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Ecology and Habitat Preferences of High Altitude Coleoptera from the Sierra Nevada[1]

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Extensive pitfall trapping in the central Sierra Nevada in 1973-74 was conducted to obtain information on species composition, diversity and associations for terricolous arthropods in five alpine and subalpine plant communities. Over 1200 specimens comprising 37 species in 4 families of Coleoptera were collected. The information presented here provides details of the location, habitat type and time of capture for the 37 species of Coleoptera which were trapped.

Methods and Materials

Pitfall traps consisted of 4.5 x 4 cm glass jars filled to a depth of 1 cm with technical grade ethylene glycol. Traps were collected at 14-day intervals and replaced by new traps. Ten stations of 3 traps each, with traps set 1 m apart in a line, were established in each of the 5 habitats sampled. Some supplemental collecting was done by hand in areas adjacent to the pitfall trap sites. Voucher specimens of insects collected are deposited in the collections of the author, and at the University of Alberta (Edmonton), Biosystematics Research Institute (Ottawa) and the California Academy of Sciences (San Francisco).

Study Sites

All of the trap sites were located in the Harvey Monroe Hall Area of Inyo National Forest along the crest of the Sierra Nevada in Mono County, California. The history, climate and plant affinities of the Hall Area are described in Clausen (1969).

Details of the pitfall trap sites selection, vegetation analysis of the plant communities sampled and arthropod species diversity analyses may be found in Papp (1975). Brief descriptions of the 5 plant communities follow.

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1. Lodgepole Pine Forest

Elevation 3048-3170 m. Located immediately NNW of the Carnegie Institution Timberline Station (CITS) on a SE - facing slope. Contains a considerable variety of understory subhabitats ranging from xeric, almost pure stands of *Pinus contorta* Dougl. to hygric sites with understory vegetation dominated by *Hordeum, Veratrum californicum* Durand and *Senecio triangularis* Hook. Vegetation in the drier sites is diverse, with common species including *Perideridia Parishii* (Coult. and Rose) Nels. and Macbr., *Poa epilis* Scribn. and *Potentilla glandulosa* Lindl. Pitfall trap collections 11 July to 25 September, 1973 and 26 June to 18 September, 1974.

2. Sagebrush Community

Elevation 3078 m. Located on a gently sloping gravel area, facing ESE and sloping to Slate Creek. Surrounded by scrubby lodgepole pine forest. Dominant shrub is *Artemesia cana* Pursh, with other common species including *Carex, Horkelia fusca* Lindl. ssp. *capitata* (Lindl.) Keck and *Sphenosciadium capitellatum* Gray. Pitfall trap collections 17 July to 25 September, 1973 and 26 June to 18 September, 1974.

3. Subalpine Meadow

Elevation 3048 m. Located on the floor of Lee Vining Canyon, about 1500 m WNW of CITS. The meadow vegetation is dominated by *Polygonum bistortoides* Pursh, and is bordered along Slate Creek by thick clumps of *Salix.* Pitfall trap collections 17 July to 25 September, 1973 and 26 June to 18 September, 1974.

4. Alpine Meadow

Elevation 3353 m. Located on the E ridge of Mt. Conness, on site of nival (snow-surface) aeolian ecosystem investigations conducted by Papp (1975, 1978). Dominant herbaceous vegetation includes *Juncus Parryi* Engelm., *Poa Hanseni* Scribn., *Antennaria alpina* (L.) Gaertn. var. *media* (Greene) Jepson and *Lupinus.* Pitfall trap collections 18 July to 26 September, 1973 and 11 July to 5 September, 1974.

5. Elfinwood Whitebark Pine Community

Elevation 3383 m. Located ESE of the alpine meadow on the SW slope of the unnamed peak (3426 m) which forms the W border of Saddlebag Lake. *Pinus albicaulis* Engelm. forms scattered thickets over much of the slope. Various species of alpine grasses and sedges, in addition to *Ribes cereum,* are found around the margins of the pines. Frequent disturbance of pitfall traps by the alpine rabbit *Lepus townsendii* in 1973 forced abandonment of trapping here. Pitfall trap collections 18 July to 26 September, 1973; no traps set in 1974.

Results

Distributional and ecological information for Coleoptera was obtained either from the literature, or from available museum specimen data. Distributions of some Carabidae, Elateridae and Staphylinidae were based on collection data in the Department of Entomology, California Academy of Sciences (CAS), and the California Insect Survey (CIS), University of California, Berkeley. Ecological information from the literature is given for each species, followed by additional (and sometimes contradictory) information obtained in the course of this study. The following species were previously unrecorded from the conterminous United States: *Dyschirius alticola* Lindroth, *D. truncatus* Lindroth (Carabidae); *Limonius pappi* Becker (Elateridae). The following species were recorded for the first time from California: *Amara erratica* Duftschmid, *Bembidion complanulum* Mannerheim, *B. improvidens* Casey, *B. quadrifoveolatum* Mannerheim, *Cymindis unicolor* Kirby, *Dyschirius alticola* Lindroth, *D. truncatus* Lindroth, *Harpalus seclusus* Casey (Carabidae); *Boletobius pygmaeus* Fabricius, *Mycetoporus consors* LeConte (Staphylinidae); *Limonius pappi* Becker (Elateridae).

Carabidae

Agonum fallianum Leng

Distribution: California (Lindroth, 1966)

Ecology: Previously unknown. All of the specimens (42) from the Hall Area were trapped in meadows; 29 specimens (69%) in alpine meadow and 13 specimens (31%) in subalpine meadow. In addition, 14 specimens were collected from the snow surface on Mt. Conness in the alpine zone. This species forages on the snow in both alpine and subalpine areas during the afternoon, but disappears at dusk. Of the specimens from alpine meadow stations, 33 (79%) were not trapped until late September; all but one of the remaining specimens trapped in this habitat were captured immediately following snow melt. It appears that this species either diapauses as an adult during most of the snow-free period of the summer, or spends much of the summer as an immature. A mating pair of this species was observed on June 22, 1974 on wet soil near the sagebrush area.

Amara erratica Duftschmid

Distribution: Circumpolar; in North America transcontinental, south to New England in the east and Mt. Rainier, Washington, and Colorado in the west (Lindroth, 1968); may also occur in Oregon and Idaho (Hatch, 1953); boreoalpine in Europe and Asia, occurring in the Caucasus, and in Siberia east to Kamchatka (Lindroth, 1954). Mani (1968) also records this species from the Alps, the Pyrenees, Lapland and Iceland.

Ecology: Ionescu (1969) trapped this species in five alpine stations in Romania at altitudes of 1800-2035 m, with most specimens taken from May to mid-July; occurs in open country with grass or meadow vegetation, usually on sandy moraine, on both sides of the timber limit (Lindroth, 1968). Conspicuously xerophilic, on sandy moraines in the *Betula*-zone up to 1000 m in Lapland and 1200 m in Iceland (Mani, 1968).

Most of the 26 Hall Area specimens were trapped in meadow situations (alpine or subalpine). One individual was taken in the lodgepole pine forest in late September and four others were trapped in the sagebrush area in early August. Additionally, two specimens were caught foraging on the snow on Mt. Conness on July 12, 1973.

Anisodactylus pitychrous LeConte

Distribution: A species of the dry interior, in Canada occurring only east (sic?) of the Rockies, south to Colorado and California (Lindroth, 1968).

Ecology: Previously unknown. Sixty-eight specimens were taken in the Hall Area, of which 88% occurred in the moist subalpine meadow. Five were recovered from forests, 3 from lodgepole and 2 from elfinwood whitebark pine; 3 specimens were trapped in sagebrush. Within the subalpine meadow, 73% were from marginal, relatively well-drained stations adjacent to young lodgepole pines.

Bembidion commotum Casey

Distribution: In western mountains, from Alberta and British Columbia south to Sierra Nevada of California, east to Wyoming (Lindroth, 1963).

Ecology: Apparently restricted to high mountains; in Sonora Pass, California, recorded from gravelly border of a small creek below timber limit, September 3, 1961 (Lindroth, 1963).

In the Hall Area, specimens were trapped in lodgepole pine forest, sagebrush and alpine meadow, but 76% were taken in alpine traps, with the greatest number (41%) taken immediately after snow-melt.

Bembidion complanulum Mannerheim

Distribution: In western mountains from Alberta, British Columbia and Alaska, south to northern Oregon (Lindroth, 1963).

Ecology: Taken at margin of snow patches in Waterton Park, Alberta, Chilkot Pass, British Columbia, and on Unalaska Island; apparently not riparian; normally imaginal hibernation (Lindroth, 1963).

Collected in alpine meadow, subalpine meadow, and lodgepole forest in the Hall Area. Two specimens were taken on snowfields in late June 1972 and 1973. Most of the specimens (77%) were taken in the alpine meadow, with catches quite evenly distributed over the season. This species is a facultative nival predator in alpine areas.

Bemibidion humboldtense (Blaisdell)

Distribution: Northern California, southwestern Oregon (Lindroth, 1963).

Ecology: Previously unknown. A single specimen was taken in the alpine meadow soon after snow melt in late July, 1973.

Bembidion improvidens Casey

Distribution: Mt. Rainier (above 4000 ft. elevation, Washington) (Lindroth, 1963).

Ecology: Previously unknown. Occurs sparsely only in the alpine meadow, where it was trapped at four stations; none of the alpine meadow stations differ substantially from each other with respect to exposure, plant cover or soil type.

Bembidion obscuripenne Blaisdell

Distribution: In western mountains from Washington south to California (Lindroth, 1963).

Ecology: In the alpine and subalpine regions (Lindroth, 1963). In the Hall Area, a single specimen was trapped in the alpine meadow soon after snow melt in late July 1973; at this time this area was noticeably wetter than other trap stations in the alpine meadow.

Bembidion quadrifoveolatum Mannerheim

Distribution: In the western mountains and along the coast south to Oregon (Hatch, 1953).

Ecology: Strictly riparian, occurring among stones and gravel on barren banks of usually small streams. Above timber limit in Chilkot Pass, British Columbia; hibernation apparently in both larval and adult stages (Lindroth, 1963).

This is a widespread species in the Hall Area. Although most common in the alpine meadow, where 70% were taken, it also occurs in elfinwood whitebark pine stands, subalpine meadow and in *Pinus contorta* Dougl. forest. Of those specimens taken above the timberline, 54% were captured within the first two weeks following snow melt. Those specimens trapped in the lodgepole pine forest were taken much later, with 60% captured during the last trapping period in late September. It seems probable that this species is active throughout most of the snow-free period of the year, moving to sheltered locations at lower altitudes during winter.

Specimens of *B. quadrifoveolatum* were taken on snowfields in late June and early July in 1972 and 1973, where it is a facultative nival predator. Another specimen was taken near the Hall Area in Glacier Canyon on the northwest side of Mt. Dana at an altitude of 3200 m on May 18, 1968.

Bembidion timidum LeConte

Distribution: Interior areas of western Ontario, Manitoba, Saskatchewan, Alberta, Northwest Territories and British Columbia south to Oregon, California and Colorado (Lindroth, 1963).

Ecology: Occurs in a diversity of moist habitats often with *Bembidion versicolor*; hibernates as an adult (Lindroth, 1963).

Five specimens were taken in the Hall Area, two in alpine meadow (one immediately after snow melt and the other in late September, 1973), two in sagebrush during late August and early September, 1973, and one in subalpine meadow during late August 1973. This is the only species of *Bembidion* which was trapped in the sagebrush community, which is drier than typical *Bembidion* habitats. *B. timidum* does not seem to occur in forest habitats in the Hall Area, despite its broad habitat occurrence in other areas.

Cymindis unicolor Kirby

Distribution: Transamerican, from Canada and Alaska south along the mountains to Colorado and Utah and isolated on New England mountains (Lindroth, 1969).

Ecology: In treeless country, above timberline and on tundra (Lindroth, 1969). Of the 70 Hall Area specimens 57% were trapped in alpine meadow stations; twenty were also taken in sagebrush, and ten in subalpine meadow. None were trapped in forest habitats.

Dyschirius alticola Lindroth

Distribution: Previously known only from type locality: Canada, British Columbia; the eastern of the two passpoints on Rossland Trail (10 miles west of trail) about 5000 ft. (1524 m), May 21, 1958 (Lindroth, 1961).

Ecology: On open, slightly moist, fine sandy soil, half shaded by *Alnus* bushes, at the margin of mixed forest, with almost no vegetation, except in spots of the moss *(Ceratodon purpureus)*. Associated with *Bembidion dyschirinum* (common) and *Notiophilus simulator* (Lindroth, 1961).

In the Hall Area this species was recorded only in the subalpine meadow, where the soil is very finely textured and vegetative cover is almost complete. In 1973 most individuals (58%) were trapped during the last two weeks of August when the meadow was becoming quite dry. In 1974 most (57%) were caught within a few days of snow melt in late June.

Dyschirius truncatus Lindroth

Distribution: Widely distributed but apparently everywhere rare, probably lacking in the Atlantic region. There are records from Manitoba, Saskatchewan, Alberta, Northwest Territories, British Columbia and Alaska (Lindroth, 1961).

Ecology: On barren clay-mixed sand at the margins of standing or slowly running waters; probably constantly in company with *Bledius* (Lindroth, 1961).

A single specimen was taken in the Hall Area on August, 1973 in the lodgepole pine forest. The microhabitat at this station was as follows: traps set in wet soil under shelter of a large clump of *Salix* on a south-east-facing slope; also common at this station were clumps of *Veratrum californicum* Durand, *Allium validum* Watson, *Carex* and mosses. The station lies at the base of a large granite outcrop and received abundant snow melt runoff throughout the summer.

Harpalus seclusus Casey

Distribution: From Alberta and British Columbia southward in the mountains to Colorado (Lindroth, 1968).

Ecology: On meadows at high latitudes; specimens from Alberta were captured at the margin of a snowfield about timber limit; in Manitoba it is associated with *Harpalus animosus* (Lindroth, 1968).

A very common species in the Hall Area; 51% of the 285 specimens trapped were from meadows, either alpine or subalpine. A few were taken in lodgepole pine forest and one was trapped in the elfinwood whitebark pine community, but the vast majority came from the sagebrush community, where 81% were trapped. This habitat is exceptionally well-drained, with a gravel substrate which provides for warmer surface temperatures than in the other communities sampled (Papp, 1975). Since many harpaline Carabidae are now known to be phytophagous (e.g. Johnson and Cameron, 1969; Zhavoronkova, 1969; Kabcik-Wasylik, 1971; Kirk, 1972) it is probable that this species is a seed-cacher.

Lebia viridis Say

Distribution: Transcontinental, entire United States south to Mexico; the most widespread and abundant member of the genus (Lindroth, 1969).

Ecology: On open, sun-exposed substrates, often in goldenrod flowers or resting on leaves of *Alnus* or *Ulmus* in company with more abundant *Altica* chrysomelids of the same size and color (Lindroth, 1969). Madge (1967) has shown that the larvae of *Lebia viridis* are parasitoids on the Chrysomelidae, and suggests that *Lebia* mimics its host *Altica.*

Four specimens were collected, all in 1973: 3 in subalpine meadow and 1 in the lodgepole pine forest. Interestingly, many specimens of *Altica torquata* LeConte were also trapped in the Hall Area (Papp, 1975).

Nebria ovipennis LeConte

Distribution: Sierra Nevada, from Sequoia National Park north to Yuba Pass (Kavanaugh, pers. comm., 1978).

Ecology: Previously unknown. Four specimens were collected in 1973. A submature male was found foraging on snow at 3353 m on Mt. Conness, on 9 July. A teneral male was trapped in the sagebrush community and a mature male in the subalpine meadow, both in late August. A mature female was also trapped in the subalpine meadow in mid-September.

Nebria spatulata Van Dyke

Distribution: Sierra Nevada, from Sequoia National Park north to Yosemite National Park (Kavanaugh, pers. comm., 1978).

Ecology: Previously unknown. Four males and five females were trapped all in the alpine meadow, in 1973. A teneral male was taken in mid-September, and a submature female in early August. Other specimens, all of which were fully mature, were captured from 15 July until 26 September.

Pterostichus inanis Horn

Distribution: The Cascade Range from British Columbia through Washington and Oregon, into northern Nevada and the Sierra Nevada of California; (Hacker, 1968).

Ecology: Altitudinal range of this species is from 3000 ft. (914 m) in northern Oregon to 9400 ft. (2865 m) in Fresno County, California (Hacker, 1968).

All specimens in the Hall Area were trapped in lodgepole pine forest; most of these were taken early in the season. Fourteen specimens (88%) were trapped from a single station which was located adjacent to Cabin Creek, on a south-southeast facing slope. Most abundant vegetation here was *Phyllodoce breweri* (Gray) Heller, *Solidago* and some grasses, but all of these were present at some other stations where no *P. inanis* were taken; its presence may therefore be restricted to forested situations near running water, rather than to a specific plant association.

Pterostichus protractus LeConte

Distribution: In the Rocky Mountains of Canada, from Alberta and British Columbia, south to the southern Cascades and into California (Lindroth, 1966).

Ecology: Apparently confined to montane forests; generally imaginal hibernation (Lindroth, 1966). 66% of the 133 specimens were trapped in forested situations (71 in lodgepole pine and 17 in elfinwood whitebark pine). This species also occurred in all of the other habitats sampled: subalpine meadow (18), sagebrush (25) and alpine meadow (2). Two hand collected specimens from the lodgepole pine forest were found near dead trees, one under a rotten log and the other in the soil at the base of a standing dead tree. The species shows a definite preference for dry niches with mature trees and abundant pine needle litter: 4 of the lodgepole forest stations which were of this type accounted for 88% of the specimens taken.

Trachypachus gibbsi LeConte

Distribution: From southernmost British Columbia to the Southern Sierra Nevada of California (Lindroth, 1961).

Ecology: Stenotopic, restricted to a special habitat on banks of big rivers at some distance from the water under *Populus balsamifera*. The soil, consists of finest sand, is dust dry on surface and is covered by an almost continuous layer of dead leaves. *Equisetum arvense* was present in one place, otherwise no vegetation. This habitat is doubtless flooded in the spring (Lindroth, 1961).

This species was trapped exclusively in the *Pinus contorta* forest in both 1973 and 1974. The majority of the specimens were trapped in the first period following snow melt (1973: 65%, 1974: 76%), while the soil was still moist. Litter was present as pine needles and cones, together with leaves of *Salix*, *Senecio*, *Veratrum* and *Lupinus*.

Cicindelidae

Cicindela longilabris Say

Distribution: Transamerican, from Alaska to Newfoundland, south into California, New Mexico, Colorado, Wisconsin, Illinois and New York. (Leng, 1920).

Ecology: Of the 41 specimens taken in the Hall Area, 38 (93%) were captured in the sagebrush community. The other specimens were taken in the subalpine meadow and in the lodgepole pine forest. Temporal distribution was bimodal. In both years most specimens were taken either soon after snow melt, or during the last trap period in September.

Cicindela oregona LeConte

Distribution: Alaska, south through British Columbia into California, Nevada, New Mexico and east to Montana, Utah and Idaho (Leng, 1920).

Ecology: Guppy (1948) collected this species on bare gravel below the winter tide lines on Vancouver Island. Twelve specimens were captured in the Hall Area: sagebrush (6), subalpine meadow (5), and lodgepole pine forest (1). As with *C. longilabris*, this species was trapped only in either the first or the last trap period of each year.

Staphylinidae

Aleochara affluens Casey

Distribution: British Columbia, northwestern Washington, northern Idaho and western Oregon (Hatch, 1957).

Ecology: According to Hatch (1957), all members of this genus probably live as ectoparasites on pupae of cyclorraphous Diptera.

In the Hall Area, 6 specimens were taken crawling on snow on the east ridge of Mt. Conness, 3353 m elevation, on June 25, 1973; in addition, 2 were taken in the alpine meadow in early September 1973 and 3 were taken in the subalpine meadow in early August and mid-September 1973.

Boletobius pygmaeus Fabricius

Distribution: British Columbia, northwest Washington, southeastern Idaho and northern Oregon (Hatch, 1957).

Ecology: Previously unknown. Four specimens were taken in the Hall Area, all in lodgepole pine forest, from mid-July until late August, 1973.

Mycetoporus consors LeConte

Distribution: British Columbia, Washington and western Oregon (Hatch, 1957). New York, Michigan, Indiana (Moore and Legner, 1975).

Ecology: Previously unknown. Three specimens were taken in the Hall Area: 1 from the elfinwood whitebark pine habitat in late July, 1973; 2 from subalpine meadow, late July and early September, 1973.

Platystethus americanus Erichson

Distribution: Common throughout the United States and in Mexico (Moore and Legner, 1971). Quebec and British Columbia (Moore and Legner, 1975).

Ecology: Common in manure and in isolated field droppings; occasionally in other decaying organic matter and at lights (Moore and Legner, 1971).

In the Hall Area, 1 specimen was taken in the subalpine meadow in late July, 1973; 6 others were found foraging on the snow on Mt. Conness, at 3353 m elevation.

Quedius breviceps (Casey)

Distribution: In western mountains from Alaska through British Columbia, Washington, Oregon to southern Sierra Nevada (Mineral King) in California (Smetana, 1971).

Ecology: Specimens from Valdez, Alaska, were taken beneath an *Alnus* bush at a creek. In the southern part of its range it occurs in wet biotopes in moss, under fallen leaves and often near water; in high mountain elevations (alpine and subalpine zones) it occurs in moss, lichens, grass patches, under stones, etc., and often in rather dry biotopes (Smetana, 1971).

Of the 85 specimens collected in the Hall Area, all but one were taken in lodgepole pine forest traps. Most of the specimens (58%) were taken soon after snow melt in late July. No subhabitat preferences within the lodgepole forest were evident.

Quedius validus Smetana

Distribution: From type material only: holotype male, California: Stanford University, May 13, 1950, PSB; allotype female, California: Grassy Lake, September 27, 1914, Lassen National Forest, Lassen County, ex R. Hopping collection, California Academy of Sciences (Smetana, 1971).

Ecology: No details of habitats known; a related species, *Q. explanatus* LeConte, occurs under stones; development may be in mammal burrows (Smetana, 1971).

Eight specimens of this distinctive species were collected in the subalpine meadow and in the lodgepole pine forest, in August and September of both years. As this is evidently a boreal species, the data for the male holotype is probably erroneous, and the designation of that specimen as the holotype is unfortunate.

Tachyporus californicus Horn

Distribution: From southern British Columbia, south into Wyoming, Idaho and Oregon (Blackwelder, 1936); also in California (Fall, 1901).

Ecology: Members of this genus are commonly taken sweeping herbage (Blackwelder, 1936).

A single specimen was taken crawling on snow on the east ridge of Mt. Conness, 3353 m elevation, on July 5, 1973.

Elateridae

Ampedus phelpsi (Horn)

Distribution: From Alaska, across most of Canada, and south into New York (Mt. Marcy), New Hampshire (Mt. Washington), Michigan, Wisconsin and Minnesota; in the west it occurs in the Rockies south to the Parowan Mountains in Utah, and in the Sierra Nevada south to Bubbs Creek Canyon on the Kings River.

Ecology: Previously unknown. A single specimen was collected beneath the bark of a dead whitebark pine *(Pinus albicaulis)* near the Carnegie Institution Timberline Station on June 17, 1973.

Ctenicera aeripennis (Kirby)

Distribution: From Alaska, south and east through the Yukon, Northwest Territories, Alberta and British Columbia, along the mountains into Washington, Oregon and California; also in the Rocky Mountains through Montana, South Dakota, Wyoming, Colorado, Utah and New Mexico.

Ecology: Previously unknown. A single specimen was taken in the sagebrush community in early August, 1973.

Ctenicera candezei (Leng)

Distribution: In the Sierra Nevada of California, from the Lake Tahoe area south into Madera County (Lake Ediza).

Ecology: Previously unknown. Three specimens were collected, all crawling on the snow on the east ridge of Mt. Conness, elevation 3353 m; one was taken on June 21 and the others on July 12, 1973.

Ctenicera edwardsi (Horn)

Distribution: From localities around Vernon, British Columbia south through Washington and Oregon, and into California as far south as Marin County along the coast and Fresno County (Lower Hot Springs) in the Sierra Nevada; there are additional records from what appears to be an isolated distribution on Mt. Timpanogos in north central Utah.

Ecology: One specimen was taken in the Hall Area in the subalpine meadow during late July, 1973. Also recorded from 1981 m in Nevada Co., California, on *Juniperus.*

Ctenicera tahoensis Van Dyke

Distribution: In the high Sierra Nevada of California from Placer County south to Lake Alpine in Alpine County.

Ecology: Previously unknown. In the Hall Area, 2 specimens were captured while crawling on snow, one on the east ridge of Mt. Conness at 3353 m elevation on June 28, 1972, and the other near Spuler Lake, elevation 3024-3194 m, 0815-0845 hours. Five others were taken in pitfall traps, as follows: *Pinus contorta* Dougl. forest, late July, 1973 (2 specimens) and late July-early August, 1974; subalpine meadow, late July, 1973; alpine meadow, late July, 1973.

Hypolithus bicolor Esch.

Distribution: A common species transcontinental in Canada below treeline and extending into the northern United States along mountain chains (Becker, 1978, pers. comm.).

Ecology: Previously unknown. Of the 176 specimens captured in the Hall Area, 97% were taken in meadow situations: subalpine meadow, 99 specimens (56%), alpine meadow, 71 specimens (40%). Becker (1978, pers. comm.) reported that all specimens examined from the Hall area were wingless females, and that parthenogenesis is known in this species.

Limonius nitidulus Horn

Distribution: From southern British Columbia and southwestern Alberta south to the high mountains of California (Becker, 1978, pers. comm.).

Ecology: Apparently unknown. Three specimens were captured crawling on the snow on the east ridge of Mt. Conness, elevation 3353 m, on June 21, June 25, and July 2, 1973. One specimen was taken in the *Artemesia* community in late July, 1973, and two others were trapped in the *Pinus albicaulis* habitat in late July, 1973.

Limonius pappi Becker

Distribution: Recently described from material collected in the Harvey Monroe Hall Natural Area, Inyo National Forest, Mono County, California (Becker, 1976).

Ecology: The most commonly collected elaterid in the Hall Area, where 226 specimens were trapped. All but 4 of these were taken in meadow habitats: 196 specimens (87%) from the alpine meadow, and 26 specimens (12%) from the subalpine meadow. A few additional specimens were collected in pitfall traps under elfinwood whitebark pine (*Pinus albicaulis*), on foliage of *P. albicaulis*, and on snowfields on the E ridge of Mt. Conness, 3353 m elevation.

Discussion

Most of the 37 species treated herein represent extensions of widespread boreoalpine species into southern latitudes. For example, in the Carabidae 13 species including *Amara erratica, Anisodactylus pitychorus, Bembidion commotum, B. complanulum, B. obscurripenne, B. quadrifoveolatum, B. timidum, Cymindis unicolor, Dyschirius truncatus, Harpalus seclusus, Pterosticus inanis, P. protractus* and *Trachypachus gibbsi* are reported from other boreoalpine localities. Of these only *Amara erratica* occurs outside of North America. The cicindellid species *Cicindela longilabris* is also boreoalpine. Of the Staphylinidae, 6 of the 7 species collected are broadly boreoalpine, as are 7 of the 8 elaterid species collected.

Five boreoalpine species, including the carabids *Agonum fallianum, Bembidion humboltense, B. improvidens* and *Dyschirius alticola* and the elaterid *Limonius pappi* have rather limited distributions, in some cases restricted to type localities, and probably reflect the formation of disjunct islands during Pleistocene glaciations.

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(Carabidae: *Nebria*); A. Smetana, Biosystematics Research Institute, Ottawa (Staphylinidae: *Quedius*); J. Strother, Jepson Herbarium, University of California, Berkeley (vascular plants).

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A New Parthenogenetic *Timema* from California

(Phasmatodea: Timemidae)

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The timemas are an endemic western family. Species have been described from Arizona, Nevada and California. California claims the greatest number of described species with five now known. Timemas are of interest because of their unique robust appearance and the presence of distinctive asymmetrical genitalia in the males. Species are usually locally abundant and appear as adults from mid to late spring. They are most often associated with chaparral plants and can be found on the most pungent of shrubs. Most species emit an acrid odor when handled. Such an odor is not associated with the species herein described. The taxonomy of the Timemidae was reviewed most recently by Tinkham (1942) and later Strohecker (1966) added two species. The total number of known species now stands at 7.

Parthenogenetic phasmids are not unknown, (see White 1973). To date only a single parthenogenetic phasmatid has been recorded from the United States, but this is the first purported case in the Timemidae. Such a conclusion was achieved by two collectors independently. Mr. H.B. Leech, California Academy of Sciences (retired) wrote the author in 1971 suggesting the possibility after studying a large collection of nymphs and adults which he had made. Subsequent trips to the same location yielded additional specimens, but there were no males. Concurrently, Ms. Genevieve Prlain and Dr. C.D. MacNeill of the Oakland Museum discovered the species at Arroyo Mocho and began extensive studies to determine if any males could be located. They reared individuals from eggs of captive females and discovered no males in the progeny. Continuous collecting each season from 1973 through 1977 has failed to uncover a single male. In all other species of timemas known to this author, adult females are encountered in the field with males atop, not necessarily in copulation. Males are seldom found singly. It would seem that if males were present in the populations examined here, they would have appeared by now. Adults have been reared by Ms. Prlain from adult females collected as immatures during the previous season. Therefore, in any case, males are not necessary in these populations to produce subsequent generations.

This species is being described at the request of the scientists at the Oakland Museum and because of its potential interest to geneticists due to its parthenogenicity.

The Pan-Pacific Entomologist 54:173-177. July 1978.

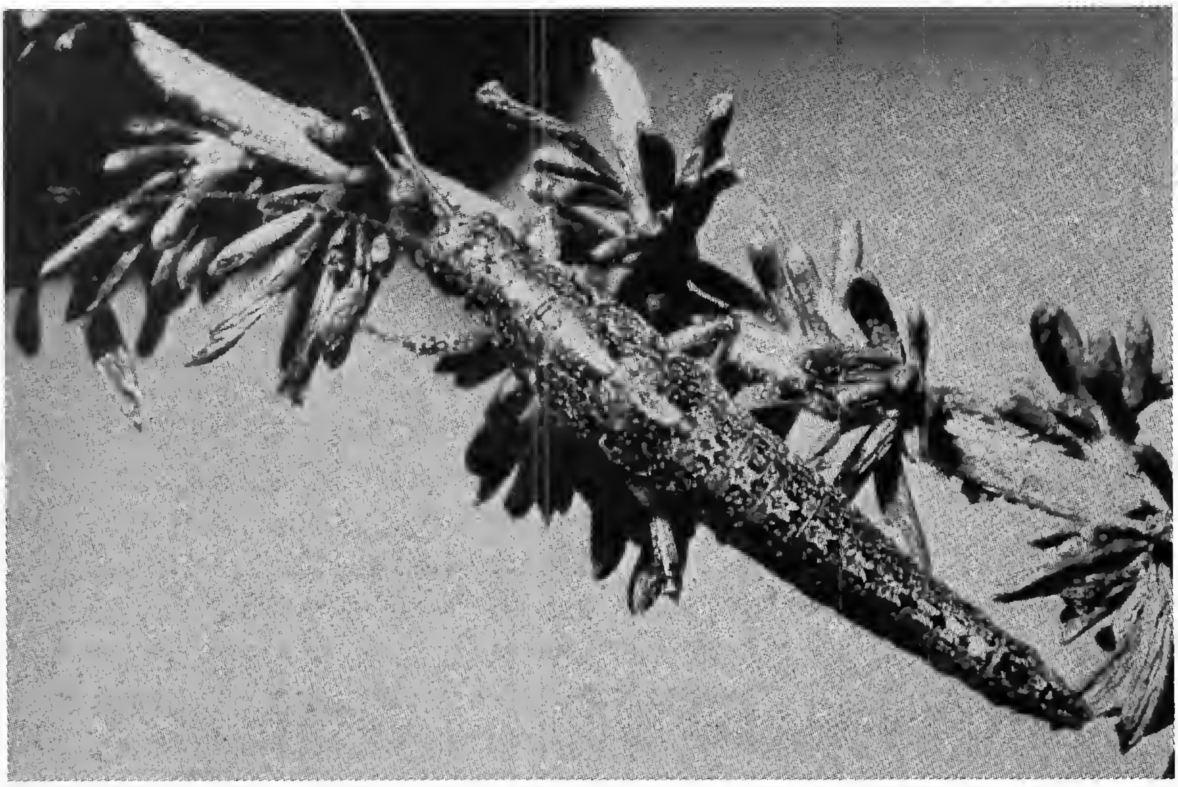


Figure 1. *Timema genevievae* Rentz, new species on chamise.

Timema genevievae, new species

HOLOTYPE FEMALE. California: Alameda County: Arroyo Mocho, 29 May 1974. C.D. MacNeill, R.E. Love collectors. Holotype in California Academy of Sciences, number 13025. Type series taken mostly on chamise, *Adenostoma fasciculatum* H. & A. and mountain mahagany *Cercocarpus betuloides* (Hook.) Nutt.

Description.—Form normal for genus. Head broad and flat, dorso-ventrally flattened; eyes prominent, globular, much more produced than in any other known species. Antenna with 22 articles, positioned well in front of eyes; scape very elongate, four times longer than basal width, somewhat constricted basally; pedicel hardly distinguishable from succeeding antennal articles; internal margins of antennal sockets produced between eyes. Thorax; prothorax 1.65 times broader than long, sides straight, anterior margin somewhat produced (Fig. 2), posterior margin concave; mesothorax slightly smaller than prothorax, sides convex, posterior margin more concave, anterior margin indistinct; mesothorax with lateral margin more strongly convex. Legs stout, undifferentiated, unspined. Abdomen narrowing apically, not modified. Supra-anal plate rather elongate, lying just anterior to middle of cercus, without central sinuation as seen in *T. boharti* Tinkham; tenth tergite produced, emarginate. Subgenital plate (Fig. 3) constricted basally, lateral margins obtusely produced mesad, converging to rather blunt apex. Cercus elongate (Fig. 5), apices subacute, internal dorsal and ventral margins minutely serrate. Ovipositor completely concealed by subgenital plate, valvulae strongly recurved in apical portion, aciculate; dorsal valves longer, more sharply recurved than ventral valves.

Coloration.—Surface of body glabrous; overall coloration intensely greyish brown, dorsum with indistinct longitudinal stripes; margins of thoracic nota and abdominal terga dotted with yellow; ventral surface light grey, each sternum bearing a pair of dark brown spots; legs pale grey, speckled, except apex of hind femur and adjacent tibia solid dark brown, antenna grey brown, first twelve articles somewhat darker.

Holotype measurements.—(in mm) Length body 23.7, length pronotum 2.2, width pronotum 3.5, length mesonotum 2.0, width mesonotum 3.7, length metanotum 2.0, width

	Total length	Length pronotum	Width pronotum	Length mesonotum	Width mesonotum	Length metanotum	Width metanotum	Length Head
Paratop-type n = 21	$\bar{X}$24.14 (±1.15)	$\bar{X}$2.38 (±0.08)	$\bar{X}$3.44 (±0.24)	$\bar{X}$1.83 (±0.14)	$\bar{X}$3.96 (±0.13)	$\bar{X}$1.45 (±0.10)	$\bar{X}$4.11 (+0.26)	$\bar{X}$2.56 (±0.26)
Mines rd n = 11	$\bar{X}$19.97 (±0.97)	$\bar{X}$2.11 (±0.12)	$\bar{X}$1.75 (±0.15)	$\bar{X}$1.75 (±0.11)	$\bar{X}$3.48 (±0.18)	$\bar{X}$1.45 (±0.10)	$\bar{X}$3.67 (±0.16)	$\bar{X}$2.0 (±0.14)

metanotum 3.8, length posterior femur 3.1, length posterior tibia 3.3, length subgenital plate 2.5

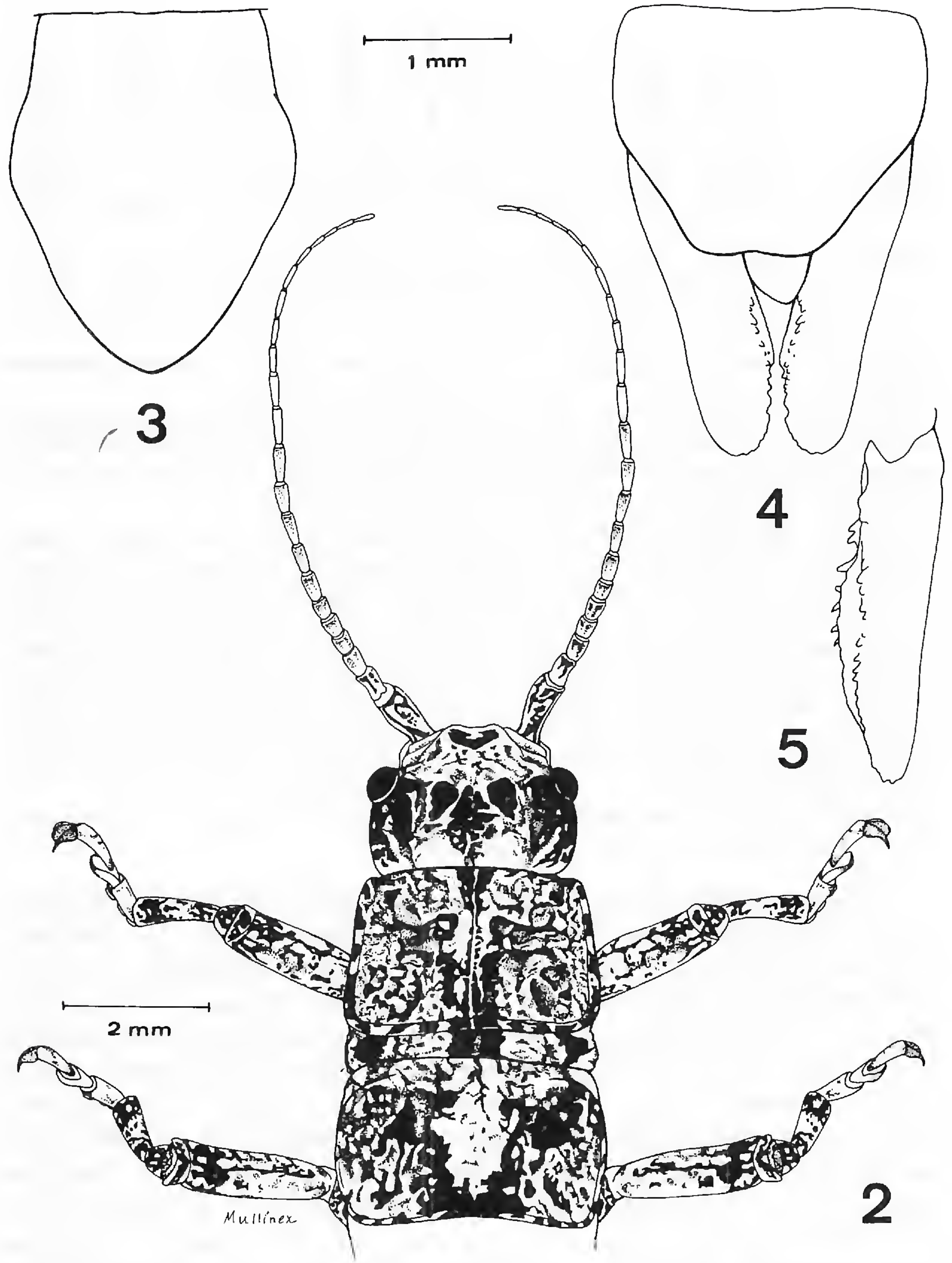
Measurements from the type series were made from liquid-preserved specimens. Specimens from localities other than those listed were pinned and too distorted for accurate measurement. All measurements made with ocular micrometer and are in millimeters. The number in parentheses is the standard deviation.

Records.—CALIFORNIA: ALAMEDA COUNTY: Arroyo Mocho, San Antonio Valley, Taravel Creek, 21-V-1974, 29-V-1974, I-VI-1973 (C.D. MacNeill, G. Prlain, R.E. Love, 62♀, including type, CAS). SANTA CLARA COUNTY: South end of Mines road, 30 mi. by road S.E. of Livermore, 720 m alt., 14-V-1972 (H.B. Leech, 15♀, 1 3rd instar in alcohol, 35♀ pinned, CAS). 28 mi. by Mines road S. of Livermore, 720 m alt., 12-VI-1971 (H.B. Leech, 43♀, pinned, CAS). STANISLAUS COUNTY: Del Puerto Canyon, 2-V-1970, 2-V-1972 (R.M. Brown, 2♀, CAS); Frank Raines Park, Del Puerto Canyon, 2-V-1970 (R.M. Brown, 4♀, CAS). All specimens designated as paratypes. Paratopotypes will be deposited in the Academy of Natural Sciences of Philadelphia and Smithsonian Institution at the request of the Oakland Museum.

Derivation of name.—This species is named in honor of Ms. Genevieve Prlain in recognition of her interest in the bionomics of the species.

E. genevievae Rentz, new species differs from its closest relative *T. boharti* Tinkham (from mountainous desert regions of western southern California) in its greyish, never green, coloration, smaller, less robust size and sculpture of the internal surface of the cercus (Fig. 5). In *T. boharti* the apex of the cercus is truncate to emarginate and always with a prominent dorsal tooth often with several smaller teeth in females. In *T. genevievae* the apex is more or less evenly serrate. The dorsal internal margin of the cercus of *T. genevievae* is serrate along the entire margin but smooth in *T. boharti*. The subgenital plate of the two is also quite different. In *T. genevievae* this structure is more constricted basally with the proximal margins nearly parallel. In *T. boharti* the base of the subgenital plate is not parallel but the margins obtuse. *T. genevievae* can be immediately distinguished from *T. chumash* Hebard (coastal and inland central California) by the much broader and obtuse subgenital plate and the absence of prominent serrations on the cercus.

Ms. Prlain reports that *T. genevievae* shows a preference for chamise both in the field and in the laboratory. Chamise samples from Sierran localities were reluctantly accepted, but the captive timemas always fed on chamise from the type locality and they



Figures 2-5. Fig. 2, dorsal view anterior portion of paratopotype; Fig. 3, subgenital plate; Fig. 4, apex of abdomen, dorsal view; Fig. 5, individual cercus, dorsal view. Figs. 3-5, holotype female, *Timema genevievae* Rentz.

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preferred the budding tips. Even though, a few individuals were collected on buckbrush *(Ceanothus cuneatus* (Hook.) Nutt.) and mountain mahogany *(Ceroocarpus betuloides* Nutt.), these shrubs were rejected as food in the laboratory.

Eggs from captive females were placed outdoors and moistened occasionally over winter. In general, they hatched in early January. Usually six weeks and 4-5 instars later, adults were obtained. At the type locality, adults were present from mid to late May and mostly gone by the end of June. Eggs are freely broadcast by females but are sticky and adhere to the first surface touched.

Timemas should be preserved in a fixative, then stored in alcohol. Pinned specimens are usually hopelessly shriveled and distorted. I prefer the fixative described by Williams (1968) for arachnids which is a modification of the widely used Pampel's fixative. Pierce (1942) described a method for drying specimens and then pinning them. Color and form was reportedly preserved. His method was to place the living specimens in 70% alcohol for 1 hour, then transfer to 95% alcohol for 1 hour, then move into xylol for 24 hours. The dried specimen could then be pinned. He also stated that the same results could be obtained by placing the timema into xylol and foregoing the dehydration in alcohol.

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Over-winter Occurrence and Maturation of Gonads in Adult *Psychoglypha subborealis* (Banks) and *Glyphopsyche irrorata* (Fabricius)

(Trichoptera: Limnephilidae)

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Adults of several species of limnephilid caddisflies are collected only from fall to spring and are variously referred to (for example, Leonard and Leonard, 1949; Nimmo, 1971; Anderson, 1976) but essentially they are members of a winter fauna. The actual time of emergence of adults of these species is usually unknown and the functional significance of over-wintering adults (in contrast to winter-emerging adults such as *Dolophilodes distinctus* (Walker)) has not been established.

In this paper I describe observations on the occurrence and gonad maturation of adult *Psychoglypha subborealis* (Banks) and *Glyphopsyche irrorata* (Fabricius) from fall to spring in the vicinity of Juneau, Alaska, and suggest a functional significance for over-wintering of these adult caddisflies.

From 1962 to 1974 I casually collected adult caddisflies in the vicinity of Juneau, Alaska (58°18'N, 134°20'W) (most collections were made around my home). Because of their presence from fall to spring, *P. subborealis* and *G. irrorata* were especially noticed. I have 30 collections of *P. subborealis* (17 males, 22 females) and 20 collections of *G. irrorata* (9 males, 21 females; Table 1). *Psychoglypha subborealis* occurred every month from October through May, and *G. irrorata* occurred every month from October through May except January.

The adaptation to cold indicated by Denning (1970) for *Psychoglypha* in general is confirmed for *P. subborealis* and *G. irrorata* by the minimum temperatures for each month I made a collection (Table 1) and by my subjective observation of no correlation between occurrence and warming periods during the winter season. Adults were collected during very cold weather when all known fresh water was covered by ice and snow. The implication is not that these adult caddisflies had recently emerged but that they had emerged during open-water periods and survived into winter. The adults could have originated from two small permanent streams and several intermittent ponds and streams within 2 km of the collection sites. Nimmo (1971) refers adults of *P. subborealis* and *G. irrorata* to habitats ranging from ponds to rivers but does not mention temporary waters.

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Table 1. Summary of minimum air temperatures for each month a collection of *Psychoglypha subborealis* or *Glyphopsyche irrorata* was made, number of collections, and numbers of males and females collected near Juneau, Alaska, 1962-1974.

Month	Minimum air temperature[1] (range, °C)	Number of:					
		Psychoglypha subborealis			Glyphopsyche irrorata		
		collections	males	females	collections	males	females
October	-4 to 1.5	3	2	3	5	6	0
November	-16 to -7	4	3	1	1	0	1
December	-21.5 to -6	3	1	2	1	0	1
January	-30 to -19	2	2	0	0	—	—
February	-19 to -15.5	3	4	0	1	1	0
March	-20 to -9	10	5	11	3	2	2
April	-14.5 to -4	4	0	4	6	0	11
May	-4 to -2	1	0	1	3	0	6
Totals		30	17	22	20	9	21

[1] Local Climatological Data, Juneau, Alaska, National Weather Service Forecast Office, Municipal Airport, National Oceanic and Atmospheric Administration Environmental Data Service.

Emergence dates of adults (not collection dates), seasonal deposition of eggs, and life span of *P. subborealis* and *G. irrorata* are not recorded in the literature, but the sequence of maturation of the ovaries implies certain aspects of their life history. Comparison of ovaries from my fall to spring collections indicates that ova mature during the winter and oviposition occurs in early spring in both species. During the fall, ovaries are undeveloped and minute and the abdomen is distended with what appears to be fatty tissue. By midwinter the ova are enlarged but remain within the ovariole; much of the fat has disappeared. In early spring the eggs are fully developed for oviposition and most of the body fat has disappeared.

Deposition of eggs of *P. subborealis* appears to commence in early March since abdomens of two females collected then were only partially filled with eggs (147 and 150), which is about half the average of 302 (range 226 to 353) for six subjects "apparently full" of eggs. No partially spent females of *G. irrorata* were collected. The average number of eggs found in six *G. irrorata* collected from 24 March to 5 May was 360 (range 243 to 472). The female *G. irrorata* with the fewest eggs (243) was collected on 5 May and her abdomen appeared to be full.

Apparently both species emerge as sexually immature adults in the fall; the males and females remain active during the winter months, gradually become sexually mature, and mate and oviposit in the spring. Males have abundant fatty tissue in the fall and it is almost totally absent in the spring; however, progressive development of testes was not apparent from examination of my preserved specimens. I did not find pairs in copula but the absence of males in April and May indicates that mating occurred by March followed soon after by death of males. Although the evidence is circumstantial, it appears that the life span of adults is 5 to 7 months.

In a study of adaptations of caddisflies to life in temporary ponds, Wiggens (1973) reviewed the literature on long-lived adults that emerge in early summer and survive to oviposit in the fall. These species have egg matrices which are adapted to permit survival of drought and freezing. Wiggens' studies involved species adapted to live in ponds which were dry from summer to fall (autumnal ponds) or from summer to following spring (vernal ponds). Over-wintering in a gelatinous matrix resistant to drought and cold as described by Wiggens (1973) would be hazardous in climates where freezing droughts are often interspersed with periods of warming and heavy rains. Warming and flooding of the gelatinous matrix could result in dissolution of the matrix and release of larvae susceptible to freezing and desiccation. Functionally, over-wintering adults with gradually maturing gonads and spring oviposition permits survival of winter drought without requiring specially resistant egg matrices, the dry period in this instance being due to freezing of surface drainage waters rather than absence of precipitation.

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Eugene Graywood Smyth, Ph. D. (1886 - 1975): Obituary and Bibliography of an Entomologist

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The death of Eugene Graywood Smyth, one of the old-time entomologists, is a great loss to the scientific world. He was born in Topeka, Kansas on July 28, 1886 and began studying insect life at an early age. He achieved local fame as a teenager for his butterfly collection.

Dr. Smyth would talk for many hours about the days he was under the tutorage of Dr. F.H. Snow of the University of Kansas. This was the era of coal oil lamp use for night collecting and traveling by horse and wagon. He was a student under Dr. Snow during the years from 1903 to 1907. Between July 22 and August 1 in 1903, he was collecting insect specimens around Congress Junction in Yavapai County, Arizona; between August 3 and September 3 near the Tappan's Ranch on the Bill Williams fork of the Colorado River; in 1904, at Thomas' Ranch in Oak Creek Canyon below Flagstaff, Arizona in Coconino County; and in 1905, he collected on the San Bernardino Ranch in the valley of Sycamore Creek east of Douglas, Arizona in Cochise County. The San Bernardino Ranch belonged to J.H. Slaughter, presumably the John Slaughter who was sheriff of Tombstone after the Earp-Clanton shoot-out in the early 1880's. On an expedition in 1906, Mr. S.E. Crumb, one of Dr. Smyth's fellow students, was collecting near the craggy peaks of the Baboquivari Mountains south-west of Tucson, Arizona, and while stopped for a lunch break, Crumb discovered and collected some *Amblycheila baroni*, a very rare tiger beetle at that time, which was climbing over rocks. The other members of the expedition then searched and collected as many other specimens as they were able to locate. They discovered that these particular tiger beetles would emerge in late afternoon at dusk. But, the collectors were supposedly endangered by bear and cougar and could not collect after dark. Each day, Dr. Snow would awaken his students with the cheery call: "Blyc, blyc, blyc it again boys, let's be off." Referring to the 1905 expedition, Dr. Snow wrote "My assistants on this trip were three students: Eugene Smyth, Ebb Crumb, and Rollin Perkins. And I have never had a more indefatigable corps of collectors." On these expeditions, the students were allowed to keep one specimen out of ten for each species collected. Dr. Smyth would recall the many times he became so absorbed in collecting in one place too long and would have to run to catch the disappearing wagon.

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Economic Entomology was the field of science Dr. Smyth pursued for most of his life. He won a scholarship to Chicago University. Upon graduation he joined the United States Department of Agriculture in Washington, D.C. Working with L.O. Howard, he helped pioneer the research which proved that house flies contribute to epidemics of typhoid. Eyebrows were lifted by local residents as Dr. Smyth would pedal by on his bicycle collecting sticky paper containing fly specimens for this research.

In 1910, he was sent to Smyra, Turkey to investigate the fig damaging moth *(Esphestia cautella* Walk.). After solving this control problem, he was sent to Arizona in 1911 to work on alfalfa pests. At this time, blister beetles were defoliating acres of alfalfa. Between the years 1913 and 1920, he worked with the Department of Agriculture in Puerto Rico, where he devised new control measures to eliminate the spread of sugar cane pests. His methods are still used today for fumigating the ships importing and exporting produce to and from Puerto Rico. While in Puerto Rico, he worked out the life history of ten species of white grubs *(Lachnosterna)*, of which five were species new to science. In 1922 and 1923, L.O. Howard, Chief of the Bureau of Agriculture, sent Dr. Smyth to southern Mexico and Guatemala in search of parasites for use in the control of the bean beetle. Working for the United States Department of Agriculture, he searched for agricultural pests, mainly *Epilachna*, and encountered many discomforts such as diarrhea, strange foods, and bed bugs, to name a few. Traveling into the steep baranncas around Coatepeque by horse or mule was quite dangerous during the rainy season. In a letter to F.H. Chittenden, Chief of Entomology in Washington, D.C., Dr. Smyth commented how slippery it became and preferred to trust his own feet to riding a mule. While in Guatemala and Mexico, he also collected many specimens of the local flora, which were later donated to the University of California in Santa Barbara.

During World War I, Dr. Smyth was a U.S. Army officer in Puerto Rico. While stationed in Puerto Rico, he met and married Laya Machat, a prima donna with a touring opera company. She later gave up her singing career to take care of Gene and his insects for the rest of her life. In 1926, Mrs. Smyth, accompanied by Dr. Smyth, traveled to Italy for a singing engagement. While there, Dr. Smyth collected many beetles and visited different research stations in France and Italy. In 1925, Dr. Smyth was elected a Fellow of the American Association for the Advancement of Science.

From 1929 to 1938, he worked for the Grace and Company sugar estates in Trujillo, Peru. Here he reared sixty million parasitic wasps to be turned loose in the sugar cane fields to work where insecticides could not reach in the heavy sugar cane stalks. In February of 1933, while on one collecting trip to the remote parts of the Chancamayo Valley in Peru, Dr. Smyth recalled how he was almost done in by some local Indians. In one particular steep canyon, Dr. Smyth is quoted as saying "The Indians started rolling large boulders down upon me. With my Colt .45, I sent a volley of shots into the air; and the small, brown, naked men departed with great haste." While in South America, he received his Ph.D. at the University of Peru in Lima.

Semiretired in 1943, Dr. and Mrs. Smyth moved to their home in Glen Ellen, California, aptly named "The Perch." After three years in The Valley of the Moon, Dr. and Mrs. Smyth moved to Los Angeles in 1946, where he became Associate Curator of Entomology at the Los Angeles County Museum of Natural History (on a temporary budget item, July 1, 1946 to June 30, 1951). In 1954 Dr. Smyth retired and moved to Scarab Hill, the name of his home in Santa Barbara, California. His love of Entomology led Dr. Smyth to the Chiricahua Mountains in southern Arizona, with the aid of a grant from the David Rockefeller Foundation, American Museum of Natural History, New York, to collect the eggs of *Plusiotis gloriosa* and to work out its life history back at his home in Santa Barbara in 1958. He resided in this coastal city until he passed away on July 30, 1975, three months after the death of Mrs. Smyth. There were no children surviving them.

Even after seventy years of collecting insects around the world, Dr. Smyth, when picnicing with his wife, would be sure to have a vial of formaldehyde along in order to perhaps add a few more specimens to his collection of over 100,000 insects. Many of his specimens were donated to the University of Kansas, Los Angeles County Museum of Natural History, and National Museum of Natural History. He also donated many unmounted specimens to my own personal collection, along with his correspondence, papers, books and journals. I am currently undertaking the task of fulfilling his wish to have his insects cared for and mounted. As a scientist, Dr. Eugene Graywood Smyth left behind much completed work and much yet to be completed. His special love was tiger beetles (Cicindelidae), of which he was able to on-sight identify over a hundred species. Surely a man who loved Entomology as much as he, must, even now, have with him a vial of formaldehyde.

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The Mango Leaf-Coating Mite, *Cisaberoptus kenyae* K.

(Eriophyidae, Aberoptinae)

El Fatih Osman Hassan

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and

H. H. Keifer

Sacramento, Cal.; Collaborator, Agricultural Research Service, USDA

Cisaberoptus kenyae Keifer 1966 is a tiny leaf-coating mite widespread in the tropics, having been transported on its host, mango, *Mangifera indica* L. It occurs in southern Asia, east Indian islands, where mango is grown in Africa, and in South America. The white leaf coatings it develops on mango leaves are notable in Kenya and the Sudan. Leaf coatings are conspicuous in Bali, but probably less so in Thailand. These notable white coatings develop primarily along the midrib on the upper surface, but as the colony grows the coating follows lateral veins and goes to leaf margins (Fig. 1).

Leaf specimens submitted from Thailand by Dr. L. C. Knorr, of the Plant Protection Service of the United Nations, reveal that the activities of this mite first can begin inconspicuously on the underside of the leaf petiole. Petioles thus attacked then become covered with the typical coating, and show surface roughening under the coating. But as the colonies enlarge the mites move up the petiole and transfer for the most part to upper leaf surface areas where they start the typical development.

When first examined this mite seemed to be a leaf miner and as such was thought to damage the leaf mechanically. Investigations in the Sudan have shown that there is no leaf mining. Leaf sections from coated leaves do not disclose any direct damage to internal tissue (Fig. 4). What eventually does happen is that as coatings become more and more extensive the leaves tend to yellow and drop prematurely.

A recently published paper by Knorr, Phatak, and Keifer (1976), entitled *Web-spinning eriophyid mites*, may have a suggestion as to the relationship of the white coating to the *kenyae* mites. In the case of the web-spinning species, *Aculops knorri* Keifer (1976), the webs consist of fine discrete strands over the colonies on the upper leaf surfaces. *Aculops knorri* infests a sapindaceous tree, *Lepisanthes rubiginosa* (Roxb.) Leenh., in Thailand. Serological tests proved that the proteinaceous nature of the web these mites cover themselves with, and the mite body proteins, are antigenically closely related.

The Pan-Pacific Entomologist 54:185-193. July 1978.

Fig. 1 — Mango leaves showing upper surface leaf coatings caused by *Cisaberoptus kenyae.* Left leaf with early infestation; right leaf with more advanced infestation. Ca. 0.57 X.

While the white coating on mango leaves does not readily disclose separate strands, like the webbing on the *Lepisanthes* leaves, microscopic examination of the coating (Fig. 3) reveals that it consists of what might be called *crude strands* that are irregular. These strands assume various forms and bunches. The view adopted here is that the white leaf coating is some sort of regurgitation.

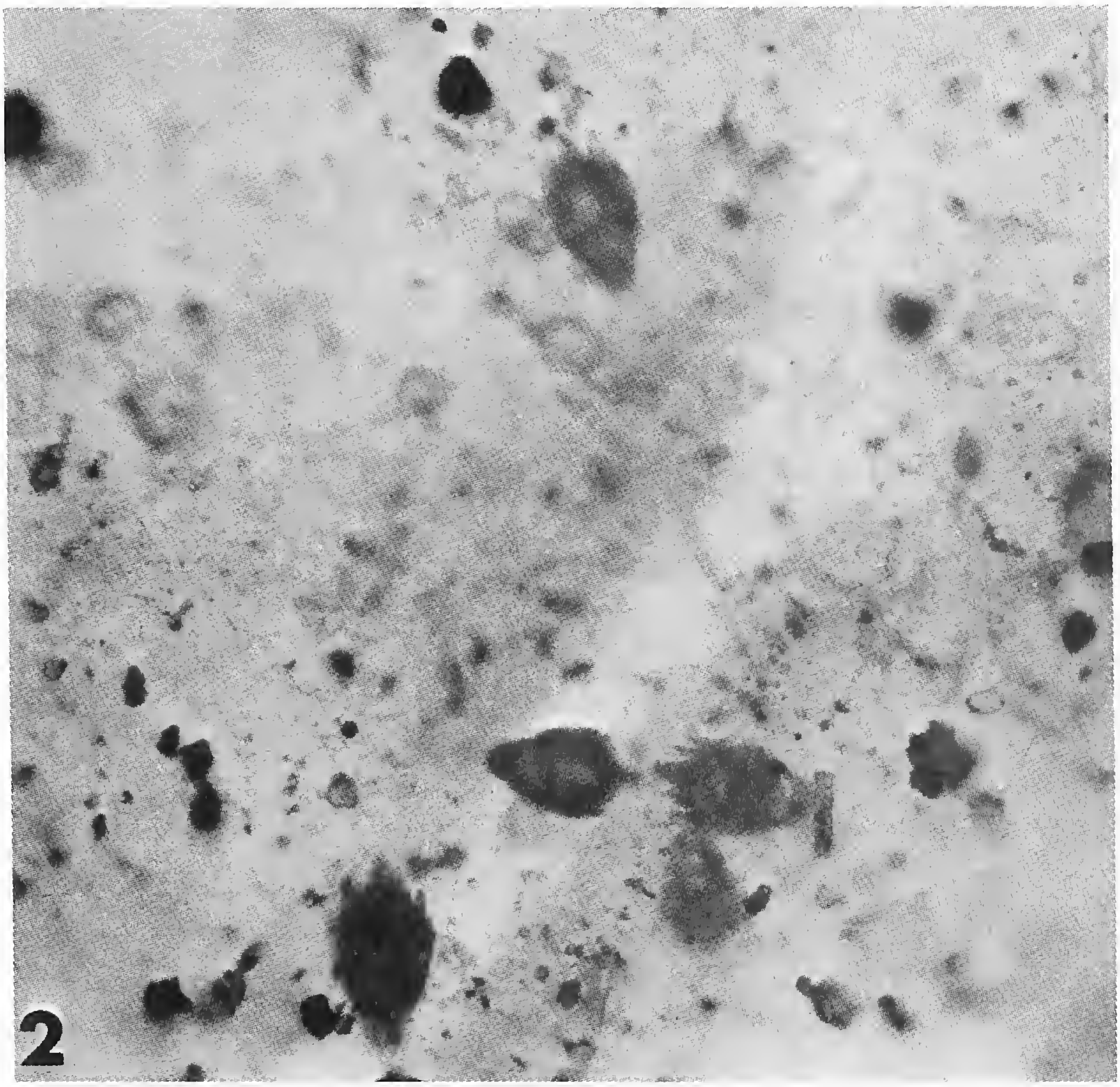

Fig. 2 — Heteromorphic females as they appear under coating. Ca. 228 X.

Cisaberoptus kenyae is not only notable for the coatings it makes, but it is also of interest because of different structural forms in colonies under the coatings. There are three adult forms or types as follows:

One form is the male (Plate 1) which is a rather ordinary, somewhat flattened eriophyid, with generalized structures, and which fits easily into the genus *Eriophyes*. It has an ordinary-type gnathosome. The propodosomal shield has dorsal setiferous tubercles on the rear margin directing the setae to the rear. This male shield is almost entirely devoid of any markings or pattern, but it does show a curved line just on the inner side of the dorsal tubercle that is similar to the curved line present in the same position on the shields of females in the colonies. The abdomen is completely microtuberculate and it tapers regularly to the terminal lobes. Males vary somewhat in size and the feather-claws (empodia) have 5 to 8 or 10 rays. The genital

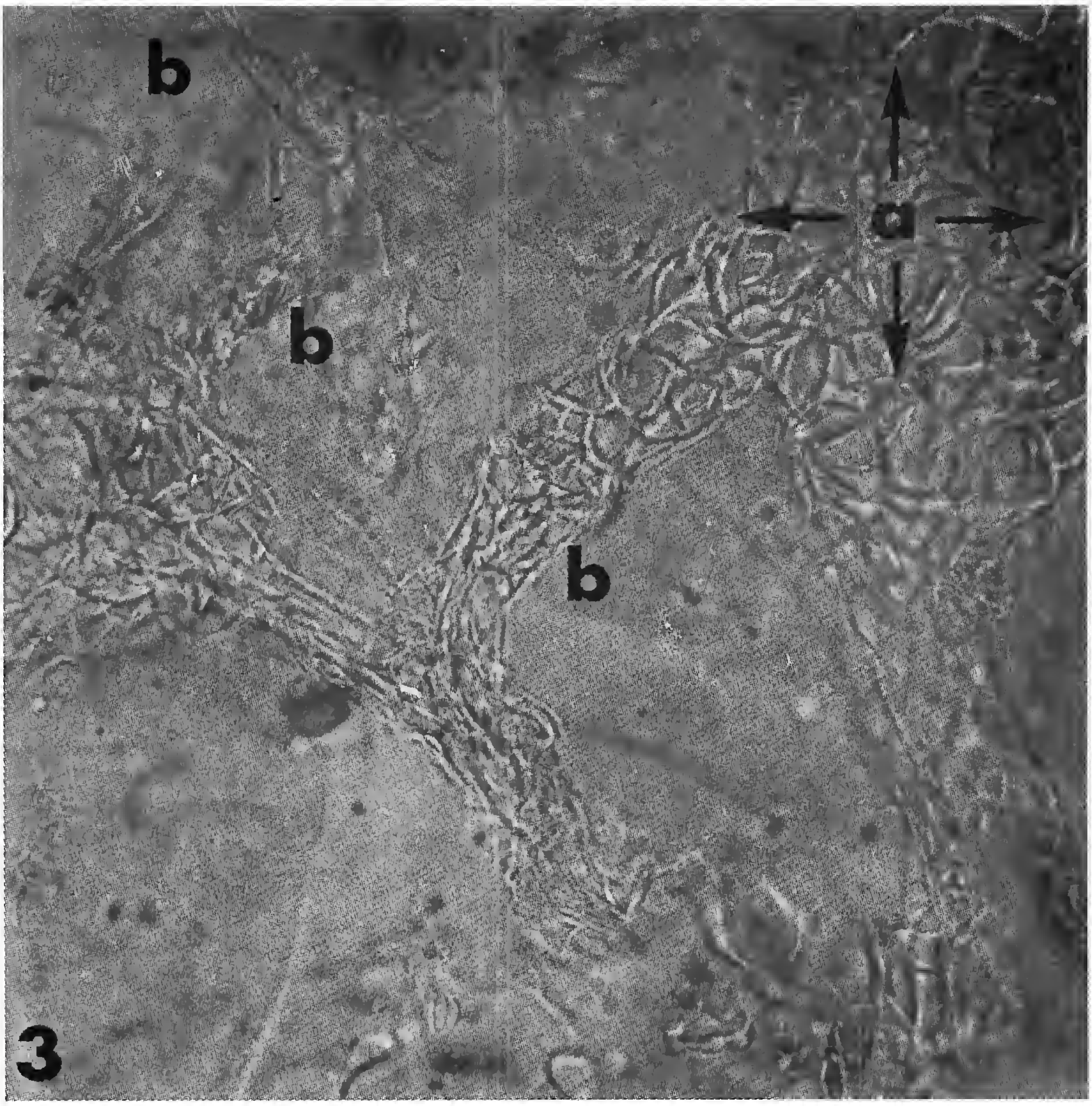

Fig. 3 — a. Bunched strands in coating
b. Separate strands forming compartments. Ca. 1140 X.

setae are quite small. Average male length from the anterior shield edge to the termen is 140μ.

The second form in these colonies is the female which more or less resembles the male, except for genitalia, and is therefore the protogyne or primary female. These protogynes vary somewhat in size and in featherclaw rays, and it is possible to divide them into subgroups. Featherclaw rays on these protogynes run from 7 to 12. Protogyne gnathosomes are normal in shape. Protogyne lengths range from 145μ to 165μ.

The third adult form under the coatings is the most numerous, the most standardized, and usually the only type easily recovered for examination (Fig. 2). It is the female that differs notably from the more generalized types described above (Plate II). This third form is the deutogyne. It is flattened, but its most outstanding features are the

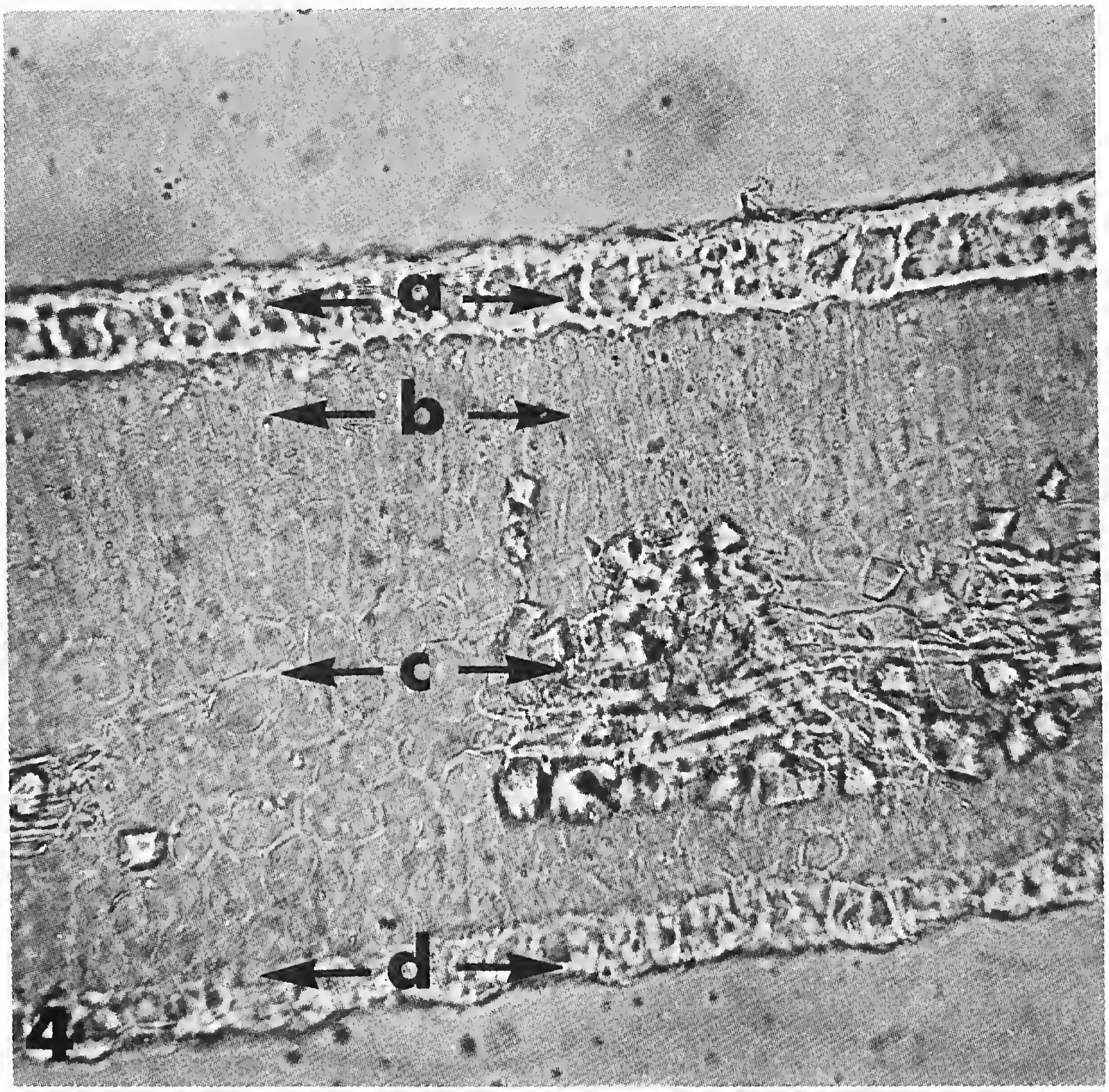

Fig. 4 — Cross section of infested leaf showing interior tissue is not entered by the mites. a. upper epidermis; b. palisade cells; c. parenchyma cells; d. lower epidermis.

stocky legs, large complicated featherclaws, and most notably the stiffened gnathosome. This gnathosome projects ahead and terminates in a pair of expanded spatulate structures. (Fig. 2 and Plate II). These spatulate or 'shovel-nosed' females are therefore the secondary females and differ mainly by the modified gnathosomal structures and enlarged legs. These deutogynes are similar to the primary females, or protogynes, as regards genital structures and the curved lines on the inner side of the propodosomal shield tubercles. The large complicated featherclaws have what appears to be 16 to 18 rays. Deutogynes average 170μ in length.

No nymphs of *kenyae* on slides have shown spatulate gnathosomes, but a few second stage nymphs have disclosed developing adults inside that have spatulate gnathosomes.

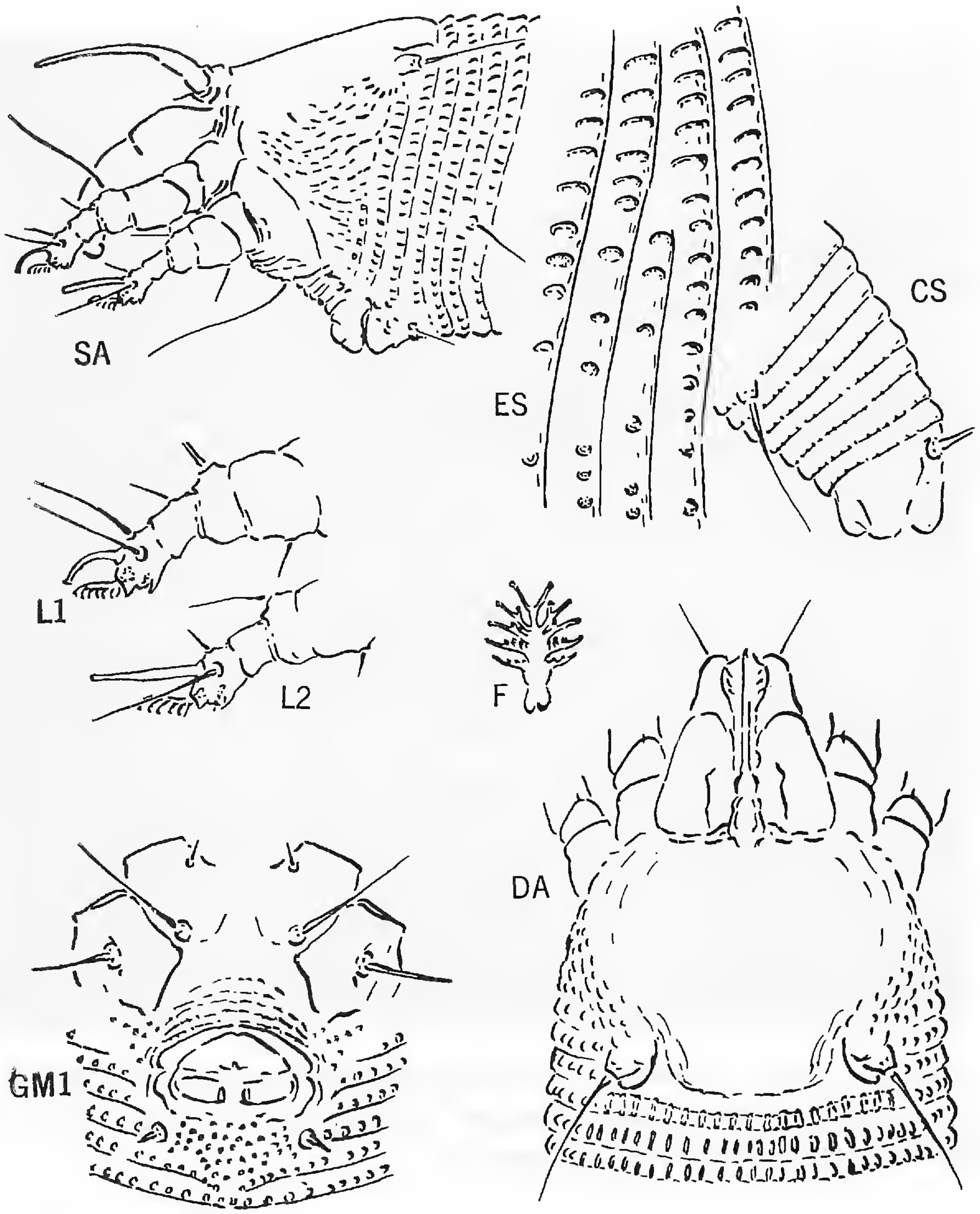

Plate I — *Cisaberoptus kenyae* male.

Abbreviations on Plate I and II

API — internal female genital structures; CS — caudal section of mite; DA — dorsal view of anterior section of mite; ES — detail of side ring structures and microtubercles; F — featherclaw or empodium; GF1 — female genitalia and coxae; GM1 — male genitalia and coxae; L1 — left foreleg; L2 — left second leg; S — lateral diagram of mite; SA — lateral view of anterior section of mite

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The first stage nymphs of *kenyae* have about the same basic arrangement of the dorsal shield tubercles and setae, and the same interruption of anterior abdominal dorsal rings as other first nymphs

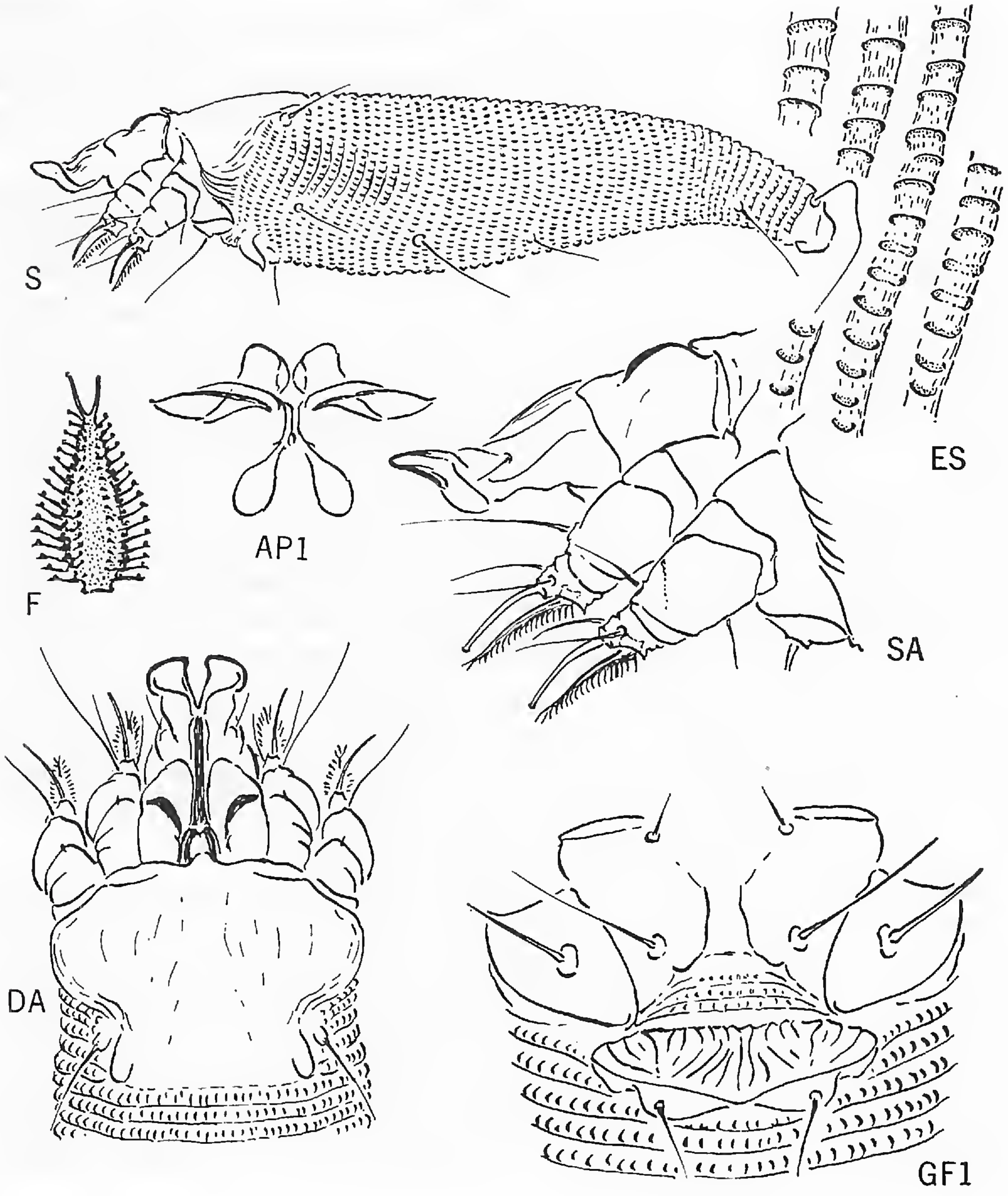

Plate II — *Cisaberoptus kenyae* deutogyne.

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in various genera of the Eriophyidae have (Jeppson, et. al. 1975:432, 442). The dorsal tubercles are set ahead of the rear shield edge and the setae point up and ahead. Several rings behind the shield are discontinuous dorsally. The first three subventral abdominal setae on these first stage nymphs are reduced to small or minute size. The last subventral abdominal setae before the terminal lobes are of usual size. *These first stage nymphs lack* the *genital setae* which is a feature not previously observed on other first stage nymphs. There are no abdominal microtubercles present on the first stage nymph.

Second stage nymphs have setae about as on adults, perhaps shorter, but the second stage nymphs share with first stage nymphs the lack of genital setae. Abdominal microtubercles on the second nymphal abdomen are present behind the shield, behind the coxae, and just before the terminal lobes.

This mango leaf coating eriophyid was the first tropical member of this family that has proved to be deuterogynous. (For a second tropical deuterogynous species see Keifer 1977:1,2). Deuterogyny is common among temperate and cold region eriophyid species, mainly among those that live on deciduous hosts. The female present in temperate regions that displays structures not on the male is the deutogyne or secondary female. These temperate region deutogynes serve to carry the species over unfavorable periods, chiefly through winter. In the spring these overwintering deutogynes start new colonies and then disappear from the colonies. New deutogynes develop later in the summer in response to changing host and weather conditions. While these new deutogynes carry sperm over winter they are not known to be able to lay eggs until they are subjected to winter chill.

On the other hand *kenyae* deutogynes, with spatulate gnathosomes, are always present in colonies on mango leaves, and they are active egg layers, as shown by slide mounted females of this type that contain eggs. Thus the *kenyae* deutogyne performs a function different from the temperate region deutogyne.

Leaf coating deutogynes in colonies, as well as being active egg layers, are evidently the form principally instrumental in tending the coatings. These females congregate around the edges of the covered areas where they presumably expand the coating, and by means of their stiff, spatulate gnathosomes keep the coating raised enough to provide mite space for the colony members. Inactive living *kenyae* deutogynes can aestivate for a period of a month or more. These deutogynes also travel as shown by their presence on grease coated plates hung in infested groves.

There is at present only one other eriophyid known to be a close relative of *kenyae*. This is *Aberoptus samoae* Keifer (1951). It occurs on mango in the Samoan Islands. It differs from *kenyae* principally by having the spatulate organ on each of the foretibiae, and the forelegs are stiffened. While this suggests that the female of *samoae* as described is the deutogyne, and has functions similar to *kenyae*, the bionomy of *samoae* is as yet unknown.

Together, *Aberoptus samoae* and *Cisaberoptus kenyae* constitute the eriophyid subfamily Aberoptinae.

The mango genus, *Mangifera*, has several species in it. The host of *kenyae* is *Mangifera indica* L., the well known mango. The precise identification of the Samoan host of *samoae* is unknown, and the differences between the position of the spatulate organ on the two species of eriophyids suggests that possibly the Samoan tree is not *indica*. Further exploration may well disclose additional members of the Aberoptinae.

As far as presently known all deutogynes in the large subfamily Eriophyinae of the Eriophyidae are more generalized in their structures than the males and protogynes, and therefore do not furnish characters useful in defining taxa. So the practice has been to ignore them for such definitions.

But this rule now proves inapplicable to members of the subfamily Aberoptinae of the Eriophyidae. The stiff spatulate gnathosome of the *kenyae* deutogyne, and the stiff spatulate forelegs of *samoae*, compel their use in defining the genera and subfamily to which they belong.

But the Aberoptinae are not the only group in the Eriophyoidea that have deutogynes with useful defining features. In the Diptilomiopidae there are two species possessing flat-backed deutogynes that constitute the genus *Abacoptes* (Keifer, 1939b, 1944). The two diptilomiopids are now quoted as *Rhyncaphtoptus ulmivagrans* Keifer (1939a), and *Rhyncaphytoptus fagifoliae* Keifer (1940). These two species should now be referred to as *Abacoptes ulmivagrans* (Keifer), and *Abacoptes fagifoliae* (Keifer). For an account of the rearing that proved that the genotype of *Abacoptes,* which is *platynus* Keifer, is the deutogyne of *ulmivagrans* see Keifer (1944).

Acknowledgement

We are indebted to Dr. L.C. Knorr of the United Nations Plant Protection Service for his contributions to the bionomy and distribution of this curious mango leaf coating mite.

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The Neotropical Species of *Oncylocotis*

(Hemiptera: Enicocephalidae)

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Oncylocotis was erected by Stål in 1855 for the African species *nasutus*. Since then the number of *Oncylocotis* species has greatly increased with 48 species in the Ethiopian region (Villiers 1969), 2 species in the Palearctic region (Jeannel 1942, Štys 1970), 12 species in the Oriental region (Usinger 1945, Miyamoto 1965), 2 species in the Australian region (Usinger 1945), 5 species from the Oceanic region (Usinger and Wygodzinsky 1960, Usinger 1945), and 6 species from the Neotropical region (Stål 1860, Champion 1898). *Oncylocotis* has not been collected in the Nearctic region.

Presented herein are descriptions of the six Neotropical species of which three are new. A key to the Neotropical species is also provided.

Oncylocotis Stål 1855

Type-species by original designation.—*Oncylocotis nasutus* Stål (1855).

Moderate to large enicocephalids, 3- 11 mm.

Head with deep postocular impression. Posterior lobe usually with transverse impression. Rostrum short, eyes and ocelli of moderate size.

Pronotum distinctly divided into three lobes. Anterior lobe sometimes with slight tubercles; intermediate lobe with deep inverted T shaped sulcus and impressions on each side.

Scutellum triangular shaped.

Foreleg with two claws and four spines on tarsus, one hook-shaped spine and other three spines curved (Fig. 1). Apical end of the Neotropical species tibia with seven spines, innermost two spines pear shaped, remainder spines conical and erect (Fig.1).

Forewings with basal cell present and discal cell closed.

Male genitalia without distinct parameres, posterior apophysis of pygophore opening below the anus.

Female stouter than male. Eyes smaller, posterior lobe of head wider, middle lobe of pronotum larger, and forelegs more robust. Genitalia reduced to opening below anus.

Key to the Neotropical Species of Oncylocotis

1. Posterior lobe of pronotum greatly wider than intermediate lobe (Fig. 2) . . . . *rhyparus*
   Posterior lobe of pronotum not greatly wider than intermediate lobe 2

2. Posterior lobe of pronotum with deep median diverging suture (Fig. 3) . . . . *mexicanus*
   Posterior lobe of pronotum without deep median diverging suture 3
3. Posterior lobe of pronotum deeply separated from intermediate lobe (Fig. 4) . . . . *stannardi*
   Posterior lobe of pronotum not deeply separated from intermediate lobe 4
4. Posterior margin of intermediate lobe of pronotum with deep indentations, and posterior margin of posterior lobe of head shallowly emarginate (Fig. 5) . . . . *braziliensis*
   Posterior margin of intermediate lobe without deep indentations, posterior margin of posterior lobe of head not emarginate 5
5. Sparsely covered with short setae (Fig. 6) . . . . *concolor*
   Sparsely covered with long setae . . . . *annulipes*

Oncylocotis rhyparus (Stål 1860)
(Fig. 2)

Type-locality.—Rio de Janeiro, Brazil.

Male length 5.00 mm. Body sparsely covered with setae. Head, pronotum, and wings dull black; rostrum, antennae and legs dark brown.

Head 1.06 mm long. Posterior lobe convex with a slight transverse impression. Eyes and ocelli of moderate size. Length of antennal segments I, 0.10 mm; II, 0.27 mm; III, 0.30 mm; IV, 0.34 mm.

Pronotum with trapazoidal intermediate lobe with median sulcus and Y-shaped sutures on both sides. Posterior lobe much wider than intermediate lobe, shallowly emarginate.

Forelegs slender; femur length to width ratio 3.27; tibia length to width ratio 3.70.

Forewings venation complete, small basal cell equal in length to discal cell length.

Material examined collected in Utcuyacu, Peru, Prov. Tarma, 1600-2800 meters elevation, March 15, 1948 (collected by F. Woytkowski).

Oncylocotis mexicanus, new species
(Fig. 3)

Female length 3.50 mm. Moderately covered with short setae. Body deep brown in color, legs lighter brown than rest of body.

Head 0.87 mm long. Posterior lobe strongly convex with a deep transverse impression. Ocelli of moderate size, directed laterally. Length of antennal segments I, 0.08 mm; II, 0.25 mm; III, 0.27 mm; IV, 0.27 mm.

Anterior lobe of pronotum with two small median tubercles. Intermediate lobe with deep median sulcus and deep lateral Y-shaped sutures. Posterior lobe shorter than intermediate lobe with a transverse impression dividing posterior lobe into three parts.

Forelegs stout; femur length to width ratio 2.72, tibia length to width ratio 2.81.

Forewing venation complete with long narrow basal cell, discal cell shorter.

Holotype; female; Tapachula, Mexico. May 1902 (collected by Cook and Collins). The type is deposited in the United States National Museum.

Oncylocotis stannardi, new species
(Fig. 4)

Female length 3.50 mm. Sparsely covered with short setae. Legs, rostrum, and wing bases yellow; remainder of body dark brown.

Head 0.87 mm long. Posterior lobe of head very convex with deep transverse furrow. Ocelli of moderate size, laterally directed. Length of antennal segments I, 0.08 mm; II, 0.27 mm; III, 0.25 mm; IV, 0.25 mm.

Anterior lobe of pronotum with two small tubercles. Intermediate lobe with a deep median sulcus and deep lateral impressions. Posterior lobe as long as intermediate lobe, distinctly separated from intermediate lobe, with emarginate posterior margin.

Forelegs slender; femur length to width ratio 3.11, tibia length to width ratio 3.50.

Forewing with basal cell equal in length to discal cell.

Holotype: female; Bocaiuva, Brazil, 35° 11' N, 49° 04'W; May 1964 (collected by Fritz Plaumann). This species is named after Dr. Lewis J. Stannard, Jr., who has made many valuable contributions to this study. The type is deposited in the United States National Museum.

Oncylocotis braziliensis, new species
(Fig. 5)

Female length 3.5-4.0 mm. Moderately clothed with long setae. Legs, rostrum, and wing bases yellow; remainder of body deep brown color.

Head 0.95 mm long. Posterior lobe very convex, with deep transverse impression. Ocelli of moderate size, laterally directed.

Pronotum with two small tubercles on anterior lobe. Intermediate lobe with deep inverted T-shaped sulcus and lateral impressions ending in deep indentations in posterior margin. Posterior lobe with rounded sides. Shallowly emarginate posterior margin.

Forelegs stout; femur length to width ratio 2.80, tibia length to width ratio 2.81.

Forewings with narrow and equal length discal cell and basal cell.

Holotype: female; Nova Teutonia, Sta. Caterina, Brazil; June 30, 1955 (collected by F. Plaumann). Six paratypes; females; same locality as holotype; 2 specimens collected on April 8, 1953; 1 specimen collected on July 2, 1953; 2 specimens collected on June 30, 1955; and 1 specimen collected on August 15, 1955. The types are deposited in the United States National Museum.

Oncylocotis concolor (Champion 1989)
(Fig. 6)

Type-locality.—Guatemala, Guatemala.

Female length 4.25 mm. Densely covered with short setae. Legs and rostrum pale brown, remainder of body reddish brown color.

Head 1.00 mm long. Posterior lobe very convex with a transverse suture. Ocelli of moderate size and laterally directed. Length of antennal segments I, 0.10 mm; II, 0.30 mm; III, 0.32 mm; IV, 0.27 mm.

Pronotum with two small tubercles on anterior lobe. Intermediate lobe with deep

→

Figs. 1-6, *Oncylocotis* sp. Fig. 1, *O. braziliensis*, foreleg; Fig. 2, *O. rhyparus*; Fig. 3, *O. mexicanus;* Fig. 4, *O. stannardi*; Fig. 5, *O. braziliensis*; Fig. 6, *O. concolor.*

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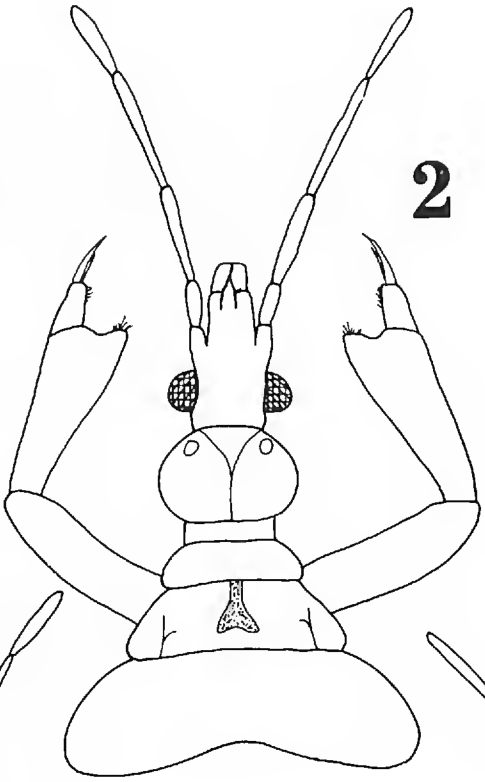

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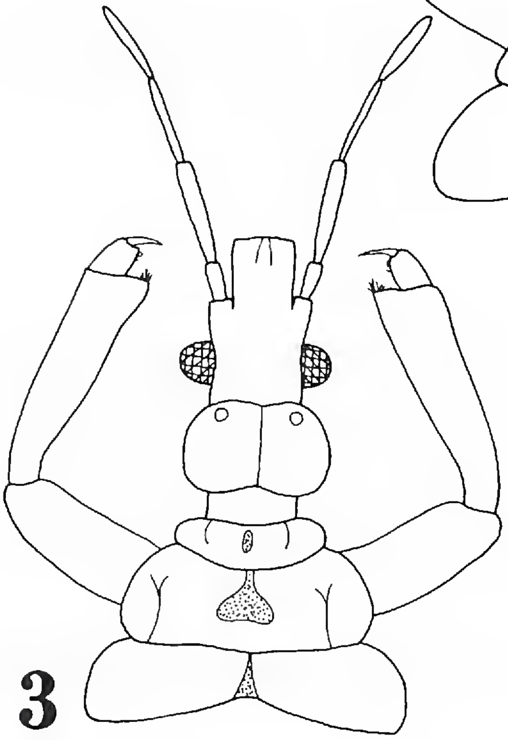

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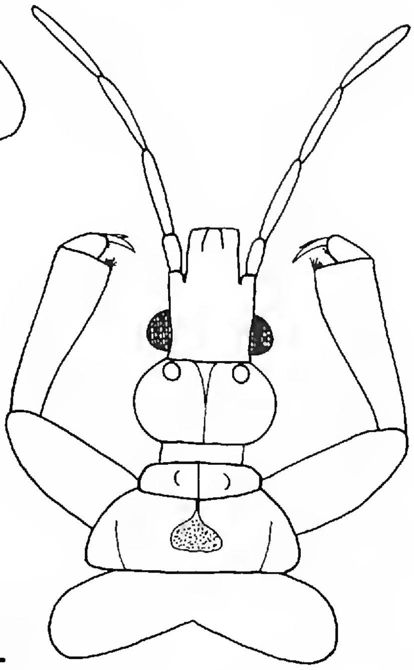

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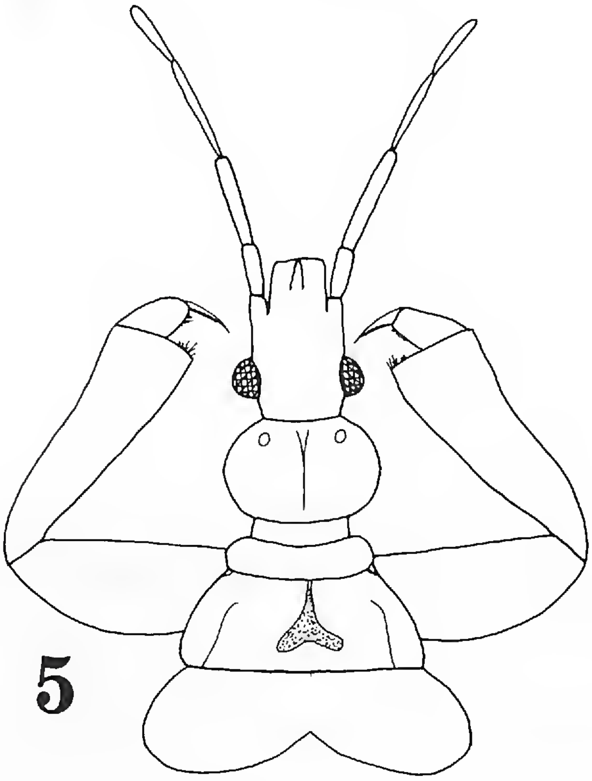

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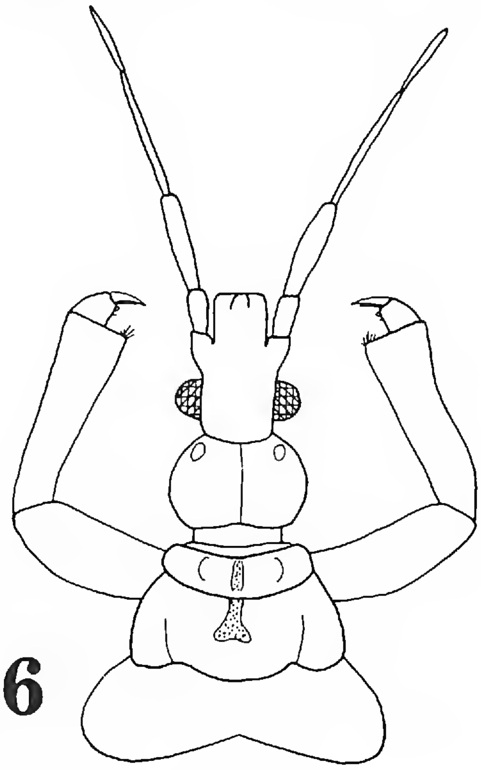

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sulcus and lateral impressions. Posterior lobe with rounded sides posterior margin emarginate.

Forelegs stout; femur length to width ratio 3.07, tibia length to width ratio 2.84.

Forewings with basal cell equal in length to discal cell, discal cell narrow.

Material examined was collected in Union Juarca, Chiapas, Aug. 11, 1950 (collected by Goodnight & Goodnight); and from Panama collected by R. Hyssey.

Oncylocotis annulipes (Champion 1898)

Type-locality.—Volcan de Chiriqui, Panama.

Length 4 mm. Sparsely covered with long setae. Body dull black with antennae, abdomen, and legs lighter color.

Posterior lobe of head convex with a weak transverse impression. Ocelli larger than *concolor.*

Intermediate lobe of pronotum with a deep median impression and lateral impressions on each side. Posterior lobe with rounded sides and shallowly emarginate posterior margin.

Forewing venation with long narrow basal cell and discal cell shorter.

Acknowledgments

The author would like to thank Dr. Lewis J. Stannard for his help while completing the study. The author also acknowledges the following individuals and institutions for the loan of specimens: Dr. Richard C. Froeschner, United States National Museum; Dr. P. A. Arnaud, California Academy of Science; Dr. Jerry Powell, University of California, Berkeley; and Dr. Thomas Moore, University of Michigan.

Most of this work was completed while the author was associated with the Department of Entomology, University of Illinois and the Illinois Natural History Survey.

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

(Trichoptera)

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In this paper I record 21 species of adult caddisflies collected along Sashin Creek and vicinity and describe their relative abundance and spatial distribution. Also, incidental observations on biology are recorded for several species. The collections were made intermittently from 1965 through 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). The annual range in volume of flow is about 0.2 to 20 m^3/s. This study was conducted in and near the stream between its mouth at tidewater and a 30-m falls about 1,200 m upstream. The stream water is generally cool, clear, and fast-moving, and the substrate is mostly gravel and rubble. Further details of the physical and biological setting are available in Ellis (1975).

Materials and Methods

Most of the collecting was done along the stream below the falls but some was done above the falls and at nearby lighted windows. I collected with an air net and by hand-picking with forceps at lights. A few species were collected only at lights. A gasoline lantern and white sheet were used at three sites below the falls — one close to tidewater, one about 300 m, and another about 500 m above tidewater. Lighted windows were visited at residences at the mouth of the stream (residence I) and about 300 m away along the shore of the estuary (residence II). None of the sampling was done on a regular time or area basis, but on most sampling days, collections were made from tidewater to falls. The following discussion and list of adult caddisflies from Sashin Creek are based on specimens collected along the stream below the falls with air net unless otherwise noted.

Seasonal Distribution and Abundance

On 48 days between 6 June and 4 October I made 206 collections which yielded 735 adult caddisflies. To compare seasonal occur-

The Pan-Pacific Entomologist 54:199-206. July 1978.

rence, it is assumed that timing and sequence of emergence of caddisflies are essentially the same from year to year in Sashin Creek and therefore all collections are combined from 1965 through 1972. The distribution of collecting by period (approximately a week) is summarized in Figure 2 together with periods of occurrence for each species. No collections were made between the first weeks of October and March which may explain the absence of *Glyphopsyche irrorata* and presence of only one specimen of *Psychoglypha subborealis*, both winter caddisflies common in the Juneau, Alaska area (Ellis, 1978).

Several species of caddisflies differed in abundance and length of occurrence and I have combined the collection data under six general categories (Table 1 and Fig. 2). The categories and species are:

1. Very abundant for several weeks:
   Ecclisocosmoecus scylla (330 specimens in 52 collections made on 31 days)
2. Abundant for several weeks:
   Onocosmoecus unicolor (83 specimens in 41 collections made on 23 days)
   Dicosmoecus atripes (88 specimens in 29 collections made on 18 days)
3. Very common for a few weeks:
   Ecclisomyia conspersa (56 specimens in 20 collections made on 9 days)
   Rhyacophila alberta (38 specimens in 24 collections made on 11 days)
   Lenarchus vastus (32 specimens in 23 collections made on 15 days)
4. Common for a few weeks:
   Lepidostoma roafi (19 specimens in 14 collections made on 10 days)
   Rhyacophila narvae (16 specimens in 12 collections made on 9 days)
   Polycentropus halidus (16 specimens in 13 collections made on 9 days)
5. Occasional over several weeks:
   Rhyacophila vaccua (5 specimens in 3 collections made on 3 days)
   Rhyacophila vao (10 specimens in 3 collections made on 3 days)
   Limnephilus harrimani (7 specimens in 6 collections made on 6 days)
   Limnephilus nogus (6 specimens in 6 collections made on 6 days)
   Limnephilus sitchensis (6 specimens in 5 collections made on 5 days)

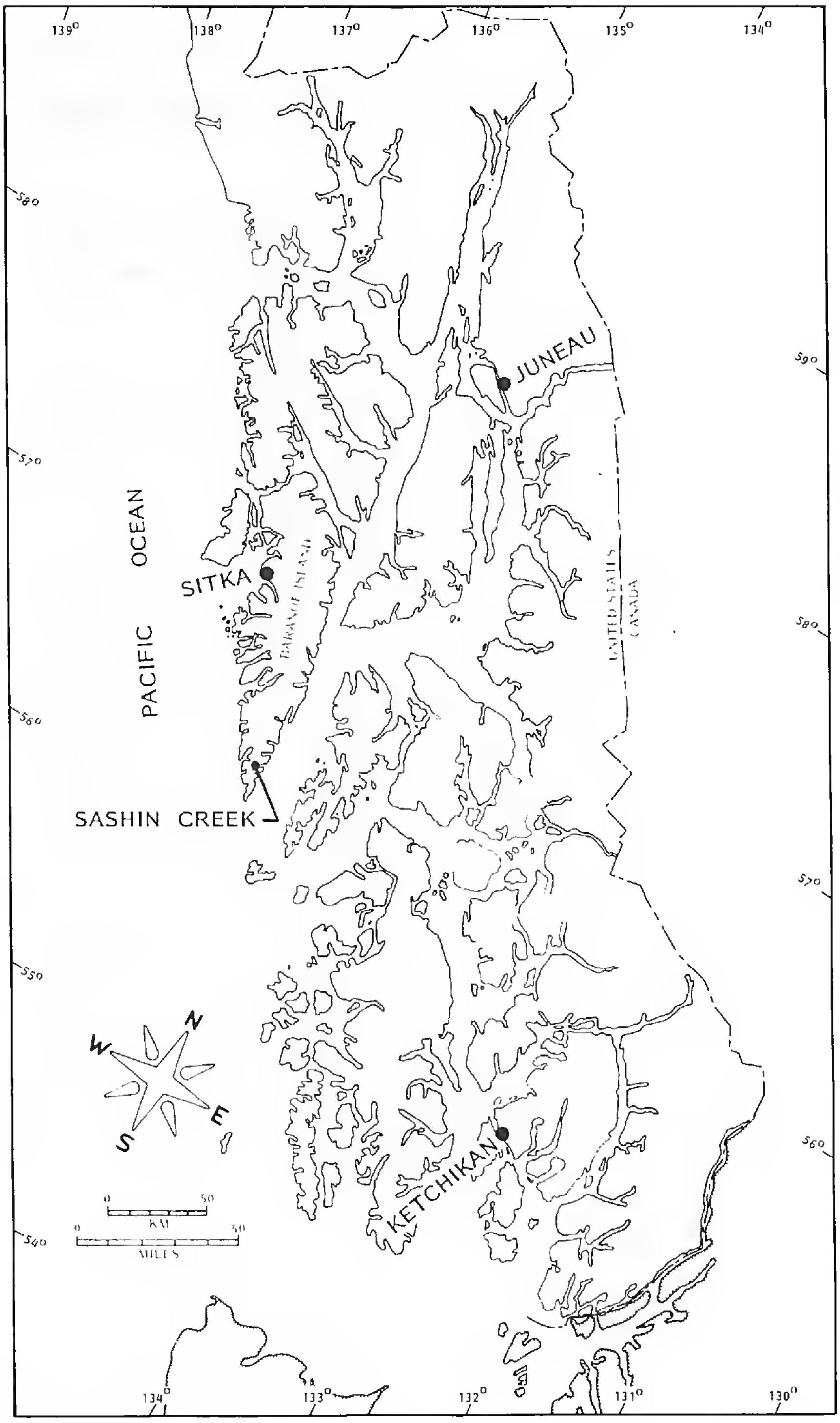

Fig. 1. Map showing location of Sashin Creek in southeastern Alaska.

6. Rare for up to a few weeks:
   Glossosoma penitum (2 specimens collected on 2 days)
   Rhyacophila rickeri (1 specimen)
   Rhyacophila grandis (1 specimen)
   Rhyacophila verrula (2 specimens collected on 2 days)
   Ptilostomis ocellifera (2 specimens collected on 2 days)
   Micrasema sp. (2 specimens in one collection)
   Parapsyche elsis (1 specimen)
   Chyranda centralis (1 specimen)

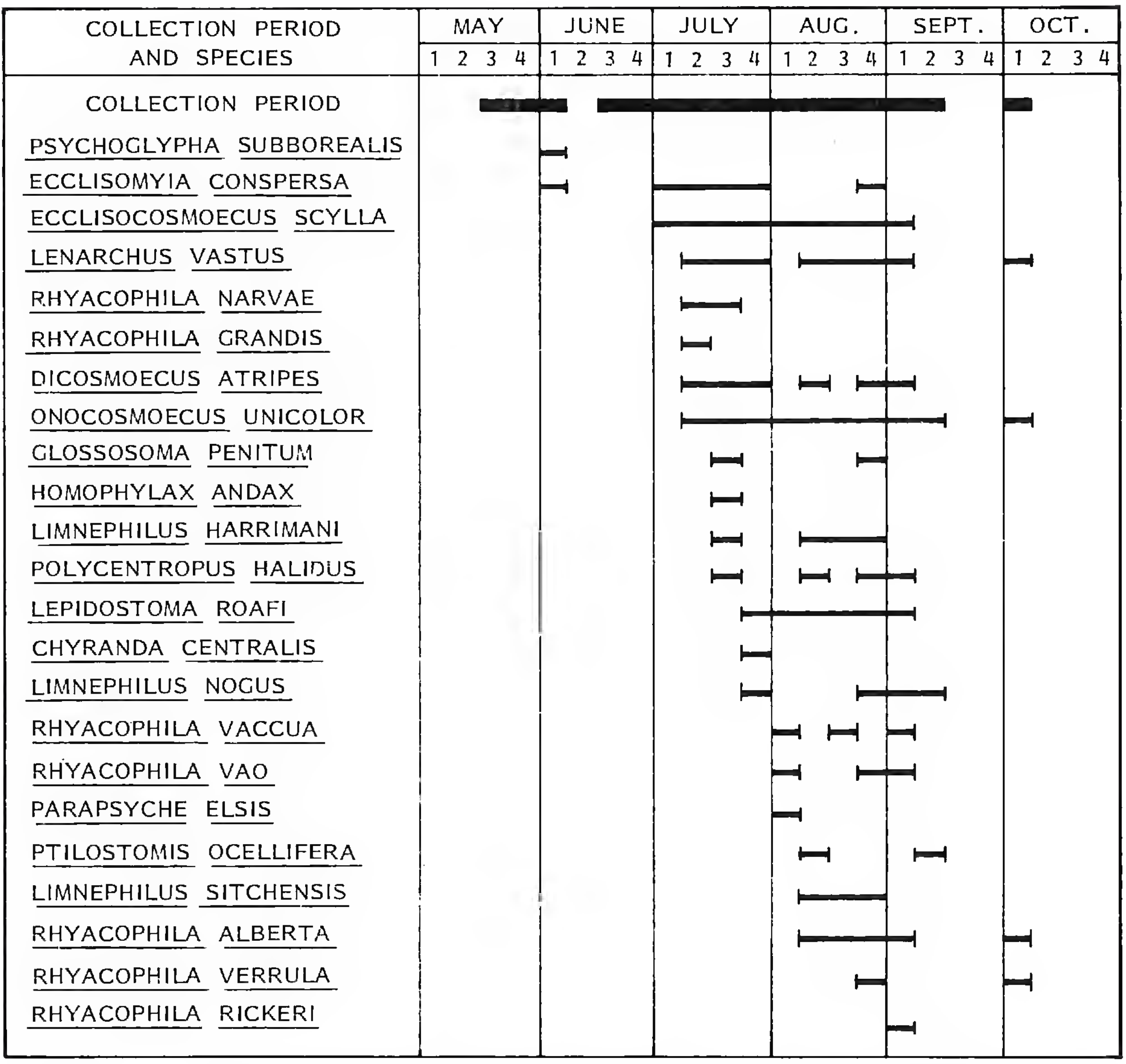

Fig. 2. Periods when collections of caddisflies were made in Sashin Creek 1965-72 (top line), and periods of occurrence of each species by week.

Homophylax andax (2 specimens in 1 collection)
Psychoglypha subborealis (1 specimen).

The main period of appearance of adult caddisflies in Sashin Creek is from mid to late summer (Fig. 2). The seasonal progression of species emerging and the long period of emergence (or long adult life) for some species make it likely that 8 to 12 species can be collected on any day from about 15 July to 7 September.

Identification of Material

The caddisflies of Alaska have not been treated as a unit and the descriptions are scattered in the literature. The basic reference work for the material reported here is Denning (1956). Dr. D.G. Denning either identified specimens or verified my identifications of all species reported here. Responsibility for correct identifications of all remaining material not seen by him is my own.

Table 1. Number of specimens, collections, and collection days for each species of adult caddisfly collected in Sashin Creek, 1965-72.

Family and species	Number of specimens		Number of collections	Number of collection days
	Males	Females		
Rhyacophilidae				
Rhyacophila alberta	36	2	24	11
Rhyacophila grandis	1	0	1	1
Rhyacophila narvae	13	3	12	9
Rhyacophila rickeri	1	0	1	1
Rhyacophila vaccua	5	0	3	3
Rhyacophila vao	8	2	6	3
Rhyacophila verrula	2	0	2	2
Rhyacophila spp.	0	14	9	9
Glossosomatidae				
Glossosoma penitum	2	0	2	2
Phryganeidae				
Ptilostomis ocellifera	0	2	2	2
Lepidostomatidae				
Lepidostoma roafi	19	0	14	10
Lepidostoma sp.	0	8	8	6
Brachycentridae				
Micrasema sp.	1	1	1	1
Polycentropodidae				
Polycentropus halidus	1	15	13	9
Hydropsychidae				
Parapsyche elsis	0	1	1	1
Limnephilidae				
Chyranda centralis	1	0	1	1
Dicosmoecus atripes	71	17	29	18
Ecclisomyia conspersa	47	9	20	9
Ecclisocosmoecus scylla	295	35	52	31
Homophylax andax	2	0	1	1
Lenarchus vastus	10	22	23	15
Limnephilus harrimani	7	0	6	6
Limnephilus nogus	1	5	5	5
Limnephilus sitchensis	1	5	5	5
Onocosmoecus unicolor	47	36	41	23
Psychoglypha subborealis	0	1	1	1

Collection Data

RHYACOPHILIDAE.—Seven species of *Rhyacophila* were found — one was very common *(R. narvae)*, one was common *(R. alberta)*, and the rest were occasional or rare.

Rhyacophila alberta Banks.—Most abundant rhyacophilid. Thirty-six males, two females, August to September, in 24 collections on 11 days. Above and below falls, air net and light.

Rhyacophila grandis Banks.—One male. Captured at light at residence II on 12 July.

Rhyacophila narvae Navás.—Thirteen males, seven females, in 12 collections on nine days, 11 July to 30 August, above and below the falls.

Rhyacophila rickeri Ross.—One male. Captured above the falls on 1 September.

Rhyacophila vaccua Milne.—Five males, no females, in three collections on three days, 1 August to 1 September, above and below the falls.

Rhyacophila vao Milne.—Eight males, two females, in six collections on three days, 1 August to 1 September, above and below the falls.

Rhyacophila verrula Milne.—Two males, no females in two collections on two days, 29 August and 4 October.

Rhyacophila spp.—Fourteen females, in nine collections on nine days, 19 July to 2 September.

GLOSSOSOMATIDAE.—A single species, *Glossosoma penitum* Banks. Two males in two collections, 19 July and 27 August, above and below the falls.

PHRYGANEIDAE.—A single species, *Ptilostomis ocellifera* (Walker). Two females in two collections on 9 and 13 August. Both collections at light. One female contained 50 eggs.

LEPIDOSTOMATIDAE.—A single species was identified, *Lepidostoma roafi* (Milne). Nineteen males, no females in 14 collections made on 10 days, 24 July to 1 September. Eight females in eight collections are referred to as *Lepidostoma* sp.

BRACHYCENTRIDAE.—A single species, *Micrasema* sp. (bactro group). One male and one female in one collection, 15 July.

POLYCENTROPODIDAE.—A single species, *Polycentropus halidus* Milne. One male, 15 females in 13 collections from lights and air net on nine days, 15 July to 2 September.

HYDROPSYCHIDAE.—A single species, *Parapsyche elsis* Milne. One female above falls, 1 August.

LIMNEPHILIDAE.—The limnephilids were the dominant caddisflies in the study area both in total numbers (over 75% of all specimens) and in number of species (11, or about 45% of the number of species collected). The four most abundant species were *Ecclisocosmoecus scylla, Dicosmoecus atripes, Ecclisomyia conspersa,* and *Onocosmoecus unicolor.*

Chyranda centralis (Banks).—One male, 29 July.

Dicosmoecus atripes (Hagen).—Seventy-one males, 17 females, 11 July to 2 September, air net and lights (including residence I). The second most abundant species in this study. The larvae of this large limnephilid were conspicuous in the stream; they are often eaten by the water ouzel as evidenced by the abundant empty cases on the near-water sites frequented by this bird.

Ecclisomyia conspersa (Banks). — Forty-seven males, nine females in 20 collections on nine days from 6 June to 30 August, above and below the falls, air net and light. The fourth most abundant species in this study.

Ecclisocosmoecus scylla (Milne).—Two hundred ninety-five males, 35 females in 52 collections on 31 days from 2 July to 2 September, above and below the falls. This was the most abundant species in the study area and was abundant in both air net and light collections.

Homophylax andax (Ross). — Two males in one collection from a light on 15 July.

Lenarchus vastus (Hagen).—Ten males, 22 females in 23 collections on 15 days from 10 July to 5 October. Although most collections were from lighted windows at residence II, three collections were made with air net along the Creek — one above the falls and two below.

Limnephilus harrimani (Banks). — Seven males in six collections, 18 July to 27 August. The type locality of this species is in Alaska.

Limnephilus nogus (Ross). — One male, five females in five collections, 30 July to 1 September. Collections made only at mouth of Sashin Creek with air net (one collection) and at lights at residence II. Perhaps larvae do not live in Sashin Creek.

Limnephilus sitchensis (Kolenati).—One male, five females in five collections on five days from 9 August to 24 August, air net and light. The females have not been illustrated but the wing patterns of males and females are similar. Type locality is in Alaska.

Onocosmoecus unicolor (Banks).—Forty-seven males, 36 females in 41 collections on 23 days from 11 July to 4 October. Below falls only, air net and lights (including residence I). The third most abundant species in the study area.

Psychoglypha subborealis (Banks).—One female on 6 June, below falls. This is a winter species usually collected only from fall to spring (October to May in southeastern Alaska). Type locality is in Alaska.

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SCIENTIFIC NOTE

***Goniopsita oophaga* (Diptera: Chloropidae) A Predator of Grasshopper Eggs.** — At the time of its description *Goniopsita oophaga* Sabrosky was associated as an egg predator of *Melanoplus sanguinipes* (Fabricius) and its possible economic significance was pointed out (Sabrosky, 1967. J. Kansas Entomol. Soc., 40:151-156). Information presented herein extends the host range of *G. oophaga* to include a slant-faced grasshopper, *Chloealtis aspasma* Rehn and Hebard and covers the frequency and extent of predation on that host.

During 1972 and 1973 numerous ovipositional sites of *C. aspasma* were noted in dead, pithy stems of elderberry, *Sambucus* sp. Oviposition was also induced using stick traps cut from elderberry (Foster, 1974. Pan-Pacific Entomol., 50:207-208). During both years numerous fly larvae were observed infesting egg pods of *C. aspasma*. Egg pods returned to the insectary during May, 1973 yielded larvae from which *G. oophaga* adults were reared.

Predation data from the total of 204 *C. aspasma* egg pods examined during the study are tabulated below. Of these, 138 (68 percent) were infested with *G. oophaga* larvae and pupae. Substantial egg mortality due to the chloropid is further indicated by comparing the average number of eggs destroyed per infested pod (7.1) with the observed average oviposition rate of *C. aspasma* (7.9). Egg counts of the 204 pods revealed 1,621 grasshopper eggs, of which 981 (60.5 percent) were destroyed by *G. oophaga* larvae.

Present knowledge of the life history of *G. oophaga* is fragmentary. The presence of two dead females entrapped on the surface of the recessed plugs of two egg pods indicates that females may oviposit in the immediate vicinity of the egg pod cap. Although the grasshopper's ovipositional period extends from mid-July through August, there is no evidence that more than one generation of the chloropid develops per year on this host.

All specimens taken during this study were collected 16 mi. northeast of Ashland, Jackson County, Oregon.

I wish to thank Drs. Ashley B. Gurney and Curtis W. Sabrosky, both of the Systematic Entomology Laboratory, USDA, Washington, D.C., for their respective identifications of *C. aspasma* and *G. oophaga*, and Dr. W.F. Barr, University of Idaho, who provided laboratory space and helped with certain aspects of the field work. — **David E. Foster,** *Department of Entomology and The Museum, Texas Tech University, Lubbock, Texas 79409.*

Egg Pod Data	Total Number	Percent	Average Number/Pod	Range
Egg pods examined	204	----	----	----
C. aspasma eggs	1621	----	7.9	4-8
Egg pods infested	138	68	----	----
G. oophaga larvae and pupae	575	----	2.3	1-10
Number eggs destroyed	981	60.5	----	----
Number eggs destroyed/fly	----	----	1.7	1-4
Number eggs destroyed/infested pod	----	----	7.1	0-8

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A New Species of *Graptocorixa* from Mexico

(Heteroptera, Corixidae)

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When identifying miscellaneous Mexican Corixidae I found a species of *Graptocorixa* which did not agree with any of the descriptions in Hungerford (1948). This new species is described herein and compared to other species of the genus.

Graptocorixa breweri, new species

Size: Length 7.5-8.5 mm, width across head 2.3-2.7 mm.

Color: General facies medium to dark brown, head and legs yellow, mesosternum and metasternum smoky to black. Abdominal venter smoky to black in males, yellowish in females. Pronotum crossed by 8-10 dark bands which are anteriorly broader but posteriorly narrower than the yellow bands. Transverse yellow bands of hemelytra generally regular, but somewhat broken in the middle of corium.

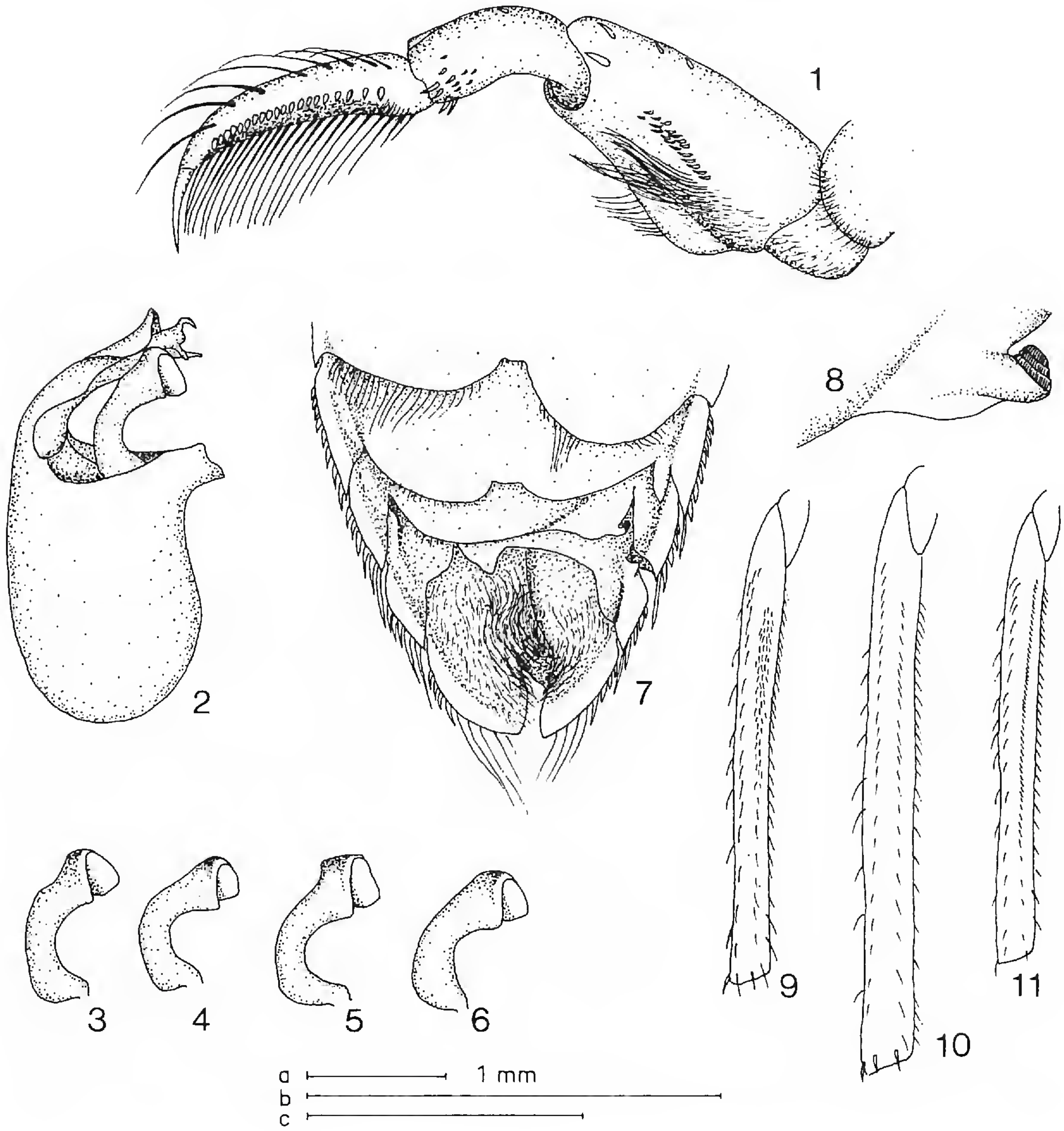
Structural characteristics: Face not reduced, frontal depression of male shallow and broad, slightly hairy; face of female also slightly hairy. Infraocular portions of genae broad as seen in cephalic view. Rear margins of eyes slightly concave. Prothoracic lobe elongate. The lower basal angle of fore femur conspicuously produced and anteriorly covered by a patch of long hairs in male, somewhat produced and with a few hairs in female. The pala of male as in Fig. 1, possessing about 20 pegs. Length of middle leg femur : tibia : tarsus : claw = 100 : 32 : 29 : 27. Length of hind leg femur : tibia : tarsus 1 : tarsus 2 = 100 : 98 : 120 : 41. Metaxyphus slightly longer than broad. The male genital capsule as in Fig. 2, with Figs. 3-6 showing variation in shape of the right paramere (= clasper). Male abdominal dorsum with a posteriorly pointing fingerlike projection near to the right margin of the fifth tergite, and a small dorsolaterally pointing projection at outer base of the right penultimate lobe (= seventh tergite) (Fig. 7). Strigil minute, with three combs (Fig. 8).

In Hungerford's (1948) key for identification of *Graptocorixa* species *G. breweri* ends up near *G. serrulata* (Uhler) and *G. gerhardi* (Hungerford). Clear differences between the three species appear in both sexes in arrangement of caudo-ventral pegs of middle femora: *G. breweri* has a multiple row of small pegs (Fig. 9), while *G. gerhardi* has a single row of rather slender, basally almost hair-like pegs (Fig. 10) and *G. serrulata* a closely set row of small but sturdy pegs (Fig. 11). In males clear differences also appear in shape of the right paramere, and only males of *G. breweri* have a patch of long hairs on fore femora. Further, while males of *G. breweri* have both the fingerlike projection on the fifth abdominal tergite and the small projection at the base of the right penultimate lobe, males of *G. gerhardi* have only the former and males of *G. serrulata* only the latter.

Etymology: The species is named simply according to the collector of the specimens that first caught my attention.

Holotype (male): Mexico, Zacatecas, 25 mi. W. Fresnillo, Laguna Balderama, 7900 ft., 23.VI.1954, R.H. Brewer. Deposited in the col-

The Pan-Pacific Entomologist 54:207-209. July 1978.



Figs. 1-9: *Graptocorixa breweri.* Fig. 1. Front leg of male. Fig. 2. Genital capsule of male. Figs. 3-6. Variation in shape of the right paramere. Figs. 3-4. Zacatecas. Fig. 5. Michoacan. Fig. 6. Hidalgo. Fig. 7. Dorsal view of male abdomen. Fig. 8. Strigil. Fig. 9. Middle femur of female. Fig. 10. *G. gerhardi*, middle femur of female. Fig. 11. *G. serrulata*, middle femur of female. — Scale lines (1 mm) apply as follows: a = Figs. 7 and 9-11, b = Fig. 8, c = Figs. 1-6.

lections of the California Academy of Sciences.

Paratypes: 6♂♂ and 5♀♀, same data as the holotype (deposited in the collections of the California Academy of Sciences and Zoological Museum, University of Helsinki); 1♂ and 3♀♀, otherwise same data as the holotype, but collected on 21.VI.1954 (Calif. Acad. Sci. collections).

Data on distribution: Besides the type series, I have seen the following: 1♀, Mexico, Zacatecas, 45 mi W Fresnillo, 7700 ft., 25.VI.1954, R.H. Brewer (Calif. Acad. Sci.); 3♂♂ and 2♀♀, Mexico, Zacatecas, 10 mi NW of Sombarete, 7700 ft., 1.VII.1954, R.H. Brewer (Calif. Acad. Sci. and Univ. Helsinki); 2♀♀, Mexico, Durango, 35 mi SW El Salto, 8400 ft., 23.VII.1953, Univ. Kansas Mexican Expedition, Slesnick Field No. 73 (Snow Entomological Museum, Univ. Kansas); 2♂♂ and 1♀ Mexico, Hidalgo, Tasquillo, 23.VI.1955, R.E. Beer & party (Univ. Kansas); 1♀, Mexico, Michoacan, Morelia, 4.IX.1938, H.D. Thomas (Univ. Kansas), and 1♂, Mexico, Michoacan, 15 mi S of Carapan, 7.XII.1948, H.B. Leech collector (Calif. Acad. Sci.).

In general, *G. breweri* seems to be restricted to the central highlands of Mexico, and is probably rather common in this area. In the various collections it might have been overlooked as *G. gerhardi*, because the two have rather similar general appearance.

Acknowledgements

I am indebted to the following for loan of material: Dr. D.C. Rentz (California Academy of Sciences) and Dr. P.D. Ashlock (University of Kansas).

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Corrections of Homonyms in *Conotrachelus*, and a Species List for *Pheloconus*

(Coleoptera: Curculionidae)

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In preparation for renewed studies in New World Coleoptera, the following necessary changes have come to my attention.

Conotrachelus Schönherr

aculeatus Papp, **new name** for *hirsutus* Fiedler 1940:108 (not Montrouzier 1860:893) from Bolivia. Type in the Kraatz collection, Deutsches Entomologisches Institut, Berlin.

carli Papp, **new name** for *humeridens* Fiedler 1943:14, and 15-16 (not Hustache 1940:124) from Brazil. Type in the Chevrolat Collection, Museum Stockholm. In honor of the late Dr. Carl Fiedler.

exoptorostris Papp, **new name** for *longirostris* Bondar 1945:327 (not Champion 1904:354) from Brazil. Type in the Bondar collection, American Museum of Natural History, New York.

inquinoflavus Papp, **new name** for *griseoflavus* Fiedler 1943:26, and 28-29 (not Fiedler 1940: 329) from Colombia. Type in the Chevrolat collection, Museum Stockholm.

nigrivallus Papp, **new name** for *quadraticollis* Fiedler 1954:131, and 136-137 (not Fiedler 1940:348-349, and 358) from Brazil. Type in the Sahlberg collection, Museum Stockholm.

pallidus Papp, **new name** for *albosignatus* Bondar 1945:321 (not Champion 1904:359) from Brazil. Type in the American Museum of Natural History, New York.

paranus Papp, **new name** for *tuberosus* Fiedler 1940:244, and 266 (not LeConte 1876:233) from Brazil and Colombia. Type in the British Museum (Natural History), London.

quaestosus Papp, **new name** for *pallidirostris* Fiedler 1943:45, and 56-57 (not Fiedler 1940: 154,161-162) from Cayenne. Type in the Chevrolat collection, Museum Stockholm.

schoofi Papp, **new name** for *tibialis* Schoof 1942:91-94 (not Hustache 1939:101; not Fiedler 1940:35, and 48) from Mississippi, Iowa, Illinois, Kansas, Louisiana, Massachusetts, Missouri, West Virginia. Holotype (male, No. 54310) and Allotype (female) in the United States National Museum, Washington, D.C.

secernosus Papp, **new name** for *divisus* Fiedler 1954:131, and 136 (not Champion 1904:401) from Brazil. Type in the Kraatz collection, Deutsches Entomologisches Institut, Berlin.

variabilis Papp, **new name** for *variolosus* Fiedler 1943:15, and 25 (not Hustache 1939:99) from Brazil. Type in the Chevrolat collection, Museum Stockholm.

vorruptus Papp, **new name** for *interruptus* Fiedler 1943:28, and 42-43 (not Pascoe 1889:330) from Cayenne. Type and paratypes in the British Museum (Natural History), London, additional paratypes in Museum Dresden.

In 1948, when I completed my papers on Cryptorhynchini (Papp: 1950 and 1951) I was unaware of the publication of Blackwelder's Checklist, Part 5 (1947), where adjustments were made for, among

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others, one of Fiedler's names, which I had also corrected. The correct citation should now be:

repetitio Blackwelder 1947:853 for *lutulentus* Fiedler 1940:358 (not Fiedler 1940: 86, and 92) from Brazil (type in the Faust collection, Museum Dresden).
syn.: *fiedleri* Papp 1951:484 (not Bondar 1944:195).

Pheloconus Roelofs

Hustache (1936:38) regarded *Phelocomus* as an independent genus very closely related to *Conotrachelus*. Species shuffling between the two genera is recorded in the bibliographical data by Hustache (1936). Working with Fiedler's types (Papp 1950, and 1951) and evaluating Fiedler's argument (1940:6, and 15; 1943: 4-5, this paper sometimes erroneously cited as 1944) on the validity of the generic concept, we (Papp and Varga, 1951) came to the conclusion that despite the morphologically slight differences in generic characters, the genus *Pheloconus* Roelofs should be recognized. Fiedler's final position was later clearly reflected in his writing (Fiedler 1954) and attempts to break up the genus *Conotrachelus*.

There is considerable confusion as far as the type of the genus is concerned. Roelofs selected *pilosellus* Boheman (1845) as genotype, a species known in *Conotrachelus*. Then Champion made a statement (1904:419) "I have seen the types of *C. rubicundulus* and *C. pilosellus*, Boh., the former being abraded and the latter densely squamose." On this basis then *pilosellus* became a synonym of *rubicundulus*, as recorded by Champion (1904:418), and Hustache (1936:38).

The following list of species includes three species from North America, north of Mexico. Their inclusion in the genus is based solely on description, as mentioned by Fiedler (1940:15; *hispidus* LeConte mispelled "hispidulus". Not identical with *hispidulus* Hustache 1924:184). To assist further study of the individual species of the Neotropical region the location of the type specimens are mentioned.

Roelofs, Ann. Soc. Entomol. Belg., 18, 1875:193. — Fiedler, Monograph. London 1940:6. — Papp and Varga, Portug. Acta. Biol., (B), 3(3), 1951:8. — Fiedler, Neue Südamer. Rüsselk., Jena 1954:138.

aequalis Fiedler, Monograph 1940:8, and 12 *(Conotrachelus)*. Type in the British Museum (Nat. Hist.). *New combination.*	Brazil
albifrons Fiedler, Neue Südamer. Rüsselk., Jena 1954:91, and 93. Type in the Kraatz collection, Deut. Entom. Inst., Berlin.	Paraguay
albomaculatus Fiedler, Monograph 1940:7, and 8-9 *(Conotrachelus)*. Type in the Kraatz collection, Deut. Entom. Inst., Berlin. *New combination.*	Brazil
ambiguus Faust, Stett. Ent. Zeit., 54,1893:361. Type in the Faust collection, Museum Dresden. *New combination.*	Venezuela

atrofasciatus Fiedler, Neue Südamer. Rüsselk., Jena 1954:90, and 91. Type in Museum Hamburg.	Brazil
cretatus Fiedler, Monograph 1940:7-8, and 11-12 (*Conotrachelus*). Type and paratype in British Museum (Nat. Hist.). *New combination.*	Brazil
cribricollis Say, Descr. Curc. North Amer., 1831:28 (*Cryptorhynchus*). Proposed by Fiedler 1940: 15.	Eastern half of USA.
fasciolatus Kirsch, Abhandlg. Zool. Mus. Dresden (4), 1889:33 (*Conotrachelus*). Type in Museum Dresden. *New combination.*	Ecuador
flavicans Fiedler, 1940:8, and 12-13 (*Conotrachelus*). Type in Museum Stettin. *New combination.*	Brazil
flavosparsus Fiedler, Neue Südamer. Rüsselk., Jena 1954:138, and 140. Type in Museum Stockholm.	Brazil
glabriventris Champion, Biol. Centr.-Amer., Col. 4, 1904:356. Type in the British Museum (Nat. Hist.). Proposed by Fiedler 1940: 15.	Panama
hispidus LeConte, Proc. Amer. Philos. Soc., 15,1876:235 (*Conotrachelus*). Champion (1904:419) and Fiedler (1940:15) indicates that this species probably synonym to *rubicundulus* Boheman (1837:447) with distribution from Mexico to Argentina.	Georgia
hystricosus Champion, Biol. Centr.-Amer., Col. 4, 1904:419 (*Conotrachelus*). Type in the British Museum (Nat. Hist.). Proposed by Fiedler, 1904:15.	Panama
infector Boheman, in Schönherr, Gen. Spec. Curc. 8(2), (*Conotrachelus*). Type in Museum Stockholm. Proposed by Fiedler, 1940:15.	New York, Pennsylvania, Indiana
lividipes Fiedler, Neue Südamer. Rüsselk., Jena 1954:138, and 141-142. Type in Museum Stockholm.	Brazil
longirostris Fiedler, op. cit., 1954:91, and 93. Type in Museum Hamburg.	Brazil
luticollis Fiedler, op. cit., 1954:138, and 142. Type in Museum Stockholm.	Brazil
moestus Fiedler, op. cit., 1954:138, and 142. Type in Museum Stockholm.	Brazil
nebulosus Fiedler, Monograph 1940:8, and 13-14 (*Conotrachelus*). Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin. *New combination.*	Bolivia, Peru
nudoscutellatus Fiedler, Neue Südamer. Rüsselk., Jena, 1954:138, and 139. Type in the Paris Museum.	Venezuela
nubiferus Fiedler, op. cit., 1954:90, and 92. Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin.	Brazil
olivaceus Fiedler, op. cit., 1954:91, and 93-94. Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin.	Bolivia
orchestoides Fiedler, Monograph 1940:7, and 11 (*Conotrachelus*). Type and paratypes in the British Museum (Nat. Hist.). *New combination.*	Brazil
pallidus Faust, Stett. Ent. Zeit. 54, 1893:361 (*Conotrachelus*). Type in Museum Dresden. *New combination.*	Panama, Colombia, Brazil
pallisteri Kissinger, Amer. Mus. Novit., 1962:15-18. Types in the Amer. Mus. Nat. Hist., New York. *New combination.*	Mexico
plagiatus Fiedler, Neue Südamer. Rüsselk., Jena 1954: 138-139. Type in Museum Stockholm.	Brazil
propinquus Fiedler, Monograph 1940:7, and 9 (*Conotrachelus*). Type in the Kraatz collection, Duetsch. Ent. Inst., Berlin. *New combination.*	Brazil
rubicundulus Boheman, in Schönherr, Gen. Spec. Curc. 4 (1), 1837:447 (*Conotrachelus*). Type in Museum Stockholm.	Mexico to Argentina
subcarinatus Fiedler, Neue Südamer, Rüsselk., Jena 1954:90, 91 and 92. Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin.	Brazil

subtriangularis Fiedler, op. cit., 1954:138, and 141. Type in Museum Stockholm.	Brazil
sylvius Boheman, in Schönherr, Gen. Spec. Curc. 8(2), 1845:51. Type in Museum Stockholm. *New combination.*	Guiana
tricinctus Fiedler, Neue Südamer. Rüsselk., Jena 1954: 90, and 92. Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin.	Bolivia
tricolor Fiedler, op. cit., 1954:138, and 139-140. Type In Museum Stockholm.	Chile
variegatus Boheman, Eugen. Resa 1859:143 *(Conotrachelus).* Type in Museum Stockholm. *New combination.*	Brazil
versicolor Fiedler, Monograph 1940:8, and 14-15 *(Conotrachelus).* Type in the Kraatz collection, Deutsch. Ent. Inst., Berlin. *New combination.*	Peru

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RECENT LITERATURE

The following Occasional Papers in Entomology has recently appeared, and is available free, upon request.

No. 27. The Clearwing Moths of California (Lepidoptera: Sesiidae), W. Donald Duckworth and Thomas D. Eichlin, 90 pp.

Write to: Library Chairman, Insect Taxonomy Laboratory, 1220 N St., Sacramento, CA 95814.

Notes on Male Mate-Locating Behavior in Some Bees and Wasps of Arizona

(Hymenoptera: Anthophoridae, Pompilidae, Sphecidae, Vespidae)

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Relatively little is known about the reproductive behavior of male bees and wasps. Yet even from the limited data available it is clear that the diversity of mate-locating strategies exhibited by males of these groups is impressive (Alcock et al., in press). Through comparative studies it may be possible to determine why so many different kinds of mating adaptations have evolved in the Hymenoptera. This paper provides brief descriptions of male behavior in five species of bees and wasps for use in future analyses of the relation between the reproductive behavior and ecology of these insects.

The research was done at three study sites in southeastern Arizona. Study site 1: A flat plain about 1 km north on the road to San Simon near Portal, Arizona (Cochise County) at an elevation of about 1600 m. The area was covered with a relatively dense stand of creosote bush. For a full description of the flora in this region see Linsley and Cazier (1972). Study site 2: A dry stock tank 1 km to the north of Study site 1. The floor of the tank was partly covered with a flowering shrub, *Baccharis* sp., which was attracting many Hymenoptera. The earthen bank of the stock tank had a sparse cover of shrubs and gourds. Study site 3: A ridge in the Chiricahua Mountains 2 km to the south of Portal, Arizona at an elevation of about 2100 m. Peaks along this ridge supported scattered shrubs and small pines.

Some individuals of all the species studied were captured and given distinctive color marks of acrylic or enamel paints on the dorsum of the thorax. Records were then made of the activities of known individuals. A stop watch was used to time the duration of flights from perches or along patrol routes.

Voucher specimens of the undescribed species have been placed in the entomology collection at Arizona State University.

Results

Triepeolus n. sp. (in manuscript) (det. by Paul D. Hurd, Jr.)

Males of this parasitic anthophorid bee were observed at study site 1 from 3-15 August 1977. Individuals patrolled regular routes through creosote bush stands from 0730-1330. They flew rapidly, briefly visiting bushes that were an average of 8.1 m apart (N = 19; range = 4.8 - 24

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m). Upon reaching a creosote station on its route a male would usually slow somewhat and spend 1-3 sec circling over a portion of the bush, almost always ½-1 m above the ground, before flying on to the next inspection point. On three occasions, all between 0815-0845, a male alighted on creosote leaves on what proved to be a regularly visited station and walked quickly over the foliage in a small area (probably applying a pheromone in the process). If this was pheromone-marking behavior, one brief (less than 5 sec) application lasted for at least one morning.

The routes of males must have been roughly circular because recognizable individuals always appeared at a station moving in the same direction. The interval between visits to the same station averaged 8.3 min (n = 20, Male "White"), 8.3 min (n = 7, Male "Pink"), 9.3 min (n = 7, unmarked male), 12.0 min (n = 9, Male "Red-White"), and 9.8 min (n = 16, unmarked male). I estimated conservatively that a male required 5 sec to travel 10 m and to inspect one station. Assuming this rate of travel and taking the minimum time between two visits to a bush as the time needed to fly around the entire route, these five males covered patrol routes with a circumference of at least 450-600 m. Because of the difficulty of following the rapid, low-flying males through the creosote stand, I was never able to trace the path of a male for more than 80 m.

Some males followed all or a portion of the same route over a period of days with White, Pink and Red-White seen at one of their stations on two consecutive days. Pink visited the same inspection point on 4-6 and 8 August.

There was substantial overlap in routes travelled by different males. On numerous occasions two males were seen at the same station, sometimes almost simultaneously. Three marked males were seen at one bush on 5 August. Often males arrived at an inspection site from different directions but some individuals followed the same routes for at least four inspection points.

The behavior of this species of *Triepeolus* resembles the behavior of those male bumblebees that mark vegetation at intervals along a "trapline" which they patrol (Free and Butler, 1959; Kullenberg et al., 1973). Bumblebee females wait at an inspection point and copulate with a male that finds them. This is probably true for this *Triepeolus* as well. I collected conspecific females foraging at creosote bushes and crushed their thoraxes. The immobilized individuals were placed on the foliage at stations visited by males. Some specimens elicited no response but on six occasions, a male located the female (usually after circling slowly in and around the portion of the creosote bush on which she had been placed) and attempted copulation. When a male landed on a female's back, he quickly oriented himself so that his head was above the female's head. He then stroked the female with his legs and antennae, while his abdomen rhythmically tapped the female's abdomen and his wings whirred in synchrony with the rapid stroking and tapping movements. This pattern is similar to that of the anthophorid *Centris pallida* Fox (Alcock et al., 1977) and the oxaeid *Protoxaea gloriosa* (Fox) (Alcock, pers. observations).

The slow circling flight of males as they zeroed in on a female indicated that they may initially use an odor cue to detect a female that has landed at a station. Additional evidence for this possibility comes from four observations of males circling and hovering for over 5 sec in the vicinity of creosote leaves from which a female specimen had recently been removed. In one case, a male actually alighted on leaves from which a female specimen had been removed some minutes previously.

Nomada n. sp. (det. by R. R. Snelling)

This is an undescribed species near *N. gutierreziae* which was observed at study site 2 between 3-7 August 1975. Males of this anthophorid bee also appear to have a patrol route many meters in length with stations that they visit and mark. Tengo and Bergstrom (1977) report that males of some European species of *Nomada* follow patrol routes used by males of the host species parasitized by their females. I located a single station at the top of an earthen bank of a stock tank in an area with cucurbit gourd ground cover and a few stalks of grass about 15-25 cm high. A male that visited the site would circle slowly in the vicinity of two grass stalks about 1 m apart before flying to and alighting upon one or the other of these plants. It then walked quickly up the stem and along the curving blade of the grass with its abdomen and head held close to the substrate (Fig. 1). After walking a distance of about 10 cm it would fly off so quickly that I was unable to follow the male to any other station. Tengo and Bergstrom (1977) do not mention marking of vegetation by European *Nomada* although they did find that males applied chemical substances to the backs of females during copulation. These odors mimic those of the species of *Andrena* parasitized by the female *Nomada* and may permit the female to gain access to a host nest more easily. The behavior of

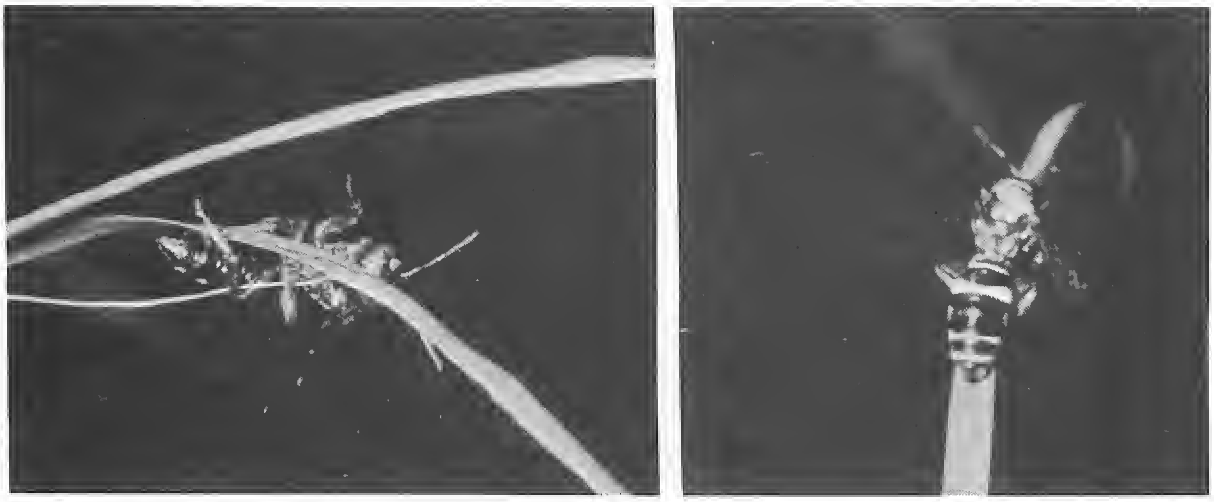

Fig. 1. Two views of a male of an undescribed species of *Nomada* walking along grass blades that were visited repeatedly by this and other males.

males of European *Nomada* may be derived from marking substrate with an odor similar to an *Andrena* host in order to lure a female to a site where she might be found and induced to copulate.

The two grasses were visited primarily by one male "Orange" that returned to the station at an average interval of 181 sec on 5 August (N = 10; 0840-0925; range, 90-445 sec) and 242 sec on 6 August (N = 11; 1015-1100; range, 70-355 sec). On its first visit of the day on 5 August it marked both grass stems four or five times and remained in the area for several minutes. Thereafter it marked one grass stem once or twice and left after less than 30 sec. Although Orange was the primary visitor, other males were seen at the site on three of the five mornings of the study. When Orange was collected a new male became a regular visitor on the following day. Thus as in *Triepeolus* and the trap-line visiting bumblebees, more than a single individual may come to the same station(s).

Philanthus gibbosus (Fabricius) (det. by H. E. Evans)

Males of this sphecid wasp were observed at study site 2 from 2-8 August 1975. The behavior of male *Philanthus* has been reported in some detail for a number of species (Simon Thomas and Poorter, 1972; Alcock, 1975 a, b; Evans 1975). Although Evans (1973) found that males of *P. gibbosus* spend the night in nests occupied by their sisters, he did not discuss male reproductive behavior. I found 2-4 males of this species on each day between 2-8 August at a cluster of yucca stalks on the earthen bank of the stock tank. Individuals perched at heights of 2-2½ m on dried branches or twigs (Fig. 2) and were separated by about 1½-3 m. The wasps regularly flew out from their perches (usually 2-3 times per min) for an average flight of 5.6

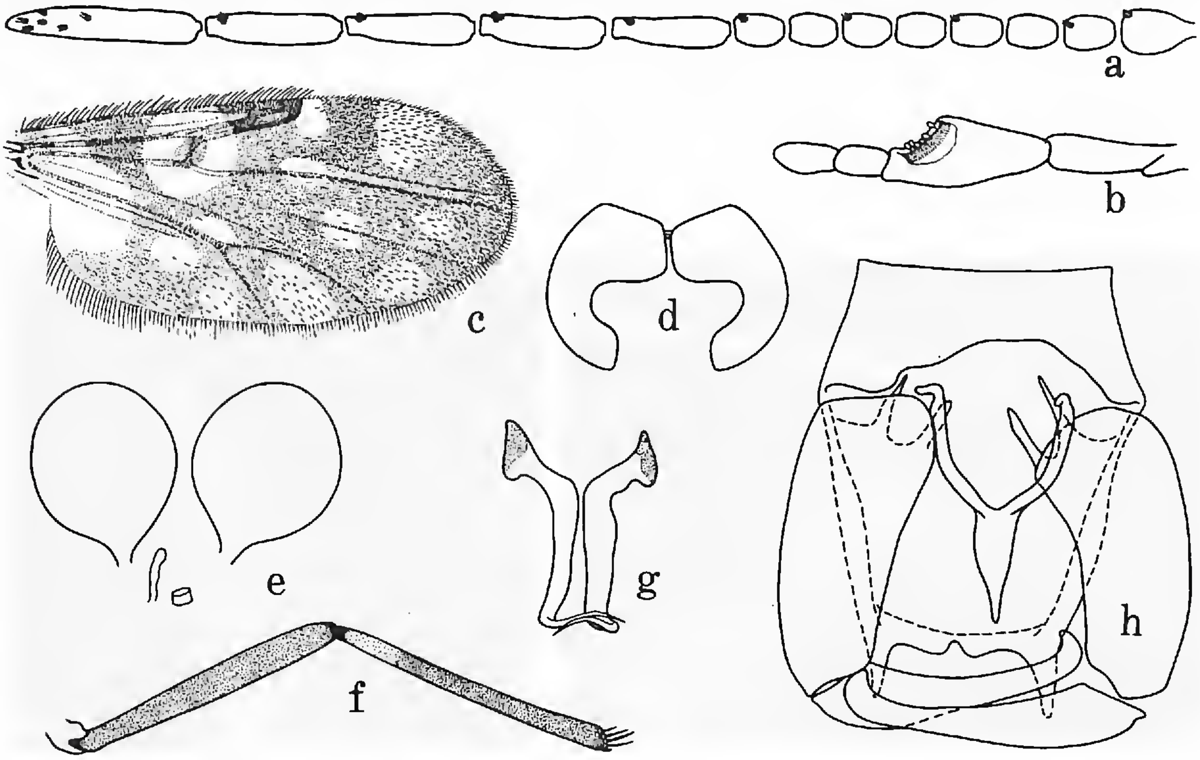

Fig. 2. A male of *Philanthus gibbosus* at its territorial perch on a yucca stem.

sec (N = 54; range 1-25 sec) before returning. Upon landing the male was likely to pump his abdomen up and down while standing on the perch or walk along the stem dragging the venter of his abdomen on the substrate for several cm (see Fig. 7, Alcock, 1975a). This behavior may be associated with the deposition of a sex pheromone (Alcock, 1975a) although during approximately 14 hr of observation no copulating pairs nor any females appeared in the vicinity of the perches. Perch owners did attract other male "visitors" (Simon Thomas and Poorter, 1972; Alcock 1975 b). The resident male flew off his perch at the approach of a visitor or visitors (up to three intruders were seen simultaneously at a perch site) and pursued the interloper(s). Males of *P. gibbosus* interacted with little or no physical contact, restricting themselves to simple chase flights. Visitors often remained for several minutes before finally being driven off or departing of their own volition. On two occasions a marked resident male was replaced at its perch by another individual after an interaction between them.

Males claimed perch sites in the early morning (0800-0930) and might remain until midday. Records of marked males show that individuals held their territories for an average of about 2.2 hrs per day (with a maximum of 3.5 hrs; N = 7). There was a high daily turnover of males at the site. Of eight marked individuals only two appeared at perch for more than one day (one male for two days and another for four days). Apparently there were many males floating through the area judging from the number of visitors. On 7 August at midmorning I removed a resident male from each of four yucca stalks and on the next day two of the stalks were held by new males.

The social system of male *P. gibbosus* is similar to that of several other philanthine wasps (Simon Thomas and Poorter, 1972; Alcock, 1975a; D. L. Gwynne, pers. communication). Males of these species form small aggregations of pheromone-applying, territorial individuals that rarely spend more than a few hours at their perches. Territorial sites are attractive to other males with several visitors inspecting the perch on any given day and the same perch occupied by different males on each of several days in succession. Perch sites are located near flowering plants or near small diffuse clusters of nesting females. One active nest of *P. gibbosus* was found within a few m of the yucca perch area.

Hemipepsis ustulata ochroptera Stål (det. by P. D. Hurd, Jr.)

Males of this pompilid wasp were studied between 14-19 August 1977 at study site 3. They were found exclusively on three peaks along a mountain ridge behind Portal, Az. and behaved like a typical "hilltopping" insect (Shields, 1967). The tarantula hawk males perched on the tips of pine needles on the stunted, flat-topped pine trees on the peaks. As many as seven males were seen, each on a separate tree, during one morning at one peak. Males were active between at least 0830-1200 and on one afternoon excursion to the site I found a few males present at 1800.

Males flew out from their perches at irregular intervals looping around the tree several times, usually to inspect or pursue a passing *Hemipepsis* from another tree. Normally interactions involved only a brief period of pursuit in horizontal flight followed by the separation of males and their return to their respective perches. Despite the customary absence of overt aggression, this species is clearly territorial as shown from the following observations:

(1) Never more than a single male occupied the same tree top (areas of 3-5 m^2).

(2) Three of five males that were marked on 14 August held the same tree tops on subsequent visits to the area on 16 and 19 August. (The other two males were not seen again.)

(3) When a male (White) on the highest tree on the peak was captured and held in a net, its tree top was occupied within 7 min. by an unmarked male. After 5 min. more, White was released and immediately returned to its perch area. There followed a series of elaborate aerial duels between the two males. These began with the horizontal circling chases that occur among established resident males. The chases quickly led to steep spiral flights with the two males side-by-side (so close that wing clashing often occurred). After reaching a height of 10-25 m, the two *Hemipepsis* broke off the encounter with first one and then the other diving back to the perch tree. Within 4 min., White had replaced the unmarked male although 10-15 additional vertical flights were seen after White had regained control of the tree.

Transient males were regularly seen. They usually perched in a tree top for a short time and interacted with nearby resident males. They then left. Desirable territories were evidently in short supply despite the availability of unoccupied trees; I removed resident males from four trees on 19 August and within 4-11 min. three of the trees were taken by a replacement male. There was some evidence that the higher the tree, the more desirable it was as a territory:

(1) Males never perched in trees on the lower half of the peaks or on trees on the saddles between peaks.

(2) The two marked males that did not return to their perches were captured on the two lowest trees of the five pines that were occupied on 14 August.

(3) I assume that one of the factors that determines the ability of males to gain and hold a desirable territory is the size of the individual. This is true for many territorial invertebrates (e.g. Potter et al., 1976; Hamilton et al., 1976; Alcock et al., 1977). If this holds for *H. ustulata* very small males may be forced to occupy inferior sites. There was substantial size variation among territorial males. The three smallest individuals of 11 collected males had head-widths of 3.85-4.20 mm vs. 4.50-5.05 mm for the

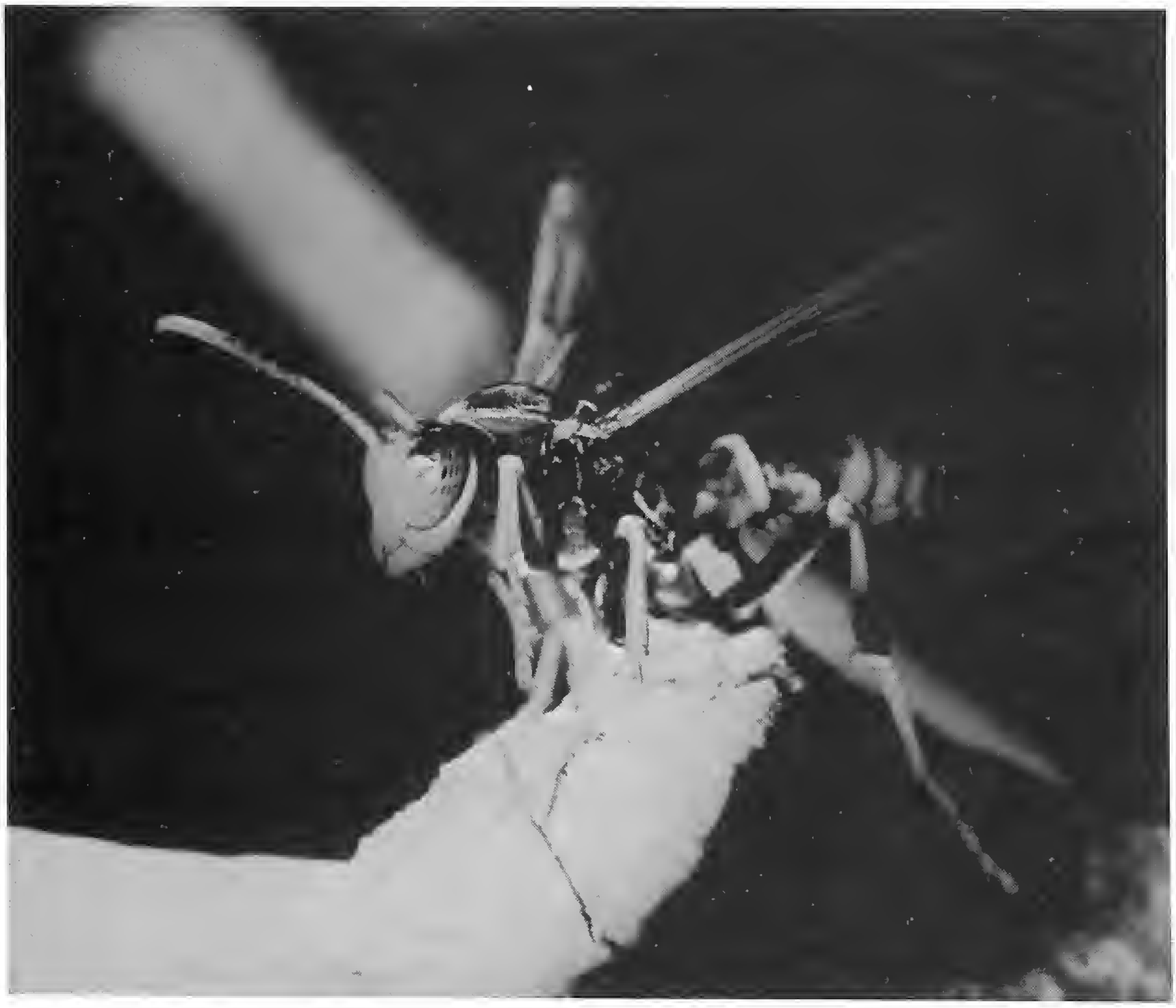

Fig. 3. A male of *Polistes canadensis navajoe* at its territorial perch at the tip of a dead pine branch.

others; all three were captured on trees well down the slope of the peak below the other eight males.

No copulations were seen nor were any females observed at the peaks, although a few were seen searching for prey on mountain slopes in the Chiricahuas.

Polistes canadensis navajoe Cresson (det. by R. M. Bohart)

This vespid was observed on the same peaks occupied by *Hemipepsis* males between 14-19 August 1977. Eberhard (1969) and Lin (1972) have described territorial behavior in several species of *Polistes*, including a different subspecies of *P. canadensis*, in which males defended perches near nest sites and hibernation areas. The males I watched held territorial perches on dead pine branches (Fig. 3), yucca stalks, rocks and patches of foliage on living pines and other shrubs. The diversity of the perches and the exposed nature of the peaks makes it unlikely that these wasps were defending hibernation areas or any other resource of value to females.

During the major period of activity (1000-1900) dozens of males were present in the area. They constantly made short forays out from their perches which were separated by a meter or two. Usually these flights occurred when another *Polistes* flew within several meters of their perch, although *Hemipepsis* males were repeatedly pursued and struck in flight and even butterflies were approached. Intraspecific encounters generally involved fairly slow sinuous flight chases without contact. Because several males often occupied the same tree, when one male flew up others were likely to join one by one in the chase forming an aerial conga line with all participants returning to their home perches within 15-30 sec. Sometimes however wing clashes occurred. More rarely males butted heads in flight and fell to the ground to grapple together. Four prolonged struggles with much biting and wrestling were seen.

Marked territory owners exhibited strong site tenacity. Of 12 males captured and marked on 14 August, 10 returned to their perches promptly that day, 9 were seen again on 16 August and 8 were at their territories on 19 August.

One copulation was observed at 1005. A female was seen after she had arrived on a branch in a male's territory. The male quickly scrambled onto her back. He probed with the tip of his abdomen and soon achieved copulation which lasted less than 30 sec. The pair then separated (perhaps disturbed by my approach) and the female flew off.

Discussion

The reproductive behavior of these five bees and wasps is the product of selection for (1) the ability of males to compete with one another for access to females and (2) the ability of males to locate productive areas in which to search or wait for mates. The competitive component of male behavior is most obvious in the territorial species in which individuals seek to exclude others from perch sites. At least some males in the populations of *P. gibbosus, H. ustulata* and *P. canadensis* in the Portal area appear to be forming leks in which aggregated males compete for ownership of purely "symbolic" territories. Defended sites in lek species do not in themselves contain females or a resource that draws females to the area. However receptive females may visit the lek to select a male that has demonstrated his dominance abilities in competitive interactions with other males. Leks may evolve when males are unable to monopolize females directly (e.g. by guarding an emergence area) or indirectly by controlling resources (such as a nest site or nectar sources) that females require (Emlen and Oring, 1977).

The competition among males of the *Nomada* and *Triepeolus* bees was more subtle. They patrolled such a large area that they could not possibly exclude conspecific males from their searching route and they did not attempt to do so. But perhaps the male visitors that came to an inspection point were exploiting the male that marked the station by seeking to intercept a female attracted to the area by his pheromone.

Males of all bees and wasps presumably compete for the best locations in which to find potential mates. For many species this means searching at emergence sites and mating with emerging virgin females (Alcock et al., in press). But for all five species whose behavior has been described here, emerging females may not be easy to locate because they are probably not clumped spatially. Females of *Hemipepsis* nest where they can find an appropriate spider burrow and victim (Williams, 1956). *Polistes canadensis* are not uncommon but their nests are scattered and the emergence of future queens occurs over a period of weeks (Eberhard, 1969). *Philanthus gibbosus* does sometimes form dense nesting groups (Evans, 1973) but in the Portal area the species is uncommon and nests appear to be distributed in ones and twos over a broad area (Cazier and Mortenson, 1965). The species of *Nomada* and *Triepeolus* are almost certainly sparsely distributed; females may emerge from whatever host burrow their mother happened to locate. Therefore in these species, males resort to alternate patterns of mate location. The wasp species gathered at conspicuous landmark beacons (yucca stalks on an elevated bank, rocks and vegetation at the top of isolated hill tops) in the vicinity of nesting habitat of their species. The *Philanthus* lek was near a nest of a conspecific female. Female *Hemipepsis* were seen on mountain slopes searching for prey and female *Polistes* nest in rock crevices on mountainsides.

The two parasitic bees employed the very different alternate strategy of cruising around a circular route looking for females attracted to their pheromone stations. Male *Triepeolus* patrolled traplines in areas with flowering creosote bushes visited by conspecific females and their hosts. Males of the European species of *Nomada* patrol areas in which females of the host species are nesting (Tengo and Bergstrom, 1977).

The landmark and trap-line strategies are employed by other male bees and wasps whose females are scarce and widely dispersed (Alcock et al., in press). Perhaps the landmark strategy evolves in those species whose scattered females have a tendency to search elevated areas (be they banks, hills or mountain peaks) for flower resources, or prey or nesting habitat. Males that gather in such areas and advertise their presence and competitive ability through pheromones or conspicuous flight patterns may have better-than-average chance to encounter a receptive female.

The trap-line method may evolve in species whose females have no preference for conspicuous topographical features in their environments. Here the superior strategy may be to spread a net of pheromone marked stations through habitat likely to be visited by females searching for food or for potential hosts.

Summary

Male mating strategies are described for five species of bees and wasps found in southeastern Arizona. This is the first report of male reproductive behavior for representatives of the genera *Triepeolus* and *Hemipepsis*. Males of the wasps *Philanthus gibbosus, Hemipepsis ustulata* and *Polistes canadensis* gather at landmark sites and form lek-like assemblages in which males compete for control of perch territories. Males of undescribed species of *Nomada* and *Triepeolus* patrol routes through habitat which may contain flowers visited by potential mates or nests of the host species parasitized by their mates. Both strategies may arise because receptive females are scarce, dispersed, and difficult to monopolize directly or indirectly through control of a localized resource valuable to females.

Acknowledgements

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Life History of *Zygogramma disrupta* in Southeast Texas

(Coleoptera: Chrysomelidae)[1]

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The ragweeds (*Ambrosia* spp.: Compositae) are important agricultural and hayfever-inducing weeds throughout much of North America (NAS 1968, Wodehouse 1971) and Eurasia (Kovalev and Runeva 1970, Kovalev 1971). The most abundant and widespread species include common ragweed (*A. artemisiifolia* L.), western or perennial ragweed (*A. psilostachya* DC.), and giant ragweed (*A. trifida* L.) (Payne 1970). Surveys of the entomofaunas of these and other North American ragweeds have revealed the existence of a diverse assemblage of insects (Hack 1935, Harris and Piper 1970, Piper 1970, Stegmaier 1971, Goeden and Ricker 1974a, 1974b, 1975, 1976a, 1976b, 1976c).

In southeast Texas, *A. psilostachya* is attacked by several species of phytophagous Coleoptera. One such associate is the chrysomelid, *Zygogramma disrupta* (Rogers).

The genus *Zygogramma* Chevrolat contains 14 species in America north of Mexico (Arnett 1968) and 85 Neotropical species (Bechyne 1952). Linell (1896) provided a key to the Nearctic species. Biological information is available for only 2 North American species, the sunflower beetle, *Z. exclamationis* (Fabricius) (Walker 1936), and *Z. suturalis* (Fabricius) (Piper 1975). Rogers (1856) described and illustrated the adult of *Z. disrupta*. The occurrence of this beetle on weeds and willow (*Salix* sp.) during the summer months in Kansas was noted by Douglass (1929). The paucity of information on the biology of *Z. disrupta* prompted the study reported herein.

Materials and Methods

Studies on the life cycle of *Z. disrupta* were conducted in the laboratory and correlated with field observations. The laboratory colony, started from adult beetles collected from *A. psilostachya* growing in or near College Station (Brazos Co.) during 1976 and 1977, were maintained in the laboratory at 24 ± 2°C, 75 ± 5% RH, and a 14L:10D photoperiod. Eggs, larvae, and adults were confined to 10.0

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x 1.5 cm petri dishes provisioned with moistened filter paper and ragweed foliage. Water and food were renewed at 48 hr intervals. Pupae were held in petri dishes containing moist peat moss.

Life History

Zygogramma disrupta has been recorded from Nebraska, south to Mexico, east to Louisiana, and west to Arizona (Rogers 1856, Powell 1932, Wilcox 1975). Based upon descriptions provided by Rogers (1856) and Linell (1896), adults are broadly oval, convex, with the head and pronotum dark brown; each elytron cream-colored, with suture and four narrow discal vittae dark brown; first vitta free, slightly abbreviated basally and apically; second and third sinuous, abbreviated basally and confluent apically; fourth short, confluent with third basally; three submarginal spots apically; fourth short, confluent with third basally; three submarginal spots apically; epipleuron cream-colored with dark brown margin. The lengths of 25 males and 25 females averaged 5.75 ± 0.06 mm and 6.47 ± 0.07 mm, respectively.

Z. disrupta is a bivoltine species in southeast Texas. First generation overwintered adults began emerging during early June at a time when *A. psilostachya* plants were 20-25 cm in height. Peak populations were attained by mid-June. Adults of the second generation emerged in late July with peak populations being found during early August. Both sexes emerged concurrently. Sex ratio was determined by examining 94 beetles which emerged from laboratory-reared first generation pupae. The male:female ratio was 1.0:1.3.

The beetles did little flying, remaining closely associated with the uppermost foliage of the host plant. Rarely were more than three individuals found per plant in nature. The adults fed upon both older and newly developed leaves, often consuming leaf laminae in their entirety except for the midribs and immediately adjacent tissue. Adults feign death and drop from the plant at the slightest disturbance, their coloration blending imperceptibly with the soil and/or litter below. The average life span of laboratory-reared adults was 49.3 ± 8.4 (range 12-83) days for males and 58.4 ± 5.4 (range 10-111) days for females.

The premating period was not determined. Mating occurred most frequently during either the late morning and/or mid- to late afternoon in both the field and laboratory. All matings observed in nature occurred on the upper surfaces of leaves or in leaf axils of the host plant. The act of copulation in *Z. disrupta* was similar to that of *Z. suturalis* (Piper 1975). The male mounted the female from behind by moving directly forward and onto her dorsum. The male positioned himself on the posterior dorsum at a 45° angle with his forelegs resting upon the female's elytra near the second vittae. The middle pair of legs grasped the elytral margins or epipleura near the apex.

The male's hind tarsi flanked the vagina. The tarsal lobes were rubbed across the vaginal area preparatory to aedaegus extrusion and intromission. The female generally was quite passive after the initiation of copulation and often fed while in copula. When a female became restless and started to move about on the plant, copulatory activity was suspended immediately; the male merely rode the female's dorsum until another site was selected. Upon the cessation of female movement, the male resumed copulation. The time spent in copula varied from 15 min to two hr. Repeated matings between the same male and female occurred frequently in the laboratory both before and after oviposition had commenced. However, mating declined steadily in frequency as the female aged. A male was capable of mating with different females and a female accepted different males.

The preoviposition period, from emergence to first deposition of eggs, of 25 females averaged 12 ± 0.8 (range 9-14) days. The oviposition period averaged 37.3 ± 4.7 (range 7-97) days during which time the females laid an average total of 262 ± 43 (range 27-845) eggs. Daily egg production was quite variable. Based only on days when females oviposited, the daily totals ranged from 1 to 40 and averaged 9.3 ± 0.7 eggs.

Oviposition occurred most commonly during the late afternoon or evening. Eggs characteristically were deposited in clusters of 2 to 18 on the undersides of young ragweed leaves. Of 100 clusters examined, 75 contained two to five eggs, with a mean of five eggs/cluster. The eggs overlapped one another and stood out from the leaf at a 45° angle. In the field, first generation eggs were found from mid-June to late July; second generation eggs from mid-August to late September.

The egg is ellipsoidal, yellowish-orange and has an asperate chorion. The mean length and width of 25 eggs were 1.57 ± 0.01 mm and 0.69 ± 0.01 mm, respectively. The incubation period of 300 eggs averaged 6.26 ± 0.03 (range five to seven) days. Eggs in the same cluster usually hatched concurrently.

Recently hatched larvae were pale orange and fed together at the margin of the leaf on which the eggs had been laid. The pale yellow second-, third-, and fourth-stage larvae were less gregarious and distributed themselves among the uppermost foliage. Larvae fed on the upper surfaces of leaves and the resultant damage resembled that produced by adult feeding. When touched or disturbed while feeding, third- and fourth-stage larvae either regurgitated undigested foodstuffs or voided a droplet of fecal material, a behavioral trait also characteristic of *Z. suturalis* larvae (Piper 1975). Confinement of late stage larvae to potted ragweed usually resulted in extensive defoliation and plant death. However, the damaging defoliation levels produced in the laboratory were never observed among field populations of *Z. disrupta* larvae.

The maximum lengths attained by 25 first- to fourth-stage larvae were 2.43 ± 0.02 mm, 3.22 ± 0.06 mm, 4.25 ± 0.07 mm, and 6.00 ± 0.13 mm, respectively. Under laboratory conditions, the stadia of larval development were as follows: first, 5.2 ± 0.1 (range four to seven) days; second, 3.6 ± 0.2 (range two to six) days; third, 4.2 ± 0.2 (range three to eight) days; and fourth, 7.3 ± 0.4 (range six to ten) days.

During the fifth or sixth day of development, a fourth-stage larva ceased feeding, descended to the ground directly beneath the plant, and burrowed five to ten cm into the soil. Having reached a suitable depth, the larva pushed and compacted the surrounding soil, creating an ellipsoidal chamber. After completing the earthen cell, the larva became quiescent and entered the prepupal stage which lasted 6.8 ± 0.6 (range five to nine) days.

Pupation occurred within the chamber. The pupa is pale yellow and the mean length of 25 pupae was 5.87 ± 0.06 mm. The duration of the pupal period averaged 7.8 ± 0.1 (range seven to nine) days. After ecdysis, teneral adults remained underground one to two days before emerging. Upon emergence, adults are pale and are still quite soft. Normal coloration and complete sclerotization were attained within eight to twelve hr. During late September and October, overwintering of adults produced from second generation pupae commenced within the pupal cells. In the laboratory, the time required for a complete life cycle, from egg to adult, was 39 ± 1 (range 28-41) days.

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A Mating Aggregation of *Dasymutilla foxi* in Southern Arizona

(Hymenoptera:Mutillidae)

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In general, velvet ants are most abundant in deserts or similar arid regions (Hurd, 1951). In the United States, numerous species belonging to the genus *Dasymutilla* Ashmead occur in the southwestern states.

Velvet ants are not frequently encountered in large numbers. Fattig (1936) described seeing unusual mating behavior involving *Mutilla briaxus* Blake, in which "at least" 40 males were involved. Linsley *et al.* (1955) told of an "unusually large concentration" of *Dasymutilla formicalia* (Rohwer) in which 31 males and 37 females were collected in a period of about one hour. Other records have been made of specimens in higher densities than usual (Mickel, 1928; 1938), but these apparently have not involved any true aggregation.

The present study involves a very large aggregation, including both males and females, of *D. foxi* (Cockerell). The site was located in Pinal Co., Arizona, about 40 km (25 miles) north of Tucson (Star Flat Tank, Black Mt., 7½ min. topographic series, about 32°45'00"N/110°52'30"W). It was discovered on September 11, 1976, and has now been under observation for more than 12 months. The site consists of two reservoirs used for watering cattle, separated by an earthen dam. Each reservoir is approximately one half hectare in area. The dam is nearly devoid of vegetation, though some trees of the species *Prosopsis juliflora* (Swartz) border the water in the reservoirs. The dominant plant species in the area is *Larrea divaricata* Cavanilles. Vegetation is relatively sparse. Two species of bees, *Diadasia rinconis* Cockerell and *D. opuntiae* Cockerell (identified by E. Ordway), were nesting at the site.

Materials and Methods

Visits every two to three weeks for the 12 months were made to the study area for purposes of collection and observation, and for deter-

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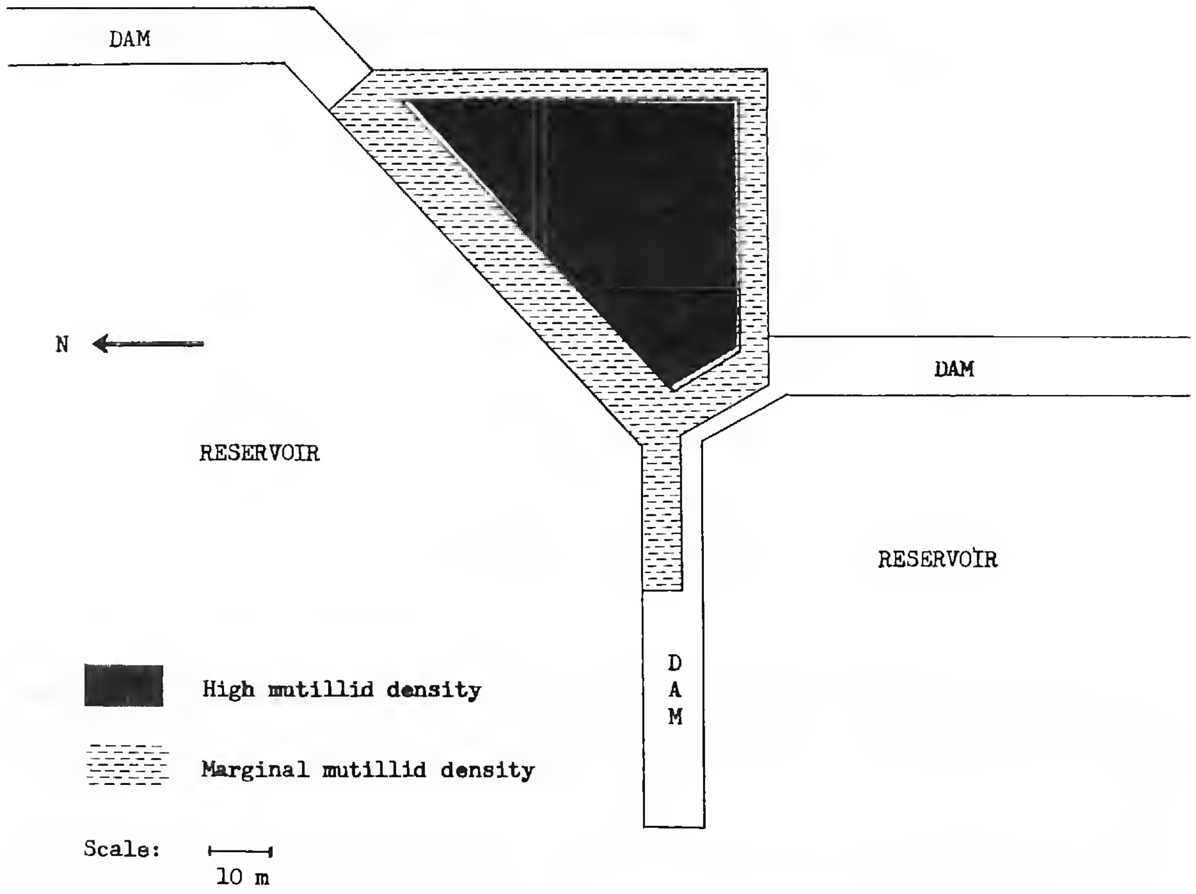

Fig. 1. A map of the aggregation site at which mutillid activity was observed. There was an area of high density surrounded by an area of marginal density on and near the earthen dams.

mining the population size. During a visit on September 29, a map (Fig. 1) was made in which the aggregation was located. A marginal area was also noted. Within the location, five one square meter plots were marked off. The distance between the sample areas was about 6 meters. The number of male and female mutillids in each square meter was first counted at 1710 MST, and then at 10 minute intervals for 80 minutes.

Visits were made to the site during all daylight hours to determine when the mutillids were most active.

It was suspected that the aggregation may have been for purposes of courtship and mating, as many pairs were observed in copulation. To determine whether successful mating was being accomplished, several pairs of specimens were collected *in copula* on September 22 and taken to the USDA Bee Research Lab in Tucson for dissection.

Results

The area of high concentration covered approximately 1300 square meters (Fig. 1). Using the data collected from the one meter squares

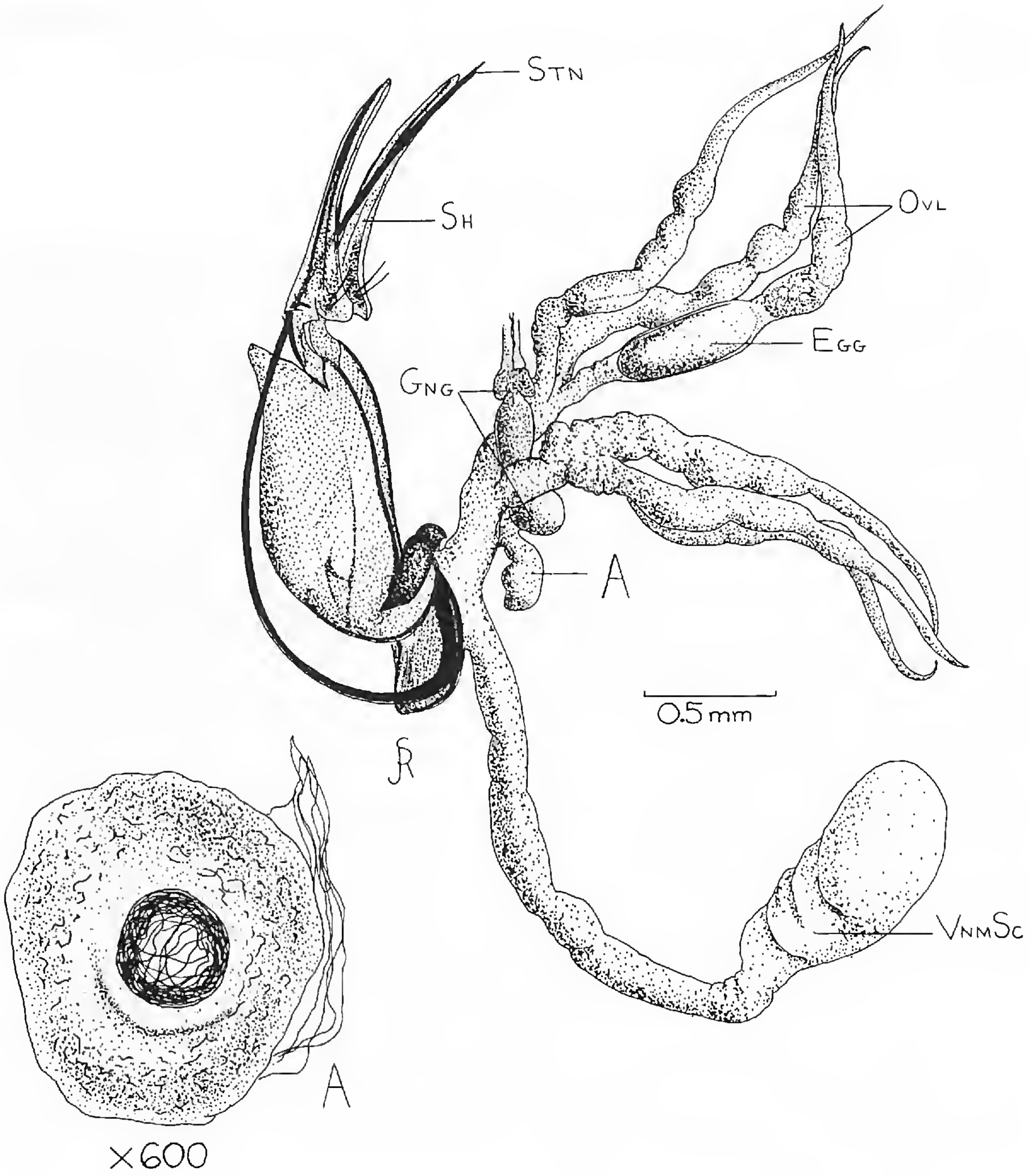

Fig. 2. A drawing of the reproductive tract of a female *Dasymutilla foxi*, with an enlarged drawing of the spermatheca (A) showing the sperm therein. GNG, ganglion; OVL, ovariole; SH, sheath; STN, sting; VNMSC, venom sac. (Drawing by R. Schmalzel).

within the area of high mutillid concentration, it was calculated that there were nearly 5 velvet ants per square meter in the area. Using this, and the total area of the aggregation, it is estimated that the population consisted of approximately 6000 individuals, with a sex ratio approaching 1:1.

Activity was observed during all daylight hours, and even shortly after sunset. Greatest activity, however, was observed from about 1500 to 1900 MST.

It was determined that successful mating was occurring within the population, as live spermatozoa were observed in spermathecae. A drawing of the female reproductive system and the spermatheca (enlarged) is shown in Fig. 2.

Discussion and Conclusions

Even in the Southwest, where velvet ants are relatively numerous, it is unusual to see many individuals in any one location. It seems reasonable to assume that the large aggregation observed was not present at the same location at the same time purely by coincidence.

The aggregation of velvet ants was first observed on September 11, 1976. Subsequent observations were made through October 11, 1977. The density of the aggregation was greatest from the time of discovery until about mid-October, at which time the number of individuals present began to decline. The decline continued through November, by which time no further specimens could be found.

Much of the area in which the mutillids were numerous, particularly on the slope of the earthen dam, was dotted with burrows measuring about 5 mm in diameter. Velvet ants, both males and females, were observed entering and exiting the burrows. It has been documented that *D. foxi* is parasitic upon bees of the genus *Diadasia* Patton (Cockerell, 1896). In the fall of 1976, although several burrows were excavated, nothing was found in them. It seemed probable that the burrows belonged to the host, but that the burrows were empty due to the relatively late dates at which they were examined.

No mutillid activity was observed at the site from November until the following April. At that time there was considerable host nesting activity. Burrows were again excavated and host pollen balls and larvae were found. At that time the mutillid population was very light and limited to females. No males were observed until mid-May. The mutillid population remained small and steady throughout the summer and early fall. At no time during 1977 did the population reach even ¼ the size of the fall 1976 population.

The activity over the course of the year seems to clearly indicate that the site is being used as a courtship and mating site for the mutillids, as well as a host nesting site.

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BOOK REVIEW

A Revision of the Subfamily *Coelidiinae* (Homoptera: *Cicadellidae*) II. Tribe *Thagriini.* Nielson, M. W. 1977. Pacific Insects Monograph 34. Published by Entomology Department, Bishop Museum, Honolulu, Hawaii. 218 pages, generic and specific check lists and keys, 808 text figures. Price: $12.50 soft cover; $14.00 hard cover.

The leafhopper Subfamily *Coelidiinae* contains over 600 species, nearly 100 genera and 6 tribes. Leafhopper species within this subfamily are primarily inhabitants of tropical areas. Most of the genera are found in the Neotropical Region while over half of the species are known from the Oriental Region and another 50 species are represented in the Ethiopian Realm. Only two or three of more than 600 species are known from the United States and their origins are thought to be elsewhere.

This kind of worldwide revision of a large subfamily is a monumental task, in this case necessitating the publication of the revision in four parts. The first has been published in the Bulletin of the British Museum (Natural History) Entomology, Supplement 24, 1975 and is entitled "A Revision of the Subfamily *Coelidiinae* (Homoptera: *Cicadellidae*) Tribes *Tinobregmini, Sandersellini* and *Tharrini.*" The remaining two parts will be published elsewhere.

Part II, which concerns us here, covers the large genus *Thagria* with 137 species from the Oriental and Australian Regions and the smaller genus *Tahara* from New Guinea. Part II, as with Part I, is a perfect example of what a revisionary work should be and for this the author is to be highly commended. Introductory sections are short, concise and well written. Ample descriptions of all tribes, genera and species are given and the keys provided appear quite adequate. Text figures illustrating the genitalic and cephalic characters necessary for specific identifications are excellent.

Pacific Insects Monograph #34, along with the other three parts of the revision of the *Coelidiinae* will make an excellent and important addition to the Hompterist's library. **R. J. Gill,** *California Department of Food and Agriculture, Sacramento, 95814.*

Two New Species of Neotropical *Culicoides*

(Diptera: Ceratopogonidae)[1]

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In our studies of Neotropical biting midges we have found two new species of *Culicoides* that are especially interesting from distributional and taxonomic aspects, enough to merit their description and discussion at this time. We wish to thank Mrs. Molly Griffin for making the illustrations.

Antennal ratio (abbreviated AR) is the combined length of the five elongated distal flagellomeres (for convenience referred to as segments) divided by the combined length of the eight shorter preceding segments. Palpal ratio (PR) is the length of the third palpal segment divided by its greatest breadth. Proboscis/Head ratio (P/H Ratio) is the length of the proboscis measured from the distal end of the labrum-epipharynx to the anterior margin of the tormae, divided by the distance measured from the anterior margin of the tormae to the median hair socket between the eyes. Wing length is measured from the basal arculus to the wing tip; costal ratio (CR) is the length of the costa measured from the basal arculus to the tip of the second radial cell divided by the wing length.

Culicoides kuscheli, new species

(Fig. 1)

Female.—Length of wing 1.21 mm; breadth 0.54 mm.

Head: Eyes (Fig. 1d) contiguous to narrowly separated; bare. Antenna (Fig. 1a) with lengths of flagellar segments in proportion of 30-22-23-23-24-24-24-25-30-30-30-30-50, AR 0.88, five distal segments very little elongated; sensory pattern 3,7-10. Palpus (Fig. 1b) with lengths of segments in proportion of 15-25-50-20-23, PR 2.1; third segment moderately swollen, with a moderately large and deep, round sensory pit. Proboscis

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moderately long, P/H Ratio 0.88; mandible with 11-12 teeth.

Thorax: Dark brown, with dense dark grayish pollinosity, without prominent pattern. Legs brown, without pale rings, knee spots darker, tarsi paler; hind tibial comb with four spines, the one nearest the spur longest (Fig. 1e).

Wing (Fig. 1c) with pattern as figured; second radial cell in a very dark spot, dark to its distal extremity; pale spot over r-m crossvein prominent, extending broadly from costal margin to medial stem. Cell R5 with large poststigmatic pale area and a large irregular pale spot toward apex of cell, the two separated in posterior part of cell by a very dark area. Cell M1 with two elongate, indistinct pale spots, more or less streaklike, distally not reaching wing margin. Cell M2 indistinctly pale on basal half, darker distally with a more distinct distal pale spot more or less meeting wing margin. Cell M4 with a large pale area more or less filling distal portion of cell. Anal cell with rather indistinct pale area at base and a more distinct pale spot in distal portion. CR 0.57; radial cells distinct, the second relatively broad; macrotrichia rather coarse and moderately sparse, confined to distal half of wing and in anal cell. Halter pale.

Abdomen: Brownish. Spermathecae (Fig. 1f) two plus a rudimentary third and sclerotized ring; functional spermathecae ovoid, subequal, measuring 0.047 by 0.033 mm and 0.043 mm by 0.031 mm.

Male.—Unknown.

Distribution.—Chile.

Types.—Holotype, female, Chile, Antofagasta, Paposo, 6 October 1957, G. Kuschel (Type no. 72237, USNM). Paratypes, 18 females, same data.

Discussion: This species is named for Guillermo Kuschel, Entomology Division, Department of Scientific and Industrial Research, Nelson, New Zealand, in appreciation of his intense interest in the Chilean biting midge fauna and for his important field collections.

Culicoides kuscheli does not appear to be closely related to any known Neotropical species, which is less surprising when one considers that it occurs on the extreme southern range of the genus in South America. Only one species, *C. venezuelensis* Ortia and Mirsa, has been recorded from farther south in Chile, where it was described as *pictipennis* (Philippi) from Santiago. There is considerable varia-

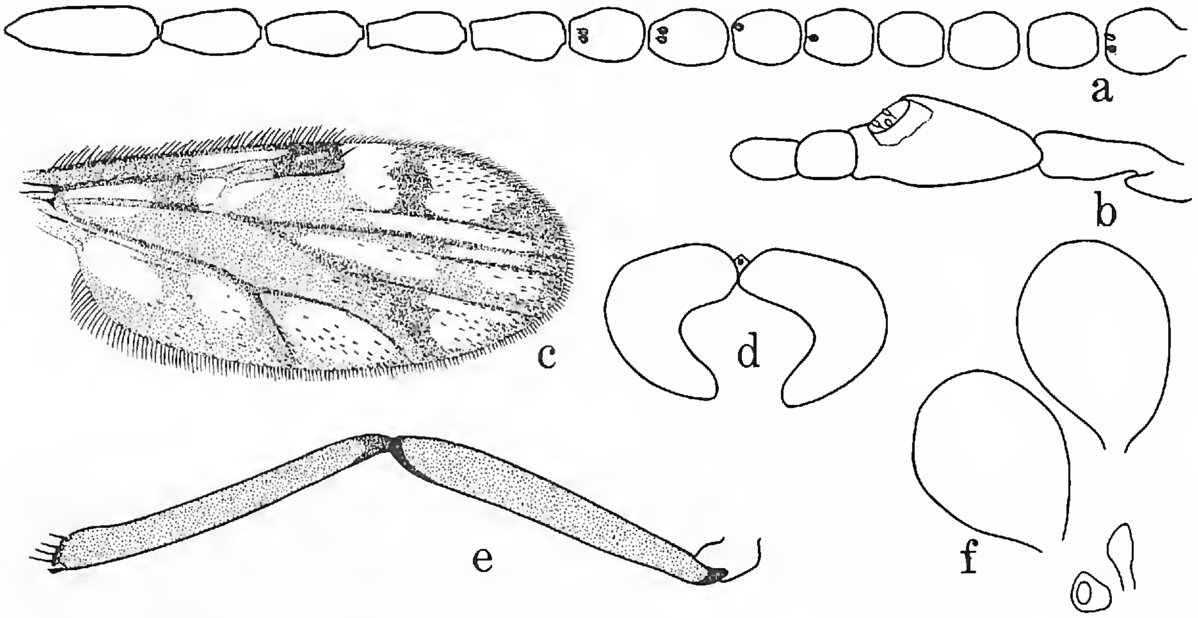

Fig. 1. *Culicoides kuscheli*, female: a, antenna; b, palpus; c, wing; d, eye separation; e, femur and tibia of hind leg; f, spermathecae.

tion in wing markings in *C. kuscheli,* and the figure illustrates the extreme maximum extent of the pale markings (holotype). In most of the type series the markings are more or less reduced, and in a few specimens the distinct pale spots are confined to the marking over the r-m crossvein, the poststigmatic pale spot, and an oblique pale mark toward the apex of cell R5. Such specimens will key out in Wirth and Blanton (1959) to *C. alahialinus* Barbosa (from Ecuador and Panama). *C. alahialinus* differs in having the pale mark in the middle of cell R5 small and faint and confined to the middle of the cell, the antennal sensory pattern is 3, 8-10, and the mesonotum has a prominent pattern of small blackish punctiform dots. Nevertheless, *C. kuscheli* is perhaps as closely related to *C. alahialinus* as to any other Neotropical *Culicoides* species. Discovery of the male would certainly help clarify the taxonomic position of *C. kuscheli.*

Culicoides parascopus, new species

(Fig. 2)

Female.—Length of wing 1.71 mm; breadth 0.81 mm.

Head: Eyes (Fig. 2d) narrowly separated; bare. Antenna (Fig. 2a) with lengths of flagellar segments in proportion of 38-29-27-27-26-26-25-28-60-60-66-70-96, AR 1.65; sensory pattern 3,4,6,8,10-15. Palpus (Fig. 2b) with lengths of segments in proportion of 15-35-55-19-23, PR 2.1; third segment moderately swollen, with a moderately large, round, shallow sensory pit. Proboscis moderately short, P/H Ratio 0.70; mandible with 15 teeth.

Thorax: Dark brown, without prominent pattern. Legs brown, knee spots darker; all tibiae with narrow pale rings; tarsi paler; hind tibial comb with 4-5 spines, the two nearest the spur longest, subequal (Fig. 2f).

Wing (Fig. 2c) with pattern as figured; second radial cell in a very dark spot, dark to its distal extremity; pale spot over r-m crossvein moderately large and circular, bearing a prominent small dark spot in center lying over r-m crossvein itself. A distinct oval pale spot straddling vein M2 at its midlength. Cell R5 with a small pale spot on anterior margin just past tip of costa and a second larger, quadrate pale spot halfway between the former and tip of cell, the second spot not quite reaching vein M1 caudad. Cell M1 with one small oval pale spot in distal portion, failing by its own length to reach wing margin. Cell M2 with a small pale spot lying immediately in front of mediocubital fork and a moderately large rounded pale spot at wing margin in apex of cell. Cell M4 with a large rounded pale spot nearly filling distal portion of cell. Anal cell with two rounded pale spots in distal portion. Base of wing with a large pale area extending distad in midportion to about half the distance to mediocubital fork. CR 0.58; radial cells distinct, the second moderately broad; macrotrichia rather long and moderately dense, extending nearly to base of wing. Halter pale.

Abdomen: Brownish. Spermathecae (Fig. 2e) two plus rudimentary third and a faintly sclerotized narrow ring; functional spermathecae subspherical with short, slender necks, subequal, each measuring 0.058 by 0.041 mm.

Male.—Similar to female with usual sexual differences; antennal plume well developed, brownish; last three antennal segments with lengths in proportion of 90-80-85. Genitalia (Fig. 2h): Ninth sternum short with shallow caudomedian excavation, ventral membrane not spiculate; ninth tergum moderately long, slightly tapered to long, slender, widely separated apicolateral processes, the caudal margin between them transverse with a slight median indentation. Basistyle with ventral and dorsal roots slender and elongate;

dististyle with slender, pointed, distinctly hooked tip. Aedeagus with basal arch rounded, extending to half of total length of aedeagus, basal arms slender and curved; distal median process slightly bulbous proximad and tapering to simple slender tip. Parameres (Fig. 2g) separate; each with well developed basal knob, slender proximal portion abruptly bent about 120 degrees with the straight, moderately slender, median stem portion; the latter gradually tapering distally, the tip abruptly bent ventromesad and ending in a simple filamentous point.

Distribution.—Mexico.

Types.—Holotype, female, allotype, male, Mexico, Michoacan, Puerto Garnica, 2828 meters, 47 km east of Morelia on Hwy 15, 20 August 1964, F. S. Blanton, light trap (Type no. 72238, USNM). Paratypes, 4 males, 7 females, same data.

Discussion: The name *parascopus* is a Latin noun taking its name because of the close relationship of this species to *C. scopus* Root and Hoffman. *C. scopus* is a more widespread species in higher elevations ranging from Mexico south to Chiriqui, Panama. It differs in having the female palpus with a slightly smaller sensory pit; antennal sensory pattern 3,8,10-15; male aedeagus with short, blunt tip; and male parameres with the distal stem abruptly narrowed before the slender, ventrally directed, distal portion bearing apical fringing hairs.

Culicoides parascopus was taken in a light trap operated at the border to the Insurgente Morelos National Park in a well developed montane forest of fir and pine in the Sierra Ozumatlan. Cabrera and Willink (1973) place this area in their biogeographic "Provincia Mesoamericana de Montana", characterized by rather open forests of pine, fir and oaks.

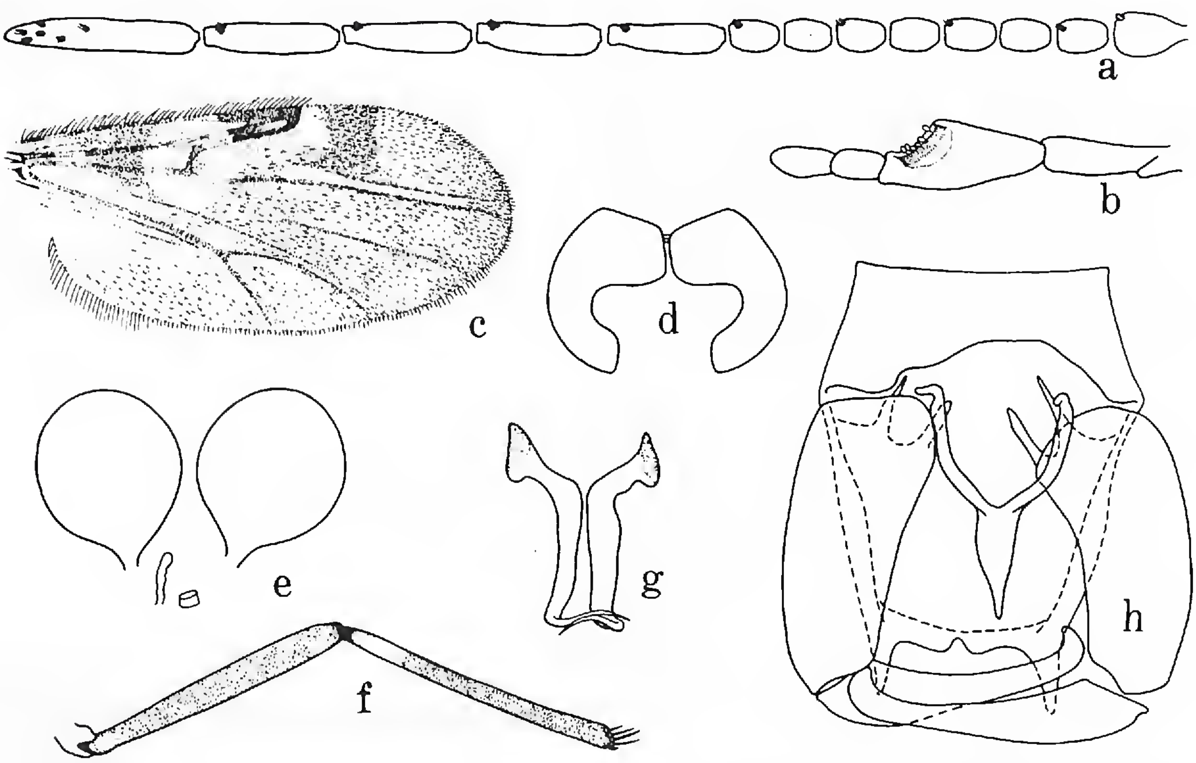

Fig. 2. *Culicoides parascopus*, a-f female, g-h, male: a, antenna; b, palpus; c, wing; d, eye separation; e, spermathecae; f, femur and tibia of hind leg; g, parameres; h, genitalia, parameres removed.

Literature Cited

Cabrera, A. L., and A. Willink, 1973. Biogeografia de America Latina. Organization of American States, Washington, D.C. 120 pages.

Wirth, W. W., and F. S. Blanton, 1959. Biting midges of the genus *Culicoides* from Panama (Diptera: Heleidae). Proc. U.S. Nat. Mus. 109: 237-482.

ZOOLOGICAL NOMENCLATURE ANNOUNCEMENT A.N.(S.) 106

The 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.* 35, part 1, 31 July, 1978).

680 *Blatta germanica* Linnaeus, 1767 (Insecta, Dictuoptera, Blattodea): proposal to conserve and to designate it as type-species of *Blattella* Caudell, 1903.

2143 Proposal to conserve the specific name *tenebricola,* as published in *Linyphia* by Wider, 1834, but in the sense of Kulczynski, 1887 (Arachnida).

2213 HESPERIIDAE Latreille, 1809 (Insecta, Lepidoptera): request for addition to the Official List.

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April issue mailed Sept. 5, 1978.

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