews the literature on the physiology of molting, stressing the function of ingested air or water in swelling the thorax to cause the initial integumentary rupture. He does not mention the importance of substrate in this context, but other authors (Snodgrass 1919, Corbet 1957) suggest that adequate substrate is a requisite for the molting of some insects, with the implication that contractions of thoracic musculature associated with the legs may be necessary to initiate ecdysis.

Respiration presents a special challenge in the molting of aquatic Hemiptera. The majority of nymphs of totally aquatic bugs (Hydrocorisae) utilize an air film for underwater respiration. Air is obtained from the atmosphere at the air-water interface and maintained on the body of the insect by means of hydrofuge pubescence. Since this air store is integral with the integument, it is effectively, if not actually, lost shortly after the onset of shedding. Hungerford (1920) reviews the literature on the biology and ecology of aquatic Hemiptera, but fails to mention molting behavior. In his notes on the last molt of *Lethocerus americanus* Say, Torre Bueno (1924) stated that this insect floats "with its back up" during the molting process. Menke (1960) observed that *Abedus* nymphs shed "while the bug is floating, legs spread, at the

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surface." Tawfik (1969) seems to be the first to have speculated on the adaptive significance of surface molting by a belostomatid. He stated that in *Lethocerus niloticus* Stål (= *Lethocerus cordofanus* Mayr), "The functional abdominal spiracles, which are located dorsally on the adult, are situated ventrally on the nymph's body. For this reason the mature nymph, in the act of molting, becomes anxious to keep the thorax over the water surface and thus the thoracic spiracles become (sic) in contact with atmospheric air." Some of Tawfik's ideas on respiratory morphology, presumably taken from Presswalla and George (1935) are in error, and he fails to mention the behavior of nymphs in molting prior to the definitive molt. It is also unclear from his statements why it would be important to keep the thoracic spiracles in contact with air if the abdominal spiracles are the functional ones, but I agree that surface molting must in some way function to provide for the respiratory needs of the emerging nymph or imago.

It is my purpose in this paper to recount in detail the molting behavior of *Abedus herberti* Hidalgo, to point out certain neglected aspects, and to discuss ways in which surface molting may function to provide for respiratory needs of the molting individual.

METHODS AND MATERIALS

In the genus *Abedus*, females lay their eggs on the back of the male. I obtained first instar nymphs from egg-encumbered male *Abedus herberti* collected in central Arizona. Laboratory rearing of 31 individuals provided ample opportunity to observe numerous molts of all instars. No less than three molts of each instar were observed. I used still and motion picture photography to record events for detailed study. My rearing techniques are detailed in another paper (Smith 1974).

MOLTING BEHAVIOR

The following account is a synthesis of my observations on the molting behavior of first through fifth instars. Since the description is keyed to Figure 1, the final molt is emphasized.

One to five days prior to the onset of actual shedding of the old skin, the integument begins to darken. This signals the separation of the old integument from the new. In later instars the wing pads show a reddish reticulate pattern; this is especially pronounced in the fifth instar. The day before a molt is to occur, the abdomen and to a lesser extent the thorax and wing pads take on a deep brownish-orange color. Dark black triangles appear on the visible portion of each side of the

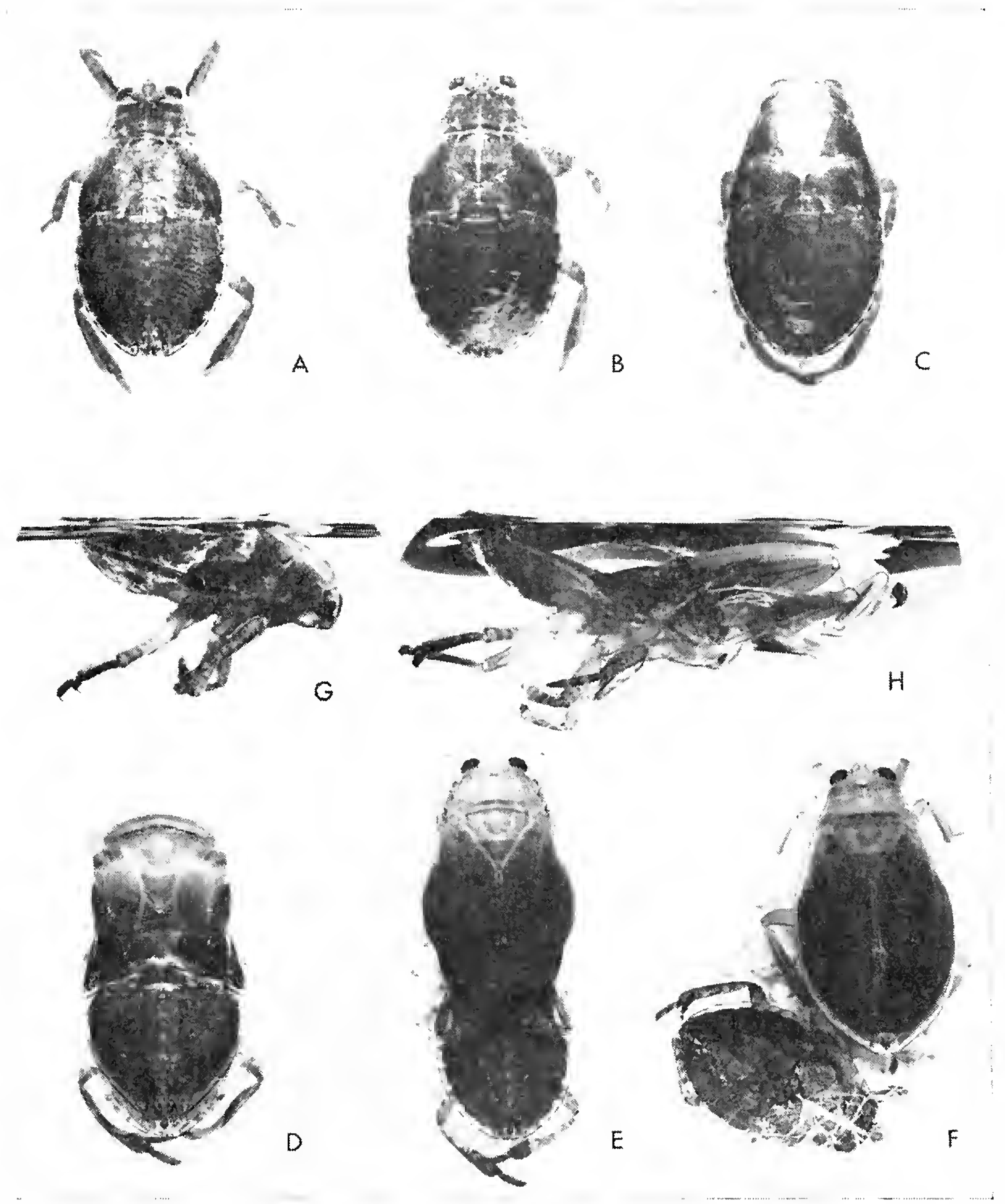

FIG. 1. Final molt of *Abedus herberti*. A through F: Dorsal aspects of the molt sequence. G: Lateral view equivalent to C. H: Lateral view equivalent to E.

metatergum, with the base of each adjacent to the wing pads, and its apex pointing toward the midline. Nymphs ignore food at this time, and remain floating at the surface continuously.

Dorso-ventral thickening occurs noticeably on the day of the molt, and actual ecdysis begins with the distention of the head away from the prothorax and the prothorax from the mesothorax (Fig. 1A). This seems the point of no return, although an individual can still swim awkwardly if disturbed. No amount of disturbance, however, can long delay the following process which proceeds at the discretion of the bug. In all of the more than 15 molts I observed, the nymph initiated integumentary rupture by grasping its mesotibia with its raptorial protibia (Figs. 1B, 1G, and 2). This causes the thorax to arch and the resulting pressure immediately ruptures the integument (Fig. 2) along the middorsal (ecdysial) line beginning at the juncture of the pro- and mesotergum and proceeding posteriorly to the juncture of the meso- and metatergum. At this point the bug begins bending its head ventrally, continuing the integumentary split anteriorly into the coronal and laterally into the frontal ecdysial sutures of the head (Figs. 1C, 1G, and 2). Abdominal peristaltic-like contractions cause lateral separation of the meso-metatergal suture to the wing pads or lateral margin, leaving the conjunctival membranes intact. Shortly following, the metatergal, first abdominal-tergal junction is separated on both sides of the split, as the middorsal split lengthens through the metathorax into the scutellum. At about this time the head and prothorax are freed from the old skin. Contractions continue, and in the case of the emerging adult, the wings are inflated as they are withdrawn from their pads (Fig. 1D). It is noteworthy that at some time between the conditions illustrated in Figure 1C and Figure 1D, the silvery ventral abdominal air store is lost. When the bug is two-thirds free of its old skin, it flattens its body (in relation to the water's surface), extracting the legs which are brought forward, folded and nested at the sides of the pronotum (Fig. 1E and 1H). The individual usually rests in this position for from one to 20 minutes. Several quick thrusts with the hind legs complete the molt, leaving the exuvia floating and streaming its white tracheal linings (Fig. 1F). At this time the adult's wings are completely inflated and the hemelytra locked together. Newly molted instars and imagoes are light yellow in color. Pigment development and cuticular hardening required from one hour in the case of a second instar to eight hours for an adult. A newly emerged nymph or imago quickly acquires a new air store by breaking the surface film with its abdominal apex or air straps, and then generally spends some time grooming its beak with the forelegs and respiratory organs (abdominal air-retaining pubescence and/or air straps) with the hind legs preparatory to assuming a predatory stance below the surface.

Molting in the laboratory occurred throughout the day. In the field, I observed four individuals molting; two of these occurred at night and two during the day.

Surface Molting and Respiration

Molting on the surface of the water would seem to be disadvantageous for several reasons: the surface-molting individual is exposed to predation from above and below; it fails to take advantage of available cover (plants, debris, etc.) occurring below the surface; and it is deprived of a substantial substrate to facilitate integumentary rupture. Why then has this behavior evolved? The easiest explanation is that surface molting places the emerging nymph or imago in proximity to its primary source of oxygen, *i.e.* the air-water interface. This is not, however, an entirely satisfactory explanation. *Abedus* usually lives in quiet water of shallow streams where a swim to the surface for the first "breath" of air after a molt would not seem overly taxing. An alternative hypothesis is that the respiratory requirements of the pre-molting or molting nymph preclude subsurface ecdysis.

Dr. Margaret Parsons has offered (*in letteris*) some tentative ideas on how respiration may occur during surface molting. The reader should take care to note that Dr. Parsons' interpretations are based only on her study of Figure 1 against the background of her investigations of respiratory morphology in aquatic Hemiptera including *Belostoma flumineum* (1972a, 1972b, 1973). Her interpretations and underlying assumptions follow in this paragraph: Assuming (1) that *Belostoma* and *Abedus* are essentially similar in respiratory behavior of both nymphs and adults, and (2) that spiracular function is much the same in both genera (*i.e.* the first abdominal spiracles are the main inhalant pair for both), the problem for the nymph is to keep the first abdominal spiracle in contact with a source of oxygen prior to and perhaps during the time it takes to shed the nymphal cuticle. To do so, this main inhalant spiracle must be kept in contact with atmospheric air. Figure 1G shows the fifth instar with its posterior end and dorsal surface in contact with the water's surface. In this position atmospheric oxygen can reach the first abdominal spiracle by way of the ventral abdominal air store (ventral bands of hydrofuge pubescence), which communicates posteriorly with the atmosphere. This enables the bug to inhale atmospheric oxygen until the stage shown in Figure 1D and 1H. Here the posterior end of the body is submerged and as previously noted, the ventral abdominal air store has disappeared. Perhaps the adult (nymphal) first abdominal spiracle is able to inhale air from the cast-off nymphal skin, since there appears to be no other obvious source of oxygen communicating with these inhalant spiracles at this stage in the molt. (The duration of the rest period previously referred to,

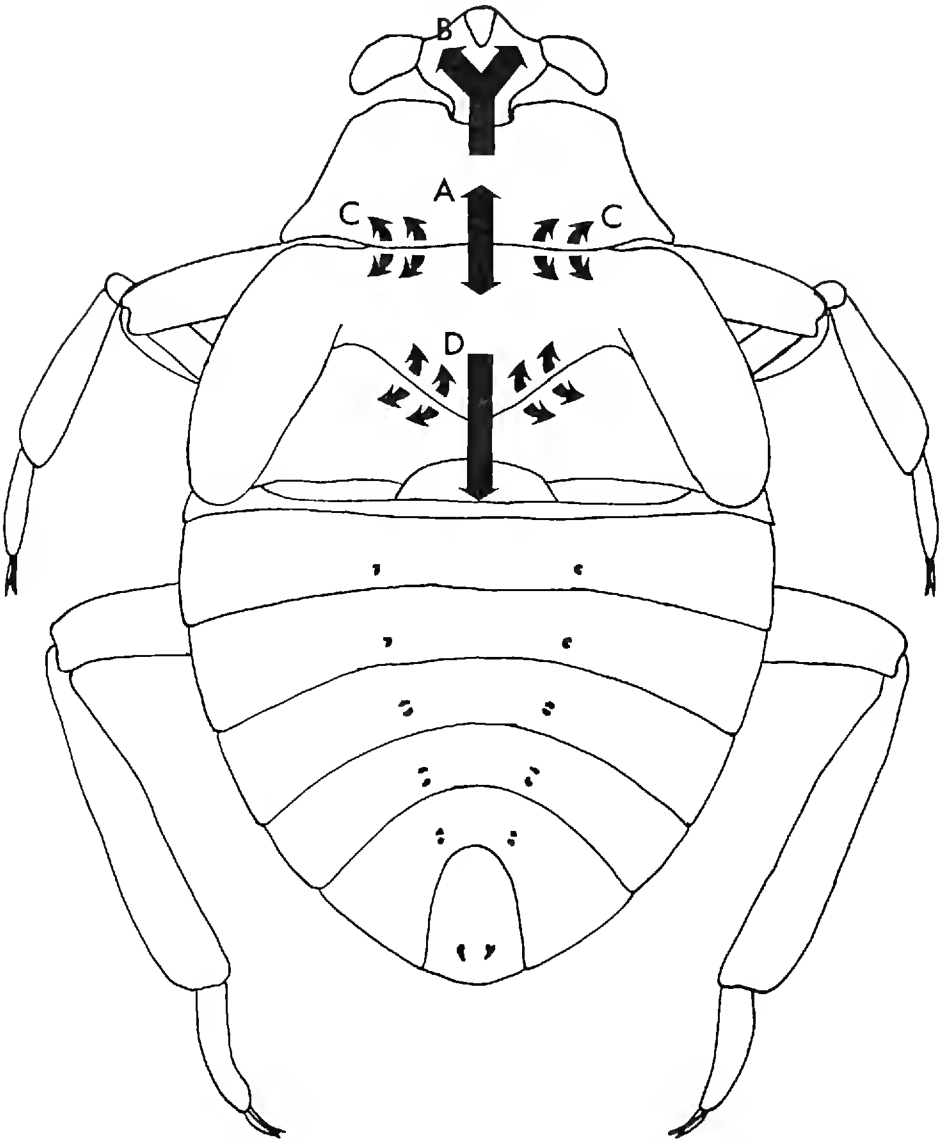

FIG. 2. Integumentary rupture sequence. A: Rupture from pro- and mesotergum. B: Elongation into coronal and frontal sutures of head. C: Spreading of meso-metatergal sutures. D: Elongation of middorsal split through metathorax into scutellum, and spreading of metatergal, first abdominal-tergal suture.

lasting from one to 20 minutes, is apparently governed by the bug's ability to secure oxygen in this way.)

Once the old cuticle is shed, the freshly emerged second through fifth instar nymphs can again obtain atmospheric oxygen via the abdominal air store. A newly emerged adult theoretically has two ways of getting oxygen: first, via the subalar air store, and second, via the ventral abdominal air store. My observations suggest that adults favor the former method. If this is the case, it would be advantageous for the emerging adult to have its wings expanded and hemelytra interlocked to provide the subalar store as soon as possible after leaving the last nymphal skin. As Figure 1 illustrates, the subalar air storage system is available to the adult as soon as it is clear of the old skin. The bug must surface to provision the system with air.

An Experiment

A first instar and two third instar nymphs were denied access to the surface of the water at the onset of their molting, after each had gripped its middle legs as shown in Figure 1B, G. This was accomplished by means of a fiberglass screen wire disc which displaced the molting individuals below the surface. In all three cases, molting proceeded as previously described to the point at which an emerging nymph or adult would normally rest (Fig. 1E). Under the experimental conditions, nymphs did not rest, but rapidly abandoned their skins and began wild swimming under the plastic screen. When the screen was removed, each of the three nymphs immediately went to the surface, assumed the air acquisition position, and remained there for from two to ten minutes. These results suggest that surface contact is not essential during the actual shedding process, but that the resting period that follows depends on access to atmospheric air through the cast skin.

Discussion

An adaptation to meet the respiratory requirements of molting nymphs may have occurred early in the shift of the Hydrocorisae from littoral to truly aquatic habitats (see China 1955, and Lauck and Menke 1961 for phylogeny). Certain problems accompanied the "need" to molt on the water's surface, not the least of which are weightlessness and lack of a holding substrate. Anyone who has attempted to shed his clothing while floating free in water will better appreciate the difficulty of this feat. *Abedus herberti* seems to have solved these problems by establishing an allostatic basis when it clasps its middle legs with its raptorial front legs. The resulting pressure and leverage obtained by this behavior seem essential to the molting process, and the ability to perform the behavior was probably a necessary preadaptation to surface molting. What nonmolting behavioral patterns of belostomatids and of nepids suggest that such a preadaptation did in fact exist? Grooming. Both nepids and belostomatids retain the ability to groom their middle legs with their front legs even though the forelegs are directed anteriorly and are highly specialized for grasping prey. The grooming pattern differs from the molting in that the middle legs are groomed separately but clasped simultaneously at the onset of shedding.

Emerging adults belonging to several hemimetabolous orders (Odonata, Homoptera, Orthoptera, and other Hemiptera) characteristically do not begin inflating their wings until free from the nymphal skin. Apparently the subalar air storage system is sufficiently important for belostomatids that selection has favored a system whereby wing inflation is accomplished during the molting process. Since nepids also employ a subalar air store as adults (Parsons 1973), I suspect they possess this adaptation as well. Studies on the molting behavior of representatives of all groups of the Hydrocorisae are needed to establish the origin of both surface molting and early wing inflation.

ACKNOWLEDGMENTS

My thanks to Dr. Margaret Parsons for her contribution to this paper and to Dr. M. Parsons, Dr. A. S. Menke, and Dr. G. B. Castle for review.

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SCIENTIFIC NOTE

Biological Observations on *Tropidishia xanthostoma* Scudder (Orthoptera: Gryllacrididae).—*Tropidishia xanthostoma* Scudder is an obscure troglophile of the subfamily Rhaphidophorinae in the monogeneric tribe Tropidishiini occurring only on the Pacific Slope. S. H. Scudder (1861, Proc. Bost. Soc. Nat. Hist., 8: 6–14 and 1862, Bost. Journ. Nat. Hist., 7(3): 409–480) and A. N. Caudell (1916, Proc. U.S. Nat. Mus., 49: 655–690) describe taxa. This note offers biological observations on the cricket. Additional observations have been offered by Buckell (1922, Proc. Ent. Soc. Br. Col., 20: 9–41 and 1930, Proc. Ent. Soc. Br. Col., 27: 17–51) and Fulton (1928, Ent. News, 39: 8).

My observations were made from January to November, 1973, at an abandoned mine near Mill City, Oregon, in a coniferous forest type biome. The *Tropidishia* population and other troglophilic fauna occurred inside the mine within 70m of the entrance.

T. xanthostoma nymphs of body size to 5mm exhibit conspicuous coloration being light tan to cream color having antennae, thorax, abdomen, metathoracic femora, and tibiae mottled or banded dark brown as characteristic of uniformily colored adults. Maculation disappears through early instar development yielding uniform dark amber coloration which slightly darkens into rich brown at maturity. Antennae and tibiae remain banded through development.

Strong white or red light or sound in the mine does not appear to affect the crickets. Antennae are generally very active and the insects exhibit remarkable agility. Individuals were never noted on the mine floor or in ponded water in the mine tunnels.

Several nymphs were observed in spider webs near the mine entrance but no predation on specimens was observed. No specimens were observed in surrounding subterraneous and epigenean habitats either at night, during the day, or during crepuscular periods. A pit-fall trap line deployed in August, October, and November failed to capture any *Tropidishia* specimens.

Ecdysis in *Tropidishia* is similar to the process in other insects beginning with symmetrical splitting of the ventral notum. Spent exoskeletal tissue peels from the emerging insect. Coloration of the new instar darkens slightly after emergence and the insect, characteristic of other cavernicoles, consumes the exuvium.

I wish to express thanks to my wife, Joan, for her assistance and generous support during the project.—Brent L. Prothero, *P.O. Box 361, Corvallis, Oregon 97330.*

Tiaja insula, a New Megophthalmine Leafhopper from the Santa Barbara Channel Islands

(Homoptera: Cicadellidae)

JANE R. SAWBRIDGE
Nanaimo, British Columbia

This paper records an interesting new species of megophthalmine leafhopper belonging to the genus *Tiaja* Oman, from Santa Barbara Island, a small, windswept member of the California Channel Islands. This is only the second addition to the genus since Oman's (1941) revision of the tribe, and with *T. arenaria* Oman (1972) brings the total number of species known to eight. This new species, *T. insula*, is the first to be recorded from the offshore islands, where it was collected from Sea Blite, *Suaeda californica* Wats. The host association appears definite because, according to R. J. Gill (personal communication) to whom I am indebted for making the material available for study, single plants were isolated and either beaten or swept to collect whatever insects were present. The species is described at this time to make the name available for use in a comprehensive biosystematic treatment of the genus *Tiaja* currently being prepared.

Tiaja insula, new species

Diagnosis: This species is intermediate in size between *T. californica* (Ball) and *T. interrupta* (Ball) with the head considerably more pointed than that of any other species of *Tiaja*. In Oman's (1941) key to the Nearctic Megophthalminae, females run to *T. californica*; males cannot be keyed at all as their genital plates and genital hooks are different from those of all other species.

Male: Length from apex of head to apex of wings 3.0–3.5 mm. Head relatively pointed; mean W/L ratio calculated from width of crown anterior to the eye divided by the length of the crown from base to apex is 2.20 (Comparable ratios for other *Tiaja* species range from 2.50 to 3.68). Color pale to medium brown with some more heavily pigmented areas on the wings; no extreme color variations present in the series examined. Aedeagus (fig. 2) stout and compact; apex short and blunt. Styles slender and tapered apically (fig. 1). Connective as illustrated (fig. 3). Genital hooks on Segment X (fig. 4) with two triangular-shaped, sharply pointed projections, one directed posterodorsally and the other directed posteroventrally. Genital hooks relatively small and inconspicuous in uncleared specimens in contrast to some other members of the genus in which genital hooks are clearly visible. Genital plates (fig. 5) large, with posterolateral

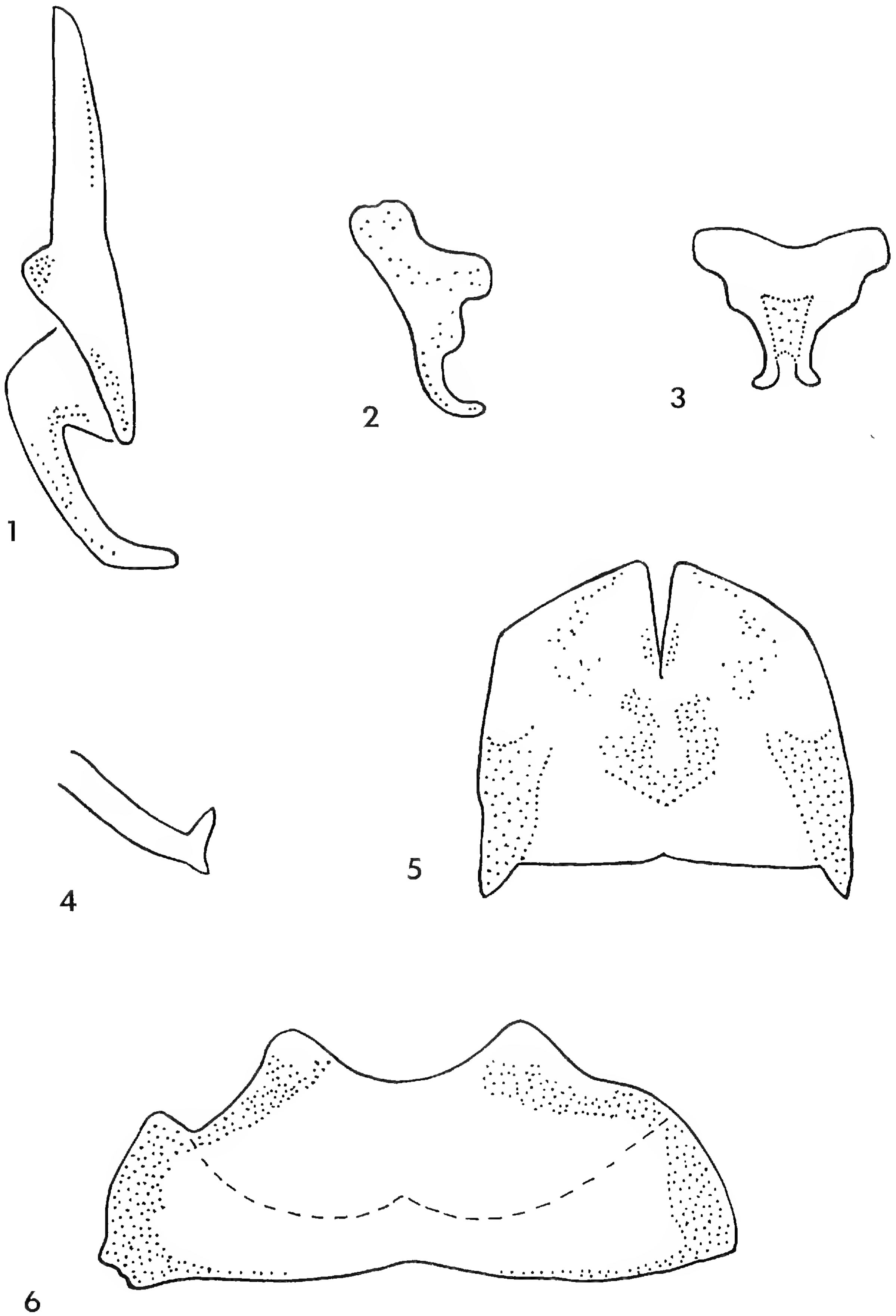

Fig. 1–6. *Tiaja insula*, genital structures. Fig. 1. Right style, dorsal view. Fig. 2. Aedeagus, left lateral view. Fig. 3. Connective, dorsal view. Fig. 4. Left genital hook, lateral view. Fig. 5. Genital plates. Fig. 6. Female seventh sternum.

margins straight and median incision slightly greater than one third the total length of the plates.

Female: Length 3.5–3.75 mm. Coloration and head shape similar to that of males. Seventh sternum (fig. 6) short with two rounded projections, one each side of a median U-shaped emargination; dorsal extension of seventh sternum (represented by a dotted line on illustration) single and highly pigmented.

Holotype male, and 6 paratypes (2 male and 4 female) from CALIFORNIA, LOS ANGELES COUNTY, SANTA BARBARA ISLAND, 6 June 1974, E. L. Paddock and R. F. Hobza. The holotype and 4 paratypes will be deposited in the California Academy of Sciences. Two paratypes will be deposited in the United States National Museum of Natural History.

Distribution: *Tiaja insula* has been positively identified only from the type locality of Santa Barbara Island. A single female specimen from San Miguel Island, a larger, more northerly member of the Channel Islands Group, probably belongs to this species.

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NEW JOURNAL

JOURNAL OF CHEMICAL ECOLOGY. R. M. Silverstein and J. B. Simeone, Editors. SUNY College of Environmental Science and Forestry, Syracuse, New York 13210. Published quarterly, initial issue, January 1975. $15.00 (personal), $35.00 (institutional).

This journal will provide a publication outlet for the increasing amount of pheromone related research, as well as other work dealing with chemically mediated interactions among organisms.

Mexican Pogonocherini
(Coleoptera: Cerambycidae)

John A. Chemsak and E. G. Linsley
University of California, Berkeley, California 94720

The present report is an attempt to clarify the status of some of previously described Mexican Lamiinae of the tribe Pogonocherini and to make known a number of new species which have special significance in relation to other studies currently in progress. Other presumably undescribed species are before us but are represented by inadequate material for proper interpretation.

Previous writers have disagreed as to the appropriateness of recognizing this group of beetles as a separate tribe and also in the interpretation of the characters expressed in the genera assigned to it. Two of the characters shared by the genera included here are closed intermediate coxal cavities and middle tibiae with an external sinus.

This study was supported by the National Science Foundation (Grant GB-BM574) for a monograph of North American Cerambycidae.

For the loan of specimens, we gratefully acknowledge the following: American Museum of Natural History, New York; Department of Entomology, University of Arizona, Tucson; California Academy of Sciences, San Francisco; Essig Museum of Entomology, University of California, Berkeley; Canadian National Collection, Ottawa; Department of Entomology, University of California, Davis; Field Museum of Natural History, Chicago; Snow Entomological Museum, University of Kansas, Lawrence; Los Angeles Museum of Natural History; Museum of Zoology, University of Michigan, Ann Arbor; Department of Entomology, Ohio State University, Columbus; National Museum of Natural History, Washington D. C.; E. Giesbert; H. F. Howden; G. H. Nelson; and R. L. Westcott.

KEY TO THE GENERA OF MEXICAN POGONOCHERINI

1 Femora gradually enlarging, not distinctly clavate 2
– Femora distinctly clavate 3
2(1) Pronotum without a lateral tubercle; head flat between antennal tubercles; antennae extending beyond elytral apices in both sexes .... *Lypsimena*
– Pronotum with a distinct lateral tubercle; head fully concave between antennal tubercles .... *Pygmaeopsis*
3(1) Pronotum with or without conical discal tubercles 4

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– Pronotum with discal tubercles in the form of an elongated ridge .... *Callipogonius*

4(3) Antennae with scape slender, fourth segment shorter than third 5

– Antennae with scape stout, fourth segment incurved, longer than third segment 7

5(4) Pronotum with discal tubercles; body clothed with long flying hairs 6

– Pronotum without discal tubercles; body lacking long flying hairs .... *Ecteneolus*

6(5) Antennal tubercles, dorsal tubercles of pronotum and basal crested tubercles of elytra very prominent; eyes small, upper lobes distinctly separated by more than greatest diameter of antennal scape, lower lobe separated from base of mandibles by much more than their vertical length .... *Alphomorphus*

– Antennal tubercles small, dorsal tubercles of pronotum and basal crested tubercles of elytra moderate; eyes large, upper lobes at most separated by approximate diameter of scape, lower lobe separated from base of mandibles by distinctly less than their vertical length .... *Poliaenus*

7(4) Pronotum rounded or obtusely swollen at sides, without lateral tubercles 8

– Pronotum armed with lateral tubercles .... *Pogonocherus*

8(7) Body clothed with long flying hairs .... *Pogonillus*

– Body without long flying hairs .... *Ecyrus*

GENUS LYPSIMENA LECONTE

Lypsimena LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 155; Thomson, 1864, Systema Cerambycidarum, P. 397; Lacordaire, 1872, Genera des coléoptères, 9: 653; LeConte, 1873, Smithsonian Misc. Coll., 11(265): 342; LeConte and Horn, 1883, Smithsonian Misc. Coll., 507: 327; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23: 139; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 78; Knull, 1946, Ohio Biol. Surv. Bull., 39: 259.

Alloeoscelis Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 358; Gahan, 1895, Trans. Entomol. Soc. London, 1895: 123.

Estoloderces Melzer, 1928, Arch. Inst. Biol. São Paulo, 1: 147.

This genus may be recognized by the elongate cylindrical form, unarmed pronotum, and by the absence of flying hairs on the body.

LYPSIMENA FUSCATA LECONTE

Lypsimena fuscata LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 155; Chevrolat, 1862, Ann. Soc. Ent. France, (4)2: 253; Lacordaire, 1872, Genera des Coléoptères, 9: 653; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23: 139; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 79; Knull, 1946, Ohio Biol. Survey Bull., 39: 259, pl. 23, Fig. 91.

Alloeoscelis leptis Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 358; Gahan, 1895, Trans. Ent. Soc. London, 1895: 123.

Lypsimena californica Horn, 1885, Trans. Amer. Entomol. Soc., 12: 194; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23: 140; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 79. New synonymy.

Male: form subparallel; integument brown to dark brown, clothed with irregular longitudinal whitish and brownish vittae. Head densely punctate; antennae slender, extending about three segments beyond elytral apices, scape brownish, flagellar segments rufescent, annulated. Pronotum wider than long, sides rounded, base constricted, disk convex, coarsely, irregularly punctate. Elytra coarsely, densely punctate; apices rounded. Abdomen with sternites coarsely punctate, more densely so at sides; last sternite subtruncate or feebly emarginate at apex. Length, 6–8 mm.

Female: antennae exceeding apex of elytra by approximately one segment; abdomen with last sternite rounded at apex. Length, 6–9 mm.

This is a widespread species, occurring from the United States to South America and the West Indies.

LYPSIMENA STRANDIELLA BREUNING

Lypsimena Strandiella Breuning, 1943, Folia Zool. Hydrobid., 12(1): 58.

Male: Form moderate sized, slightly tapering posteriorly. Color dark reddish brown, pronotum infuscated at apex and sides, elytra infuscated along margins from base to beyond middle, antennal scape and apices of other segments dark, front and middle legs infuscated; pubescence moderately dense, short, appressed, gray and brownish. Head with vertex abruptly declivous from neck; antennae slender, extending about 2 segments beyond elytra, third segment straight, longer than first, fourth about as long as third, outer segments short. Pronotum broader than long, sides rounded; base deeply impressed, apex not impressed; disk prominently humped at middle, coarsely, contiguously punctate; punctures longitudinal; pubescence short, appressed, denser at sides, middle shining; prosternum short, intercoxal process rounded, expanded at apices, coxal cavities closed; mesosternal process broad, emarginate behind; metasternum coarsely, densely punctate, densely pubescent. Elytra with two large obtuse gibbosities at base near suture; punctures coarse, dense, becoming finer toward suture; pubescence thick, gray, brownish on gibbosities, apical one third with brown finely pubescent vittae on each side, the first semicircular, median, connecting to a transverse band; middle of elytra concave, apices somewhat declivous, narrowly rounded. Abdomen micropunctate; basal segment with large shallow punctures at sides; pubescence dense at sides; sparse on middle; last segment broadly subtruncate at apex. Length, 8 mm.

Type locality: PUEBLA, MEXICO

We have seen only the type of this species which is partially coated with some sticky substance. It is in the National Museum of Natural History mislabelled as, "*Lypsimena bicristata* Breuning."

The prominent basal gibbosities and pubescent pattern of the elytra should readily separate this species from *fuscata.*

GENUS PYGMAEOPSIS SCHAEFFER

Pygmaeopsis Schaeffer, 1908, Bull. Brooklyn Inst. Arts Sci., 1: 347.

This genus may be recognized by the small size, feebly clavate femora and laterally tuberculate pronotum. One species is known.

PYGMAEOPSIS VITICOLA SCHAEFFER

Pygmaeopsis viticola Schaeffer, 1908, Bull. Brooklyn Inst. Arts Sci., 1: 347.

Male: integument brown, variegated with darker brown or blackish spots on elytra. Head moderately densely punctate; antennae about as long as body, scape stout, segments three to ten annulate apically with darker brown or black, third segment slightly longer than scape, fourth segment about one-third longer than third, about twice as long as fifth, remaining segments subequal to fifth but decreasing slightly in length toward apex. Pronotum with sides feebly rounded, wider than long; disk densely and rather coarsely punctate, without dorsal tubercles; scutellum densely white-pubescent. Elytra about three times as long as basal width, coarsely, densely, irregularly punctate; apices rounded. Underside clothed with recumbent cinereous pubescence. Length, 4 mm.

This species described originally from Brownsville, Texas, has not been seen in Mexican material available to us. However, it undoubtedly extends southward, perhaps as far as Veracruz.

GENUS CALLIPOGONIUS LINSLEY

Callipogonius Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 79.

This genus appears to be related to *Ecyrus* but differs in the elongate, ridge-like pronotal tubercles and the presence of long flying hairs on the body and legs. Two species are known, both occurring in Mexico.

CALLIPOGONIUS HIRCINUS (BATES)

Poliaenus hircinus Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 358.
Callipogonius hircinus, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 80.

In addition to the type specimen from Jalapa in the British Museum (Natural History), we have examined a specimen from Cordoba, Veracruz, collected by G. H. Nelson on June 27, 1972.

CALLIPOGONIUS CORNUTUS (LINSLEY)

Ecyrus cornutus Linsley, 1930, Pan-Pacific Entomol., 7: 86, figs 1, 2.
Callipogonius cornutus, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 81.

This species differs from *C. hircinus* primarily by having the dorsal prothoracic ridges prolonged backward into a horn. The type series is from Brownsville, Texas but we have seen specimens from 6.6 miles east of Sontecomapan, Veracruz, 1500 ft. elev. (George E. Ball and D. R. Whitehead) and 1 mile southwest of La Resolana, Jalisco, 20 November, 1950 (Ray F. Smith).

GENUS ECTENEOLUS BATES

Ecteneolus Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 356; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 87.

Body elongate, without flying hairs. Head subconcave between the antennae; front short, convex; eyes coarsely granulated; antennae shorter than the body (female), clothed on inner side with flying hairs, segments three to eleven gradually decreasing in length toward apex. Prothorax stout, cylindrical, armed with lateral tubercles. Elytral apices shortly, obtusely truncate. Anterior coxal cavities broadly angulated, open. Femora clavate; intermediate tibiae with an external sinus.

Type species: *Ecteneolus flohri* Bates (monobasic).

This genus has not been seen and the above characters are drawn from Bates' description and the remarks following the description. It resembles *Ecyrus* in the absence of long flying hairs on the body, but because of the lateral tubercles of the prothorax it is associated with *Poliaenus.*

ECTENEOLUS FLOHRI BATES

Ecteneolus flohri Bates, 1885, Biologia Centrali-Americana Coleoptera, 5: 360; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 88.

Described from "Mexico, near the city."

GENUS ALPHOMORPHUS LINSLEY

Alphomorphus Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 100.

This genus is apparently related to *Poliaenus* but differs, among other features in the much smaller eyes and strongly developed antennal tubercles and more prominent tubercles of the dorsum of the pronotum and subbasal area of the elytra. A single species is known.

ALPHOMORPHUS VANDYKEI (LINSLEY)

Pogonocherus vandykei Linsley, 1930, Pan-Pacific Entomol., 7: 82.

Alphomorphus vandykei, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 100.

Poliaenus vandykei grandis Linsley, 1933, Bull. Brooklyn Entomol. Soc., 28: 185. New synonymy.

Alphomorphus vandykei grandis, Linsley, 1935, Ann. Entomol. Soc. Amer., 28, pl. 1, fig. 3.

Poliaenus mexicanus Breuning, 1940, Folia Zoologica et Hydrobiologia, 10: 185. New synonymy.

This species was first described from a specimen from Uvalde, Texas, taken inside a motel. Later, the subspecies *grandis* was named and illustrated from Tejupilco, in the State of Mexico. The circumstances surrounding the capture of the original specimen, the fact that no examples have been subsequently taken in the United States, and that all material seen by us has been from central and southern Mexico, suggests that the type specimen was a vagrant, perhaps escaping from luggage carried by a traveler from Mexico or from imported plant or other material. We propose to remove it from the list of Cerambycidae occurring in America north of Mexico.

Considerable variation in size (8–12 mm) and coloration (tawny and pale to predominantly dark brown) is evident in the material before us. On this basis we have synonymized the subspecies *grandis* which was based primarily on these characters. Although we have not seen the type of *Poliaenus mexicanus* Breuning, recorded as from Tlatizapan, Mexico (= Tlaltzipan, Morelos?), the description fits the present species very well.

Data from Mexican specimens examined by us are as follows: Tejupilco, Mexico, 4000–6000 ft., July 1932, ♂ ♀ (H. E. Hinton); Cuernavaca, Morelos, October, 1946, on stem of *Opuntia*, ♂ (N. H. L. Krauss); Cuernavaca, 15 August 1967, ♀; Cuernavaca, 10 mi. E., 31 July 1963 ♂ (J. Doyen); Cuernavaca, 7 kilometers E., 5800 ft., 11 August 1962, 1♂, 3♀ (G. E. Ball); Iguala, Guerrero, 24 miles S., 18 July 1963, ♂ (F. D. Parker and L. A. Stange); Rio Mexcala, Guerrero, 6 mi. S. (Highway 95), 5 August 1965, ♂ ♀ (G. H. Nelson).

GENUS POLIAENUS BATES

Poliaenus Bates, 1880, Biologia Centrali-Americana Coleoptera, 5: 120, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 81.

This genus resembles *Pogonocherus* but differs in the structure of the antennae and prothorax and shape of the front coxal cavities and elytral apices.

Four species are known to occur in Mexico.

KEY TO THE MEXICAN SPECIES OF POLIAENUS

1 Moderate sized species with dorsal surface wholly or largely obscured by dense mats of moderately long appressed, white, ochraceous or golden pubescence, often thinner laterally and apically; antennae with flying hairs predominately white, with black hairs intermixed on basal segments 2

– Small species with dorsal surface mostly shining, appressed pubescence, where present, short, fine, not covering integument; antennae with flying hairs predominately black; pronotum with dorsal tubercles polished, lateral tubercles moderate, obtuse, scarcely recurved. 5.5 mm. Nayarit .... *sparsus* n.sp.

2(1) Pronotum with lateral tubercles recurved; elytra with basal tubercles and crest prominent, black setae of dorsal surface long, coarse, conspicuous 3

– Pronotum with lateral tubercles conical, obtuse, rarely slightly recurved; elytra with basal tubercles and crest small, not prominent, not crested, black setae of dorsal surface short, largely confined to apical one-half; pubescence predominately whitish and ochraceous, usually denser in a broad arc over basal two-fifths 7–9 mm. Baja California .... *concolor* (Schaeffer)

3(2) Body robust, elytra distinctly less than twice as long as basal width, integument brown; pronotum with lateral tubercles very prominent, apices acute or subacute, dorsal tubercles well developed, glabrous and shining or obscured by pubescence. 6–9 mm. Baja California, Sonora, Sinaloa .... *volitans* (LeConte)

– Body slender, elytra twice as long as basal width, integument dark brown to blackish; pronotum with lateral tubercles moderate, only slightly recurved, apices obtuse, dorsal tubercles moderate, shining. 7.5 mm. Nuevo Leon .... *nuevoleonis* n.sp.

Poliaenus sparsus, new species

Female: Form small; integument dark brown, shining, irregularly clothed with short, fine, appressed, golden pubescence, which is not dense enough to obscure the surface, flying hairs long, erect and suberect, predominately white at sides and ventral surface and legs. Head about as broad as long; antennae exceeding elytral apices by slightly more than one segment, scape slender, attaining lateral pronotal tubercle. Pronotum, across lateral tubercles about one and one-third times as wide as long; disk, including dorsal tubercles shining, prostrate pubescence short, fine, sparse. Elytra about twice as long as basal width; prostrate pubescence somewhat denser over basal one-third behind humeri and basal tubercles and near suture behind middle but pattern, at most, indistinct; basal tubercle small, obscurely tufted with black, as are the postmedian costal tubercles; epipleurae very coarsely punctate over basal half of elytra; apices conjointly rounded. Ventral surface finely punctate, finely clothed with appressed pale pubescence which does not conceal the surface; abdominal sternites fringed with white, surface with a few suberect pale hairs; last sternite emarginate at apex. Length 5.5 mm.

Holotype female (California Academy of Sciences) from 24 Miles South of Tepic, Nayarit, Mexico, 7 July 1963 (F. D. Parker and L. A. Stange.)

This species differs at once from other known Mexican *Poliaenus* in the small size, shining, sparsely pubescent integument, and predominately black flying hairs of the antennae.

POLIAENUS CONCOLOR (SCHAEFFER)

Pogonocherus concolor Schaeffer, 1909, Jour. New York Entomol. Soc., 17: 102; Fall, 1910, Entomol. News, 21: 9; Schaeffer, 1932, Bull. Brooklyn Entomol. Soc., 27: 154.

Poliaenus concolor, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 83; Linsley, 1942, Proc. California Acad. Sci., (4)24: 81.

Poliaenus obliquus Linsley, 1942, Proc. California Acad. Sci., (4)24: 81. New synonymy.

This species was originally described from "California?" Later, this was corrected to "Lower California (S. Beyer)" and finally, Mr. Schaeffer informed one of us (Linsley) that it had undoubtedly come from Santa Rosa.

The type is a faded specimen with the erect hairs of the head and thorax largely denuded. Although we have not compared specimens with the type, there is little doubt that *P. obliquus* Linsley, described from five miles south of San Miguel and from Triunfo, Baja California Sur, is based upon fully maculated and pubescent examples of *P. concolor* Schaeffer.

We now have before us 33 specimens representing the following localities: Baja California Sur: 4 miles east of La Paz, 12 December 1958, ex dead *Bursera* (H. B. Leech); 4.5 mi. S.E. of La Paz, 3 August 1966 (J. A. Chemsak, P. D. Hurd, Jr., E. G. and J. M. Linsley); 7 mi. west of La Paz, 6 September 1967 (J. A. Chemsak, A. E. and M. M. Michelbacher), 25 mi. west of La Paz, 30 August and 4 September 1959 (K. W. Radford and F. G. Werner); 4 mi. north of Todos Santos, 2 September 1959 (Radford and Werner); 1 mi. southwest of Punta Palmilla, 13 September 1967 (Chemsak and Michelbachers); 2 mi. northwest of San Pedro, 19 September 1967 (Chemsak and Michelbachers); and 6 mi. north of San Jose del Cabo, 15 September 1967 (Chemsak and Michelbachers). Baja California Norte: Las Arrastas de Arriola, 3 April 1973 (J. Doyen, J. Powell and S. L. Szerlip).

POLIAENUS VOLITANS (LECONTE)

Lophopoeum volitans LeConte, 1873, Smithsonian Misc. Coll., (11)264: 232; Horn, 1894, Proc. Calif. Acad. Sci., 2(4): 340.

Pogonocherus volitans, Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23: 136; Schaeffer, 1909, Jour. New York Entomol. Soc., 17: 103; Fall, 1910, Entomol. News, 21: 7; Linsley, 1930, Pan-Pacific Entomol., 7: 85.

Poliaenus volitans, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 86; Linsley, 1942, Proc. Calif. Acad. Sci., (4)24: 81.

Poliaenus hirsutus Bates, 1880, Biologia Centrali-Americana, Coleoptera, 5: 120; Chemsak and Linsley, 1970, Jour. Kansas Entomol. Soc., 43: 416 (lectotype designation).

Poliaenus incertus Breuning, 1943, Folia Zoologica et Hydrobiologica, 12: 58. New synonymy.

In this species the basic pubescent pattern of the elytra consists of a broad ante-median saddle mark of dense appressed white pubescence often tinged with golden, which is arcuate behind the humeri and basal tubercles and narrows posteriorly toward the elytral suture where it continues more or less parallel-sided to apical one fourth. The most characteristic feature is the prominent, recurved, acute structure of the lateral tubercles of the prothorax. As in other species of the genus, the last abdominal sternite is entire in the male, emarginate in the female.

We have examined the type of *volitans* from Cape San Lucas, the type of *hirsutus* from Capetillo, Guatemala and the type of *incertus* from California Meridionalis. The last is a badly rubbed specimen with broken appendages but with the body structures identical with *P. volitans*.

Sixty-five Mexican specimens are before us from the following localities: Baja California Sur: 7 mi. west of La Paz, 4 August 1968 (J. A. Chemsak, P. D. Hurd, Jr., E. G. and J. M. Linsley); Santiago, 8 July 1938 (A. E. Michelbacher and E. S. Ross); 6 mi. southwest of Santiago, 31 August 1969 (K. W. Radford and F. G. Werner); 5 mi. west of San Bartolo, 13 July 1938 (Michelbacher and Ross); 6 mi. north of San Jose del Cabo, various dates in September, 1967 (J. A. Chemsak and A. E. and M. M. Michelbacher); and 10 mi. southwest of San Jose del Cabo, 1 September 1959 (Radford and Werner). Sonora: Desemboque, various dates in August and September, 1953 (B. Malkin); Louis, 26 September 1953 (B. Malkin); Puerto Libertad, 2 August 1950 (J. P. Figg Hoblyn). Sinaloa: 13 mi. north of Los Mochis, 7 August 1964 (J. A. Chemsak and J. Powell).

The Sonoran population has a somewhat different facies from that in Baja California and there is a tendency for the apices of the lateral pronotal tubercles to be more strongly produced and the dorsal tubercles glabrous.

Poliaenus nuevoleonis, new species

Male: Body slender, elytra twice as long as basal width, integument dark brown to blackish, clothed with long flying hairs, mostly black on front of head, basal segments of antennae, and dorsal surface of pronotum and elytra, pubescence fine, appressed, golden above, white or vaguely ochraceous at sides and on ventral surface; elytral humeri prominent, basal tubercle moderate, crested with black, oblique impression from inside humerus to elytral suture deep, broadening rapidly to include sutural area from basal tubercle to mid-elytra, densely clothed with fine appressed golden pubescence which extends posteriorly along the suture to apical one-third. Head about as broad as long; antennae brown, exceeding elytral apices by about three segments, scape moderately slender, attaining lateral prothoracic tubercle, third segment longest, segments four to ten densely clothed with appressed white pubescence except at apices. Pronotum with width across lateral tubercles about one and one-third times length; lateral tubercles moderate, only slightly recurved, apices obtuse, dorsal tubercles moderate, shining. Elytra coarsely punctate especially basally and laterally, but punctures mostly obscured by pubescence; costae not well defined, obscured by pubescence, with a few polished tubercles near median area and a dense patch of brown hairs surrounded by golden pubescence at apical one-third; apices conjointly rounded. Abdomen with sternites fringed with white hairs, last sternite with apex entire. Length 7.5 mm.

Holotype male (Canadian National Collection) from Chipinque Mesa, 5400 ft., near Monterrey, Nuevo Leon, Mexico, 23 July 1963 (H. Howden).

This is the first species of *Poliaenus* known from the eastern portion of northern Mexico. It appears to be related to *P. volitans*, but differs in the narrower body form, less strongly developed lateral prothoracic tubercles and darker color.

GENUS POGONOCHERUS ZETTERSTEDT

Pogonocherus Zetterstedt, 1828, Fauna Ins. Lapponica, p. 364; LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 159; Lacordaire, 1872, Genera des coléoptères, 9: 653; Horn, 1878, Trans. Amer. Entomol. Soc., 7: 42; Leng and Hamilton, 1896, Trans. Amer Entomol. Soc., 23: 135; Schaeffer, 1909, Jour. New York Entomol. Soc., 17: 102; Fall, 1910, Entomol. News, 21: 5; Casey, 1913, Memoirs on the Coleoptera, 4: 345; Linsley, 1930, Pan-Pacific Entomol., 7: 79; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 95.

Pityphilus Mulsant, 1863, Coléoptères des France, Longicornes, p. 302; Lacordaire, 1872, Genera des coléoptères, 9: 635, fn. 2.

The proportions of the first, third and fourth antennal segments, shape of the anterior coxal cavities, and the form of the elytra will distinguish this genus from the others.

A single species extends into Mexico.

POGONOCHERUS (EUPOGONOCHERUS) ARIZONICUS SCHAEFFER

Pogonocherus arizonicus Schaeffer, 1908, Bull. Brooklyn Inst. Arts. Sci., 1: 346; Schaeffer, 1909, Jour. New York Entomol. Soc., 17: 102; Fall, 1910, Entomol. News, 21: 8; Casey, 1913, Memoirs on the Coleoptera, 4: 346; Linsley, 1930, Pan-Pacific Entomol., 7: 80.

Pogonocherus (*Eupogonocherus*) *arizonicus*, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 98.

Pogonocherus (*Eupogonocherus*) *medianus* Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 98; Linsley, Knull and Statham, 1961, Amer. Mus. Novitates, 2050: 31. New synonymy.

One example from P. Buenos Aires, 37 miles west of El Salto, Durango, Mexico, 1 July, 1964, ex *Pinus* (H. F. Howden). This is the first record for the genus from Mexico.

Unfortunately, when Schaeffer described this species he gave the length as 13 mm. Actually, the size range as presently known is from 6–8 mm. This discrepancy in addition to variation in the number of subsutural tufts of erect black hairs on the elytra and the arrangement of the abdominal pubescence resulted in the above synonymy.

GENUS POGONILLUS BATES

Pogonillus Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 360.

This species may be recognized by the lack of dorsal and lateral tubercles on the pronotum and by the long flying hairs of the body.

Type species: *Pogonillus subfasciatus* Bates, by present designation.

POGONILLUS INERMIS BATES

Pogonillus intermis Bates, 1885, Biologia Centrali-Americana, Coleoptera, 5: 360.

Male: Body small, subparallel; integument brown to dark brown; pubescence variegated with brownish, grayish and black, flying hairs mostly brownish. Head finely punctate, pubescence of face mostly appressed; antennae barely exceeding elytral apices, lightly annulated with brown, scape with long erect hairs on all surfaces, remaining segments densely clothed with long hairs internally, sparsely so externally, setae most conspicuous near apices of segments. Pronotum about as long as broad, finely punctate with scattered coarser punctures superimposed, pubescence fine, dense, appressed with scattered long erect hairs. Elytra with punctation similar to that of pronotum, prostrate pubescence mostly whitish and patchy, erect hairs mostly dark brown; apices rounded. Abdomen with last segment truncate at apex. Length 4.5 mm.

Female: Antennae distinctly shorter than the body; abdomen with last segment rounded at apex. Length 4–4.5 mm.

In addition to the type, which is a male from Cordoba and the associated female from Jalapa in the British Museum (Natural History) we have examined a male from 19 miles NE of Cordoba, Veracruz, 1 July 1958, 1000 ft. elev. (University of Kansas Mexican Expedition) and a female from Temescal, Oaxaca, 5 July 1965 (G. H. Nelson and family).

GENUS ECYRUS LECONTE

Ecyrus LeConte, 1852, Jour Acad. Nat. Sci. Philadelphia, (2)2: 161; Leng and Hamilton, 1896, Trans. Amer. Entomol. Soc., 23: 137; Linsley, 1930, Pan-Pacific Entomol., 7: 85; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 88.

The absence of flying hairs on the body, unarmed sides of the pronotum, short, clavate antennal scape, and the long incurved fourth segment of the antennae will distinguish this genus from others in the tribe.

Six species are known from Mexico.

KEY TO THE MEXICAN SPECIES OF ECYRUS

1 Elytra with three or more rows of tufts of short brownish or blackish hairs; pronotum without glabrous discal calluses; scutellum brown pubescent 2

– Elytra with a single row of three fascicles of long, erect brownish or blackish hairs; pronotum with a small glabrous callus on each side just anterior to middle of disk, and with a dense patch of chalky-white pubescence on each side of middle over basal half or two-thirds; elytra with similar dense, chalky-white pubescence at base and over most of apical one-half; scutellum white pubescent. 6–11 mm. Texas to Vera Cruz and Sinaloa .... *penicillatus* Bates

2(1) Pronotum without a glabrous median longitudinal line, discal tubercles conical, pubescent 3

Pronotum with a narrow glabrous median longitudinal line, discal tubercles narrowly elongate, with a glabrous black line which sometimes extends to anterior and basal margins. 6–10 mm. Oaxaca and Veracruz .... *lineicollis* n.sp.

3(2) Elytra with basal tubercles forming a short, transverse black line 4

Elytra with basal tubercles forming an obliquely arcuate black line along the edge of post-humeral depression, not reaching suture nor humeri, sometimes obscured by overlying black and brown pubescence over basal one-third or one-fourth, apical two-thirds of elytra predominantly white, grading into light brown over apices. 8–11 mm. Yucatan and Quintana Roo and Guatemala .... *arcuatus* Gahan

4(3) Face clothed with brown pubescence; vertex with a pair of prominent longitudinal ridges above eyes; antennae with fourth segment about as long as second and third combined 5

– Face clothed with dense white pubescence between the eyes and over the antennal tubercles; vertex with a narrow polished longitudinal ridge on each side of middle above eyes; antennae moderately densely fringed internally with long-fine curled white hairs, intermixed with shorter, stiff, black ones, especially near apices of third and fourth segments, fourth segment distinctly longer than second and third combined. 10 mm. Cuernavaca .... *albifrons* n.sp.

5(4) Antennae ciliate internally but cilia mostly straight; elytra moderately coarsely punctate; antennal scape only moderately stout. 6–8 mm. Baja California, Sonora, Sinaloa .... *pacificus* Linsley

– Antennae densely ciliate internally with fine white hairs, longer and curved apically in the male; elytra very coarsely punctate although punctures often obscured pubescence; antennal scape stout. 8–10 mm. Michoacan and Guerrero .... *ciliatus* n.sp.

ECYRUS PENICILLATUS BATES

Ecyrus penicillatus Bates, 1880, Biologia Centrali-Americana, Coleoptera, 5: 137; Linsley, 1930, Pan-Pacific Entomol., 7: 89; Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 91, pl. 1, fig. 7; Chemsak and Linsley, 1970, Jour. Kansas Entomol. Soc., 43: 410 (lectotype designation).

Ecyrus fasciatus Hamilton, 1896, Trans. Amer., Entomol. Soc., 23: 137; Linsley, 1931, Pan-Pacific Entomol., 7: 105.

This species may be readily recognized by the characters enumerated in the key. In addition to the type specimen of *E. penicillatus* from Mirador, Veracruz, Mexico (British Museum—Natural History) and that of *E. fasciatus* from Brownsville, Texas, we have seen examples from the following localities in Mexico: East edge of San Jose de las Pusias Mtns., 30 miles NNE of Aldama, Tamaulipas (Martin Robins); 8 miles E. Padilla, Rancho Sta. Ana, 12 December 1941 (Cantrall, Friauf.); 1 mile W Anton Lizardo, Veracruz, 23 June 1961 (Univ. Kansas Mexican Expedition); Puente Nacional, Veracruz, 17 August 1960 (H. F. Howden); Mazatlan, Sinaloa, 5 August 1968 (M. Bentzien, J. Bigelow, S.

Williams, M. Cazier) and 5 miles north of Mazatlan on various dates in July and August (J. A. Chemsak, E. Giesbert, H. F. Howden, G. H. Nelson, J. Powell).

In Texas this species has been collected in late May, June and early July from dead branches of willow (*Salix*). Most of the examples from Mazatlan were attracted to "black light" at night.

Ecyrus lineicollis, new species

Male: Form moderately robust; integument dark to reddish brown; pubescence variegated, brownish, golden-brown and white, black over subbasal elytral tubercles. Head finely punctate, finely, densely clothed with an intermixture of brownish and whitish prostrate pubesence; white pubescence denser between eyes and over antennal tubercles, vertex with a glabrous longitudinal ridge on each side of midline; antennae exceeding elytral apices by four segments, scape moderately robust, finely densely punctate, clothed with long, prostrate white and golden appressed pubescence, shorter than third segment, fourth segment much longer than third, slightly less than twice as long as scape, segments three to ten clothed beneath with long, pale cilia which become more erect on outer segments, annulated with dark brown at apices, third segment dark brown, remaining segments light brown. Pronotum only slightly wider than long, obtusely swollen but not tuberculate at sides, pubescence predominantly brown with some intermixture of white, disk with a median, glabrous, shining black line, ante-median lateral discal tubercles glabrous, longitudinal, shining, black; pro- and mesosterna coarsely punctate, largely white pubescent. Legs reddish brown, white pubescent. Elytra variegated with brownish and whitish pubescence, brown predominantly basally and apically, white medially, surface rather coarsely punctate and tuberculate; basal tubercles in the form of an arcuate ridge along edge of ante-median impression; apices shallowly emarginate. Abdomen shining, finely punctate, clothed with prostrate white pubescence with some erect hairs at apex; apex entire with a fringe of short golden hairs. Length, 8 mm.

Female: Antennae barely exceeding elytral apices; abdomen with apex of last segment shallowly emarginate. Length, 7 mm.

Holotype male and *allotype* (California Academy of Sciences) from 5 MILES WEST OF TEHUANTEPEC, OAXACA, MEXICO, 1 July 1972 (G. H. Nelson). Paratypes: one with same data as holotype and allotype, one from 7 miles west of Tehuantepec, 2 July 1972 (G. H. Nelson), four from 3 miles west of Tehuantepec, 19 July 1965, on *Acacia pennatula* (G. H. Nelson), one from Tehuantepec, 23 July 1964 (Paul J. Spangler), two examples from 23 miles south of Matias Romero, Oaxaca, 5 April and 22 April 1962 (F. D. Parker and L. A. Stange), one from 21 miles south of Matias Romero, 12 July 1962 (J. M. Campbell) and one from 7 miles northeast of Juchitan, Oaxaca, 18 July 1952 (E. E. Gilbert, C. D. MacNeill). Additional material not designated paratypic includes one specimen from Temescal, Oaxaca, 16–23 August 1965 (A. B. Lau) and two from 6 miles south of Tinaja, Veracruz, on Highway 145, 26 June 1972 (G. H. Nelson).

This species differs from the other *Ecyrus* presently known by the narrow polished longitudinal midline of the pronotum and the narrowly elongate discal tubercles which are overlaid with a black line which sometimes extends to the basal and apical pronotal margins.

ECYRUS ARCUATUS GAHAN

Ecyrus arcuatus Gahan, 1892, Trans. Entomol. Soc. London, p. 259, pl. 12, fig. 2, Linsley, 1930, Pan-Pacific Entomol., 7: 90, Linsley, 1935, Ann. Entomol. Soc. Amer., 28: 91, pl. 1, fig. 9.

This species was described originally from Temax, North Yucatan (Gaumer). In addition to the type which was examined in the British Museum (Natural History) we have seen a specimen labelled "Yucatan" "G. F. Gaumer" in the collection of the University of Kansas, an example from Piste, Yucatan, 1 September 1967, and 5 more from X-Can, Quintana Roo, 12–14 June 1967 (E. C. Welling) and 1 from Peten Tikal, 31 March 1956 (I. J. Cantrall).

Although the arcuate subbasal row of black or brown tufted tubercles on the elytra are always evident, in one of the X-Can specimens they are overlaid with a broad dark brown transverse band covering the basal one-third or more. Also, all of the X-Can examples have most of the apical half of the elytra densely white pubescent, shading into light brown over the elytral apices.

Ecyrus albifrons, new species

Male: Form moderately robust; integument dark brown, pubescence variegated with brown and white above, face between eyes, antennal tubercles, median transverse band on elytra, most of venter and legs predominantly white pubescent, basal and apical thirds of elytra largely pale brown pubescent, subbasal tubercles black. Head finely punctate, a black tubercle on each side of mid-line just above the eyes connected to a similar pair of tubercles on outer margins of pronotum by a narrow polished ridge; antennae exceeding elytral apices by about four segments, scape moderately robust, a little shorter than third segment, fourth segment distinctly longer than second and third segments combined, less than twice as long as scape, third segment brown pubescent, annulated with white at base, segments four to ten white pubescent, annulate with brown at their apices, segments three to ten ciliate beneath, the cilia predominantly brown on third segments and apices of remaining segments which also bear long recurved whitish hairs. Pronotum slightly wider than long, sides swollen at middle, pubescence predominantly brown, intermixed with lighter brown and some white; disk thinly pubescent and shining at middle but without a glabrous median line; pro-, meso- and metasterna, coxae and legs largely white pubescent but with scattered irregular glabrous or semi-glabrous areas. Elytra with a pair of subbasal black tubercles arranged more or less transversely, not curving forward in an arc along edge of antemedian depression; apices truncate. Abdomen shining, finely punctate, basal segments and remaining segments at sides clothed with prostrate white pubescence; apex entire, fringed. Length 10 mm.

Holotype male (California Academy of Sciences) from CUERNEVACA, MEXICO (A. Fenyes).

This species is distinctive in the very narrow polished longitudinal ridges of the vertex above the eyes. It futher differs from *E. arcuatus* in the number and arrangement of the subbasal elytral tubercles and from *E. lineicollis* by the absence of longitudinal glabrous lines on the pronotum.

ECYRUS PACIFICUS LINSLEY

Ecyrus pacificus Linsley, 1942, Proc. Calif. Acad. Sci., (4) 24: 80.

This species, described originally from San Domingo, Baja California, 19 July 1938 with a paratype from 21 miles north of Comondu, 2 July 1938, both examples having been captured at light by A. E. Michelbacher and E. S. Ross, has recently been taken in numbers on the west coast mainland of Mexico. We have the material before us as follows: Alamos, Sonora, 15–20 July 1958 and 15–16 July 1973 (R. L. Westcott); 7 miles W of Alamos, 8 August 1964 (J. A. Chemsak, J. Powell); and 5 miles north of Mazatlan, Sinaloa, 8 August 1964, 10 August 1965 (G. H. Nelson), 1 August 1965 (J. A. and M. A. Chemsak, E. G. and J. M. Linsley), 26–29 July 1973 (J. A. Chemsak, E. G. and J. M. Linsley, A. E. and M. M. Michelbacher).

The median band of the elytra is at times more or less triangular and does not reach the suture and sometimes is in the form of a broad band extending across both elytra.

Ecyrus ciliatus, new species

Male: Form robust; integument dark brown, shining, finely punctate with coarser punctures superimposed, especially on elytra; pubescence variegated with brown and white above except for an oblique median band on elytra; body beneath and legs clothed with prostrate white pubescence broken by irregular glabrous areas, especially on legs. Head finely punctate, facial pubescence predominantly brown; vertex with a prominent longitudinal ridge on each side of midline above the eyes; antennae extending about four segments beyond elytral apices, pubescence predominantly white mixed with some brown, apices annulated with brown, more extensively so on outer segments fourth segment about as long as second and third together, segments three to eleven densely ciliate within, cilia of segments four to eleven long, recurved, mostly pale. Pronotum slightly wider than long; sides obtusely swollen at middle; disk polished, surface shining beneath the slightly sparser pubescence but without a median longitudinal glabrous line, anterior margin bituberculate, the tubercles clothed with short dense black hairs; pro-, meso- and metasterna white pubescent, finely punctate, metasternum with scattered, largely obscured, large punctures superimposed. Elytra coarsely punctate, with a pair of black subbasal tubercles placed transversely, not curving forward in an arc along ante-median depression; apices feebly truncate. Abdomen shining, thinly clothed with long white prostrate pubescence; apex entire, fringed. Length, 9.5 mm.

Female: Antennae barely exceeding elytral apices, moderately densely ciliate internally, cilia mostly straight, not long and recurved; abdomen with apical segment slightly emarginate. Length, 9 mm.

Holotype male and *allotype* (California Academy of Sciences) from 11 MILES EAST OF APATZINGAN, MICHOACAN, MEXICO 20 August 1954 (E. G. Linsley, J. W. MacSwain & R. F. Smith) and six paratypes with the same data. Additional paratypes include: one dated, 19 August 1954, 5 miles east of Apatzingan (Linsley, MacSwain and Smith); one from Apatzingan, alt. 1200 ft., 21 August 1941, from *Acacia* (Harry Hoogstraal); one from 31 miles S. Nueva Italia, Michoacan, 26 September 1959 (Cantrall and Cohn); and one from 24 miles south of Iguala, Guerrero, Mexico, 18 July 1963 (F. D. Parker and L. A. Stange).

This species is very close to *E. pacificus* Linsley, but the average size is larger (8–10 mm as against 6–8 mm) and the antennae are more densely ciliate internally, sex for sex. Since the two as now known are allopatric it is possible that with longer series from a greater variety of localities they may prove to be only subspecifically different. As in *E. pacificus*, the oblique pale area of the elytra may or may not extend to the suture.

SCIENTIFIC NOTE

Observations on the Egg Laying and Sleeping Habits of *Euparagia scutellaris* Cresson (Hymenoptera: Vespoidea).—All known masarid wasps provision their nests with pollen except *Euparagia scutellaris* Cresson which is predatory on weevil larvae. Clement and Grissell (1968, Pan-Pac. Entomol., 44: 34–37) reported that *E. scutellaris* provisions the cell before depositing its egg. This represents the only known exception in the superfamily Vespoidea since all others deposit the egg before provisioning.

While at the University of California's Sagehen Creek Field Station, Nevada County, California in July, 1974, I had the opportunity to excavate several nests of *E. scutellaris*. The excavation technique used, although not original, gave excellent results. A piece of grass or twig was inserted into the nest entrance as a marker and a 25 cm deep trench was then dug around the nest to encircle an area of about 25 square cm. When the soil was rocky, water was added to the trench to aid in the excavation. Then, each nest was carefully removed and dissected with fine tools under proper lighting conditions.

One nest contained three cells with 36, 34, and 4 weevil larvae respectively. Each cell contained a wasp egg or larva located at its base. Obviously, the cell with 4 weevil larvae was still being provisioned. The position of the egg and the fact that an egg was found in a partially provisioned cell strongly indicate that eggs are deposited prior to provisioning. Thus, *E. scutellaris* conforms to the egg deposition behavior of other Vespoidea.

It is well-known that the males of many wasps and bees sleep in aggregations while perched upon twigs, grass, and shrubs. In July 1974, several groups of *E. scutellaris* males were found on grass stalks at the Sagehen Creek Field Station. I believe this is the first report of such a phenomenon in masarids.—WAYNE S. MOORE, *Department of Entomology, University of California, Davis, California 95616.*

The *Drosophila pinicola* Species Group
(Diptera: Drosophilidae)

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Two Western North American species, i.e., *D. flavopinicola* Wheeler and *D. pinicola* Sturtevant, constitute the *Drosophila pinicola* species group. Sturtevant (1942) in his analysis of the evolution and phylogeny of *Drosophila* concluded (1) that *D. pinicola* belongs to the subgenus *Drosophila* with its closest relatives being members of the *D. virilis* species group, and (2) that *pinicola* is also closely related to both the genus *Scaptomyza* and the subgenus *Sophophora* of *Drosophila.* Since he assumed that *Scaptomyza* and *Drosophila* were coordinate genera, he regarded *pinicola* to be a "primitive type." Patterson and Stone (1952) accepted Sturtevant's interpretation. Throckmorton (1962, 1966 and 1968) showed that *Scaptomyza* is not coordinate with *Drosophila* but rather that *Scaptomyza* is an "exgroup genus derived from one of the lineages within the genus *Drosophila.*" Throckmorton concluded that *pinicola* is a relative of *Scaptomyza* but he excluded *pinicola* from being considered as a primitive member of the genus *Drosophila.*

Investigations of the endemic Hawaiian Drosophilidae (Hardy, 1965; Throckmorton, 1966; Spieth 1966; Carson et al. 1970) uncovered a surprising degree of overlap in various characteristics of the endemic Hawaiian drosophiloids and scaptomyzoids. A resultant possible conclusion from such data is that the genus *Scaptomyza* arose on the Hawaiian islands from the same ancestral immigrant stock that also gave rise to the endemic drosophiloids. Further, the characteristics of the Hawaiian *Drosophila* species are such that their ancestor could not have been derived from any known South Pacific drosophiloid group. Some area of the North Pacific appears more likely to have been the ancestral home of the original introduction that gave rise to Hawaiian drosophiloid fauna. Additionally, a recent study (McDonald, Heed and Miranda, 1974) which compares the larval leaf-feeding habits of species of Lauxaniidae from the north coast of California with Hawaiian leaf-breeding *Drosophila* elucidates the ecological similarities between the two areas.

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Because of the phylogenetic placement of the *pinicola* subgroup, its geographical distribution and the ecological similarities, it therefore seems appropriate to investigate its possible relationship to the Hawaiian fauna.

DISTRIBUTION

The exact geographical limits of the distributions of the two species have not been determined, but present data indicate that they are allopatrically distributed in the coniferous or mixed coniferous-hardwood forests of California, Oregon and Washington. *D. pinicola* is known to range from Mt. San Jacinto in Southern California, northward on both sides of the San Joaquin and Sacramento valleys to Yosemite National Park (Mather) on the eastern side and to St. Helena, California, on the western side. Neither species has been collected east of the Sierra Nevada Range in California or the Cascade Range in Washington and Oregon. *D. flavopinicola*, originally collected by Wheeler and Heed in 1951, has been found only in the coastal areas extending from Trinidad, California, to the Olympic National Forest (Sequim) in Washington.

NATURAL HISTORY

Drosophila pinicola has been reared from field-collected mushrooms (Dobzhansky, personal communication). We have reared *D. flavopinicola* from several species of soft bodied mushrooms, especially species of *Amanita*. In the Trinidad, California, area three drosophilid species (*D. flavopinicola, D. melanderi* Sturtevant, and *D. subquinaria* Spencer) utilize the same individual fungi (mushrooms) for ovipositional substrates. Field-collected individual mushrooms produced in the laboratory numerous adults of all three of the *Drosophila* species as well as a species of Psychodidae, two species of Tipuloidea and two additional species of Acalypterate diptera. How these eight species are able successfully to partition the resources of a single fungal body has not been determined.

None of the three (*flavopinicola, melanderi* and *subquinaria*) appears to have a large population of adults in the field, even when suitable mushrooms are abundant. At the Trinidad sites direct observation, sweeping over mushrooms and baiting with bananas all indicate that *subquinaria* is the rarest of the three and *flavopinicola* the most abundant. At Mather, California, during the late spring and early summer when mushrooms are present in numbers, *pinicola* is quite abundant but it is rare at other seasons.

D. melanderi males assume courtship stations on the upper surface of mushroom caps. Highly pugnacious, they vigorously defend the area surrounding them. As a result, usually one and never more than two *melanderi* males have been observed on a single mushroom cap. If another drosophilid individual enters the defended area, the male will immediately approach and attempt to court.

D. flavopinicola males apparently never utilize the upper surface of the mushroom cap, but, rather, sit on the substrate around the base of the mushroom, perhaps on the mushroom stem. The male courtship displays thus seem to occur primarily on the ground at the base of the mushroom rather than on the mushroom proper. The courtship behavior of neither *D. subquinaria* nor *D. pinicola* was observed in the field.

In the laboratory both *flavopinicola* and *pinicola* prefer to oviposit in the commercial mushroom *Agaricus disporus* rather than in cornmeal or banana media. Larvae hatched from eggs oviposited in *A. disporus* complete their development and produce normal adults. The adults, however, cannot be maintained solely on *A. disporus* and must have access also to a carbohydrate rich food source such as the standard *Drosophila* media. Significantly, Sturtevant (1942) suggested that the adults of *pinicola* are sap feeders since he observed them on moist spots on the trunks of *Sequoiadéndron gigantèum* (Lindl.).

The mature larvae of *flavopinicola* and *pinicola* avoid pupating in or on the surface of their food substrate. Typically they pupate either in the cotton plug of the rearing vial or crawl through the plug and escape from the rearing bottle. Removal of the cotton plug and placement of the open rearing vial in a larger jar which has a layer of moist sand on its bottom results in the mature larvae leaving the rearing vial and pupating on the surface of the sand.

Similarly, the larvae which develop in a field collected mushroom which has been placed in a "sand jar" leave the mushroom when mature and pupate on the sand some distance from the remains of the mushroom.

In the laboratory *flavopinicola* and *pinicola* will oviposit in any portion of a mushroom, although they prefer the stem and cap surfaces and tend to avoid the gills. *D. subquinaria* exhibits similar behavior but *melanderi* refuses to oviposit in the gill area and prefers the surface of the mushroom cap.

Sturtevant (1942) noted that *pinicola* was difficult to maintain under laboratory conditions and must be kept at low temperatures. The reason is that the female oocytes of both species will not develop unless the individuals are kept at a temperature below 18–19°C. The adults can remain apparently healthy at higher temperatures, e.g., at 22–25°C, and at least some of the males will develop viable sperm. Occasionally on old female will become inseminated even though her ovaries show no sign of development. If individuals which are sterile because of "high" temperature are then placed under 18°C temperature, the females will within 7–10 days develop mature fertile ova.

It thus appears that *flavopinicola* and *pinicola* are fungivorous species that are constrained to live in areas where the females are able to find micro niches having temperatures lower than 18°C for relatively prolonged periods of time. The adults must be able to find both fungus in which the females can oviposit and an additional food substrate for themselves.

LIFE CYCLE

Both *flavopinicola* and *pinicola* reach maturity slowly and there is considerable inter-individual variation between flies reared and aged together. *D. flavopinicola* females reared and maintained at 18°C ± 1.5 begin to deposit eggs when they are 20–22 days old. *D. pinicola* matures about five days faster than does *flavopinicola.* Embryonic, larval and pupal development takes about 20 days for *pinicola* and 25 days for *flavopinicola,* thus resulting in generation times of about 35 and 45 days, respectively.

MORPHOLOGY

Wheeler (1954) noted that *flavopinicola* adults differ from *pinicola* mainly in their larger size, more yellowish body color and more highly pigmented wings. Thus *pinicola* appears blackish with a brownish tinge, and has clear wings except for a faint melanistic cloud on the posterior cross vein. It varies from 2.5–3.0 mm in body length and from 3.0 to 3.5 mm in wing length. *D. flavopinicola* appears brownish with a yellowish tinge, and has strong melanistic clouds on both cross wings and in the costa cell. The entire wing is also suffused with a brownish tinge. It varies from 3.5 to 4.5 mm in body length and from 4 to 5 mm in wing length. *D. pinicola* is therefore a medium sized species while *flavopinicola* is one of the largest drosophiloids found in North America. The eggs, larvae, pupae, the male genitalia, the ovipositors and the female ventral receptacles and dorsal spermatheca of the two species are also essentially identical except for size.

KARYOLOGY

The larval metaphase chromosomes of *D. flavopinicola* were described by Clayton and Ward (1954) as 5 pairs of rods and one pair of dots. The X and Y chromosomes could not be distinguished. We examined one larval brain smear from Trinidad, California (sex undetermined) and found the same configuration as in Plate 1 of Clayton and Ward with the exception that the sex chromosomes were longer, about 3 times the length of the autosomes and had satellites. The microchromosomes were minute. The larval polytene chromosomes showed 5 arms plus a dot with much diffuse centromeric heterochromatin.

The metaphase chromosomes of *D. pinicola* were described by E. Novitski in Sturtevant (1942) as follows: "Three pairs: X is J-shaped, Y is V-shaped, each arm about as long as the long arm of the X. There are two pairs of autosomes, a V and a rod, each of the three arms concerned being about the length of the short arms of the X." We have examined two male and two female larval ganglion cells (Stock M-72-12) and concur with the description above but with the following additions: (1) there is a pair of very small microchromosomes (dots); (2) the long arm of the X is about 3 times the length of the arms of the autosomes, and (3) the Y chromosome has a secondary constriction in one of its arms. The larval polytene chromosomes show 5 arms plus a dot with much diffuse centromeric heterochromatin.

D. pinicola and *flavopinicola* have the following characteristics in common: double length X chromosomes probably due to the addition of heterochromatin, and very small dot chromosomes. The *pinicola* metaphase is derived by one autosomal fusion and an X-autosomal fusion.

Behavior

(1) *D. pinicola*: A sexually alert male moves about bobbing his abdomen up and down, then orients upon a nearby or passing female, approaches and strikes sharply against her body with one or both forelegs. He then moves quickly to the rear of the female, positions himself directly behind her and lunges forward, thrusts his head under her wings, curls the tip of this abdomen under and forward and attempts to make genitalic contact. At the same time he attempts to grasp the female's abdomen with his forelegs and to push her wings apart with his head. A receptive female allows the male to achieve intromission, mount, and spread her wings. During copulo all of the male's legs are engaged in grasping the female's body but 1 to 2 minutes before termination of the copulation the male releases his legs, falls backwards and assumes a motionless trance-like state. During this time the female kicks with her hind legs, attempting to break the genitalic union, and eventually the male abruptly withdraws.

A non-receptive female may kick or decamp but most frequently she elevates the tip of her abdomen and "extrudes" by exposing the articulating membranes surrounding the ovipositor and terminal sclerites.

Copulation is relatively long, averaging 15′11″, with a maximum of 19′17″ and a minimum of 12′40″.

(2) *D. flavopinicola*: A sexually alert *flavopinicola* male bobs his abdomen up and down. The amplitude of movement is larger than that displayed by *pinicola* and is accompanied by small up and down movements of both wings. The male exudes an anal droplet and infrequently depresses the tip of his abdomen against the substrate and deposits the anal liquid on the substrate. Typically he moves about with short quick steps as he displays. Periodically he will cease bobbing, clean the tip of his abdomen with his hind legs and then uses the same legs to clean his wings. Presumably the anal droplet contains a volatile pheromone which is thus released into the atmosphere. Such low intensity display may continue for prolonged periods but usually it quickly and smoothly changes into a high intensity display which involves continuance of the abdominal bobbing accompanied by flicking both wings outward and upward in increasing amplitude until after several flicks the wing vanes attain about 45° outward and upward. Both vanes are then held immobile in this extended position. Simultaneously he depresses his head and elevates his abdomen until his longitudinal axis forms a 30°–40° angle with the substrate and the large genital claspers are fully opened. He then engages in "bounce-bobbing," i.e., the entire body is bounced up and down; with each bounce both extended wings are flicked 7°–10° further outward and at the same time the body is rotated slowly back and forth about 15° along its longitudinal axis. Five to six bounce-bobs occur while a single rotation cycle is completed from one side to the other and back. This complex display occurs in bouts of 1–2 second's duration and may be repeated many times. Between bouts the male often stamps rapidly against the substrate with one or both hind legs.

A *flavopinicola* male will spontaneously display in an observation cell and if a female moves into close proximity he orients upon her, moves to her rear, taps with his forelegs and lunges forward thrusting his head under her wings, simultaneously curling his abdominal tip forward. He then grasps the female with his forelegs, attempts to mount and achieve intromission. A receptive female allows the male to mount, achieve intromission and spread her wings. During copulation the male's legs are all used to grasp the female but he does not go into a trance at the end of the copulatory period. Rather, he quickly dismounts without preliminary movement. A non-receptive female may kick, decamp, or elevate the tip of her adomen and extrude. The duration of copulation is quite similar to that of *pinicola* with an average time of 16′04″, a maximum of 20′30″ and a minimum of 11′50″.

The courtship of the two species displays unique elements when compared to other continental species that have been studied.

Males of both species engage spontaneously in display activities. This is surprising since almost invariably *Drosophila* males orient, approach, tap with their forelegs and then engage in display actions (Bastock and Manning 1955; Spieth 1952). The display of *pinicola* is quite simple and consists simply of abdomen bobbing. The display of *flavopinicola* is more complex and ranges from abdomen bobbing, a low intensity display, similar to the courtship of the *pinicola* male to a complex high intensity display involving the entire body of the fly. The transition from low to high intensity is smoothly graduated. Significantly, the *flavopinicola* male will orient and attempt to mount and copulate regardless of the level of intensity of his display at the time the female is encountered.

The elements of mounting, intromission, copulation posture and dismounting behavior are essentially identical for the two species except that the *pinicola* male displayed the motionless trance-like state at the termination of copulation, whereas with *flavopinicola* this element was never observed.

Discussion

Egg, larval, pupal and adult morphologies indicate that *flavopinicola* and *pinicola* are closely related. *D. flavopinicola* possesses the primitive *Drosophila* karyotype of five pairs of rods and a pair of dots, while *pinicola* has a more derived karyotype, resulting from one autosomal fusion and an X-autosomal fusion. Both species are fungivorous and live in areas that are cool and moist. Both species have double length X chromosomes. The courtship behavior of *pinicola* consists of only a few elements, i.e., bobbing of the abdomen, curling the tip of the abdomen under and lunging onto the female. The *flavopinicola* male also exhibits comparable courtship elements but can and usually does display a number of additional elements. *D. pinicola* males engage in a motionless trance-like behavior at the end of the copulatory period, but *flavopinicola* appears to lack this behavior. The basic courtship pattern of *Drosophila* males is to orient upon a female, tap with the fore tarsi and then engage in courtship display. Both *flavopinicola* and *pinicola* will display without the physical presence of a female. Thus the male display is in reality an advertising ploy that presumably may serve to attract receptive females to him.

In a number of ways, especially in male courtship sequences of the two species, there are unique display elements which are lacking in most *Drosophila* species but are exhibited by a number of Hawaiian drosophilids. For example, the use of both wings in the display, the production and deposition on the substrate of an anal droplet, the elevation of the tip of the abdomen with concurrent lowering of the head, the trance state at the end of the copulation and the performance of the display without the immediate presence of a female. Likewise, the excessively long X chromosomes are similar to those of the Hawaiian species. The female ventral receptacles are similar to those of many Hawaiian species. Most Hawaiian species have dorsal spermathecae that lack an introvert (Throckmorton 1966), but two species, *D. anomalipes* Grimshaw and *D. quasianomalipes* Hardy, which appear to be archaic members of the Hawaiian fauna (Spieth, in press), have spermathecae that are similar to those of *pinicola* and *flavopinicola*. The long life cycle and the restriction to relatively low environmental temperatures (i.e., 18–19°C) are also characteristic of the Hawaiian species.

These evidences lead us to suggest that *pinicola* and *flavopinicola* are the descendants of an ancestral population that was closely related to the ancestor which gave rise to the Hawaiian *Drosophila* fauna.

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RECENT LITERATURE

THE INSECTS OF VIRGINIA: NO. 7. THE AQUATIC AND SEMI-AQUATIC HEMIPTERA OF VIRGINIA. Marvin L. Bobb. Virginia Polytechnic Institute and State University Research Division Bulletin 87:1–195. 1974.

This portion of the series dealing with Virginia insects includes 97 species in 30 genera among 14 families of Hemiptera. Keys are provided to the families and for the genera and species of each family. A brief diagnostic statement is given for each taxon and additional information on distribution, habitat, and biology is presented for the species. The 20 plates are well-done and should aid in the identification of the species. On the whole, the paper appears well-done and should be useful for studies on aquatic Hemiptera in that region.—EDITOR

THE INSECTS OF VIRGINIA: NO. 8. THE AQUATIC HYDROPHILIDAE OF VIRGINIA. James F. Matta. Virginia Polytechnic Institute and State University Research Division Bulletin 94:1–44. 1974.

This is cited as being the forerunner of treatments of the aquatic Coleoptera of Virginia. The aquatic Hydrophilidae are presented in similar fashion as other groups in this series. A total of 49 species are discussed with keys for their separation. Although illustrations of adults are lacking, genitalia of several species are figured.

SCIENTIFIC NOTE

The Occurrence of a Second Genus of Spongilla-Fly (*Sisyra vicaria* (Walker)) at Clear Lake, Lake County, California.—A revision of the Sisyridae (Neuroptera) by Parfin and Gurney (Proc. USNM No. 3360, Vol. 105:421–529) in 1956 reported *Climacia californica* Chandler to be the only species of spongilla-fly in California. The distribution of this species was limited to Oregon and the single locality of Clear Lake in California.

On May 18, 1968 at Clear Lake sisyrid adults, pupae, prepupae and larvae were collected at the type locality of *Climacia californica* on an aquatic entomology field trip. A recent close examination of the material showed two species to be present. Collections of adults and cocoons from under a wharf during the morning provided 23 ♂ and 13 ♀ adults of *Climacia californica* and 3♀ and 2 pupae of *Sisyra vicaria* (Walker). Ten cocoons were collected which contained pupae, prepupae, or pupal exuviae. Seven of 10 cocoons had an inner layer and an outer layer of closely woven and irregularly criss-crossed fibers. Three cocoons had the outer layer of loosely woven fibers hexagonal in pattern. Five of the cocoons with criss-crossed fibers had pupae or pupal exuviae identified as belonging to the genus *Sisyra* by their maxillary palpi and 10th tergite. All 3 of the cocoons with the hexagonal pattern had pupae or their exuviae that keyed to *Climacia.* Chandler (In Usinger 1956, Aquatic Insects of California, p. 236) reported the hexagonal pattern for the cocoon to be restricted to the genus *Climacia* and the criss-crossed construction to be typical for *Sisyra.* Parfin and Gurney listed *Sisyra fuscata* (Fabricius) as also producing a cocoon with a hexagonal net pattern at times. This was the only species of *Sisyra* known to show an exception to the criss-crossed pattern of cocoon construction. The wing venation of the 3 *Sisyra* adults from Clear Lake was typical of *S. vicaria.* Eight 3rd instar larvae were also collected on this date on sponges just below water (½ to 2½ feet deep) on a rocky shoreline about ¼ mile from the wharf. The larvae appeared to be *Climacia californica* but the identification was not positive. Parfin and Gurney reported the 3rd instar larvae of *C. californica* and *S. vicaria* to be very similar and difficult to separate.

On July 25, 1975 the same locality was again revisited. The underside of the wharf was closely examined but no adults were collected. Nine cocoons were removed from beneath the wharf, 6 with prepupae and 3 with pupal exuviae. The 3 pupal exuviae were identified as *Climacia* and all 9 cocoons had their outer covering of hexagonal netting, indicating the entire collection to be *Climacia californica.* Two weeks following the collection a species of Pteromalidae (*Sisyridivora* sp. ♂) emerged from one of the cocoons of *C. californica.* Reported parasitization by *Sisyridivora* is limited to the species *cavigena* on *Climacia aerolaris* (Hagen) in Ohio (Gahan, 1944. Ann. Ent. Soc. 44: 100–2). Sponges on the wharf piling and on small rocks below the wharf did not contain spongilla-fly larvae but the sponges were rather sparse in this area. The same rocky shoreline as in 1968 was inspected for 2 hours. Sponges were abundant but no larvae were found at depths from ½ to 4 feet.

Brown (1952, Amer. Midl. Nat. 47: 157) noted that sponges from comparatively cool clean Lake Erie yielded only larvae of *Climacia* while those from a warm, shallow, polluted pond in Ohio yielded only *Sisyra* larvae. Parfin and Gurney reported that Hungerford collected both *Sisyra* and *Climacia* larvae from two lakes in Michigan. It seems unusual that a collection of 29 type specimens of *Climacia californica* in May of 1949 would not have also revealed *Sisyra vicaria* if it were present. However, the same species ratio as was found in 1968 would have only resulted in 2.4 adult specimens of *Sisyra* in 1949. It is more likely that it was missed in 1949 than the collection in 1968 representing a 300 mile extension of its distribution from Oregon. It is questionable that the species of host sponge would be the critical factor in the distribution of these species of spongilla-flies. Poirrer (1969, Amer. Mid. Nat. 81: 573–5) reported no apparent host specificity in Louisiana and Texas for several spongilla-flies including *Sisyra vicaria,* and *Climacia areolaris* (Hagen) which had 4 and 5 species respectfully of host sponges, including 3 in common.—A. A. GRIGARICK, *Department of Entomology, University of California, Davis.*

NEW JOURNAL

ENTOMOLOGICA GERMANICA. A. W. Steffan, Editor, Petzower Strasse 34, D-1000 Berlin 39. Published quarterly, approximately 400 pp per volume. Initial issue, January 1975. DM 98.—per volume, DM 35.—per single issue.

This journal will publish original manuscripts from all non-applied fields of entomology. Classical areas (comparative morphology, phylogeny), as well as currently popular branches of research will be considered. Manuscripts need not be in German, but that will be the main publication language. Band 1, Heft 1 contains works dealing with functional morphology and fine structure of anal papillae of aquatic syrphid flies, the phylogenetics of Plecoptera, and a revision of a genus of ichneumonid wasps, as well as other articles.—*Editor.*

RECENT LITERATURE

CALIFORNIA WASPS OF THE SUBFAMILY PHILANTHINE (HYMENOPTERA: SPHECIDAE). R. M. Bohart and E. E. Grissell. Bulletin of the California Insect Survey, 19: 1–92; 151 figs., 46 maps. 1975.

Treats the 6 genera and 65 species which occur in California. Species treatments include capsule summaries of biological information, as well as distribution maps and listings of California records. Figures comparing facial markings, abdominal color patterns, and especially the outline of the lower face and mandibles in *Philanthus* supplement the keys and other descriptive material.—*Editor.*

Notes and Descriptions of Some North American Omethinae
(Coleoptera: Omethidae)

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Linfield Research Institute, McMinnville, Oregon 97128

The tribe Omethini was elevated to family status by Crowson (1972), as a member of the superfamily Cantharoidea. Crowson recognized three subfamilies in this family: Driloniinae with the single genus *Drilonius* Kiesinwetter (Asiatic species); Matheteinae, *Matheteus* LeConte and *Ginglymocladius* Van Dyke (North American species); Omethinae, *Omethes* LeConte, *Blatchleya* Knab, *Troglomethes* Wittmer and *Symphyomethes* Wittmer (North American and east Asian species). Magis and Wittmer (1974) confirmed the validity of Crowson's findings.

Crowson (1972) separated the Omethidae from the Cantharidae on the following characters: Labrum free, sclerotized and visible; abdominal tergites without paired glandular openings; wings with five anal veins in the main group and a closed anal cell; claws without setae; tarsal segments 3 and 4 with deeply bifid ventrally adhesive lobes. Characters of the Cantharidae are: Labrum not distinct, more or less membraneous; abdominal tergites with paired glandular openings; wings with not more than four anal veins in the main group and no closed anal cell; each claw with one or more setae; ventral adhesive lobe of tarsal segment 3, if present, not deeply lobed.

Wittmer and Fender (6-VII-73), collected a series of *Troglomethes oregonensis* Wittmer along the Little Nestucca River, Tillamook County, Oregon. These were collected by sweeping the herb layer of the area. Dominant plant species swept were *Polystichum munitum* (Kaulf.), *Maianthemum dilatatum* (Wood) Nels. and Macbr., *Oxalis oregona* Nutt. and *Viola glabella* Nutt. In this collected series were two females. Since the female of this species was previously undescribed, a description of the female is given below.

TROGLOMETHES OREGONENSIS Wittmer

Female.—Generally similar to male, shorter and stouter; head without transverse excavation and ornamentation; head except appendages black; pronotum black with pale margins confined to more sharply rounded anterior angles; hind wings greatly abbreviated, extending only to apex of third visible abdominal sternite in repose; intermediate antennal segments about twice as long as wide (about three times as long as wide in male).

Material examined.—Oregon, Tillamook County, Little Nestucca River, 16-VII-73, Wittmer and Fender, in the collection of the California Academy of Sciences.

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Wittmer's male type was collected at Cannon Beach Clatsop County, Oregon. Additional males have been studied from the following Oregon localities: Colombia County, Goble; Siuslaw National Forest, Castle Rock; Tillamook County, Little Nestucca River; Benton County, Marys Peak; Lane County, Blue River, H. J. Andrews Experimental Station; Iron Mountain Trail.

TROGLOMETHES LEECHI Wittmer

This species was described from a male collected at GLEN ALPINE, EL DORADO COUNTY, CALIFORNIA. Wittmer provisionally associated two females with this species from Tallac and Yosemite Valley, El Dorado County, California. Additional male records, all from California, now include: Shasta County, Burney (2) ; El Dorado County, Fallen Leaf Lake; Tulare County, Colony Mill. This gives a north-south range of some 300 miles along California's Sierra Nevada. A female from Chester, Plumas County, California, is provisionally placed with this series. In this specimen the hind wings are fully developed. It lacks the transverse excavation of the head, a character apparently confined to the males of *Troglomethes.* Wittmer (1970) noted that the excavations of the males might be secretory pores for sex pheromones.

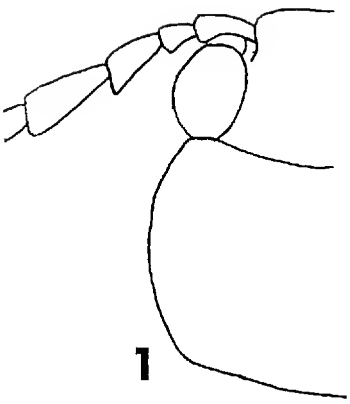
Crowson (1972) states that the wings of female *Troglomethes* are fully developed. This is apparently true of *Troglomethes leechi* Wittmer, based on provisionally placed females. In *Troglomethes oregonensis* Wittmer, the hind wings of the female are greatly abbreviated.

Malthomethes, New Genus

Type species.—Malthomethes oregonus, head somewhat protruded beyond and eyes remote from anterior margin of pronotum (fig. 2). Mandibles dentate. Last segment of maxillary palpus elongate, slender. Antennae eleven segmented, simple, third segment subtriangular, shorter and narrower than second. Pronotum transverse, sides arcuate, evenly rounded into arcuate base, hind angles obliterated. Claws simple, with a small basal tooth. Aedeagus of male with apices exposed, side pieces of dorsal plate not fused, suture quite apparent, median lobe lying ventrally free, uncovered as in other Omethinae.

Malthomethes oregonus, New Species

Male.—Black; frons, palpi, antennae and legs piceous, apices of all femora and apical tarsal segments paler, marginal bead of pronotum narrowly paler; pubescence cinereous, long, fine, sparse, suberect and inconspicuous. Length 3–4 mm. Head, including eyes, about as wide as pronotum, shining, sparsely punctured, more coarsely so behind and near eyes; mandibles long, slender and arcuate, with an acute internal tooth at middle; antennae extending to about basal third of elytra, simple, third segment subconical, shorter and narrower than second and about half as long as fourth, intermediate segments about twice as long as wide; eyes moderately large and prominent. Pronotum shining, transverse, almost half again as wide as long, anterior margin broadly shallowly concave, anterior angles



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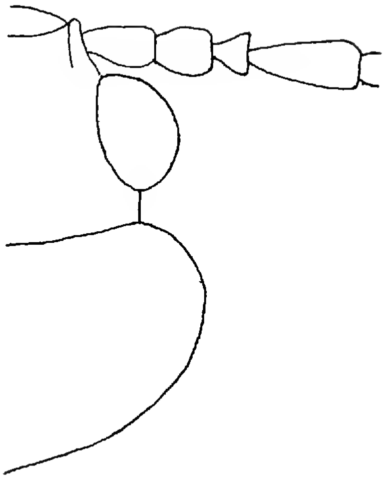

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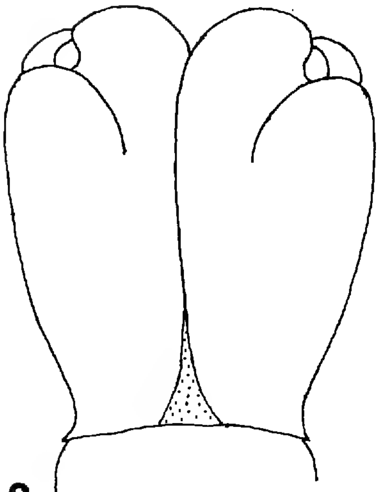

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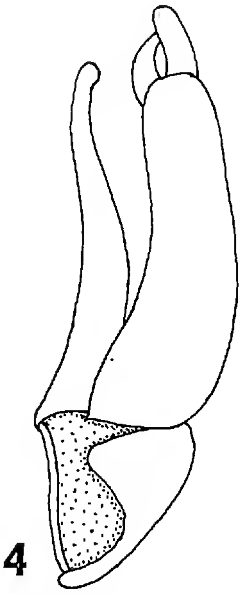

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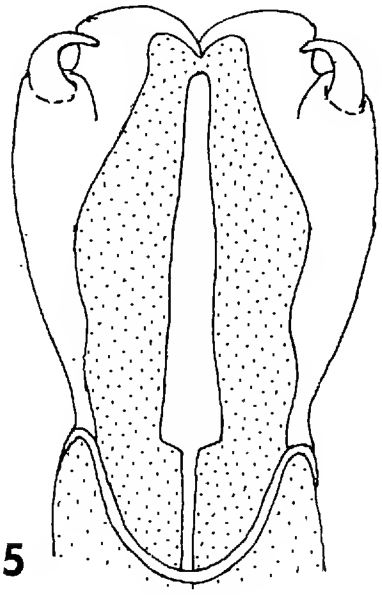

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Fig. 1. *Omethes marginatus* LeC., left half of head and pronotum. Figs. 2–5. *Malthomethes oregonus* Fend. Fig. 2. Right half of head and pronotum. Fig. 3. Aedeagus, dorsal aspect. Fig. 4. Same, lateral aspect. Fig. 5. Same, ventral aspect.

obtusely rounded, sides arcuate and narrowly reflexed, evenly rounded into arcuate base, margin broadly reflexed towards obsolete posterior angles, bottom of reflexed area closely coarsely punctured, at broadest depth with about two rows of punctures, remainder of pronotum finely sparsely punctured. Scutellum finely sparsely punctured, somewhat expanded apically, apex shallowly emarginate. Elytra elongate, ligulate, each about eight times as long as wide, extending beyond abdominal apex by nearly one-fourth their length, parallel sided to near apical fifth, then narrowing to apices, apices sharply rounded towards sutural side, feebly rugose basally, becoming more coarsely closely so apically, very delicate, strongly tending to curl in dried condition. Thorax shining beneath, finely sparsely punctured. Abdominal sternites feebly shining, more coarsely punctured than thorax, apical end of aedeagus exposed. Aedeagus as in figs. 3–5.

Female.—Unknown.

Holotype male.—Oregon, Coos County, Coos Head, 22-VII-72, D. McKey-Fender, in the collection of the California Academy of Sciences. Paratypes: (1), Oregon, 5 miles south of Gold Beach, 5-VIII-50; (4), Oregon, Lane County, Blue River, H. J. Andrews Experimental Forest, young Douglas Fir stand, I B P Biome Survey, plastic window trap, William Nagel (on following dates): 6-VII-72, 20-VII-72, 2-VIII-72 and ?-VII-73.

The genus *Blatchleya* Knab and the new genus described above require an emendation of Crowson's (1972) key to subfamilies of the Omethidae. The second dichotomy of his key should read (the figures indicated pertain to Crowson's work):

2. Mandibles stout (fig. 5). Tarsal segments 1–2 with finely setose ventral adhesive pads. Claws with a small basal tooth. Wing venation characteristic (fig. 18). Antennal segments 3 similar in size to 2, much smaller than 4. Abdominal segments with distinct paratergites. North American species. .... Matheteinae.
   Mandibles much less stout. Claws more strongly toothed. Antennal segment 3 evidently longer or evidently shorter than 2. Abdominal segments without distinct paratergites. American and east Asian species. ...... Omethinae

Wittmer's key for the separation of Omethinae males is modified to include the new genus *Malthomethes.*

KEY TO THE GENERA OF THE OMETHINAE BASED ON MALES

1. Head covered by pronotum at least to posterior margins of eyes (fig. 1) 2
   Head somewhat protruded, eyes not adjacent to anterior margin of pronotum (fig. 2) .... *Malthomethes* new genus
2. Head transversely excavated between eyes .... *Troglomethes* Witt.
   Head not excavated between eyes 3
3. Two antennal segments enlarged and excavated .... *Blatchleya* Knab.
   No antennal segments enlarged and excavated 4
4. Head strongly rugose, partly plicate. Elytra with finely impressed longitudinal lines .... *Omethes* LeC.
   Head almost smooth or a little punctate. Elytra without longitudinal impressed lines .... *Symphyomethes* Witt.

Females of many species of the Omethidae and the Cantharidae do not possess the diagnostic characteristics used to recognize the males. Unless taken in close company with the males, many are impossible to place to species or seldom even to species group. In the Omethinae, females are unknown for the genera *Malthomethes* and *Symphyomethes.* They are only provisionally recognized for *Troglomethes leechi* Wittmer. For these reasons it is felt ill-advised to attempt a key to the females at this time.

LITERATURE CITED

CROWSON, R. A. 1972. A review of the classification of Cantharoidea (Coleoptera), with the identification of two new families, Cneoglossidae and Omethidae. Revista de la Universidad de Madrid, 21(82): 35–77, 35 figs.

MAGIS, N. AND W. WITTMER. 1974. Nouvelle Repartition des Genre de la Sous-Famille des Chauliongnathinae (Coleoptera, Cantharoidea: Cantharidae). Bull. Soc. Royale des Sciences, 43(1–2): 78–95, 11 figs.

WITTMER, W. 1970. On some Cantharidae (Coleoptera) of the United States. Coleopt. Bull., 24(2): 42–46, 10 figs.

ZOOLOGICAL NOMENCLATURE

ANNOUNCEMENT A (N.S.) 96

Required six months' notice is given of the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number. (See *Bull. zool. Nom.* 32, part 2, 27th June 1975.)

2044. Suppression of *Acarus pseudogallarum* Vallot, 1836 and *Phytoptus coryligallarum* Targioni Tozzetti, 1885 (Acarina, Eriophyoidea).

1944. *Lyda alternans* Costa, 1859 (Insecta, Hymenoptera) proposed precedence over *Lyda inanis* Klug, 1808.

2068. *Phloiotribus* Latreille, 1796 (Insecta, Coleoptera) proposed suppression.

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, SW7 5BD, England. Those received early enough will be published in the *Bulletin of Zoological Nomenclature.*—MARGARET GREEN, *Scientific Assistant.*

Natural History of *Veromessor pergandei*. II. Behavior[1]

(Hymenoptera: Formicidae)

JEANETTE WHEELER[2] AND STEVEN W. RISSING[3]
Laboratory of Desert Biology, Desert Research Institute, University of Nevada System, Reno, Nevada 89507

Foraging. By far the most impressive above-ground activity of *V. pergandei* is its foraging in long narrow straight colums. Out-going and returning foragers use the same route; collisions are, therefore, frequent. Fig. 1 maps the relative positions of some of the intensively studied nests and directions and distances travelled by columns from Nest 1, 5, 8 and 10. Some entrances had columns leading in different directions at the same time. One column was 40 m long and involved about 17,000 ants. Fig. 2 maps foraging columns from the 4 craters at Nest 1 for 3 random days; note the bent column on 14 June from Entrances G, H and I. The numbers at the ends of the columns are estimates of the number of foragers in that column at a given time.

In the evening, the first indication that a column was about to form was the covering of the inside of the crater by hundreds of ants. When the temperature was high, these foragers stayed in the shaded area in the crater. However, once the crater was filled, and without any evident signal, a narrow column of ants would begin to leave the crater in one direction followed by thousands more. This process was observed frequently in the late afternoon and evening from the time when no ants were on the surface until the full column was out. There was never any advance indication which direction a column would take; no scouts or leaders were ever seen; first 2 or 3 ants would seem to lead, and then others would take their places.

In the morning, when workers were slowed by cooler temperatures, an initial cluster of several thousand led the column. Only after this cluster had reached the foraging area was the column reduced to normal width. On the morning of 19 June, one such initial cluster from Nest 8 travelled 15 m per min.

The usual column was a straight narrow band; there were, however, also a few branched and a few curved columns. On the afternoon of 13 June, there was a cloud cover and on the morning of 14 June a trace

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[1] The first portion of this study concerned nest architecture and construction (Pan-Pac. Entomol. 51: 205–216).

[2] Present address: Department of Zoology, University of Washington, Seattle, Washington 98105.

[3] The authors gratefully acknowledge financial support by the National Science Foundation, Grants GB 17731X and GB 37241, Dr. Frits W. Went, Principal Investigator.

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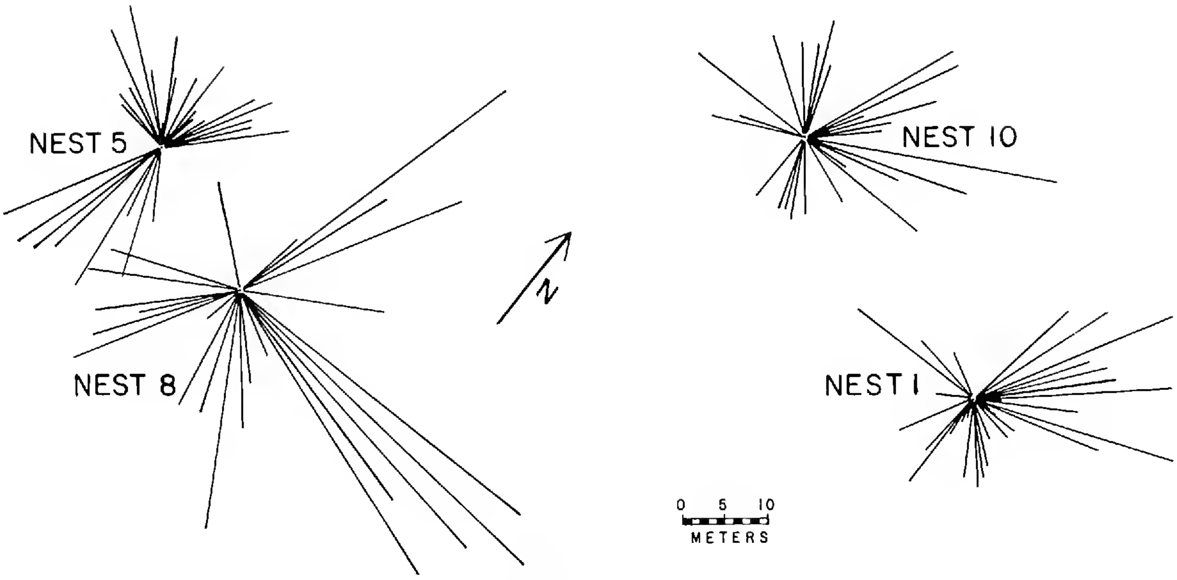

FIG. 1. Map of Nests 1, 5, 8 and 10. The radiating lines give the directions and lengths of all observed foraging columns.

of rain; the air temperature remained about 18 C throught the morning. An early morning check of Nests 1, 3, 5, 8 and 10 showed a single column at each nest; by 0930 Pacific Standard Time, Nest 1 had a branched column with approximately 8,000 workers foraging (the largest number observed at this nest); by 1030, Nests 5 and 10 had 2 columns each, while Nest 3 had 3 columns. The morning of 15 June was cool (16° C) but there was no cloud cover, the temperature rose rapidly, and each nest produced only one column.

On the evening of 9 June, 75 ants left Entrance A at Nest 8 and went 60 cm almost single-file toward the northwest. These, however, were not followed by other ants, and within 3 min there were only about 25 ants in the area. Several minutes later, a normal column started eastward; 20 min later, it was 10½ m long and included about 1500 ants. On 25 May, at Nest 8 one column started southeastward and one southwestward. Two minutes later the southeastern column had 20 foragers, while the southwestern column became 20 m long with about 5,000 ants.

Most ants went to the end of the route and spread over a wide area. Some foragers hunted along the route curving away from the column to about 50 cm on each side. They frequently climbed plants along the route, such as, *Oenothera clavaeformis* and *Mentzelia albicaulis* between Craters 3 and 4 of Nest 1. They examined all portions of the plant, but especially the seed capsules (Went *et al.* 1972, Fig. 2) even when empty. As many as 250 ants were found on one small clump of plants.

Percentages of fruits of each species taken from the foragers as well as other items brought to the nest were tallied for each nest for the entire study period. Samples of refuse piles from several nests were brought

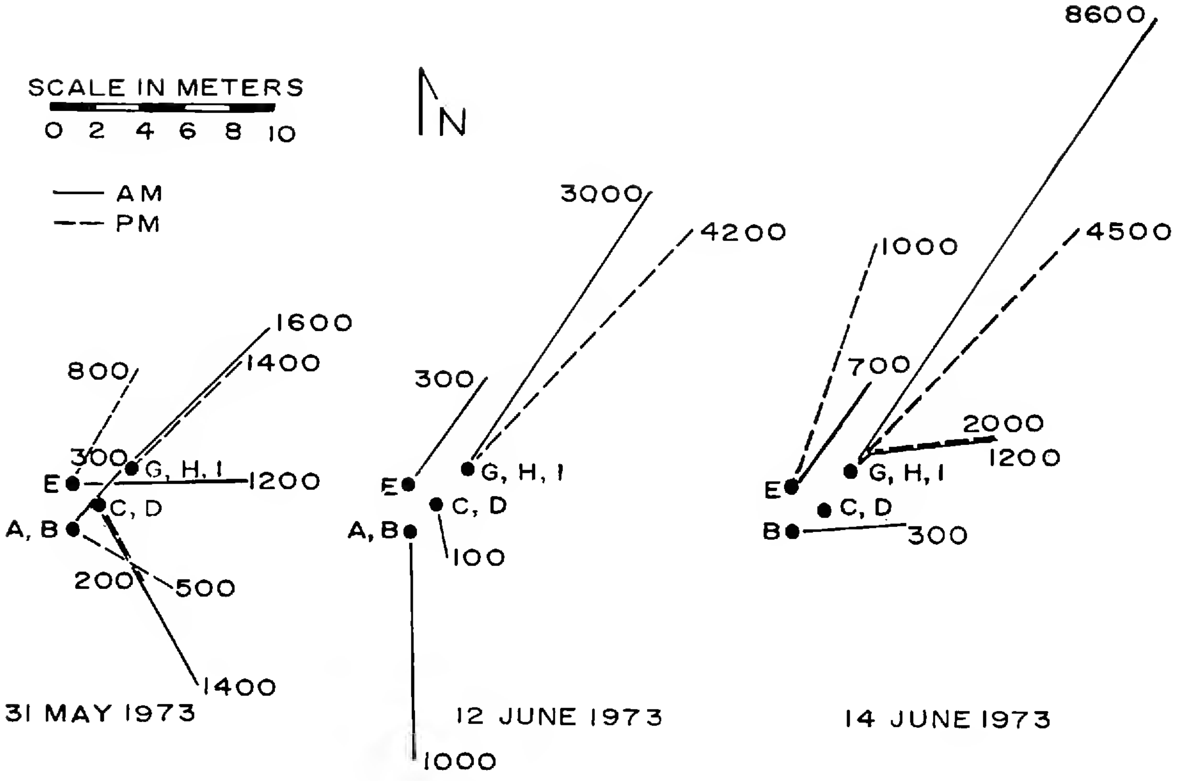

FIG. 2. Foraging columns for Nest 1 on 3 random days. On 14 June Entrance A was abandoned; C and D were inactive; G, H and I sent out double columns both morning and afternoon, the shorter had an angle of 45° about 1 m from the entrance. Numbers at the terminus of trail are estimates of foragers on trail at one time.

back to Reno. Each sample was hand-shaken through soil-sample sieves, the seeds separated by flotation from the sand and gravel, and each size-class was examined for seeds and seed coats. To test the fidelity (see under Discussion, below) of *V. pergandei*, workers were color-coded by placing one or two spots of nail polish of different colors on the dorsal surface of the gaster with a fine brush. The ant was first immobilized by chilling, coded, and finally released in its home nest.

The percentages of different kinds of fruits harvested varied greatly depending on the direction of the column. For example, when the column from Nest 5 changed from 170° to 210° (clockwise from N), the proportion of fruits from *Chenopodium pumilio* changed from 42% to 86%; when the column went in any other directions, the fruits of this species accounted for no more than 5%. The same colony harvested seeds of *Oe. clavaeformis* only when the column foraged between 30° and 40°. *Oe. clavaeformis* was collected by Nest 1 in all directions; many plants of this species grew nearby. They were taken less frequently at Nest 8, where this plant was less common. At Nest 1, however, ants from Entrances G, H and I had to pass over a 6-cm high wall of *Franseria dumosa* burs, an item that was not collected in great quantity at any nest at this time. Composite flower parts were brought into the nest even when fruits were plentiful.

On the morning of 3 June, one coded ant made 3 trips in the 15-meter column from Entrances G, H and I of Nest 1. On each trip she did her main foraging at a clump of *Oe. clavaeformis* 3½ m from the entrance and 75 cm from the main column. She left the entrance and soon began to angle toward the plants (as opposed to leaving the column adjacent to them). She searched a little on the outward trip, but when she reached the clump, hunted under large pebbles, moved smaller ones, stopped to clean herself and climbed briefly in the plants; then she found *Oenothera* seeds and carried some back to the nest. The return trip (at 2.8 m per min) was faster than the out-bound trip, although it was interrupted by brief searches. She stayed in the nest 20 sec one time and 30 sec another. This particular ant returned to the same foraging area, did not go to the end of the column before foraging, and usually used Entrance H. The times required for 3 foraging trips were 10, 12 and 17 min. This was a common pattern for foragers.

In an attempt to determine whether each forager normally carried something, foragers were aspirated at several craters and deprived of their loads. At times, fewer fruits than ants were collected. This was especially true in the morning when the temperature was rising rapidly (Nest 1, 30-V, 0825) and the ants were hurrying back to the nest. An average of 79% of all aspirated ants carried something. The amount of non-fruit plant-material (leaves, stems, flowers) brought to the nest during the observation period for all nests averaged 12% of the total. Some of the easily identifiable pieces were not found in the refuse heap.

It is interesting to speculate whether any use is made of the non-fruit plant parts brought into the nest by foragers. Dr. Johanna C. Went of Arnhem, Netherlands, studied the soil flora (bacteria, actinomycetes, fungi and yeasts) in January and March, 1972, in our death Valley area. She took samples from the open soil, from under growing *Franseria*, *Hymenoclea* and *Larrea* plants and from several places in *V. pergandei* nests. In March she took samples from the seeds in the seed chambers, from chamber soil and from soil between chambers. She found her highest counts of bacteria, actinomycetes and fungi on seeds from the seed chambers, but her only yeast cultures in all the samples were in the refuse piles of the ant nests.

Trail-marking. To determine whether *V. pergandei* used a trail-marking pheromone, a mirror was embedded in an area frequently crossed by a column from Nest 1, Entrance E. As the column crossed the glass surface, there was no evidence of trail-marking action nor a smear of any liquid. Frequently, the columns would widen and become less organized as they crossed a steep gravel embankment 1½ m high near Nests 1 and 8; then they would narrow again after crossing the obstruction. However, very large columns from Nest 3, Entrance A travelled 32 m across very rugged terrain and remained compact. Ants from Nests 1 and 8 should have no difficulty climbing the face of the embankment; the ants at Nest 3 easily managed much more rugged terrain. Such widening of the column would not be expected if the ants were following a chemical marker since the change in topography should have little effect. Such disturbance in the column, however, could result if individual ants were using geographical landmarks as navigating aids.

Several marked ants were released a few meters from their home nests, but not in a column. Many never found their nest; several, however, did head directly for the nest after a brief period of wandering. Marked ants, released in the column, usually found their way to the nest after a brief period; they went first to the nest and then went out in the foraging column.

The area around one crater was flooded so that ants returning in the column were blocked from the entrance. A short piece of marker-stake (about 2½ cm wide) was supplied as a bridge; gradually some ants started using it. When an ant carrying a seed was halfway across it, the bridge was rotated 180°. The ant proceeded ahead, now in the wrong direction, returned to the bank, turned 90°, proceeded 50 cm and then returned to the bridge. Again the bridge was rotated, but this time the ant corrected her course and proceeded to the nest.

If the soil surface over which a trail had been established was disturbed, ants would "pile up" on either side of the disturbed area. After several minutes (depending on the width of the disturbance) several crossed; and finally the column was reconstructed.

Orientation. In Death Valley in May and June 1973, a one-m shadow was cast across a column from Nest 5, as it crossed the paved road; no disturbance in the column was detected. There was still no change when the shaded area was illuminated from the east, north or south with a medium-sized mirror. Nest 2, which was located on the edge of a gravel road, had columns on 3 occasions which were completely shaded by a 60-cm high gravel embankment. These columns occurred on 12, 19 and 20 June and were 16½, 1¼ and 15 m long. At 0305 (about 2 hours before sunrise) on 21 June, a column at Nest 8 was already 5 m long; the workers were all outward bound. On 8 July 1973, a column at Nest 2 was well established (workers moving in both directions) and 12 m long at 0320—again before sunrise. At this hour there was no light visible to the human observer in the eastern sky.

In Death Valley at 0530 on 1 September 1968, ants were active on the mound and a foraging trail had been formed. At 0830 the sun had been on the crater for some time, but the ants were still foraging. On 4 September at 0530, ants were actively foraging at 2 craters; one of the trails was about 48 m long; at 0845 foraging stopped abruptly. At 0830 on 5 September, in direct sunlight the temperature was high, but there was a strong breeze; ants were foraging at 3 different craters.

In Deep Canyon on 1 May on a warm evening, we collected workers which were actively harvesting when it was so dark that flashlights were needed to find the ants. The workers seemed as numerous in the column and moved in the same manner (both in speed and in integrity of the column) as in daylight. They also seemed to be bringing in the same amount of seeds.

In Deep Canyon in winter, we placed a metal-walled trap around an actively foraging crater. The ants leaving the nest went as far as the shadow (about 20 to 30 cm long) cast by the trap-wall, milled around and returned to the entrance. The next morning, numerous entrances had been opened outside the trap and in the sunshine; ants were busy harvesting, going in the same direction that they had used before the trap was in place (Went *et al.* 1972: 82–83).

Nest-workers. In May and June, the activity of nest-workers, (the ants which removed the excavated material and organic refuse from the nest) seemed directly related to temperature. They were normally active throughout the night until 0800 or 0900 and reappeared between 1630 and 1700. On hotter days, they went underground earlier and stayed longer. On cool, cloudy days, nest-workers moved rapidly all day, but their greatest activity was at night. We observed 20 to 30 ants working while an evening column moved out; this number increased steadily until 250–300 were involved between 2300 and 0100 at Nests 5, 8 and 10. The initial evening activity was the appearance of about 10 minim nest-workers. They ran a short distance from the entrance, dropped their loads and darted back into the nest. Within 10 minutes, larger nest-workers appeared.

On the morning of 25 May, about 200 ants, most of which were nest-workers, were on the crater of Nest 5. A major worker was crushed and dropped back into the crater; immediately most of the ants rushed into the entrance. For the next 8 minutes ants approached the crushed major, palpated her with their antennae and hurried away. Finally, a minim began to pull the crushed worker away from the entrance while other ants were still palpating her; the minim left the dead ant half way down the outside of the crater. It was soon picked up by a major, which carried it 6½ m from the nest, dropped it, and then started to forage.

Guards. During the day, workers stood near the entrance, clinging to the ceiling of the vestibule, with their heads pointed toward the center of the opening, with their mandibles open and their antennae waving. At night, about 200 stood on the surface of the crater near the entrance. When disturbed, they ran frantically in and out of the entrance, alarming other workers and attacking the source of the disturbance. Sometimes guards (and nest-workers) reacted similarly when the observer leaned over the nest (during the day) or illuminated the entrance with a bright flashlight (at night); but at other times the same stimuli failed to cause any reaction. Frequently 30 or 40 ants ran frantically about and up the boots of the observer at 14 cm from the entrance at Nest 8, even though there had been no ants in the area when he approached. This often happened during the day when no guards were seen. However (see below) workers changed roles frequently and it is probable that nest-workers or foragers served also as guards. At night, it was the guards which attacked.

Role-changing and Internidal Hostility. The marking technique was used to see whether workers were usually limited to one role. At Nest 8, 35 nest-workers were marked pink and 67 guards white. The marked nest-workers foraged while marked guards did both nest-work and foraging. A nest-worker from Entrance A of Nest 8 was seen carrying sand from the newly formed Entrance B. Ninety-two foragers at Entrances G, H and I of Nest 1 were marked pink. They were frequently found later in this crater's column, but some were found in E's column, while others did nest-work and guarded at Entrances C and D, and did nest-work at B. None of the marked ants was ever found in any other nest.

Fighting occurred frequently around Nest 2 and Nest 10. At Nest 2 in May 1973, fighting was in progress, with black piles of dead ants in the vicinity. Thereafter Nest 2 became inactive temporarily; then normal foraging was resumed. On 20 and 21 January 1974, Nest 2 was active; Nest 10 was inactive or had been abandoned.

Discussion

Behavior. Creighton (1953) studied this ant at 57 stations over most of its range from early March until November. He concluded that this species is adapted to the hottest and most arid desert areas of the southwestern United States by: (1) foraging only when the soil surface was below a certain critical temperature [Equipment for measuring actual soil surface temperatures was not available then.]; (2) foraging when the light intensity was less than the maximum; and (3) foraging only after all the fruits collected in the last foraging column had been husked (p. 15).

Tevis (1958) worked on *V. pergandei* in the Coachella Valley near Palm Desert. He agreed with Creighton about the lethal effects of summer midday temperatures, but noted that ants in the Valley started work before dawn and formed foraging colums which worked after dark on especially warm summer nights. (Creighton had reported that *V. pergandei* needed direct sunlight for orientation.)

We found that this species in the alluvium of the canyon floors both in Death Valley and Deep Canyon started foraging before dawn—while there was no light visible in the sky to the human observer—and continued working after dark. The integrity of the columns did not seem to change, nor did the amount of seed brought to the nest diminish without direct sunlight. These observations were made during May, June and September. In December, January and February on cool days, there was only one midday period of activity when the temperature rose high enough to allow activity. Therefore, our only disagreement with Creighton and Tevis is that night foraging seems to be very common during the hottest months if fruits from winter annuals are abundant.

Our test of the fidelity of the foraging ants to the same trail showed not only that *V. pergandei* foragers did not always use the some trail, but that workers shifted from one task to another. This is in marked contrast to European "individual wood-ants [which] are to some extent faithful to particular routes or even particular trees at the end of the routes" (Sudd 1967: 82). Sudd noted, however, that *F. aquilonia* showed much less fidelity to one route. *V. pergandei* showed flexibility in another way: a worker deprived of a bur of *Franseria dumosa* picked up a utricle of *Atriplex hymenelytra* out of the petri dish in which she was detained. Thus, this ant was not "programmed" for one species of fruits at this time. In fact, these harvesters seemed to be "opportunists" in regards to annuals and collected any fruits which were available in approximately the number in which they were present. *Franseria* was largely ignored at this time. But no one has mentioned any ants which shifted tasks as quickly as the *V. pergandei* worker which carried a dead nest-mate away from the crater and then continued the trip to forage for food. (See Wilson 1971: 163.)

Tevis reported that these harvesters brought about 7% leaves, stems, petals and dead seedlings to the nest; he said that this material was found later in the chaff pile. Clark and Comanor (1973) reported 12% plant parts from our area for their 4 days in April. We also found an average of 12% for all nests in our intensive study. These materials were not found in the chaff pile; therefore, they must have been used in some fashion in the nest.

It is interesting that Dr. Johanna Went found yeast only in the refuse heaps of ants out of all cultures of soil samples made in Death Valley and that Weber (1972: 87) stated: "The garden of *Cyphomyrmex rimosus minutus* and its close allies consists of fungal masses . . . of thickly packed cells that look like ordinary yeast." The fungus has been identified as *Leucoprinus gongylophorus* (Moeller) "a segregate of *Lepiota*" (p. 109). He concluded, concerning the stages of evolution of fungus-growing in ants: "In relation to these stages, the behavior of other ants might seem to be relevant, such as the harvesters that collect seeds and other vegetal matter. No other ants, however, appear to show any early stages in fungus culture. A common harvester, *Pheidole*, does resemble the attine ants and further study may show a relationship." (1972: 115.) We can now note that the larvae of *Pheidole* with a specialization index of 14 (Wheeler and Wheeler 1974 in press) and the larvae of *Cyphomyrmex* with a specialization index of 25 (subfamily Myrmicinae 20; family Formicidae 22) seem unlikely candidates for similar larval feeding habits. *Veromessor lobognathus* with a specialization index of 11 is an even less likely candidate. Body shape, mandible shape and body hairs are all markedly different between the fungus-growers and the seed-harvester larvae. (Wheeler and Wheeler 1974 in press.)

Went *et al.* (1972: 82) reported that the direction of the foraging column shifted in one direction 15° for each change. At Nest 8 this seemed to be true for the next direction of the column for several days; also there seemed to be a slight tendency to move 30° if one or more successive foraging columns had all followed the same direction; these periods of regular shifting were followed by periods of apparent random shifting of direction. In nests with more than one entrance, the patterns seemed much less predictable. It may be possible that when seeds are scarce foragers cover the foraging area carefully by shifting 15° in one direction and that in times of bounty—when foraging in any direction will yield profitable amounts of desired seeds—foraging trails are random. Double and triple columns seemed to be put out in response to favorable weather conditions, i.e., morning temperatures warm enough for rapid motion, with cloud cover which held the soil-surface temperature well below the lethal temperature. On 14 June 1973, with traces of rain, a cloud-cover, and moderate (28 C) air temperature, 3 columns were formed at Nest 8 and comprised about 15,000 workers; this was the largest number of foragers seen at this nest.

What determines the direction a foraging column will go we do not know. Ultraviolet light from the sky could not be used to orient the columns which form during the dark before sunrise. A trail-pheromone could be laid down in the afternoon to be used after dark as the column continues to forage after sunset. We doubt that *V. pergandei* orients "anemotactically" (Wehner and Duelli 1971) as reported for *Cataglyphis bicolor*, since the wind changes twice a day in Death Valley in the side-canyon.

We could find no evidence that *V. pergandei* used a trail-marking pheromone as reported by Wilson (1962) for *Solenopsis saevissima* (= *invicta*) neither by making the motion, nor by marks left on a mirror. However, they apparently did "recognize" rocks and gravel which had been part of the entrance to their nest and were moved into the foraging column. Entrance materials caused excitement, with workers wandering over them and returning to examine them. Similar-sized rocks and gravel, from the surrounding soil surface, did not elicit "recognition" nor cause any excitement. The entrance rocks and gravel may have been coated with some of the "cement" used to plaster the sand and gravel around the entrance and to coat walls of galleries and chambers in the nest. This may have been the cue for recognition.

Creighton (1953: 13) reported: "A patch of shade no more than 2 feet long causes many foragers to break out of the column and wander aimlessly about." We found that in the middle of winter in Deep Canyon when we used a metal walled trap to determine what seeds the ants were collecting that the ants went as far as the deep shadow of the trap-wall and milled around and returned to the nest. The next morning there were many entrances opened around the outside of the trap in the sunshine and the ants were busy travelling in the same direction and collecting seeds. (Went *et al.* 1972: 82–83.) We thought that this corroborated Creighton's hypothesis that *V. pergandei* needed direct sunlight for orientation. In Death Valley in May and June, however, when a 1 m shadow was cast across the foraging trail, the ants ignored the shade and continued normal foraging. We now wonder if the reduction in the heat in the middle of winter was enough to cause the stoppage which we observed in Deep Canyon. Creighton in 1952 may have ignored a temperature-controlled cue which the ants might have received from air temperature when the mask was removed, or their black bodies may have received too much heat from direct sunlight and the ants may have warmed much faster than the light desert soil. No one has yet measured the internal body temperature of living ants under different meteorological conditions to see whether different colors of ant integument accounts for different responses to sunlight.

Marked ants released singly near their home nest, but not in the foraging column, frequently did not find their home nest; those released in columns did. Those single ants which did find their home nest wandered for a short time and then headed for the nest. They could not have found an old odor trail, since the trail pheromone must be volatile to be useful. (Wilson 1971: 252.) Furthermore, all columns we observed showed no sign that a trail was laid or that ants in the column were using an odor trail to orient to the food source.

Clark and Comanor (1973: 469) showed a decline in nest-workers with an increase in foragers for the 4 days in April; this activity pattern is similar to that reported by Creighton (1953). In May and June, by contrast, we found that the number of nest-workers increased from 20 to 30 while the foraging column was forming, and reached a peak of 200 to 300 ants between the hours of 2300 and 0100 while the foraging column was active. This might be due to the differences in the number of workers involved and to the warmer temperatures during our observations. Clark and Comanor observed no more than 325 ants outside their "nest" (= one entrance or crater?). This is a much lower count than we had. That so few ants could effectively cover an area 7.3 m^2 or even be dense enough so that the perimeter of the area could be mapped is puzzling.

Creighton (1953: 15) noted that gravel was brought by nest-workers as they (apparently) enlarged storage chambers; later husks were carried to the refuse pile. Finally, when all the seeds had been processed and the ants came out with empty jaws, workers were ready to go foraging again.

Creighton (1950, 1953) did not mention the species of seeds gathered by *V. pergandei.* Tevis (1958) listed a total of 14 genera collected in Deep Canyon. Eleven were collected from July to March (at the end of a 12-year drought) and 10 from April to June (after winter ephemerals had bloomed), but the percentages of species changed drastically. Clark and Comanor (1973) listed 4 genera for 4 days in April. Our list of seeds taken from the foragers and the refuse piles shows a much more varied composition: 42 species in 33 genera in 20 families.

ACKNOWLEDGMENTS

We hereby express our thanks to Dr. Frits W. Went, who very kindly identified the plants and seeds, but most of all, for his constant interest and imaginative assistance. We also thank Dr. George C. Wheeler, who was an active participant in all phases of this study. We thank the National Park Service for permission to use the study area; our special thanks go to numerous Death Valley National Mounument personnel who made our stay more profitable and enjoyable. We thank Lloyd Tevis for his collaboration at Philip L. Boyd Deep Canyon Desert Research Area (University of California, Riverside).

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A New Species of *Rhexinia* from Argentina
(Coleoptera: Pselaphidae)

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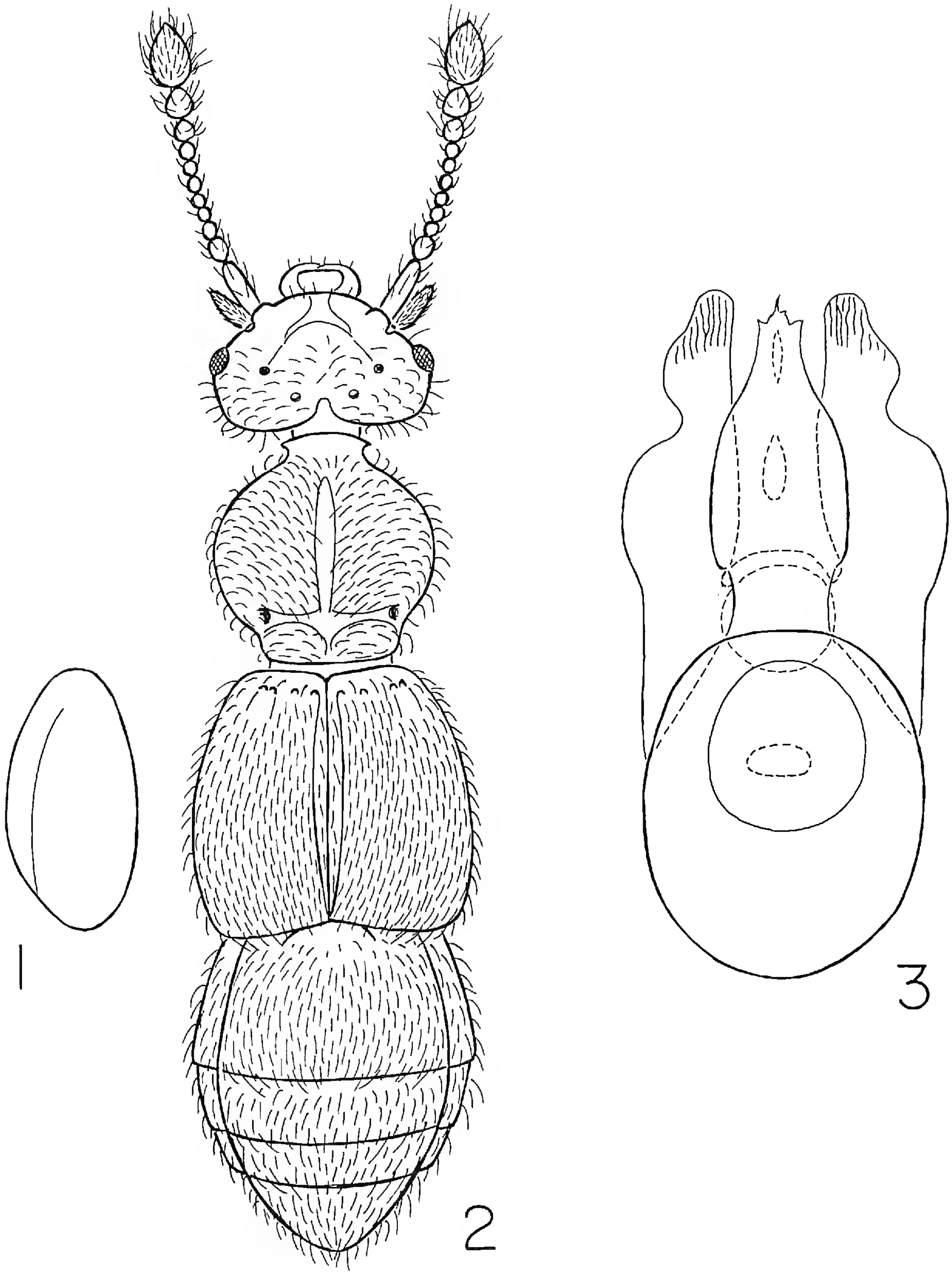
During a study of the genera of the tribe Euplectini we came across an undescribed species of the genus *Rhexinia* which had been set aside by the late Orlando Park in his collection at the Field Museum of Natural History, Chicago. This genus was revised by Park in 1952 at which time he placed *Rhexinia angulata* Raffray, 1890, and *Rhexinia versicolor* Raffray, 1908, from Central and South America in *Rhexinia* (sensu strictiore). The subgenus *Rhexiola* was created for two species from Mexico. The species described below is placed in the nominate subgenus by the presence of the following characters: Head transverse trapezoidal; pronotum subcordate with median longitudinal sulcus; and two separated mesosternal foveae.

KEY TO SPECIES OF *RHEXINIA* (SENSU STRICTIORE)

1. Head and prothorax strongly sculptured, each sculpture with short seta in center; first visible abdominal tergite with curved longitudinal carinae one-half length of segment .... *angulata* Raffray
   Head and prothorax without prominent scultpure; first visible abdominal tergite without longitudinal carinae 2
2. Basal depression of first abdominal tergite with sensory setae; each elytron with sutural and three discal foveae .... *tucumanensis* new species
   Basal depression of first abdominal tergite without sensory setae; each elytron with sutural and two discal foveae .... *versicolor* Raffray

Rhexinia (Rhexinia) tucumanensis, new species
(Figures 1–3)

Male (fig. 2). Head (excluding mouthparts) 0.36 mm. long, 0.56 mm. wide; pronotum 0.55 mm. long, 0.57 mm. wide; elytra 0.59 mm. long; abdomen 0.95 mm. long, 0.84 mm. wide. Head with vertexal foveae on line with posterior margin of eyes; postantennal foveae present on side of head with apodemes connected to those of vertexal foveae; two low rounded tubercles near posterior margin, separated by a distance slightly less than that separating vertexal foveae. Antennae not geniculate, segment I as long as segments III to VI, segments IX and X weakly hexagonal. Ventral head setae long, numerous, simple; venter longitudinally sulcate. Prothorax distinctly compressed dorsoventrally, with small but distinct anterior flange; pronotum with longitudinal and transverse sulci; procoxal foveae large. Profemur with broad oblique sulcus near apex (apparently for reception of tibia); setate carina on mesal face bordering sulcus. Elytra with sutural and three discal foveae; subhumeral fovea absent; epipleural sulcus



FIGS. 1–3. *Rhexinia tucumanensis* new species. Fig. 1. Epipleural sulcus, lateral view. Fig. 2. Dorsal aspect (except legs) of holotype. Fig. 3. Male genitalia, dorsal aspect.

present (fig. 1); winged. Mesosternum with two lateral and two median foveae; mesocoxae contiguous in confluent cavities; lateral mesocoxal foveae present, mesotibia with blunt subapical spine. First visible tergite as long as II plus III; basal depression one-sixth length of segment, between one-third and one-half width of segment excluding margins, depression setate. Sternite I flatly carinoid between coxae; II with broad transverse anterior sulcus; III, IV and V without distinctive features; VI transversely oval, distal margin sinuate. Genitalia bilaterally symmetrical (fig. 3), 0.42 mm. long, 0.18 mm. wide.

The holotype is the only known example of this species and is in the Field Museum of Natural History. It was collected in Tucuman, Argentina, May 17, 1953, C 10, by P. Wygodzinsky.

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SCIENTIFIC NOTE

Notes on Cerambycidae: Description of the Female of *Malobidion brunneum* Schaeffer.—Since the original description of *Malobidion brunneum* by Schaeffer (1908, Bull. Brooklyn Insts. Arts. Sci., 1:337) the species has been known only from the male. The genus was placed into the tribe Hesperophanini by Linsley (1962, Univ. Calif. Publs. Entomol., 20:51) with the female still unknown. Subsequently, Chemsak and Linsley (1962, Jour. Kansas Entomol. Soc., 36:207) described females of two new Mexican species of *Malobidion.*

During the past three years I have been fortunate to collect a large series of *M. brunneum* in southern Arizona which included a number of females. From a total of 85 specimens, taken at a 160 watt mercury vapor lamp, 13 were females. The description follows: Antennae 12-segmented, extending two segments beyond elytra, scape about as long as fourth segment, third about ¼ longer than fourth, fifth longest, remaining segments slightly decreasing in length to apex, twelfth segment about ⅔ as long as eleventh. Abdomcn with fifth sternite truncate at apex. Length, 9.5–14 mm.

The males of *Malobidion* all possess 12-segmented antennae while only the female of *brunneum* shares this character. The female antennae of the other two known species are 11-segmented.—David G. Marqua, *Los Angeles County Nature Centers, 1000 N. Durfee Ave., S. El Monte, California 91733.*

New Species of Trichoptera from Western North America

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The new species described herein have been selected for description since they are interesting additions to the trichopterous fauna of western United States. The new *Tinodes* represents the eleventh species, the new *Homoplectra* the eighth species and the new *Neothremma* the sixth species in these typically western genera. The peculiar limnephilid *Cryptochia* is very rare in collections and is known from only six western species; an interesting *Cryptochia* is described herein. The peculiar new *Rhyacophila* presents an interesting departure from described species and may be a relict species.

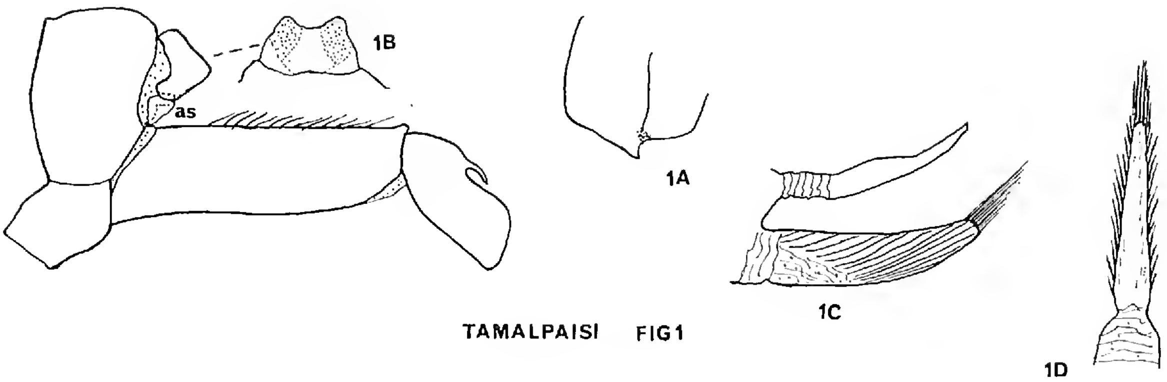
Unless stated otherwise, types of the new species will be deposited in the California Academy of Sciences, San Francisco.

Rhyacophila tamalpaisi, new species

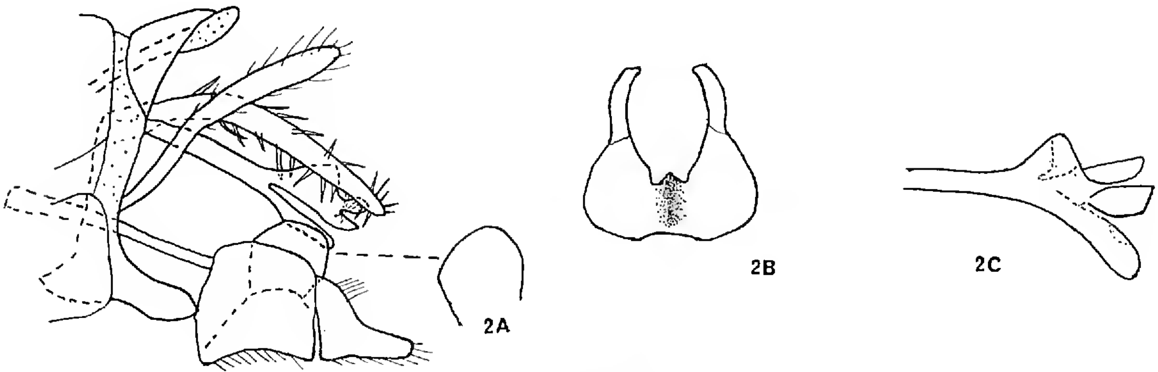
This new species may be a member of the *valuma* Milne complex. The shape of the clasper bears similarity to *colonus* Schmid, to a lesser degree there is some resemblance to the aedeagal structure of all three species in the complex. However, this new species differs from all Rhyacophila in the shape of the tenth tergum and anal sclerite, in the primitive aedeagal structure, and in the incised apicoventral portion of the basal segment of the clasper. When the female is known it is probable that the species should not be aligned to the *valuma* group.

Male.—Length 5.5 mm. General color of legs, antennae and thorax brownish, wings light brown, veins and pterostigma distinct. Legs, especially tarsal segments of last pair with heavy pilosity. Genitalia as in Fig. 1. Fifth segment with a prominent lobe. Segments seven and eight bearing prominent medial carina, Fig. 1A. Ninth segment narrowed ventrad, mesal portion sternum with deep incision. Tenth segment, lateral aspect, trianguloid, dark pigment; from dorsal view, Fig. 1B, distal margin narrowly incised, slightly concave laterally, mesal area with dark pigmentation. Anal sclerite, *as*, small, elongate, dorsal margin arcuate. Basal segment claspers long, parallel-sided, distally narrowed to accommodate a deep incision of ventral margin into which (possibly) the apical segment would repose when moved ventrad; apical segment declivent, acute mesad-curved spine along dorsal margin, distal margin truncate, apicomesal surface bearing dense pad of dark minute setae. Aedeagal complex, lateral aspect, Fig. 1C, with lightly sclerotized dorsal tubular structure acuminate to oblique apex; large ventral structure tubular, narrowed distally. Viewed laterally structure appears

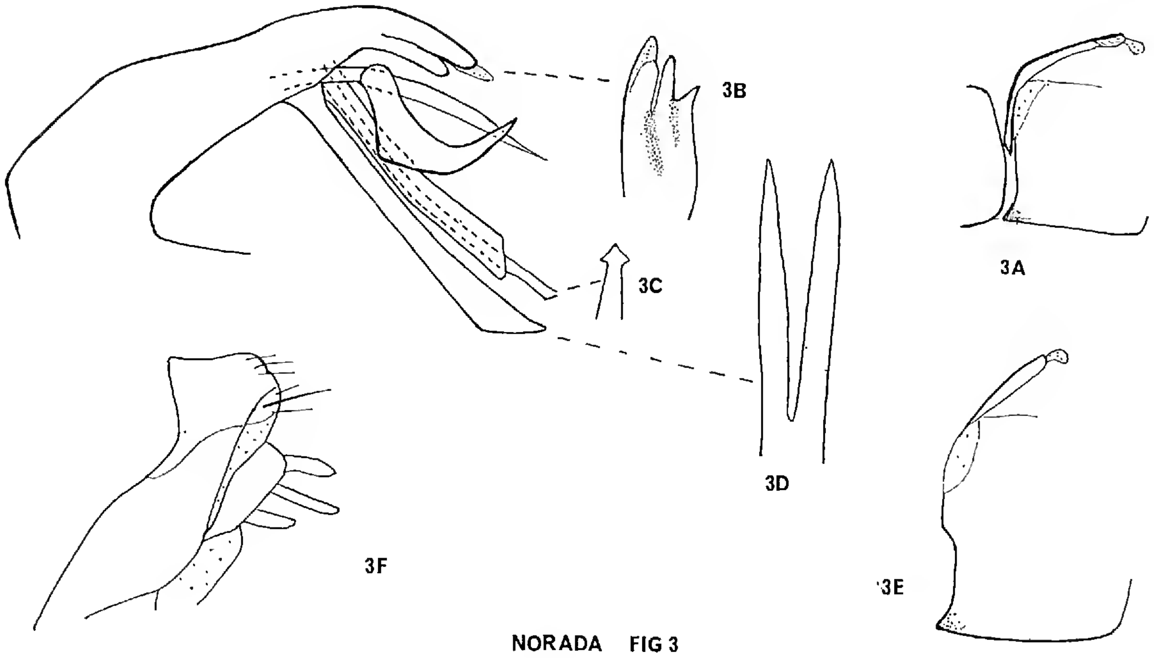
The Pan-Pacific Entomologist 51: 318–326. October 1975



TAMALPAISI FIG1



TWILA FIG2



NORADA FIG 3

FIG. 1. *Rhyacophila tamalpaisi* Denning, male genitalia, lateral view. 1A, sternum, segment 8. 1B, tenth tergum, dorsal view. 1C, aedeagal structure, lateral aspect. 1D, phallus ventral view. FIG. 2. *Tinodes twila* Denning, male genitalia, lateral aspect. 2A, lobes arising from meson basal claspers. 2B, claspers, ventral aspect. 2C, phallus, lateral view. FIG. 3. *Homoplectra norada* Denning, male genitalia, lateral view. 3A, filamentous process, segment 5. 3B, tenth tergum, dorsal view. 3C, phallus, dorsal view. 3D, ventral sheath, ventral view. 3E, segment 5, lateral view. 3F, female, lateral aspect.

striated with longitudinal brown lines, apex with dense tuft of long stout spines, from ventral aspect, Fig. 1D, the dense lateral and apical flattened setae easily discernible.

Holotype male.—Fern Creek, Mt. Tamalpais State Park, Marin County, California, 21 April 1974, Paul A. Peterson. Collection was made during high water. Although the collection site was recollected several times, no additional specimens were collected. To be deposited California Academy of Science, San Francisco, California.

Tinodes twila, new species

This represents the eleventh North American species; although the genus is cosmopolitan these described species are known only from western United States and adjoining Mexico. The majority of these species are found in the Pacific coastal areas. *T. twila* is readily distinguished by the short claspers and its circular mesal plates, and by the aedeagus and its apical pair of leaflike lobes.

Male.—Length 6 mm. Wings brownish, head, thorax and legs slightly darker, tarsal segments setose. Maxillary palpi with dense, short black setae. Spurs 2-4-4, those of forelegs densely setose. Genitalia as in Fig. 2. Anterior portion ninth sternum covered by eighth, apex ninth tergum terminated with membraneous sheath, difficult to discern. Cerci fusiform, short, directed dorsocaudad. Basal segment clasper almost quadrate, short, lobes arising from meson coalesced along ventral margin, from lateral aspect, Fig. 2A, lobes platelike, broadly ovate; apical segment elongated ventrally into slender obtuse lobe, convergent from ventral view, Fig. 2B. Phallus sheath fusiform, curved ventrad, bearing prominent spines; basal portion phallus slender, tubular, distally enlarged into prominent dorsal triangular protuberance, an apical pair leaflike processes and an elongated ventral lobe, Fig. 2C.

Holotype male.—Julia Pfeiffer Burns State Park, McWay Creek, Hwy. 1, Monterey County, California, 25 July 1974, D. G. Denning; paratype male, same data as for holotype; paratype male, unnamed creek, Hwy. 1, north of Lucas, Monterey County, California, 25 July 1974, D. G. Denning. Collections made in redwood, *Sequoia sempervirens*, grove.

Homoplectra norada, new species

This is the eighth species described in the genus. All known species: *H. nigripennis* Banks, *oaklandensis* (Ling), *alsea* Ross, *shasta* Denn., *spora* Denn., *luchia* Denn. and *schuhi* Denn. have been recorded only from Oregon and California. A majority of the species have been collected in cool Pacific coastal areas. *H. norada* is related to *luchia* differing from it in the short blunt dorsal prong, in the short filamentous process ventrad to it, in the aedeagal sheath and other details.

Male.—Length 8–8.5 mm. General color of head, thorax and abdomen dark brown; wings brownish, concolorous; setae of head and thorax aureous. Filamentous lobe of fifth segment (probably the pheromone receptor) curved laterad.

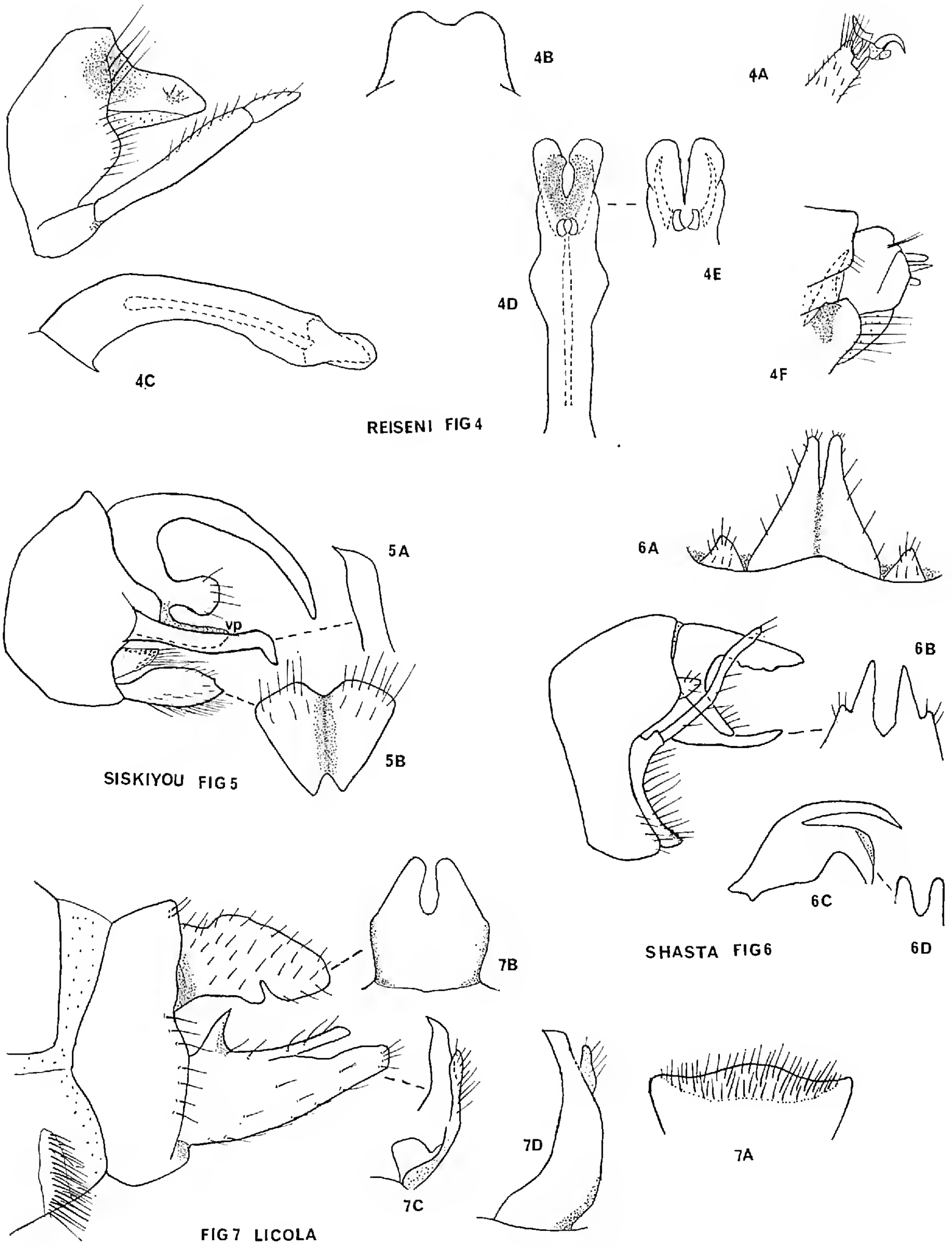


Fig. 4. *Hydropsyche reiseni* Denning, male genitalia, lateral aspect. 4A, foreleg tarsal claw, mesal view. 4B, tenth tergum, dorsal aspect. 4C, phallus, lateral aspect, 4D, ventral view, 4E, dorsal view, 4F, female, lateral aspect. Fig. 5. *Neothremma siskiyou* Denning, male genitalia, lateral view. 5A, ventral view of convergent apices. 5B, fused claspers, ventral view. Fig. 6. *Cryptochia shasta* Denning, male genitalia, lateral aspect. 6A, dorsal aspect of tergum 10 and cerci, *c*. 6B, ventral lobe of tenth tergum. 6C, aedeagal complex, lateral view. 6D, apical portion of phallus, ventral view. Fig. 7. *Lepidostoma licola* Denning, male genitalia, lateral aspect. 7A, sternum 8, ventral view. 7B, tenth tergum, dorsal view. 7C, clasper dorsal view. 7D, clasper ventral view.

A light membraneous bulb-like process apically, Fig. 3A; near center of segment 5 and 6 a dark brown minute invaginated area present. Genitalia as in Fig. 3. Diagnostic characters of aedeagal structure as follows: (1), a heavily sclerotized dark brown dorsal prong (tenth tergum?) curved ventrocaudad, bearing closely appressed spurs; from dorsal aspect, Fig. 3B, structure asymmetrical, apices approximate and terminated in a semimembraneous sheath; (2), a pair of narrow, short, acuminate semimembraneous non-pigmented processes; (3), a dark brown stout heavily sclerotized prong, acute, curved dorsad; (4), phallus long, slender, the tubular internal structure projected beyond apex, from dorsal view, Fig. 3C, apex acute; (5), the slender trough-like ventral structure into which the phallus reposes, furcate about half its length, Fig. 3D.

Female.—Length 9–9.5 mm. Similar to male except usual antigenic characters. Segment 5 with a short filamentous process projected dorsolaterad, lightly pigmented, apex bearing minute membraneous bulb, Fig. 3E. Genitalia as in Fig. 3F. Sternum 8 dorsal margin heavily pigmented, dorsocaudal corner subacute. Ninth segment annular, tergum indistinctly delineated. Tenth tergum slender, lightly pigmented, bearing three semimembraneous tubular processes.

Holotype male.—Creek near Panoramic Hwy., Stinson Beach, Marin County, California, 24 February 1974, Paul A. Peterson. Allotype, same data as for holotype. Paratypes, 5 males, 3 females, same data; 1 male Mt. Tamalpais, Marin County, California, 25 May 1974, D. G. Denning; 2 males, Samuel P. Taylor State Park, Marin County, California, 25 May 1975, D. G. Denning. Holotype, allotype to be deposited California Academy Sciences, San Francisco, California.

Hydropsyche reiseni, new species

This new species belongs to the *californica* Banks group and is related to *solex* Ross. Male diagnostic characters are the contour of the phallus and its mesal concavity, the shape of the claspers and tenth tergum and minor differences of the ninth segment. The female differs from other species by the position and shape of the clasper receptacle. Dr. W. A. Reisen collected this species in Honey Creek, Turner Falls Park near Davis, Oklahoma. The collection site is described by Dr. Reisen as follows: "Honey Creek is a medium sized rheocine originating from two springs fed from limestone aquifers in the Arbuckle Mountains and flowing northeasterly into the Washita River . . . two sizeable water falls, Bridal Veil Falls and Turner Falls lie within the park boundary . . ."

Male.—Length 7.5–10 mm. Wings irrorate, brownish, legs luteus, head, thorax, abdomen dark brown. Sexual dimorphism exhibited in tarsal claws, Fig. 4A. Genitalia as in Fig. 4. Ninth segment lateral lobe ovate, tergum with shallow depression extending caudad to lateral portion of tenth tergum. From lateral aspect tenth tergum directed caudad, apex subacute; from dorsal view, Fig. 4B, margin with a broad, narrow incision. Clasper distal segment short, subacute, convergent from dorsal aspect. Phallus, Fig. 4C, short, stocky, arcuate; lateral plates ovate, dark pigmented, obscuring view of mesal portion; from ventral aspect, Fig. 4D, lateral margin with distinct angulation, apical lateral lobes rounded, approximate mesally, mesal cavity concave, mesoventral plates elongate and convergent; from dorsal view, Fig. 4E, lateral plates separated; in cleared specimens outline of mesal cavity distinct, mesoventral plates slender, slightly curved.

Female.—Length 8 mm. Identical to male in general appearance except no modification of tarsal claws. Genitalia as in Fig. 4F. Clasper groove shallow, concave; clasper receptacle long, narrow distally, directed dorsocaudad. Lateral lobe ninth segment broadly ovate.

Holotype male.—Murray County Oklahoma, Honey Creek, Turner Falls Park, 28 April 1973, W. K. Reisen. Allotype female, same data except 21 July. Paratypes, 1 male same data except 19 July; 4 males same data except 15 August; 1 male same data except 30 March; 8 males same data as for holotype; 6 males 1 female, same data as for allotype.

GENUS NEOTHREMMA BANKS (LIMNEPHILIDAE)

The five described species in the genus are confined to western Canada and United States. Members of the genus are seldom collected and species distribution is based on small numbers of specimens.

N. alicia Bank 1930. Known from Alberta, Idaho, Oregon, Utah, and Wyoming. A new record is available from Montana: Glacier National Park, Iceberg Creek, Iceberg Lake, 4 August 1972, David S. Potter.

N. didactyla Ross 1949. Known from Washington and Oregon.

N. genella Denning 1966. Recorded from Plumas County, California. A new record is available from California: Madera County, N. Fork Arline Creek, S. W. slope Madera Peak, 7800′, 16 August 1971, Hugh B. Leech.

N. laloukesi Schmid 1968. Recorded from Lake Louise, Banff National Park, Alberta. This species is very similar to *alicia* Banks.

N. andersoni Wiggins 1975. Multnomah County, Oregon.

Neothremma siskiyou, new species

This new species is related to *genella* differing from it in the spherical plate and scooplike lobe arising ventrad from the dorsal sclerotized process, and several other details.

Male.—Length 6 mm. General color body, appendages tan, wing concolorous, tan. Spurs 3-3-4. First antennal segment slightly longer than length of head; maxillary palpi porrect, pilosity sparse. Front of head covered with long golden colored setae. Genitalia as in Fig. 5. Ninth segment narrowed dorsad to a narrow strap, from lateral margin a narrow elongated process present directed caudad beyond claspers; apex subacute, not forked; from ventral aspect apices convergent, Fig. 5A. This species and *N. andersoni* are the only two described species in which the apex of the lateral process of the ninth segment is not forked. Claspers short, compressed dorsally; from lateral aspect apex acute; from ventral aspect, Fig. 5B, claspers fused on meson, troughlike, coalesced claspers wide, scooplike. Tenth tergum curved ventrad as a pair of large, heavily sclerotized lobes; at base of lobes prominent, rounded process directed caudad; phallus small, covered from view by basal lobes. Ventrad to basal lobes is a wide scooplike plate capable of dorsoventrad movement, Fig. 5, *vp*. Dorsad to base of claspers a very lightly sclerotized process developed from ninth sternum, spiculate distally and bearing numerous long light colored setae.

Holotype male.—Siskiyou County, California, road to Taylor Lake, Salmon Mts., 5750′, Etna road, 19 August 1972, Hugh B. Leech. Type to be deposited California Academy Sciences, San Francisco, California.

GENUS CRYPTOCHIA ROSS (Limnephilidae)

The Cryptochia are rarely collected and accordingly, the distribution of the seven species comprising the genus is poorly known. Very few additions to the distributional records (Denning 1964) are available. The Cryptochia appear to be confined to western United States and British Columbia.

Known distribution

Cryptochia pilosa (Banks) 1907. Recorded from Washington, Oregon, Idaho, British Columbia. The only described female in the genus is of this species (Ross 1950, Schmid 1951).

C. furcata Denn. 1953. Known to occur in Washington, British Columbia and northwestern Montana. A new record is available from Montana; Missoula County, Deer Creek, 12 June 1973. David W. Potter, 1 ♂.

C. neosa Denn. 1954. Known only from Grant County, Oregon.

C. excella Denn. 1964. Known only from Kings Canyon National Park, California.

C. califica Denn. 1968. Recorded only from Sierra County, California.

C. denningi, Wiggins 1975. Recorded from Sequoia National Park, California.

C. shasta n. sp. Shasta County, California.

Records of the last five species are based on a single male. Most of the collection sites have been recollected but no additional specimens have been taken.

Cryptochia shasta, new species

Male.—Length 9 mm. General color wings, thorax, abdomen dark brown. Wings with heavy blackish pilosity; prothoracic setae aureous, macrochaetae of head black. Antennae, legs with dense blackish setation. Spurs 1-3-4. Segments 3 to 5 with dark pigmented line through center, fifth segment also with circular invaginated area, segment 8 not modified. Genitalia as in Fig. 6. Ninth tergum massive, projected caudad; sternum narrow; from dorsal aspect tergum narrowed to a band by a wide circular incision. Tenth tergum short, blunt, ventral margin irregular and pigmented black; from dorsal aspect, Fig. 6A, furcate less than half distance to base, median fusion results in a narrow brownish trough; ventral lobes digitate, closely appressed to massive darkly sclerotized ventral lobe, subacute, directed caudad, as seen from ventral aspect, Fig. 6B. Clasper, lateral aspect, with filamentous process long, reaching dorso-caudad above tenth tergum; basal portion coalescensed to ninth sternum, ventral apex black pigmented and curved slightly dorsad, from ventral aspect sclerite expanded to a wide concave plate occupying all of aedeagal cavity which forms attachment to ventral portion of aedeagus. Phallus, Fig. 6C, dorsal blades heavily sclerotized, acuminate, apex acute; ventral portion massive, dark pigmented apical portion blade-like, curved ventrad, ventral enlargement attached to mesal portion of claspers, apices obtuse from ventral aspect, Fig. 6D.

Holotype male.—Shasta County, California, creek near Castle Crags State Park, 17 May 1973, D. G. Denning.

KEY TO DESCRIBED MALES OF CRYPTOCHIA

1. Tenth segment reaching caudad considerably beyond base of clasper 2
   Tenth segment short, not extending caudad beyond base of clasper .... *denningi*

2. Tenth tergite lateral lobe long, narrow; filamentous process of clasper long, reaching to or beyond tenth tergum 3
   Tenth tergite lateral lobe long, wide; filamentous process of clasper short, about equal or shorter than basal portion 5

3. Ninth tergum large, elongated; aedeagus with a short ventral process .... *excella*
   Ninth tergum not greatly elongated; aedeagus with a large ventral prominent process 4

4. Tenth tergum deeply furcate, ventral arm short; ventral process phallus massive .... *pilosa*
   Tenth tergum narrowly furcate, ventral arm long; ventral process not massive .... *shasta* n.sp.

5. Ninth tergum curved caudad; tenth tergum short and obtuse; aedeagal dorsal arms curved ventrad .... *califica*
   Ninth tergum not curved caudad; tenth tergum subacute; aedeagal dorsal arms not curved ventrad 6

6. Ventral process phallus long as dorsal blades, apex hamate; dorsal blades curved only slightly ventrad .... *furcata*
   Ventral process phallus not more than half length of dorsal blades which are curved dorsad .... *neosa*

Lepidostoma licola, new species

The similarity of the tenth tergum and claspers to *L. jewetti* suggests a relationship to that species. Diagnostic differences are the distinctive spinous comb arising from the eighth segment and other differences in the aedeagal structure and tenth tergum.

Male.—Length 7–9 mm. General color brownish, wings uniformly brown, considerable pilosity. First antennal segment long, equal to length between eyes, no modifications. Maxillary palpi porrect, one segmented, abundant long setae, no modifications. Small patches of light colored scales near base of fore and hind wing, and in the small coastal cell of the forewing. Apico-ventral portion tergum eight compressed into a slender concave area; sternum eight bearing dense comb of long stout dark brown spines, projected caudoventrad, Figs. 7 and 7A. This unusual comb is similar to the spinous comb found on dorsal segments of some male Micrasema. Genitalia as in Fig. 7. Tenth tergum apical margin rotundate, ventral margin with short incision, resultant lobe not projected beyond ventral margin; from dorsal aspect, Fig. 7B, tergum narrowed distally to obtuse mesal lobes; entire structure quite spinous. Claspers, lateral aspect, Fig. 7, with apex truncate, basodorsal lobe acute, lateral lobe long, slender, subacute; from dorsal aspect, Fig. 7C, basodorsal lobe broad, platelike; from ventral aspect, Fig. 7D, lateral lobe not discernible. Phallus long, arcuate; bifed from ventral view; dorsal arms acuminate, heavily sclerotized, closely appressed to phallus and extending to apex.

Holotype male.—Sierra County, California, Yuba Pass, 6700′, 9 July 1967. Paratypes, three males, same data as for holotype. Types to be deposited in Academy of Sciences, Golden Gate Park, San Francisco, California.

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SCIENTIFIC NOTE

Temperature Preferences of Two Species of *Eleodes* Beetles (Tenebrionidae).—*Eleodes longicollis* LeConte and *Eleodes obscura sulcipennis* Mannerheim are widely distributed beetles. *Eleodes longicollis* is found in Kansas, Colorado, Texas, Arizona, and northern Mexico from around sea level to elevations of about 3500 m. *Eleodes obscura* is found in Washington, Idaho, Oregon, Wyoming, Utah, Arizona, and Sonora, Mexico (Blaisdell, 1909, U.S.N.M. Bulletin No. 63, pp. 191, 426; Pallister, 1954, Amer. Mus. Novitates, No. 1697, pp. 35, 36, 42). Unlike *E. longicollis*, *E. obscura* tends to occur primarily at higher elevations. In many areas the two beetles are sympatric, occupying subarid habitats.

We obtained a sample of 30 beetles of each species from the Verde River Valley, Az., (Yavapai Co., 8 km S.E. Clarkdake, 8 Sept. 1973, elev. 1200 m) a zone of sympatry for *E. longicollis* and *E. obscura.* Our objective was to determine whether the two species had different preferences for substrate temperatures.

The beetles were kept in the laboratory in plastic shoeboxes (32 × 17 × 10 cm) and fed rolled oats. In order to minimize environmental influences and adaptation to temperatures in specific microhabitats, all beetles were kept for 7 months under a constant temperature regime of 23 ± 2 degrees C. After this adjustment period, 20 beetles of each species were tested for their temperature preferences in a linear temperature gradient box. The gradient box was constructed from sheet metal, and had length × width × height dimensions of 63 × 10 × 21 cm. The two ends of the box were rounded to eliminate angular corners. A temperature gradient was established by immersing one end of the box in an ice bath and setting the other end on an electric hot plate. Temperatures at 11 points along the floor of the box were measured with two YSI telethermometers (Model 46 TUC) and thermistor temperature probes (YSI No. 402) attached to the floor.

All observations were done in the morning under uniform, artificial illumination. For a given set of observations, the gradient box was allowed 30–40 minutes to equilibrate after the heat and cold were applied. Single beetles were introduced into the box, and were given a 10 minute adjustment period. Following this, the beetle's position with respect to the plexiglass divisions and the temperature probes was scored each minute for 10 minutes. After 10 observations, the beetle

Table 1. Observed and expected frequencies of *E. longicollis* and *E. obscura sulcipennis* at different temperatures along a temperature gradient.

	Temperatures (°C)										
Species	6.9	9.2	11.6	16.2	19.3	22.2	24.0	26.0	30.0	35.5	59.6
E. longicollis											
Observed	35	43	28	47	31	45	51	118	64	35	3
Expected	24	29	25.5	42	32	45.5	59	119	82	39.5	2.5
E. obscura											
Observed	13	15	23	37	33	46	67	120	100	44	2

was replaced by another individual, and the procedure was repeated. A total of 500 observations were recorded for each species.

A chi-square analysis of the observed and expected values shown in Table 1 resulted in a chi-square value of 36.669, with 10 degrees of freedom. This is significant at an α level of 0.001, and strongly indicates that the temperature preferences of the two species are different. Both species show a maximum preference for 26 degrees C. However, except for this similarity, the two species are quite different in their preferences. *Eleodes longicollis* shows more preference for the lower temperatures, while *E. obscura* prefers higher temperatures.

This difference in temperature preferences of the two species may be explained as an evolutionary strategy to escape inclement weather. At higher elevations, low temperatures usually signal the onset of snow and prolonged periods of cold. At lower elevations in subarid zones, this is not generally the case. However, in subarid regions higher temperatures signal the onset of conditions that may approach a thermal lethal limit for a beetle. The present data suggest that *E. longicollis* may be better adapted to lower elevations, while *E. obscura sulcipennis* may be better adapted to higher elevations.—C. N. Slobodchikoff and D. Pedersen, *Department of Biological Sciences, Northern Arizona University, Flagstaff 86001.*

Simple Arthropod Activity Monitor.—The principle of an arthropod's (or other small animal's) body completing a path for current flow makes possible a simple, reliable activity monitor. It is simpler and more reliable than previously used photoelectric devices (Brown, 1959, J. Ins. Physiol. 3: 125–126; Brown and Unwin, 1961, J. Ins. Physiol. 7: 203–209), actographs (Gunn and Kennedy, 1936, J. Exp. Biol. 13: 450–459; Reichle, et al., 1965, Amer. Midl. Natur. 74: 57–66), activity wheels (Kramm, 1971, Amer. Midl. Natur. 85: 536–540), and switching devices (Naylor, 1958, J. Exp. Biol. 35: 602–610).

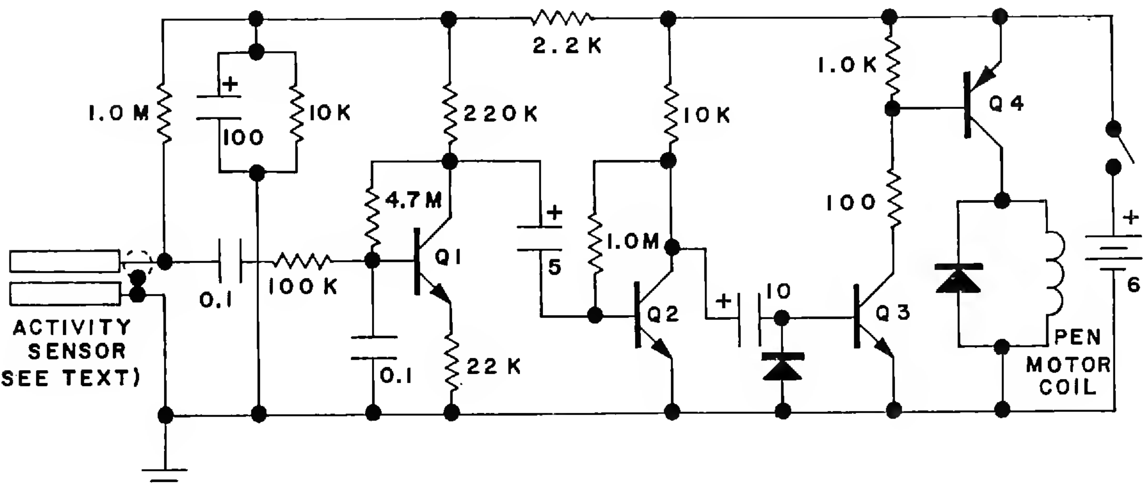

Fig. 1. Schematic diagram of the activity monitor. Resistance in ohms. Resistors ± 10% ¼ W. Capacitors in microfarads. Polarized capacitors are 10 volt electrolytics; others disc ceramic. Diodes 1N756. Transistors: NPN 2N3707; PNP 2N1305. Battery 6 volt (Burgess F4M). Parts available from Neward Electronics, 500 Pulaski Road, Chicago, Ill. 60624 or Allied Electronics, 2400 W. Washington Blvd., Chicago, Ill. 60612.

FIG. 2. Activity of *Ceuthophilus conicaudus* Hubbell maintained under constant temperature and darkness.

Two insulated conductive strips were separated by a distance of about half the body length of the insect to be studied. A low voltage was impressed across the strip with current limited to substimulus values by a current limiting resistor. Under open circuit conditions the source potential is across the strips. An arthropod walking across the conductive strips provides a path for current flow and lowers the voltage. The variation in voltage is amplified and operates an event recorder. The signal lead from the conductive strips should be shielded to minimize electrical interference. Brass shim stock material (available from automobile parts dealers) was used for the conductive strips. The wires can be soldered directly to the brass strips. A further reduction of noise may be obtained by extending the ground strip under the signal strip and insulating the two strips with mylar tape.

A complete schematic diagram is shown in Fig. 1. Current to the conductive strips is limited to less than 6 microamps by the series 1 Meg resistor. The resulting activity signal is capacitively coupled to transistor Q2 and converted to DC by the diode at the base of transistor Q3. The DC signal is amplified by transistors Q3 and Q4. Transistor Q4 provides current to operate the pen motor coil. The diode across the pen motor protects transistor Q4 from high voltage transients resulting in collapse of the magnetic field when Q4 turns off.

This activity monitor has been used successfully with the cave cricket *Ceuthophilus conicaudus* Hubbell under both laboratory and field conditions. Fig. 2 illustrates a twelve hour record (between 1800 and 0600 hr CST) of the results of a preliminary investigation of cricket activity while the crickets were maintained in an environmental chamber under constant darkness at a constant temperature (21 C). The activity monitor was also adapted to studying cricket movement within Spider Cave of Carlsbad Caverns National Park (Campbell, 1975, Amer. Midl. Natur. in press). That study demonstrated two nocturnal periods of movement with a corresponding reduction of movement in the cave during the "daylight" hours. The development of this monitor was supported in part by the Cave Research Foundation Grant.—GLENN D. CAMPBELL AND E. NORBERT SMITH, *Department of Biological Sciences, Texas Tech University, Lubbock, 79409.*

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MAILING DATES FOR VOLUME 51

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No. 3—July .... mailed 21 October 1975
No. 4—October .... mailed 26 December 1975

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