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by WOODROW W. MIDDLEKAUFF and ROBERT S. LANE

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# Contents

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# INTRODUCTION[1]

Horse flies and deer flies are economically important insects. Adult females of many species suck blood; their approach annoys potential victims and they may inflict a painful bite. Some species transmit mechanically, or in a few cases biologically, pathogenic agents such as arboviruses, bacteria, protozoa, and nematodes. Females of some Central and South American species carry eggs of the human bot fly, *Dermatobia hominis* (Linnaeus, Jr.), which causes cutaneous myiasis on a suitable avian or mammalian host. The bacterial diseases, tularemia and anthrax, are also transmitted by the bite of tabanids. For a comprehensive review of the animal disease agents transmitted by tabanids see Krinsky (1976).

Since the first treatment of California Tabanidae by Middlekauff (1950) some taxonomic problems have been resolved; 9 new species have been described and there have been several new state records; new data on geographical distribution and seasonal patterns have been acquired; and there has been an impressive increase in our knowledge of immatures and the habits of adults.

In California there are 73 species and 7 subspecies of Tabanidae in 11 genera. The genera *Chrysops*, *Hybomitra*, *Apatolestes*, and *Tabanus* contain the most species with 21, 13, 11, and 10 respectively, which account for 75 percent of all species recorded from the state.

To save space, we have eliminated detailed listing of collection data except for the less common species. For the more common species, we either list the counties or give a summary of the distribution pattern. The approximate collection localities of all specimens studied are shown on topographic maps. Seasonal flight periods are also summarized for each species. All references to time pertain to local time as far as we are aware.

The descriptive notes in the discussion section are not intended to be a taxonomic redescription of the species involved. The notes emphasize features which will aid the reader in species identification.

Information presented on adult taxonomy and distribution was prepared by Middlekauff; the biosystematic studies of the immature stages and the biology sections were prepared by Lane, unless otherwise noted.

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## ADULTS

Adult North American tabanids vary in size from about 6.5 to 30 mm in length. These usually stout, big-headed, and big-eyed flies are found from sea level to 3,300 m or more.

### Habits and Bionomics

Tabanids frequent a great variety of habitats, ranging from deserts to alpine environments, usually with a moist or wet breeding site nearby. Most are active on warm, sunny days. Flight activity decreases when it is cool, breezy, or both. There are notable exceptions along the California coast where *Brennania hera* (Osten Sacken) and *Apatolestes actites* Philip and Steffan are active under both cool and windy conditions. Some species are rare, whereas others may occur in such numbers that their persistent and painful attacks make normal outdoor activities for humans, domestic livestock and mammalian wildlife unbearable or uncomfortable.

Feeding habits of Tabanidae vary. Most females are haematophagous, but some, as well as all males, subsist on nectar and plant exudates. No tabanid is known to be host specific, although definite preferences are shown by some species. Most are diurnal feeders, although some feed at dawn, dusk, or at night, particularly in the tropics.

The haematophagous members of the family are known to favor larger mammals as hosts. Members of the horse (Equidae), cow (Bovidae), deer (Cervidae), and camel (Camelidae) families seem to be preferred

hosts, but many other mammals as well as birds, lizards, and turtles also are attacked. On rare occasions, tabanids have even been observed feeding on dead mammals. Many workers have noted that the Tabaninae generally prefer larger hosts than do the Chrysopsinae (Philip, 1931; Stone, 1930; MacCreary, 1940; Pechuman et al., 1961; Smith et al., 1970), and that humans are more often troubled by various species of *Chrysops* than by the larger flies of the genera *Tabanus* and *Hybomitra* (McAtee and Walton, 1919; Tashiro and Schwardt, 1949, 1953; Smith et al., 1970).

Under certain conditions tabanids also will bite avian hosts. In Algonquin Park, Ontario, *Chrysops indus* Osten Sacken and *C. excitans* Walker fed on a caged raven, single females of *C. indus* and *C. carbonarius* Walker were observed feeding on a crow, and an engorged *Chrysops* sp. was seen leaving a robin that had become entangled in a mist net (Bennett, 1960). Davies (1959) induced a *C. excitans* to feed on a domestic Pekin duck when both were confined to a cage, but seldom saw flies feeding when unconfined. Smith et al. (1970) collected 3 *C. excitans* and 1 *Hybomitra illota* (Osten Sacken) from a captive robin.

There are no records of tabanids feeding on amphibians.

If disturbed when feeding a female may leave the animal and quickly move to another, so that infected and healthy individuals may be attacked in quick succession by the same fly. Bite wounds can ooze quantities of blood which may exceed the amount ingested.

The simplest method of collecting female tabanids is by swinging an insect net around the head or legs of man to capture host-seeking females. A dog, horse, or cow can also serve as a host. Several types of traps have been used for collecting adult tabanids. The Manitoba trap, or a modification thereof (Thorsteinson et al., 1965), is simple and effective. It consists of a large, plastic cone with a killing jar at the apex containing an inverted cone at the mouth. A large, black sphere, such as a painted basketball or beach ball, is suspended under the cone. Presumably, female tabanids are attracted by heat emanating from the sun-warmed black ball and tend to fly upward into the killing jar. Use of a Malaise type trap is also effective. Collecting efficiency of both types of traps is considerably enhanced by the use of carbon dioxide as an attractant, as shown by the recent studies of Anderson et al. (1974).

Flies often enter buildings and parked cars in rural areas. They rarely bite when indoors, and normally fly to a window because they are positively phototrophic.

The above techniques are ineffective for collecting non-bloodsucking females. They usually have been taken from vegetation or the ground near the larval habitat or mating site. Males, with rare exceptions, are collected infrequently. Best results are attained by sweeping flowers, grass, or other vegetation near emergence sites, on sun-lit wooden walls and fences, or when they are hovering or resting near mating sites. Forest clearings, pathways, country roads, or hilltops are all likely places to look for male tabanids. Some males and females also are attracted to lights.

## Taxonomic Treatment

Flies in the compact and structurally homogeneous family Tabanidae in California can be recognized by their porrect antennae composed of 2 basal segments and a flagellum with 3-8 annuli; thorax and body often with long, silky hairs but lacking strong macrochaetae; proboscis strong, labium sclerotized and rigid; mandibles well developed in nearly all ♀♀, absent in ♂♂; characteristic wing venation, especially the widely divergent veins $R_4$ and $R_5$ that enclose the apex of the wing (Fig. 1); empodia are pulvilliform and squamae are large. Males are easily distinguished from females by their contiguous (holoptic) eyes (Fig. 5); those of the females are dichoptic (Fig. 7). A few male *Chrysops* may have the eyes narrowly separated. In life the eyes are frequently green, golden, or purple iridescent, and usually are patterned with contrasting bands or spots.

Recognition of subfamilies, tribes, and genera is based chiefly on genitalic and external characters. The most modern classification is presented in several papers by Mackerras (1954, 1955). In addition to genitalic differences, external morphological features, such as the presence or absence of hind tibial spurs; configuration of the antennae and apical palpal segment; length of proboscis; presence or absence of ocelli, frontal callosities, and ocellar tubercles; and the presence or absence of setae on the basicosta, are used for supraspecific differentiation. Species identification is based on less pronounced morphological differences of the head and its appendages; thoracic and abdominal patterns and coloration; and distinctive wing patterns, especially in *Chrysops*, *Silvius*, and *Haematopota*. Unfortunately, as Philip (1957) states ". . . it is also apparent that these [genitalic structures] will never reveal the fine specific characters such as are now so indispensable for students of the Culicidae and Simuliidae."

Following the early works of Brennan (1935) and Stone (1938), major contributions to the knowledge of adult Tabanidae in California have been made mostly by Philip (cf. references cited).

## KEY TO SUBFAMILIES AND GENERA OF TABANIDAE IN CALIFORNIA

*Adults*

1. Hind tibiae each with 2 apical spurs (Fig. 3); ocelli well developed, functional ..... 2
   Hind tibiae lacking apical spurs; ocelli lacking, vertex at most with ocellar tubercle . . . (TABANINAE) ..... 7
2. Pedicel of antenna wider than long; wings hyaline or if infuscated wholly or in part, lacking a definite pattern; basal portion of 3rd antennal segment (flagellum) swollen, with 7-8 terminal annuli (Figs. 14-17); stump vein usually present (Fig. 1) . . . (PANGONIINAE) ..... 3
   Pedicel of antenna longer than wide; wings with distinct infuscated spots or pattern; flagellum not swollen basally (Figs. 18-22), with 4 distinct terminal annuli; stump vein absent or minute . . . (CHRYSOPSINAE) ..... 6
3. Apical palpal segment (♀) swollen basally (Fig. 26), with a pit or groove; proboscis short, hardly half the height of the head (Fig. 12); at least basal callus present in ♀ ..... 4
   Apical palpal segment (♀) long and slender, not swollen basally (Fig. 31), without a pit or groove; proboscis longer, equal to half or more the height of the head (Fig. 11); frontal callosities absent in ♀, entire front pollinose (Fig. 42) ..... 5
4. Eyes and body densely pilose; apical palpal segment with a pit (Fig. 28); areas of small and large eye facets not sharply differentiated in ♂♂ ..... *Brennania* Philip
   Eyes bare or only slightly hairy; apical palpal segment grooved (Figs. 25-27); areas of small and large eye facets sharply differentiated in ♂♂ (except in *rugosus* and *willistoni*) ..... *Apatolestes* Williston
5. Stump vein present ..... *Pilimas* Brennan
   Stump vein absent ..... *Stonemyia* Brennan
6. Wings with definite dark patterns; eyes in life (or relaxed) with large, angular spots (Fig. 9) ..... *Chrysops* Meigen
   Wings hyaline or with no more than scattered, small, infuscated spots; eyes in life (or relaxed) with small, scattered, dark spots (Fig. 10) ..... *Silvius* Meigen
7. Scape swollen, much longer than wide (Figs. 48, 49); frons of ♀ widened below, broader than high, with 2 or 3 velvety black spots above basal callus (Figs. 48, 49); flagellum with 3 or 4 annuli; wings with distinct gray-brown to black pattern of small spots and rosettes (Figs. 105, 106) ..... *Haematopota* Meigen
   Scape scarcely longer than wide; frons of ♀ not broader than high, lacking velvety black spots; flagellum with 4 annuli, rarely fewer by apical fusion of annuli (except in *Tabanus fratellus*); wing pattern, if any, not as above ..... 8
8. Vertex with distinct, shiny ocellar tubercle (Fig. 7); eyes usually distinctly pilose; mostly blackish species, many with striking reddish brown side markings on basal abdominal tergites ..... *Hybomitra* Enderlein
   Vertex flat, a denuded ocellar area may be present (*T. laticeps*, *T. stonei*); if ocellar tubercle present in ♂, then it is completely pollinose, not shiny; eyes variable, usually bare (except for *T. laticeps*, *T. stonei* and ♂ *Atylotus*) . . . 9
9. Basicosta bare; tergites III-IV each with 4 apical brown spots on grayish background ..... *Stenotabanus* Lutz
   Basicosta strongly setulose (Fig. 1); tergites III-IV otherwise marked ..... 10
10. A single, narrow, diagonal dark band on eye, often showing in dried specimens (Fig. 50); eyes yellow or brown in dried specimens, distinctly hairy, especially in ♂♂; stump vein usually present (Fig. 1) ..... *Atylotus* Osten Sacken
    Eyes lacking a single, narrow, diagonal band from lower angle of eye in fresh or dried material, several horizontal bands may be present in life or in freshly killed specimens; eyes blackish when dried (certain ♂♂ have only the lower area of small facets black), not hairy (except in *stonei* and *laticeps*); stump vein absent (except in *tetropsis*) ..... *Tabanus* L.

## IMMATURE STAGES

### Habits and Bionomics

Tabanids lay egg masses on plants, stones, and other objects above aquatic, semiaquatic and, to a lesser extent, terrestrial habitats. Their single- or multi-tiered egg masses (Figs. 107, 108) usually contain from 100 to 800 eggs (Stone, 1930). The eggs are cylindrical, tapered at the ends, and 1-2.7 mm long. They are white, yellowish white, light green, reddish brown, or black in different species (Roberts, 1966). Specific characters separating the eggs of most species, however, have not been found.

While most North American tabanid larvae are aquatic or semiaquatic, larvae of some species live in drier soil away from water, for example, in the soils of hardwood forests (Tidwell and Tidwell, 1973), a hillside pasture (Spencer, 1942), a wheatfield (Cameron, 1926), or in the recently discovered habitats of *Brennania hera* in coastal sand dunes, and of *Apatolestes actites* in sandy ocean beaches (Lee et al., 1976).

Some tabanid larvae are adapted to a wide range of habitats whereas others have narrow habitat requirements. In California, Lane (1976) found larvae of *Tabanus punctifer* Osten Sacken in all major semiaquatic habitats studied, but the immatures of 7 of 14 other species were found only in 1 habitat type.

The larvae of most species of Tabanidae, except for the nonfeeding first and second instars (Chvala et al., 1972), are carnivorous. The majority of *Chrysops* larvae are presumably saprophagous (Cameron, 1926; Stone, 1930; Segal, 1936), but their precise diet is largely unknown. Thus, few species of *Chrysops* have been reared from the egg or early instars to adults.

Pupation usually occurs in drier soil near the larval habitat. The pupal period varies from approximately 1 to 3 weeks and is temperature-dependent.

### Collecting and Rearing Techniques

Techniques useful for extracting tabanid immatures from soil or vegetation include handsorting, Berlese

and Tullgren funnels, flotation, and sieving. Their efficiencies for extracting immatures from various substrata are virtually untested, although Lane and Anderson (1976) demonstrated that a sieve was more efficient than Tullgren funnels for extracting late instars of *Chrysops hirsuticallus* Philip from soil samples at 2 known larval densities.[2]

Larvae have been reared in glass beads, agar, sand, paper toweling, filter paper, and soil from the natural habitat. For observing larval activities or determining the number of moults, the use of filter paper, glass beads, or paper toweling as a medium is recommended.

The number of larval instars varies from approximately 7 to 11. Larval development may be completed in as few as 29 days in *Tabanus lineola* Fabricius (= *T. subsimilis subsimilis* Bellardi) (Schwardt, 1931) or may require 2 years or longer in other species. The developmental cycle of *Atylotus miser* Szilady was extended to 7 years in Soboleva's (1970) experiments.

Carnivorous species in captivity can be fed annelids, beef liver, snails, crayfish, coleopterous and dipterous larvae, or other animal proteins. They must be reared individually because they are cannibalistic. A diet rich in organic matter (e.g., vegetative debris from the natural habitat) seems appropriate for larvae of most *Chrysops* species, although *C. vittatus* Wiedemann reportedly was reared from egg to adult on blow fly and cranefly larvae (Logothetis and Schwardt, 1948).

## Morphology of Larvae and Pupae

Mature larvae of Tabanidae in California are ca. 12-50 mm long; white or various shades of yellow, green, or brown; cylindrical, elongate, and fusiform; with a pigmented, retractile, sclerotized head capsule; 3 thoracic and 8 abdominal segments; and a terminal respiratory siphon posterodorsally, with or without a stigmatal spine apically. The first 7 abdominal segments usually have 3 or 4 pairs of pseudopodia anteriorly, but they may be absent on abdominal segments VI and VII (e.g., *Apatolestes actites*). Graber's organ, a muscular, pear-shaped structure situated anterodorsally in the anal segment, is known only from tabanid larvae.

Pupae of Tabanidae in California are ca. 10-33 mm long; usually various shades of brown to nearly black, sometimes shades of green, orange, or yellow; obtect, arched dorsally, and elongate. The head and thorax are closely appressed. Eight abdominal segments are present, the last terminating in an aster composed of 3 pairs of pointed, sclerotized tubercles. Abdominal segments II-VII bear 1 or 2 rows of fringe spines posteriorly on all sclerites, although these may be absent or greatly reduced on part or all of some sternites (e.g., *Silvius* spp.) (Figs. 128, 131).

For a more comprehensive discussion of larval and pupal morphology, the reader is referred to Teskey (1969) and Goodwin and Murdoch (1974).

## Taxonomic studies

Teskey (1969) summarized earlier studies of the immature stages of Tabanidae and presented descriptions of and keys to the larvae and pupae of 81 North American species. Lane (1975) described the larvae and pupae of 10 additional tabanid species from California, and redescribed the larvae and pupae of *Tabanus monoensis* Hine. Burger (1977) described the larvae and pupae of 24 tabanid species in 7 genera and the larvae of 2 pangoniine species in 2 genera from material collected mostly in Arizona. These include 11 species that also occur in California.

A summary of the Tabanidae of California whose immatures have been described is presented in Table 1. Of the 73 species in 11 genera recorded from California, descriptions of the larvae and/or pupae of only 33 species (45.2%) in 6 genera have been published previously, but some of these descriptions are inadequate. Here we give for the first time some descriptive details of the larvae and pupae of *Apatolestes actites* and the pupae of *Brennania hera* (Osten Sacken) (i.e., in the generic keys to larvae and pupae). Further, some supplementary descriptive notes are presented on the immature stages of several species described by Lane (1975). The eggs of only 12 species have been described or otherwise discussed (Table 1).

The following generic keys to the known larvae and pupae of Tabanidae in California are based mainly on the following studies: Webb and Wells (1924); Cameron (1926, 1934); Teskey (1969); Goodwin and Murdoch (1974); Lane (1975); Burger (1977); and the present study. A few potential pitfalls in using the keys have been footnoted. Specific keys to the immature stages were not prepared because of insufficient information.

*Stenotabanus* is not included in the key to larvae because none has been described in the subgenus *Stenotabanus*, to which our only species in California, *S. guttatulus* (Townsend), belongs. Although complete descriptions are available for larvae and pupae of *Stenotabanus* (*Aegialomyia*) *magnicallus* (Stone) (Goodwin, 1974), the immature stages of this species,

2. Lane (1976), based on experiments in 1973, reported that a wire sieve was significantly ($p < 0.05$) more efficient than Tullgren funnels for extracting *C. hirsuticallus* from pond soil at a density of 20 larvae/0.093 $m^2$. However, the funnel experiment was repeated in 1975 with the moisture content of soil samples more carefully controlled, and the difference between the extraction efficiencies of these techniques was not significant (Lane and Anderson, 1976).

TABLE 1. TABANID FAUNA OF CALIFORNIA WITH INDICATION OF SPECIES WHOSE IMMATURE STAGES HAVE BEEN DESCRIBED

| Genus | Immatures Described[1] |
|---|---|
| *Apatolestes* (11 spp.) | *actites*: L, P (present study). |
| *Brennania* (2 spp.) | *hera*: P (present study). |
| *Pilimas* (3 spp.) | — |
| *Stonemyia* (2 spp.) | — |
| *Silvius* (6 spp.) | *notatus*: L, P (Lane, 1975). |
| | *philipi*: L, P (Lane, 1975). |
| | *quadrivittatus*: L, P (Burger, 1977) |
| *Chrysops* (21 spp.) | *aestuans*: E (Hart, 1895); E (Hine, 1906); E, L, P (Cameron, 1926; L, P (Philip, 1931); L, P (Teskey, 1969). |
| | *ater*: L, P (Teskey, 1969) |
| | *clavicornis*: L, P (Lane, 1975) |
| | *coloradensis*: L, P (Lane, 1975); E (present study). |
| | *coquilletti*: L, P (Lane, 1975); L, P (present study). |
| | *discalis*: L, P (Cameron, 1926); L, P (Philip, 1941b); E (Gjullin and Mote, 1945); E (Roth and Lindquist, 1948); E (Knudsen and Rees, 1967). |
| | *excitans*: L, P (Cameron, 1926); L, P (Philip, 1931); L, P (Teskey, 1969). |
| | *fulvaster*: E, L, P (Cameron, 1926). |
| | *furcatus*: E (Miller, 1951); L, P (Teskey, 1969). |
| | *hirsuticallus*: L, P (Lane, 1975); E (present study). |
| | *mitis*: E, L, P (Cameron, 1926); L, P (Philip, 1931); L, P (Teskey, 1969). |
| | *pachycerus* var. *hungerfordi*: L, P (Burger, 1977). |
| | *pechumani*: L, P (Lane, 1975); E (present study). |
| | *proclivis*: L, P (Cameron, 1926).[2] |
| | *surdus*: L, P (Lane, 1975). |
| | *virgulatus*: L, P (Burger, 1977). |
| | *wileyae*: L, P (Lane, 1975); L, P (present study). |
| *Stenotabanus* (1 sp.) | — |
| *Haematopota* (2 spp.) | *americana*: L, P (Cameron, 1926, 1934) |
| *Atylotus* (2 spp.) | *incisuralis*: L, P (Webb and Wells, 1924); L, P (Cameron, 1926); L, P (Burger, 1977). |
| *Tabanus* (10 spp.) | *aegrotus*: L, P (Lane, 1975). |
| | *laticeps*: L, P (Meadows, 1931). |
| | *monoensis*: L, P (Webb and Wells, 1924); L, P (Lane, 1975). |
| | *punctifer*: E, L, P (Webb and Wells, 1924); E (Herms, 1927); E, L, P (Burger, 1977); L, P (Lane, 1975); E (present study). |
| | *similis*: L, P (Tashiro, 1950); E, L, P (Roberts and Dicke, 1964); L, P (Teskey, 1969); L, P (Burger, 1977); L, P (Lane, 1975). |
| | *stonei*: L, P (Burger, 1977). |
| | *subsimilis*[3]: E, L, P (Schwardt, 1931, 1936); L, P (Burger, 1977); L, P (Goodwin, 1967, 1973). |
| *Hybomitra* (13 spp.) | *fulvilateralis*: L, P (Burger, 1977). |
| | *opaca*: P (Philip, 1936a); L, P (Burger, 1977). |
| | *phaenops*: E, L, P (Webb and Wells, 1924); P (Cameron, 1926); L, P (Burger, 1977). |
| | *rhombica*: P (Cameron, 1926). |
| | *tetrica* var. *hirtula*: L, P (Cameron, 1926). |

1. The letters, E, L, P indicate the life stage(s) (Egg, Larva, Pupa) described and/or discussed in each reference cited. Many references to eggs contain information about this life stage (e.g., where deposited, number per mass) but few or no descriptive details.

2. See biology section under *C. proclivis* in text.

3. Description based on the nominate subspecies which has not been recorded from California. The immatures of *T. subsimilis nippontucki* have not been described.

"especially the pupa, are unique and, if the other species of *Aegialomyia* are similar, the group likely should be raised to generic status" (Goodwin and Murdoch, 1974, p. 110). ***Brennania*** is omitted from the larval key for reasons given in the biology section under ***B. hera***.

## KEYS TO KNOWN GENERA OF LARVAL AND PUPAL TABANIDAE IN CALIFORNIA

### *Mature Larvae*

1. Pubescence absent on all body segments; cuticle with a reticular, scalelike pattern intersegmentally and on pseudopodia, encircling segments 1-4 anteriorly and 9-10 posteriorly; abdominal segments 1-5 each with 3 pairs of pseudopodia (rudimentary on 1st abdominal segment); respiratory siphon sessile, with an acuminate lobe dorsally and surrounded by 2 pairs of short, rounded lobes (Fig. 121); mandibles nearly straight ..... *Apatolestes*

   Some pubescence normally present on all body segments (Fig. 115); cuticle without scalelike ornamentation; abdominal segments 1-7 each with 3 or 4 pairs of pseudopodia; respiratory siphon not sessile although its length may be shorter than its basal diameter, without lobes surrounding it; mandibles sickle-shaped ..... 2

2. Cuticular striations extremely fine and narrowly spaced on all body segments (spaced <0.01 mm in *americana*); whitish with faintly contrasting pubescence ..... *Haematopota*

   Cuticular striations more coarsely impressed, spaced at least 0.01-0.02 mm on all or most body aspects where present; color and degree of pigmentation of pubescence variable .. 3

3. Third antennal segment as long or longer than 2nd; respiratory siphon with or without a stigmatal spine[3]; abdominal segments 1-7 each with 3 pairs of pseudopodia (Fig. 115) ..... *Chrysops*

   Third antennal segment shorter than 2nd; respiratory siphon usually without a stigmatal spine[4]; abdominal segments 1-7 each with 3 or 4 pairs of pseudopodia ..... 4

4. Respiratory siphon length about 0.25-0.50 its basal diameter; cuticular striations on all nonpubescent aspects of all body segments, spaced uniformly ..... 5

   Respiratory siphon length generally equal to or greater than its basal diameter; cuticular striations usually absent (sometimes reduced or irregular) dorsally and ventrally from at least thoracic segments, spaced evenly or irregularly elsewhere ..... 6

5. Three pairs of pseudopodia on each of the 1st 7 abdominal segments, pseudopodia tubular (except on abdominal segment 1 and dorsally on segments 2-3) and bearing a circlet of hooklike crochets apically on segments 2-7 (except usually absent from dorsal pair on segment 2); anal segment longer than tall; 3rd antennal segment about 0.7 as long as 2nd segment ..... *Silvius* (*Zeuximyia*)

   Four pairs of pseudopodia on each of the 1st 7 abdominal segments, pseudopodia nontubular and without crochets; anal segment taller than long; 3rd antennal segment about 0.3-0.4 as long as 2nd ..... *Silvius* (*Griseosilvius*)

6. Pubescent markings on median lateral surfaces of anal segment; larva creamy white to yellowish or light green ..... *Atylotus, Tabanus*[5]

   Pubescence absent on median lateral surfaces of anal segment or limited to 2 spots (except in *tetrica* wherein a posterodorsally curved, pubescent bar arises from anal ridge pubescence and reaches siphonal pubescent annulus); larva brownish yellow, greenish to reddish brown, beige, or dark brown ..... *Hybomitra*

### *Pupae*

1. Three pairs of mesonotal setae dorsally (Figs. 132, 133) ..... 2

   Two pairs of mesonotal setae dorsally ..... 3

2. Thoracic spiracles arcuate, without an indentation on convex surface and usually without a produced area on concave surface (Fig. 129); dorsal spines on abdominal segment I bristlelike, nearly of comparable diameter to those on metanotum (Fig. 133) ..... *Brennania*

   Thoracic spiracles with a slight indentation medially on convex surface and a corresponding produced area on concave surface (Fig. 130); dorsal spines on abdominal segment I hairlike, generally much finer than those on metanotum (Fig. 132) ..... *Apatolestes*

3. Callus tubercles bisetose (Fig. 116) ..... 4

   Callus tubercles unisetose (Fig. 124) ..... 5

4. Dorsolateral and lateral preanal combs present; abdominal fringe spines biseriate; 1 pair of basal alar setae ..... *Stenotabanus* (*Stenotabanus*)[6]

   Dorsolateral and lateral preanal combs absent; abdominal fringe spines uniseriate; 2 pairs of basal alar setae..... *Chrysops*[7]

5. Abdominal fringe spines uniseriate; lateral preanal combs absent ..... *Haematopota*

   Abdominal fringe spines biseriate; lateral preanal combs present or absent ..... 6

6. Abdominal segment I with 2 pairs of pleural setae; thoracic spiracles small, less than 0.3 mm long ..... *Silvius*

   Abdominal segment I normally with 3 pairs of pleural setae; thoracic spiracles larger, usually at least 0.4-0.5 mm long..... 7

7. Apices of dorsal and lateral arms of aster forming a straight or nearly straight line in posterior view; dorsolateral and

3. Of the 17 species of *Chrysops* in California whose larvae have been described (Table I), 11 reportedly possess a stigmatal spine (*aestuans, clavicornis, coloradensis, coquilletti, excitans, fulvaster, mitis, pachycerus* var. *hungerfordi, surdus, virgulatus, wileyae*).

4. Ten species of *Tabanus* in North America are known to have a stigmatal spine (Teskey and Burger, 1976), but none of the 7 *Tabanus* species in California whose larvae are known has one.

5. Larvae of *incisuralis* from Arizona are light green (Burger, 1977), whereas those reported as *Tabanus insuetus* ( = *A. incisuralis*) from California and Saskatchewan are yellowish white (Webb and Wells, 1924; Cameron, 1926). The larvae of the 7 *Tabanus* species in California that are known range in color from white to yellowish, but in eastern North America *Tabanus* larvae vary in color from white to yellowish to pale brown or beige (Teskey, 1969).

6. After the pupal description of *S.* (*S.*) *maculifrons* Hine (Goodwin and Murdoch, 1974). The immature stages of *S.* (*S.*) *guttatulus* (Townsend) from California are unknown.

7. Pupae of *Chrysops brunneus* Hine, *C. dixianus* Pechuman, and *C. dorsovittatus* Hine from the southeastern United States are exceptional among known North American *Chrysops* pupae by having unisetose callus tubercles (Goodwin, 1976a).

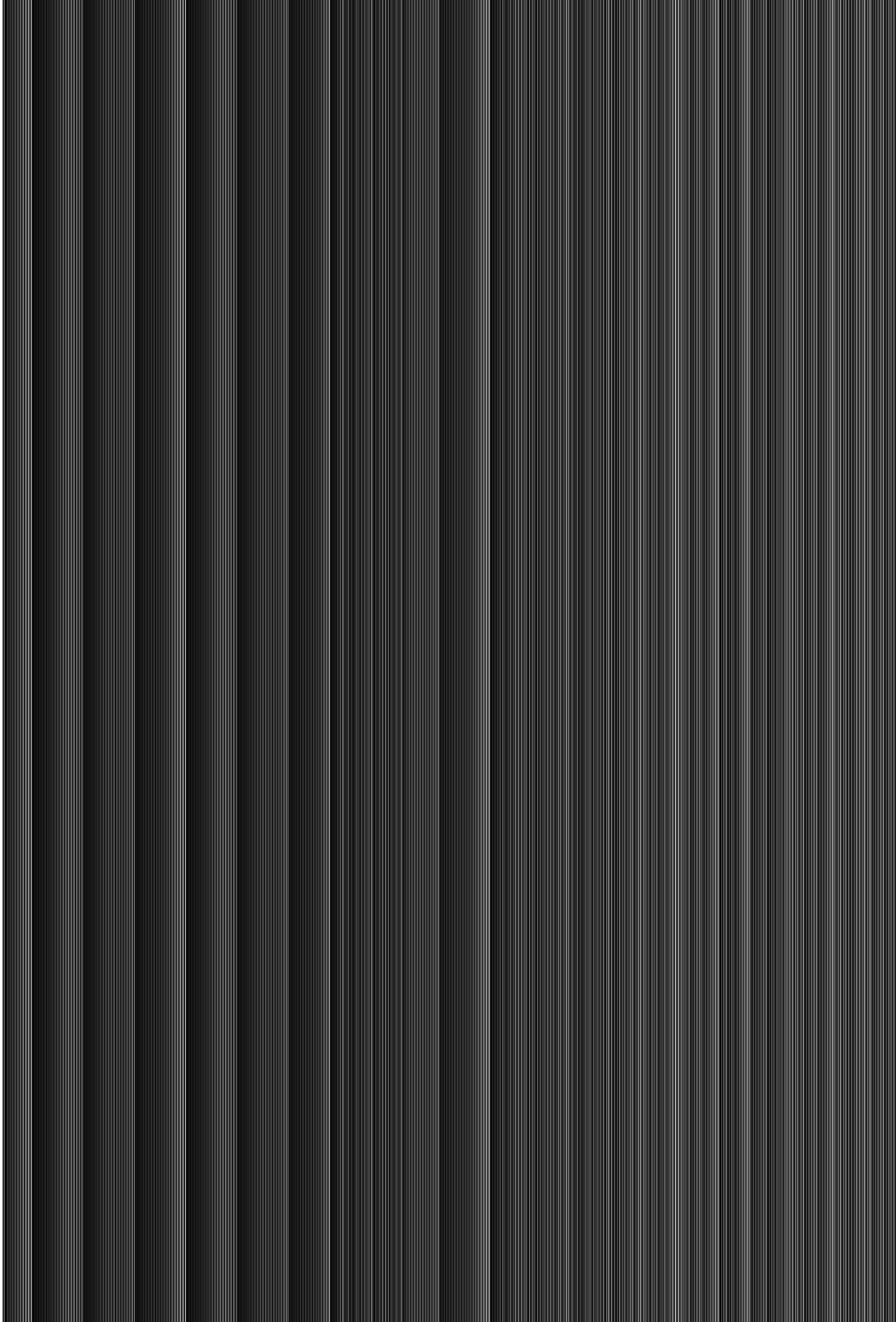
lateral preanal combs usually absent (present but considerably reduced in *incisuralis*) ..... *Atylotus*[8]

Apices of dorsal and lateral arms of aster not forming a straight or nearly straight line in posterior view (except in *T. similis* and *T. subsimilis*); dorsolateral and/or lateral pair of preanal combs usually present, sometimes vestigial ..... 8

8. Abdominal fringe spines of anterior series shorter but of comparable basal diameter to spines of adjacent posterior series ..... *Tabanus*

Abdominal fringe spines of anterior series on 1 or more segments shorter but distinctly stouter than spines of adjacent posterior series ..... *Hybomitra*

8. Key characters are based in part on the description of *incisuralis* from Arizona by Burger (1977). His descriptions of the immatures of this species differ somewhat from those from California and Saskatchewan (Webb and Wells, 1924; Cameron, 1926). Thus, the immatures of more than one species may have been described as *incisuralis*.



# Systematic Treatment/Family Tabanidae

## SUBFAMILY PANGONIINAE

### Tribe PANGONIINI

### Genus *Apatolestes* Williston

*Apatolestes* Williston, 1885:12; Brennan, 1935:370; Philip, 1941a: 187; Philip, 1954:20; Mackerras, 1955:459.

*Type species. Apatolestes comastes* Williston, 1885. Monotypic.

***Apatolestes*** **is a group of primitive species confined to the western United States, northern Mexico, and southwestern Canada. It consists of 11 species and 1 variety, all of which occur in California including 4 species known only from California.**

**The females all have the frons strongly convergent above; ocelli well developed; eyes bare; palpi with a groove; median callus absent; basal callus present; proboscis short and stout, with a large labellum; basicosta bare. Males are similar to females in color and size.**

**Little is known about the biology of most of the adults and even less is known about the immature stages. Females of *comastes* and *rugosus* have been observed taking blood from deer and have been taken in $CO_2$-baited insect flight traps. *A. ater* Brennan and *A. willistoni* Brennan reportedly bite man.**

**The mouthparts of female *A. actites* Philip and Steffan are present and apparently functional, but lack sawlike teeth on the mandible.**

## KEY TO SPECIES OF APATOLESTES IN CALIFORNIA

1. Females; eyes not contiguous ..... 2
   Males; eyes contiguous ..... 13

*Females*

2. Basal callus swollen (ridgelike), extending to eye margin on each side of frons ..... 3
   Basal callus flat, or with a central, bare tubercle (callosity) (Fig. 41) ..... 9
3. Frons below ocelli partly pollinose ..... *hinei* Brennan
   Frons below ocelli bare, shiny ..... 4
4. Body entirely subshining black, the wings smoky .. *ater* Brennan
   Body gray to dull black; only the costal cell or cross veins sometimes infuscated ..... 5
5. Basal callus yellow; body and legs brown ..... *rossi* Philip
   Basal callus normally black; body usually gray ..... 6
6. Costal cell, bifurcation, and cross veins hyaline ..... *comastes* Williston
   Costal cell, bifurcation, and cross veins lightly infuscated (Fig. 113) ..... 7
7. Femora light reddish brown ..... *willistoni* var. *fulvipes* Philip
   Femora dark gray to black ..... 8
8. Subcallus with several transverse wrinkles (Fig. 114); vertex between ocellar area and eye with golden-brown pollinosity; body 11–13 mm long; frontoclypeus sparsely haired .. *rugosus* Middlekauff and Lane
   Subcallus smooth; vertex with gray pollinosity adjacent to eye margin and a less extensive brown area adjacent to ocelli; body 8–11 mm long; frontoclypeus moderately haired .... *willistoni* Brennan
9. Basal callus tuberculate (Fig. 41); apical palpal segment short, swollen (Fig. 25) ..... 10
   Basal callus flat; apical palpal segment elongate ..... 11
10. Appearance black; shiny black notum with narrow gray lines; front tibiae reddish brown, contrasting with the darker femora; ovoid callosity (Fig. 41) ... *actites* Philip and Steffan
    Appearance hoary gray; notum pruinose gray, not shiny; legs unicolorous, light brown; elongate callosity (Fig. 44) .... *colei* Philip
11. Scutellum black or cinereous ..... *villosulus* (Bigot)
    Scutellum yellowish brown ..... 12
12. Flagellum black; front entirely pollinose when not irregularly worn; apical palpal segment about twice as long as wide (Fig. 27), with mostly white hairs ..... *parkeri* Philip
    Flagellum mostly orangish yellow; front with extensive bare area above the subcallus; apical palpal segment elongate (Fig. 26), 3 times longer than wide, with black hairs ..... *albipilosus* Brennan

*Males*

13. Palpal and many pleural hairs black ..... 14
    Palpal and most pleural hairs white or pale ..... 15

14. Femora and antennae black ..... *ater* Brennan
    Femora, scape, and pedicel dull brownish ..... *hinei* Brennan
15. Costal cell distinctly darker than rest of wing ..... 16
    Costal cell completely hyaline, or unicolorous with rest of wing ..... 18
16. Legs almost entirely and uniformly amber-brown ..... *willistoni* var. *fulvipes* Philip
    Femora considerably darker than tibiae ..... 17
17. Small eye facets black, sharply separated from brown area of large facets ..... *willistoni* Brennan
    Small eye facets not clearly separated from the large facets, both areas nearly uniformly brownish black ..... *rugosus* Middlekauff and Lane
18. Scutellum black; wings hyaline, or smoky only on cross veins 19
    Scutellum wholly, or in part, brown; wings lightly fumose ... 22
19. Cross veins of wings with pronounced dark clouds ..... *villosulus* (Bigot)
    Wings hyaline ..... 20
20. Abdominal tergites II and III reddish brown laterally ..... *colei* Philip
    Abdominal tergites black with an overlay of gray pollinosity . 21
21. Face and thorax densely covered with long white hairs that usually obscure the palpal segments; coastal species ..... *actites* Philip and Steffan
    Face and thorax much less densely covered with white hairs; palpal segments easily seen; widespread species ..... *comastes* Williston
22. Apical palpal segment long, slender at least 5X basal width; the basal segment not bulbous; area of large eye facets sharply separated from small eye facets ..... *rossi* Philip
    Apical palpal segment short, about twice as long as basal width; the basal segment bulbous; area of large eye facets blending into area of small facets ..... *parkeri* Philip

## *Apatolestes actites* Philip and Steffan (Figs. 14, 25, 41, 121, 130, 132; Map 1)

*Apatolestes actites* Philip and Steffan, 1962:41. Type, ♀, Goleta, Santa Barbara Co., California.

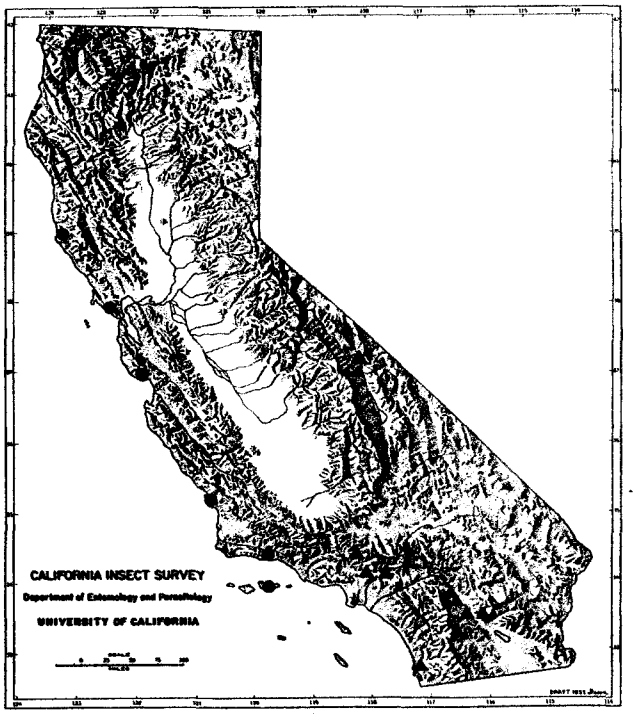
*Geographic range*—Coastal California from Mendocino County south to Santa Barbara County and Santa Cruz Island.

*California distribution*—Map 1. MARIN Co.: *Bolinas Point, 1.6 mi. W. Bolinas*, 2 ♂♂ VII-12-70, sand beach (V. F. Lee, CIS); 1 ♂, 6 ♀♀, VII-4-75, sand beach (W. W. Middlekauff, CIS); 1 ♂, 1 ♀, VII-7-74, sand beach (V. F. Lee, CAS); 1 ♀, VI-16-74 (V. F. Lee, CAS). MENDOCINO Co.: *Manchester Beach*, mouth of *Mallow Pass Cr.*, pupal case, VII-14-75, gravel type beach (V. F. Lee, CAS). SAN LUIS OBISPO Co.: *Montana de Oro State Park*, 1 ♀ (teneral), V-20-65 (E. Perry, CDHB). SANTA BARBARA Co.: *Goleta*, 1 ♀ (holotype), VI-22-59 (F. D. Parker, CAS). *Santa Cruz Island, Saucies Beach*, 1 ♀, V-14-69 (D. C. Horning, UCD). SANTA CRUZ Co.: *Davenport*, 1 ♂ (allotype), VI-14, 20 (M. T. James, USNM).

*Seasonal occurrence*—Mid-May to late July.

*Discussion*—Length: Female 16-17 mm.

A large, grayish black, shaggy, white-haired *Apatolestes* not likely to be confused with other *Apatolestes*. The mandibles of the females are thin, bladelike, smooth, and lack both hairs and small teeth.




MAP 1. Distribution in California of: *Apatolestes actites* Philip and Steffan ●; and *A. ater* Brennan ▲.

Male: Similar to female except somewhat more shaggy-haired.

*Biology*—The suspected beach habitation of *actites* was confirmed by Lee et al. (1976). Adults were collected on a beach near Bolinas Point, Marin County, from June to about mid-August with most records occurring in early July. They were more prevalent below the high-tide mark where clumps of seaweed were present. When disturbed they flew off rapidly close to the ground for several seconds before landing again.

Larvae of *actites* (Fig. 121) were collected from beaches at the above site by Lane and V. F. Lee, and at Manchester State Beach, Mendocino Co., by Lee. They were found in the supralittoral zone in slightly damp sand approximately 8 to 13 cm deep. At Bolinas, 3 larvae were collected about 26.5 m from waterline, which was three-fifths the distance from shore to the base of a bluff. Numerous pupal exuviae of *actites* were found on sand among driftwood, and several desiccated pupae were obtained by digging; at Bolinas on 6 July 1976, an *actites* ♀ was observed abortively trying to extricate itself from its pupal case.

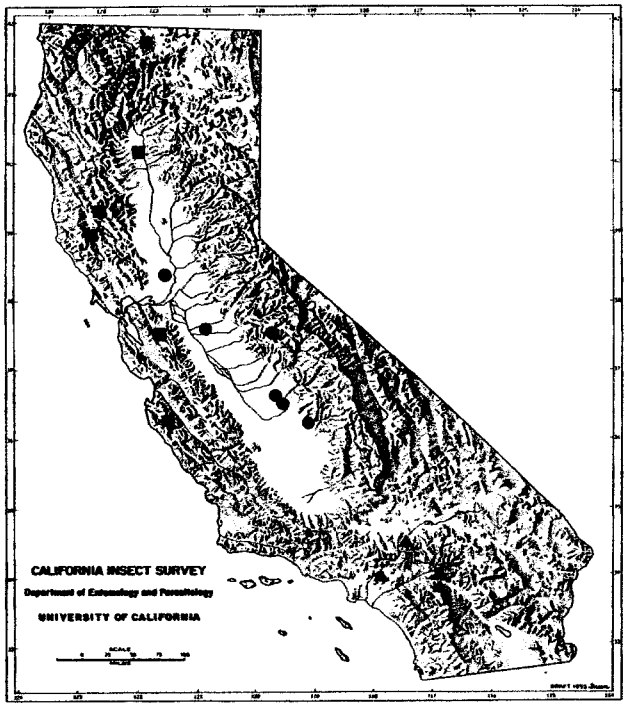
Examination of 2 pupae (Figs. 130, 132) that were reared from larvae collected at the Bolinas and Manchester State Beach collection sites revealed that they

are similar to the pupal skin associated with the *actites* ♀. These associations establish that the pangoniine larvae found at Bolinas and Manchester State Beach are those of *actites* even though none was reared to an adult. The immature stages of the other psammophilous tabanid species known from coastal Marin County, *Brennania hera*, have been obtained by Lane only from sand dunes in the Point Reyes National Seashore.

Ten immature *actites* larvae (18–27.5 mm long) were extracted from sand with a wire sieve in July 1976 at Bolinas Point. These were taken from the supralittoral zone.

Since these *actites* larvae are too large to have hatched in 1976 and too immature to complete development before 1977 (mature larvae are about 34–41 mm long), it seems likely that *actites* larvae must overwinter at least twice before attaining maturity.

This habitat is markedly depauperate in potential prey. The only other invertebrates extracted in the sieve samples were an adult histerid beetle and an isopod, *Alloniscus perconvexus* Dana. In comparison, the larval habitat of *Brennania hera*, i.e., coastal sand dunes, contains a wide variety of adult and immature insects. In the laboratory, larvae of both *A. actites* and *B. hera* feed readily on mealworms, *Tenebrio molitor* L.




MAP 2. Distribution in California of: *Apatolestes albipilosus* Brennan ●; *A. colei* Philip ▲; and *A. rugosus* Middlekauff and Lane ■.

### *Apatolestes albipilosus* Brennan (Fig. 26; Map 2)

*Apatolestes albipilosus* Brennan, 1935:371. Type, ♀, Lemoncove, California.

*Geographic range*—California, Oregon.

*California distribution*—Map 2. San Joaquin Valley and adjacent low-elevation foothills to the east. FRESNO Co.: *Reedley*, 1 ♀, VII-20-50 (Hall, CIS), *Fresno*, 1 ♀ (paratype), VII-15-22 (USNM). MARIPOSA Co.: *Yosemite Nat'l. Park*, 1 ♀, VII-24-48 (CAS). *Yosemite Val.*, 1 ♀, VI-28-21 (E. C. VanDyke, CDA). STANISLAUS Co.: *Modesto*, 1 ♂, VII-28-58 (R. P. Allen, CAS). TULARE Co.: *Lemoncove*, 1 ♀ (holotype), VII-26-29 (R. H. Beamer, U. Kansas).

*Seasonal occurrence*—Late June to end of July.

*Discussion*—Length: Female 14–15 mm.

Light brown with some gray pruinosity; wings lightly fumose, darker at the costal margin and along the veins; flagellum orangish yellow; frons narrow, nearly twice as high as basal width; an extensive bare area above the subcallus; apical palpal segment with black hairs. Most likely to be confused with *A. parkeri* but the above characteristics will serve to distinguish it.

Male: Unknown.

*Biology*—Unknown.

### *Apatolestes ater* Brennan (Map 1)

*Apatolestes ater* Brennan, 1935:371. Type, ♀, San Diego, California.

*Geographic range*—California.

*California distribution (counties)*—Map 1. Inyo, Los Angeles, Mono, Riverside, San Diego.

*Seasonal occurrence*—Late May to end of July.

*Discussion*—Length: Female 13 mm.

The shiny black appearance of the body, smoky wings, and white pilosity apically on the abdominal tergites should suffice to distinguish this species from other *Apatolestes*.

*Biology*—A female was taken while biting a human near Lake Fulmore, San Jacinto Mts., Riverside Co., July 1964.

### *Apatolestes colei* Philip (Fig. 44; Map 2)

*Apatolestes colei* Philip, 1941e:192. Type, ♀, La Quinta, California.

*Geographic range*—California, Baja California Norte.

*California distribution*—Map 2. RIVERSIDE Co.: *Banning*, 1 ♂, VI-27-52 (B. Tinglof, CAS). *Elsinore*, 7 mi. S., 1 ♂, VI-30-62 (J. Lawrence, CIS). *La Quinta* (near Santa Ana wash, ± halfway between Redlands and San Bernardino), 1 ♀, (holotype), VII-15-20 (F. C. Cole, CAS). SAN BERNARDINO Co.: *Deep Creek Public Camp*,

4 ♂♂, VI-15-57 (Menke and Stange, LACM). *Oro Grande*, 1 ♀, VI-20-31 (L. L. Pechuman).

*Seasonal occurrence*—First week of June to mid-July.

*Discussion*—Length: Female 15–16 mm.

A large, southern California, inland species closely related to *A. actites*. Both have the frons very wide, the basal width and height nearly equal; a long, narrow, bare brown streak on the middle of the frons nearly two-thirds its height; and markedly swollen genae.

*A. colei* can readily be separated from *actites* on the basis of the distributional pattern (Maps 1, 2); the brown rather than black notum; the unicolorous light brown legs, and the beige rather than gray pollinosity of the face.

Male: The smaller males superficially resemble the females.

*Biology*—Unknown.

### *Apatolestes comastes* Williston (Map 4)

*Apatolestes comastes* Williston, 1885:12. Syntypes, 2 ♀♀, California.

*Geographic range*—Widespread from British Columbia to California, Arizona, and Montana.

*California distribution (counties)*—Map 4. El Dorado, Inyo, Kern, Lassen, Marin, Mariposa, Mono, Riverside, San Bernardino, San Diego, Sonoma, Stanislaus, Tulare, Tuolumne.

*Seasonal occurrence*—Scattered records from the last week of April to first week of August.

*Discussion*—Length: Female 8–11 mm.

The shiny black frons, and swollen basal callus which extends ridgelike to the eye margin; gray to dull black body; and the wings with costal cell, bifurcation, and cross veins hyaline, will serve to distinguish *comastes* from closely related species.

*Biology*—Unknown.

### *Apatolestes hinei* Brennan (Map 3)

*Apatolestes hinei* Brennan, 1935:374. Type, ♀, San Jacinto Mts., California.

*Geographic range*—California, Nevada.*

*California distribution (counties)*—Map 3. Inyo, Los Angeles, Mariposa, Monterey, Riverside, San Bernardino, San Diego, Santa Barbara.

*Seasonal occurrence*—From April 17 (Death Valley) to August 10 (Monterey County).

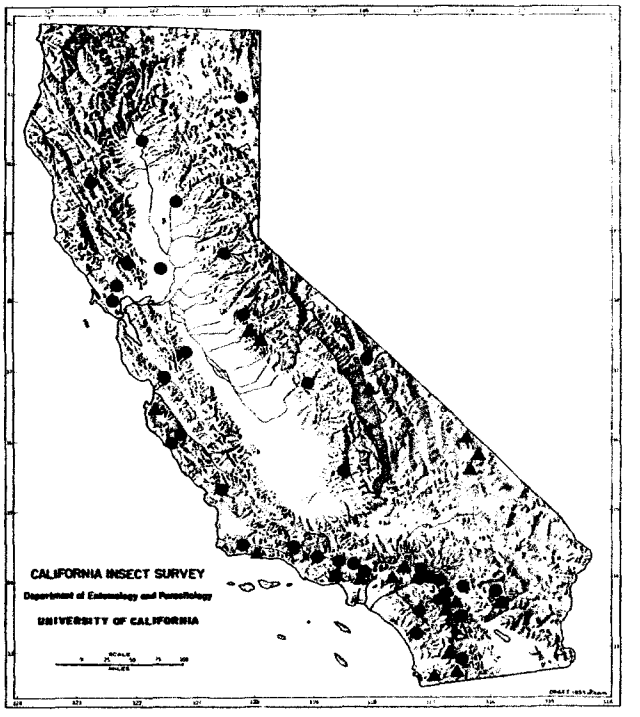
*Discussion*—Length: Female 12–14 mm.

Characteristics which distinguish this widespread, but uncommon species are as follows: body grayish brown; abdominal tergites with pale posterior margins; frons partly pollinose; basal callus slightly ridgelike extending laterally to eye margins; wings fumose; yellow facial regions with fulvous pile.

Male: The brown color of the femora and antennae will separate *hinei* from the blackish *ater*.

*Biology*—Unknown.

*New state record.




MAP 3. Distribution in California of: *Apatolestes willistoni* Brennan ●; and *A. hinei* Brennan ▲.

### *Apatolestes parkeri* Philip (Fig. 27; Map 4)

*Apatolestes parkeri* Philip, 1941a:193. Type, ♀, Ehrenberg, Arizona.

*Geographic range*—Arizona, California.

*California distribution*—Map 4. Desert areas of Imperial and Riverside Counties.

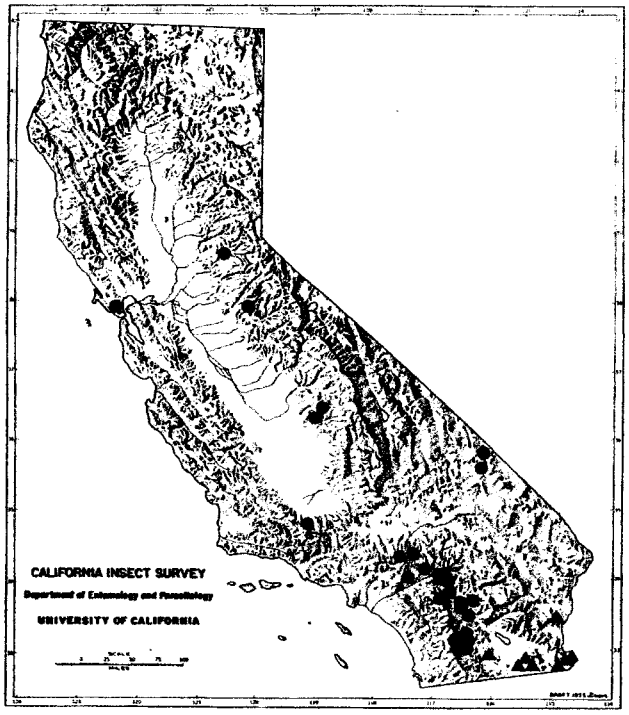
*Seasonal occurrence*—Early June to early August.

*Discussion*—Length: Female 13–14 mm.

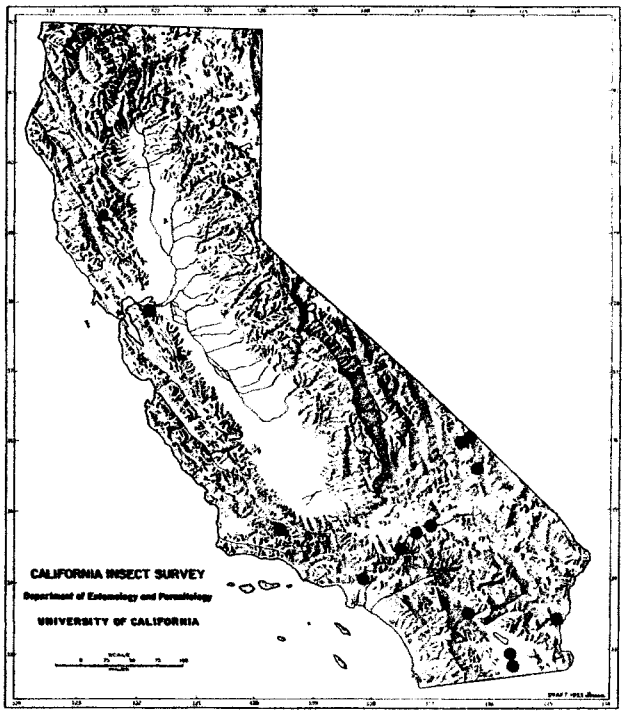
Light brown, superficially resembling *albipilosus*. The black flagellum and shortened palpi with mostly white hairs will separate this species from *albipilosus*.

Male: The bulbous basal palpal segment and less attenuated apical one will readily separate *parkeri* from *rossi*.

*Biology*—This species lives in low, hot, desert regions




MAP 4. Distribution in California of: *Apatolestes comastes* Williston ●; and *A. parkeri* Philip *.




MAP 5. Distribution in California of: *Apatolestes villosulus* (Bigot) ●; *A. rossi* Philip ▲.

and is active at low light intensities. Specimens have been taken when attracted to artificial lights.

### *Apatolestes rossi* Philip
### (Map 5)

*Apatolestes rossi* Philip, 1950a:451. Type, ♀, Hullville, Lake Co., California.

*Apatolestes comastes*; Middlekauff, 1950 (not Williston, 1885) (in part, Lake Co. record).

*Geographic range*—California.

*California distribution*—Map 5. LAKE Co.: *Hullville*, 1 ♀ (holotype), VI-14-17 (Blaisdell, CAS); 1 ♂, (allotype), same data; 1 ♀, VI-1917 (C. D. de B. Reynolds, CIS). (The town of Hullville now lies beneath Lake Pillsbury). MARIPOSA Co.: *Morman Bar*, 1 ♀, (paratype of *Apatolestes comastes fulvipes* Philip) (B. Brookman, T. Aitken, M. Cazier, CAS).

*Seasonal occurrence*—June.

*Discussion*—Length: Female 12 mm.

Body and legs uniformly brown; abdominal tergites with narrow, pale posterior margins; basal callus yellow, shiny, swollen, and ridgelike, extending laterally to eye margins; wings (teneral specimen) lightly clouded; frons below ocelli, shiny, not pollinose, with a few pale hairs laterally above basal callus. Superficially resembles *colei* but lacks the pollinose frons.

Male: It can be separated from the desert-inhabiting *parkeri* by the long, attenuated apical palpal segment, and the unswollen basal one.

*Biology*—Unknown.

### *Apatolestes rugosus* Middlekauff and Lane
### (Figs. 113, 114; Map 2)

*Apatolestes rugosus* Middlekauff and Lane, 1976:311. Type, ♀, Hopland, Mendocino County, California.

*Geographic range*—California.

*California distribution (counties)*—Map 2. Alameda, Lake, Mendocino, Monterey, Siskiyou, Tehama.

*Seasonal occurrence*—Last week of May to late August.

*Discussion*—Length: Female 12 mm (holotype).

A grayish black species closely related to *willistoni*, but can be distinguished in the female by its larger size, wrinkled (rugose) subcallus (Fig. 114), extensive brown pollinosity lateral to ocelli, and less hairy frontoclypeus. The male has the area of the small eye facets blending into the area of the large facets. The male of *willistoni* has a sharp line of demarcation between these faceted areas.

*Biology—A. rugosus* has been observed mating on a hilltop at the University of California, Hopland Field Station, Mendocino County (J. R. Anderson, personal communication). Females reportedly feed upon blacktailed deer (Anderson et al., 1974).

### *Apatolestes villosulus* (Bigot) (Map 5)

*Tabanus villosulus* Bigot, 1892:684. Type, ♀, California.
*Apatolestes similis* Brennan, 1935:374. Type, ♀, Los Angeles County, California.

*Geographic range*—Baja California Norte, Arizona, California, Utah.

*California distribution*—Map 5. CONTRA COSTA CO.: *Antioch*, 1 ♂, IX-8-48 (P. D. Hurd, CIS); 1 ♀, VII-6-38 (M. Cazier, CAS); 1 ♀, IX-21-59 (J. M. Burns, CIS). IMPERIAL CO.: *Brawley*, 1 ♀, VI-22-59 (Harrison, UCD). *El Centro*, 1 ♂, VI-12-59 (C. R. Wagoner, UCD). INYO CO.: *Death Valley, .3 mi. N. Bennett's Well*, 1 ♀, IV-17-73 (UCR). *Death Valley Jct.*, 1 ♂, 4 ♀♀, VI-17-54 (Belkin and McDonald, LACM). LOS ANGELES CO.: ♀ (holotype of *similis*), July (USNM); ♂ (allotype), same data (USNM). *Llano, 9 mi. N.*, 1 ♀, VII-2-58 (J. C. Hall, CAS). RIVERSIDE CO.: *Blythe*, 1 ♂, V-23-63 (R. M. Hardman, UCD). *Deep Canyon*, 4 ♂♂, VII-11-65 (UCR); 1 ♀, VII-11-63 (UCR). *Palm Springs*, 1 ♂, V-29-39 (W. A. Fitschen, CAS). SAN BERNARDINO CO.: *Yermo*, 1 ♂, V-23-40 (Reeves, Cazier, Ting, CAS). *Death Valley, Saratoga Springs*, 12 ♀♀, V-27-55 (J. N. Belkin, LACM). *Victorville*, 1 ♂, VII-25-58 (P. D. Hurd, CIS). SANTA BARBARA CO.: *Cuyama Val.*, 1 ♀, VI-23-52 (UCR).

*Seasonal occurrence*—From mid-April (Death Valley) through July. July and September records from Antioch, Contra Costa County, where the species probably is extinct now.

*Discussion*—Length: Female 13.5 mm.

A rather large, dark brown and gray species that is not likely to be confused with other *Apatolestes*. It shares with *parkeri* and *albipilosus* a flat basal callus, but differs in being much darker with contrasting, pale abdominal incisures; a unique broad, denuded, brown, mid-frontal streak; a black or cinereous scutellum, and subhyaline wings with infuscated bifurcation and cross veins.

*Biology*—Unknown.

### *Apatolestes willistoni* Brennan, new status (Fig. 12; Map 3)

*Apatolestes comastes* var. *willistoni* Brennan, 1935:373. Type, ♀, San Diego County, California.
*Apatolestes comastes* var. *fulvipes* Philip, 1960:364. Type, ♀, Red Bluff, Tehama County, California. NEW SYNONYMY.

*Geographic range*—Baja California Norte (Philip, 1975b), Arizona, California, Oregon.

*California distribution (counties)*—Map 3. Contra Costa, El Dorado, Fresno, Inyo, Kern, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Monterey, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Santa Clara, Sonoma, Stanislaus, Tehama, Tulare, Tuolumne, Ventura, Yolo.

*Seasonal occurrence*—Early April to mid-August.

*Discussion*—Length: Female 9-12 mm.

Easily distinguished from *comastes* by the infuscated costal cell, and the preponderance of black hairs on the apical palpal segment. The less rugose subcallus, lesser amount of golden brown pollinosity on vertex, and somewhat more densely haired frontoclypeus will distinguish it from *rugosus*; the area of small facets in *willistoni* is sharply demarcated from the area of large facets. This feature is much less sharply defined in *rugosus* males.

The variety *fulvipes* is distinguished in both sexes from the typical form by the unicolorous, bright tawny legs. The infuscation of the costal cell and cross veins indicate a close resemblance to *willistoni* rather than to *comastes*. Both forms have been collected in Mendocino, Riverside, Sonoma, Ventura, and Yolo counties. Therefore, there is no indication that *fulvipes* represents a geographic segregate.

*Biology*—There are several reports of this fly biting humans in California.

## Genus *Brennania* Philip

*Apatolestes*, subg. *Comops* Brennan, 1935:375 (preoccupied).
*Brennania* Philip, 1941a:196, new name.

*Type species*—*Pangonia hera* Osten Sacken, 1977. Monotypic.

Related to *Apatolestes*, from which it can be differentiated by the strongly haired eyes and the apical palpal segment with a pit.

## KEY TO CALIFORNIA SPECIES OF BRENNANIA

1. Pile on head and thorax straw yellow; bright orange pile on abdomen; apical palpal segment long and attenuated apically; palpal pit elongate; cell $R_5$ not constricted at wing margin ..... *belkini* (Philip)
   Pile on head and thorax darker, yellowish brown; similarly colored pile on abdomen; apical palpal segment short and blunt apically (Fig. 28); palpal pit small, round; cell $R_5$ slightly constricted at wing margin ..... *hera* (Osten Sacken)

### *Brennania belkini* (Philip) (Map 9)

*Apatolestes belkini* Philip, 1966:525. Type, ♀, Ensenada, Baja California Norte.

*Geographic range*—California, Baja California Norte.

*California distribution*—Map 9. LOS ANGELES CO.: *Inglewood*, 1 ♂, VI-30-58 (J. Robertson, LACM). *Manhattan Beach*, 1 ♀, 4-49 (L. L. Pechuman). *Playa del Rey*, 1 ♂, VI-7-47, misc. sweeping top of dune (student collection, L. L. Pechuman). *El Segundo*, 1 ♂, VII-15-53, sand dunes (L. L. Pechuman); 1 ♀, VII-17-75 (J. Powell, CIS).

*Seasonal occurrence*—The few records available indicate that this is an early season (late May to mid-July) species.

*Discussion*—Length: Female 11-16 mm.

A large, bicolored, hirsute species, superficially resembling the oestrid *Cephenemyia*, with straw yellow

pile on thorax and bright orange pile on abdomen. The appendages, including the halteres, are dark brown to black. Other characters listed in the key will readily separate this species from *hera*.

Male: Length: 13–17 mm. Not previously described, may be characterized as follows: similar to female in most respects except for sexual differences. Wings smoky; eyes distinctly pilose, the area of small facets clearly demarcated from the area of large facets; basal palpal segment bulbous, the apical one long (1.25 mm) and attenuated, both thickly clothed with long, black hairs; abdomen (unlike the teneral holotype female) is black, thickly covered with pale, golden yellow hairs.

*Biology*—Data on labels suggest that *belkini* inhabits sand dunes.

### *Brennania hera* (Osten Sacken)
### (Figs. 15, 28, 45, 129, 133; Map 8)

*Pangonia hera* Osten Sacken, 1877:214. Type, ♀, San Francisco, California.

*Brennania hera*, Philip, 1941a:196.

*Brennania hera fusca* Philip, 1954:19. Type, ♀, San Francisco, California. NEW SYNONYMY.

*Geographic range*—Coastal sand dunes of California. Marin County south to San Miguel Island and San Luis Obispo County.

*California distribution (counties)*—Map 8. Marin, Monterey, San Francisco, San Luis Obispo, San Mateo, Santa Barbara (San Miguel Island). Cole (1969) reports a Pasadena record, but we have not seen the specimen.

*Seasonal occurrence*—Except for two specimens collected in mid- to late June, our records show this species to be on the wing from mid-July through August.

*Discussion*—Length: Female 11–14 mm.

Philip (1954) proposed the subspecific name *fusca* for a dark variant taken from the same locality (San Francisco) as the nominate *hera*. Philip later (1965a) recorded *fusca* as a variety of *hera*. It does not represent a separate population since both the pale and dark forms were taken at the same time at Point Reyes National Seashore in August 1975, and a dark male and pale female were seen *in copulo* in July 1976.

This is a distinctive species. Dissection of the female head reveals fully formed, but short mouthparts. The tip of the mandibles lacks small, sawlike teeth such as are present in *Hybomitra phaenops*, a known blood sucker. Numerous short hairs are present on the tips of the mandibles.

*Biology*—There are two males in the California Academy of Sciences that were removed from the nest of the sandwasp *Epibembex comata* (Parker) on a San Francisco sand dune. This wasp normally provisions its nest with cyclorrhaphous Diptera.

P. Opler (personal communication) observed a mating pair on a low ridge behind a beach at Point Reyes National Seashore, Marin County. Males hovered about 30–45 cm above the ground and periodically alighted on perches.

In 1975, Lane collected pangoniine larvae (tribe Pangoniini) presumed to be those of *hera* in firm, slightly damp sand 20–32 cm deep in a coastal dune in the Point Reyes National Seashore. Approximately 20 pangoniine pupal skins also were taken from sand nearby. Two pupae (1 living) were collected in sand 18 cm deep at the latter site. The living pupa died within several days.

On 16 July 1976, 5 persons netted 22 *hera* adults (20 ♂♂, 2 ♀♀) at the same dune system. Most flight activity seemed to end about 1100 h. Two flies were observed *in copulo* at 1013 h on sand; the female was the light form and the male the dark form. The other 20 flies taken also were the dark form. The weather was overcast, cool (16.7°C), and windy. Kaufeldt (1955) observed *hera* mating "in the cove" of a San Francisco coastal sand dune on 15 and 21 July 1952 but presented no details.

Sampling for *hera* immatures on 16 July 1976 yielded 6 pangoniine larvae, 9 pupae (8 living), and several pupal exuviae. Males of *hera* (dark form) emerged from 3 of the 8 pupae. Larvae and pupae were found by searching the surface for pupal exuviae and then sieving the soil beneath them to depths of about 30 to 40 cm. It was impossible to determine at what depths the immatures occurred because the sand was nearly dry and frequently collapsed during digging. Sites productive for *hera* immatures were sandy areas on gradual slopes bordered by such plants as *Grindelia stricta* DC, *Lupinus arboreus* Sims, *Eriogonum latifolium* Sm., *Mesembryanthemum chilense* Mol.

Characters given in the key will distinguish pupae of *hera* from those of *Apatolestes actites*. Pupae of *hera* and *actites* possess those characters listed by Teskey (1969) as linking pupae of the 3 species in the tribe Pangoniini that have been described, i.e., *Esenbeckia incisuralis* (Say) (Jones, 1956), *Ectenopsis vulpecula* var. *angusta* Macquart (English, 1953), and *Caenoprosopon trichocerus* (Bigot) (English, 1961).[9] These include ". . . the presence of prominent tubercles, three pairs of dorsal setae on each of the mesothorax, metathorax, and first abdominal segments, and biseriate abdominal fringes of spines."

9. More recently, larvae and pupae of *Stonemyia yezoensis* (Shiraki) have been described by Japanese workers (*In* Burger, 1977), but according to Burger their descriptions are not detailed enough to compare this species with other known Pangoniini. Burger (1977) described for the first time the unreared larvae of 2 pangoniine species presumed to be *Apatolestes ?comastes* Williston and *Esenbeckia delta* (Hine).

Although circumstantial evidence strongly suggests that the pangoniine larvae found at Point Reyes are those of *hera*, they are not included in the generic key because none was successfully reared.

## Genus *Pilimas* Brennan

*Pilimas* Brennan, *In* Philip 1941a:130.

*Type species—Diatomineura californica* Bigot, 1892. Original designation.

Medium (11 mm) to large sized (16 mm); frons narrow, entirely pollinose; median and basal calli absent; proboscis half to nearly as long as head; eyes slightly hairy. Distribution entirely western. See discussion of *Stonemyia*.

The species of this genus are not known to suck blood. Several museum specimens have pollen grains on the hairy face and thorax, which indicates flower visitation.

## KEY TO CALIFORNIA SPECIES OF PILIMAS

1. Females; eyes not contiguous ..... 2
   Males; eyes contiguous ..... 4

*Females*

2. Abdominal tergites with contrasting bands of basally dark, and apically golden yellow hair; integument of notum brownish black; resembling a honey bee in general appearance ..... *californica* (Bigot)
   Integument of entire body concolorous, straw yellow..... 3
3. Scape longer than thick ..... *ruficornis* (Bigot)
   Scape with length and thickness subequal..... *abaureus* (Philip)

*Males*

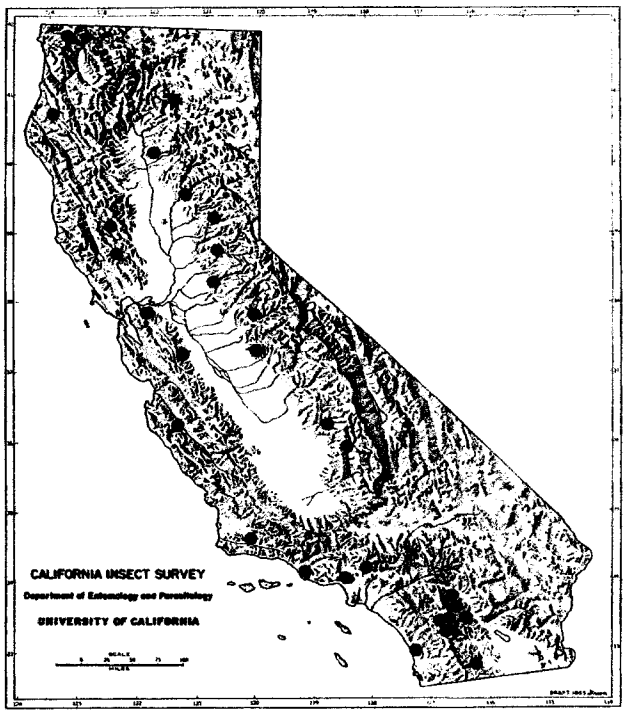
4. Integument of body, legs, and antennae concolorous straw yellow ..... *abaureus* (Philip)
   Entire thorax, and at least the coxae, dark brown to black... 5
5. Scape and pedicel with many black hairs; flagellum dark; scape no longer than wide, the sides divergent apically... *californica* (Bigot)
   Scape and pedicel with pale hairs; flagellum concolorous with scape and pedicel; scape longer than wide, sides parallel . *ruficornis* (Bigot)

### *Pilimas abaureus* (Philip)

*Stonemyia abaureus* Philip, 1941a:114. Type, ♂, Patrick Creek, Del Norte County, California.

*Geographic range*—California, Baja California Norte (Philip, 1975b).

*California distribution*—Map 6. Widespread throughout cismontane California. Absent from the Central Valley, the higher elevations of the Sierra Nevada, east of the Sierra, and the desert areas of southern California.




MAP 6. Distribution in California of *Pilimas abaureus* (Philip).

*Seasonal occurrence*—Last of May to third week of August. Most commonly in late June, early July.

*Discussion*—Length: Female 14.5 mm.

Females of *abaureus* are extremely difficult to separate from those of *ruficornis*. In general they have scapes as wide as long, while those of *ruficornis* are slightly longer than wide. In the absence of associated males it is probably unwise to attempt to identify females.

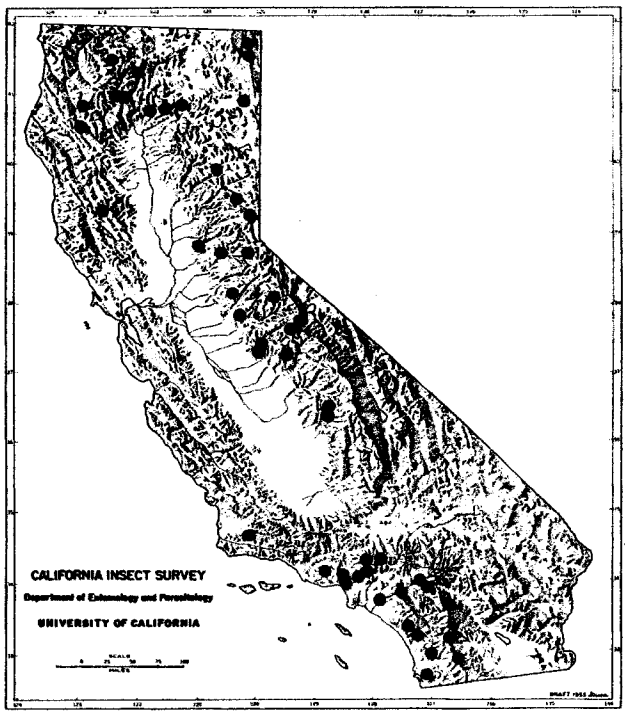
*Biology*—Unknown. Aitken collected 2 males from blossoms of *Eriogonum fasciculatum* Benth., and a female was taken from the flowers of toyon, *Heteromeles* ( = *Photinia*) *arbutifolia* M. Roem (Philip 1941a).

### *Pilimas californica* (Bigot)
### (Figs. 3, 16, 31, 42; Map 7)

*Pangonia dives* Williston, 1887:130 (preoccupied). California.
*Diatomineura californica* Bigot, 1892:618. Type, ♂, California.
*Silvius jonesi* Cresson, 1919:175. Type, ♀, California.
*Pilimas californicus* var. *beameri* Philip, 1965a:321. Type, ♀, Colton, California. NEW SYNONYMY.

*Geographic range*—British Columbia, California, Idaho, Montana, Oregon, Utah, Washington.

*California distribution*—Map 7. Widespread throughout most of cismontane California, except in the Coast Range south of Lake and




MAP 7. Distribution in California of *Pilimas californica* (Bigot).

north of Ventura counties. Also absent from east of the Sierra crest and the eastern portion of southern California.

*Seasonal occurrence*—Early June to late August. Most commonly taken in July.

*Discussion*—Length: Female 14 mm.

Philip (1942a) described a paler color variant of *californica* from S.E. California as *P. beameri*, and later (1965a) changed it to a variety. There is a pale ♀ specimen in the California Insect Survey from Blodgett Forest in El Dorado County which was taken on the same date and by the same collector as were darker spec-imens. The former could be identified as var. *beameri*, the latter as *californica*. No clear-cut, non-integrating characters can be found. Until additional material suggests otherwise, the name *beameri* is treated as a synonym.

Typical specimens have the body thickly clothed with hair. Each abdominal tergite is bicolored, the basal half dark and the distal half light, with correspondingly colored hair. The body coloration, pilosity, and size give the appearance of the common honey bee. Males constitute two-thirds of all specimens seen in museum collections.

*Biology*—A few individuals have been collected at incandescent lights, others swept from flowers, or taken while hovering during their mating flight. There is no evidence of haematophagy.

In 1955, E. Lindquist (personal communication) noticed a group of males hovering 1.5–4.6 m above a dirt logging road near Coffee Creek Ranger Station in Trinity County from 1000–1100 h. Each male seemed to exhibit territoriality, and attacked or fought with other trespassing males. If missed with an insect net or disturbed by a logging truck, males returned to the same spot in about one minute. The swarms consisted of 4–6 individuals strung out along the road.

Philip (1978) identified males that had been collected while hovering above a 300 foot giant sequoia tree near Sequoia National Park.

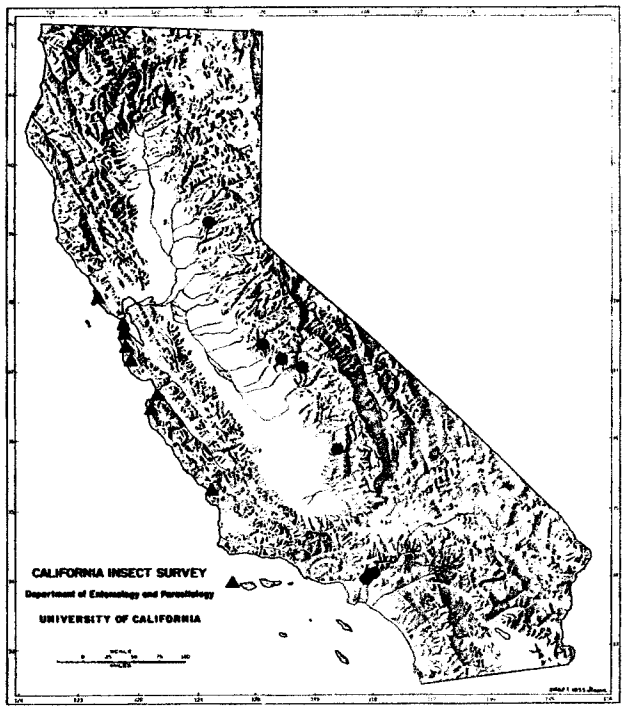
R. G. Howell collected a female near Quincy, Plumas County, in 1949 that was "ovipositing in water like a dragonfly" (Middlekauff, 1950). This phenomenon of dipping the abdomen in water, the purpose of which is unknown, has been noted previously (Hine, 1906).

### *Pilimas ruficornis* (Bigot)

*Corizoneura ruficornis* Bigot, 1892:615. Syntypes, 2 ♂♂, California.

*Geographic range*—California.

*California distribution (counties)*—Map 8. Fresno[10], Los Angeles, *Madera*, *Mariposa*, Nevada, *Shasta*, Tulare.




MAP 8. Distribution in California of: *Pilimas ruficornis* (Bigot) ●; and *Brennania hera* (Osten Sacken) ▲.

10. Because females of *ruficornis* cannot be separated with certainty from those of *P. abaureus*, we have italicized counties from which male specimens have been seen.

*Seasonal occurrence*—June through mid-August.

*Discussion*—Length: Female 11-14 mm.

The sexes are dichromatic thus making it fairly easy to distinguish males from those of ***abaureus***. Females are similar in color to those of ***abaureus***, but "the shape of the antennal scape will aid in identification" (Philip, 1954).

*Biology*—Unknown.

## Genus *Stonemyia* Brennan

*Stonemyia* Brennan, 1935:360; Philip, 1954:26; Mackerras, 1955:462.

*Type species—Pangonia tranquilla* Osten Sacken, 1875. Original designation.

According to Mackerras (1955), principal characters of *Stonemyia* lie in its distinctive genitalia. He also states that externally *Stonemyia* differs from *Pilimas* only in having the eyes practically bare in both sexes and vein $R_4$ lacking an appendix (stump vein), with the latter character seemingly the more reliable. The hairiness of the eye is useless at the generic level in California since only the ♂♂ of *P. californica* have the eyes pilose. Both sexes of all other species of *Pilimas* and *Stonemyia* in California have bare eyes, scattered hairs visible only at fairly high magnification (±50x). Further, not all specimens of *Pilimas* from California possess the stump vein. Of 123 specimens of *P. californica* in the CIS collection, 6 (5%) lack this vein.

In the genus *Stonemyia*, wherein the stump vein reportedly is absent, one ♂ of 5 *S. tranquilla fera* in the CIS collection has a stump vein on 1 wing while our only specimen of *S. velutina* has a stump vein on the left wing and lacks it on the right. Thus it is apparent that even the presence or absence of the stump vein is not completely reliable for separating these genera.

The species of this genus are not known to be haematophagous. They are usually found on flowers or on the ground in openings in wooded areas. None of the species is common, and nothing is known of their biologies.

## KEY TO CALIFORNIA SPECIES OF STONEMYIA

1. Large, robust black species 15 mm long; the mesonotum of the female thickly clothed with pale yellow pile; a small patch of pale yellow hair on middle of posterior margin of second tergite of both ♂ and ♀; proboscis short, no longer than height of head ..... *velutina* (Bigot)

   Body length usually less than 13 mm; mesonotum thinly covered with golden yellow pile; body yellow or orange with black markings; no white patch on second tergite; proboscis longer than height of head (Fig. 11) ..... *tranquilla fera* (Williston)


MAP 9. Distribution in California of: *Brennania belkini* (Philip) ■; *Stonemyia tranquilla fera* (Williston) ●; and *S. velutina* (Bigot) ▲.

### *Stonemyia tranquilla fera* (Williston) (Figs. 11, 43; Map 9)

*Pangonia fera* Williston, 1887:130. Type, ♂, Mt. Hood, Oregon. *Stonemyia tranquilla fera*; Philip, 1947:266.

*Geographic range*—Alberta, British Columbia to central California and Idaho (Eastern U.S., Maine, south to Tennessee [Philip, 1965a]).

*California distribution*—Map 9. Sierra Nevada from Mariposa County north to Plumas. One record from Sonoma County.

*Seasonal occurrence*—Mid-June to third week in July.

*Discussion*—Length: Female 10-13 mm.

Brennan (1935) stated that some forms of the eastern *tranquilla* Osten Sacken were very similar to the western *fera* Williston, but that a somewhat longer proboscis and the wholly black palpi and legs would distinguish *fera*. Pechuman (1972) stated that some New York specimens are close to *fera*, but he prefers to consider *fera* entirely western in distribution and, in series, *fera* is more brightly colored than *tranquilla*.

Philip (1947) stated ". . . but no consistent means of separation (*tranquilla* vs. *fera*) with relation to color or geographical critera have been found. It may be convenient to retain *fera* as a subspecies, but some integrating specimens will be difficult to assign to either

form." He might have also added morphological criteria since the relative lengths of the proboscis and palpi are also variable.

*Biology*—Unknown.

### *Stonemyia velutina* (Bigot)

*Corizoneura velutina* Bigot, 1892:615. Type, ♀, California.
*Stonemyia albomacula* Stone, 1940:60. Type, ♀, Bass Lake, California.

*Geographic range*—California.

*California distribution*—Map 9. MADERA CO.: *Bass Lake*, ♀ (holotype of *albomacula*), 1 ♂ (paratype), VI-7-38 (J. R. Warren, CAS); 1 ♂ (paratype), VI-7-38, 2500' elev. (N. Hardman, CAS). *Oakhurst*, 1 ♀ (paratype), VI-14-38, 3800–4000' elev. (J. R. Warren, CAS); 1 ♀, VI-8-42 (E. G. Linsley, CIS). MARIPOSA CO.: *Yosemite*, 1 ♂ (paratype), VI-14-38, 3880–4000' elev. (J. R. Warren, CAS).

*Seasonal occurrence*—June 7–14.

*Discussion*—Length: Female 14.5 mm.

A large, black, distinctive, and very scarce species. The female possesses pale yellow or white pile on the notum, and both sexes have a small tuft of white or pale yellow hairs on the middle posterior margin of tergite II.

*Biology*—Unknown.

## SUBFAMILY CHRYSOPSINAE

### Tribe Chrysopsini

### Genus *Silvius* Meigen

*Silvius* Meigen, 1820:27; Brennan, 1935:351–358; Pechuman, 1938: 165–171; Philip, 1954:53–57; Mackerras, 1955:614; Fairchild, 1975:23–27.

*Type species—Tabanus vituli* F., 1805. Monotypic ( = *T. alpinus* Scopoli, 1763).

Mackerras (1955) placed *Silvius* in the subfamily Chrysopinae (*sic*) next to *Chrysops*, but admitted that these genera are not always easy to distinguish throughout the world. One consistent character, first noted by Rowe and Knowlton (1936), is the presence of small, round eye spots in living or relaxed *Silvius* (Fig. 10), in contrast to the larger and more angular ones of *Chrysops* (Fig. 9). There is no problem in separating the California members of these genera. All of our *Chrysops* species have characteristic short, stout, black setae arising from the base of the costal vein. In *Silvius* these setae are pale, longer, and more hairlike; and except for the orange-bodied, clear-winged *S. gigantulus*, all of our *Silvius* and *Chrysops* species have distinctively spotted or patterned wings (Figs. 79–104).

Characterizations of the larvae and pupae of Nearctic *Silvius* species have been presented by Lane (1975) and Burger (1977). The first and second antennal segments of *S.* (*Griseosilvius*) *notatus* and *S.* (*Zeuximyia*) *philipi* are subequal as are those of *S.* (*G.*) *quadrivittatus* (Burger, 1977). The prominent frontal tubercles of the pupae are elevated 0.16 mm (0.1–0.2 mm) in *notatus* (N=10), 0.22 mm (0.1–0.3 mm) in *philipi* (N=10), and 0.2 mm in *quadrivittatus*. Other characters which may help distinguish *Silvius* (*G.*, *Z.*) pupae from those of other genera are as follows: callus tubercles large, raised about 0.21 mm in *notatus* (N=10), 0.25 mm in *quadrivittatus*, and 0.15 mm in *philipi* (N=10); mesothoracic spiracles short, length about 0.2 mm in *notatus* (N=8) and *quadrivittatus*, and 0.16 mm in *philipi* (N=8); abdominal segment I with 2 pairs of pleural setae instead of the usual 3 pairs of setae.

*Silvius* (*G.*) larvae can be separated from larvae of *S.* (*Z.*) *philipi* by characters given in the key and by the greater diameters of their head capsules, which are 0.45–0.56 mm ($\bar{X}$=0.51 mm, N=10) wide in *notatus* and 0.5 mm wide in *quadrivittatus* as compared with 0.33–0.41 ($\bar{X}$=0.38 mm, N=5) wide in *philipi*. The head capsules of these 3 species are generally light brown, but the posterior 0.5–0.6 of *philipi* head capsules are so pale colored that they appear nearly hyaline.

Table 2 summarizes some morphological differences between the immatures of Nearctic *Silvius* and *Chrysops* (tribe Chrysopsini). Details of the antennal segments and respiratory siphon separate larvae of these genera. Their larvae are similar in having striations at least dorsally and ventrally on all body segments (they are sometimes absent laterally in *Chrysops*), and pubescence on the median lateral surface of the anal segment. The pupae of *Silvius* and *Chrysops* are distinguishable by the number of pairs of callus setae (except in *Chrysops brunneus*, *C. dixianus*, and *C. dorsovittatus*), pleural setae on abdominal segment I, and rows of abdominal fringe spines, and by the condition of the frontal tubercles. They are similar in having 2 pairs of basal alar setae, in lacking dorsolateral and lateral pairs of preanal combs, and by their small size (i.e., usually less than 15 mm long).

The immature stages of the two North American *Silvius* species in the subgenus *Silvius* Meigen are unknown. However, larvae and pupae of *S.* (*Silvius*) *matsumurai* Kono and Takahasi from Japan have been described (Kono et al., 1940; Yajima, 1952). Larvae of *matsumurai*, like those of *notatus* and *quadrivittatus*, have 4 pairs of pseudopodia on each of the first 7 abdominal segments, but differ from Nearctic *Silvius* (*G.*, *Z.*) by possessing a nonstriated anal segment that bears 6 setiferous pseudopod-like processes. Pupae of *matsumurai* are distinguishable from Nearctic *Silvius* (*G.*, *Z.*) by having bisetose callus tubercles, uniseriate

TABLE 2. SOME MORPHOLOGICAL DIFFERENCES BETWEEN THE LARVAE AND PUPAE OF NEARCTIC *SILVIUS* AND *CHRYSOPS*

| Larvae | *Chrysops*[1] | *Silvius*[2] |
|---|---|---|
| antennal segments | third segment as long or longer than second segment | third segment shorter than second segment |
| pseudopodia | 3 pairs on each of first 7 abdominal segments | 3 (*Zeuximyia*) or 4 pairs (*Griseosilvius*) on each of first 7 abdominal segments |
| respiratory siphon | 2–5 times longer than its basal diameter in those species not bearing a stigmatal spine | length shorter than its basal diameter |
| Pupae | | |
| callus setae | 2 pairs | 1 pair |
| frontal tubercles | usually absent, sometimes present as small, median and/or paired submedial swellings | 1 pair of large tubercles raised 0.1–0.3 mm[3] |
| antennal sheaths | curved anterodorsally | curved anterodorsally very slightly or not at all[4] |
| abdominal fringe spines | uniseriate | biseriate, reduced ventrally on some or all of segments II–V |
| pleural setae on abdominal segment I | 3 pairs | 2 pairs |

1. Mainly after Teskey's (1969) generic characterizations of larval and pupal *Chrysops*.
2. Based on the descriptions of *S.* (*G.*) *quadrivittatus* (Say) (Burger, 1977), *S.*(*G.*) *notatus* Bigot (Lane, 1975), and *S.* (*Z.*) *philipi* Pechuman (Lane, 1975) unless otherwise noted.
3. Except in *phillipi*, which also usually has a smaller pair of frontal tubercles laterad of the large submedian pair.
4. Based only on *notatus* and *philipi*.

abdominal fringe spines, and by their larger size (i.e., 17–18 mm long).

## KEY TO SPECIES OF SILVIUS IN CALIFORNIA

1. Females; eyes not contiguous ..... 2
   Males; eyes contiguous ..... 7

***Females***

2. Flagellum and pedicel subequal (Fig. 21); palpi slender, not grooved . . . (Subg. *Zeuximyia*) ..... ***philipi*** Pechuman
   Flagellum at least twice as long as pedicel (Fig. 8); palpi variable ..... 3
3. Wings without infuscated spots; body orange.....
   (Subg. *Silvius*) ..... ***gigantulus*** (Loew)
   Wings with infuscated spots; body grayish black .....
   (Subg. *Griseosilvius*) ..... 4
4. Wings with a narrow apical infuscated band, and single subapical spots on $R_{2+3}$ and $R_4$ . . . ***pollinosus jeanae*** Pechuman
   Apical infuscated band absent; no subapical spot on $R_4$ ..... 5
5. Veins $R_{2+3}$, $R_5$, and M, with a subapical isolated spot (Fig. 81); without a groove on apical palpal segment .....
   ***quadrivittatus*** (Say)
   No veins with isolated subapical spots near wing margin; apical palpal segment grooved ..... 6
6. Abdominal tergites II and III dark gray, usually with a double geminate figure (Fig. 65); basal callus somewhat rectangular, nearly reaching eye margins (Fig. 78); front between eye and ocelli usually with numerous black hairs, rarely are these hairs absent; palpus and scape with some black hairs; mesonotal pale lines narrow ..... ***notatus*** (Bigot)
   Abdominal tergites II and III light gray, each with a pair of median divergent black spots and the lateral ones reduced or absent; basal callus shield-shaped though broader than tall, widely separated from eye margins; front between eye and ocelli lacking black hairs, if hairs are present they are mostly pale straw yellow; hairs on palpus and scape mostly or entirely pallid; mesonotal pale lines slightly broader ....
   ***abdominalis*** Philip

*Males*[11]

7. Abdomen orange, without dark spots; wings immaculate ..... (Subg. *Silvius*) ..... *gigantulus* (Loew)
   Abdomen usually grayish black, with dark spots; wings with at least pale infuscated spots ..... 8
8. Flagellum and pedicel subequal ... (Subg. *Zeuximyia*) ..... *philipi* Pechuman
   Flagellum considerably longer than pedicel ..... (Subg. *Griseosilvius*) ..... 9
9. Scape about 2x length of pedicel; mesonotal gray lines wide, nearly the diameter of scape; abdomen yellowish brown, marked with black ..... *quadrivittatus* (Say)
   Scape about 3x length of pedicel; mesonotal gray lines narrow, about one-half the diameter of scape; abdominal tergites IV-VI gray, pollinose, marked with black ..... 10
10. Eyes with numerous medium-sized (usually larger than an ocellus), round, black spots (Fig. 10); hairs on scape and frons black ..... *notatus* (Bigot)
    Eyes with smaller black spots (usually as small or smaller than an ocellus); hairs on scape and frons pale ..... *abdominalis* Philip

## *Silvius* (*Silvius*) *gigantulus* (Loew) (Map 10)

*Chrysops gigantulus* Loew, 1872:57. Type, ♀, California.
*Silvius trifolium* Osten Sacken, 1875:395. Type, ♀, British Columbia (Vancouver Island).

*Geographic range*—British Columbia, California, Idaho, Montana, Oregon, Washington, Baja California Norte (Philip, 1975b).

*California distribution*—Map 10. Widely distributed in cismontane California except east of the Sierra Nevada and the Mojave and Colorado deserts.

*Seasonal occurrence*—Adults have been collected from late May through the last week of August, most commonly in July.

*Discussion*—Length: Female 9-11 mm.

This relatively large, distinctive, orange *Silvius* is easily recognized.

*Biology*—*S. gigantulus* readily bites man. On numerous occasions it has been reported attacking hikers in the Sierra Nevada. Anderson et al. (1974) reported it biting penned deer at Hopland in Mendocino County.

## *Silvius* (*Griseosilvius*) *abdominalis* Philip (Fig. 79; Map 10)

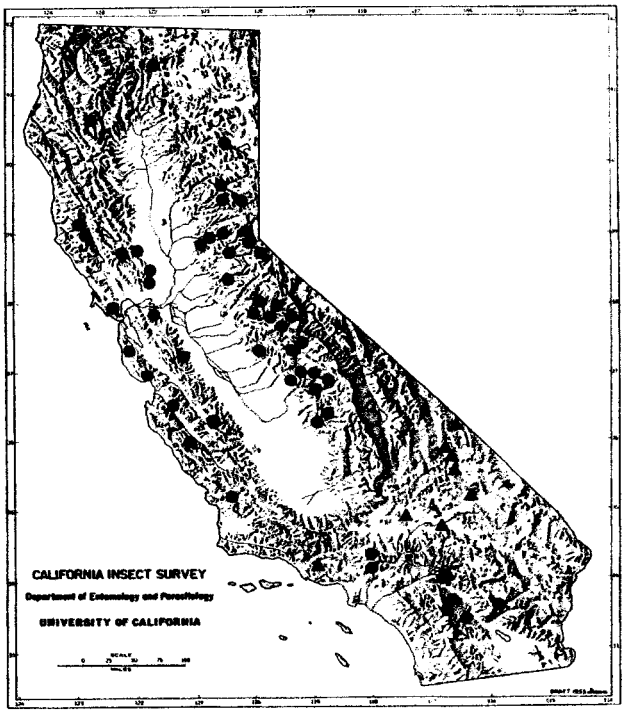
*Silvius abdominalis* Philip, 1954b:55. Type, ♀, 14 mi. E. Death Valley Junction, California.

*Geographic range*—California, Nevada.

*California distribution (counties)*—Map 10. Inyo, San Bernardino, Ventura.

*Seasonal occurrence*—Sporadic and localized from late March to the beginning of July.

11. Male of *pollinosus jeanae* undescribed.




MAP 10. Distribution in California of: *Silvius gigantulus* (Loew) ●; and *S. abdominalis* Philip ▲.

*Discussion*—Length: Female 10 mm.

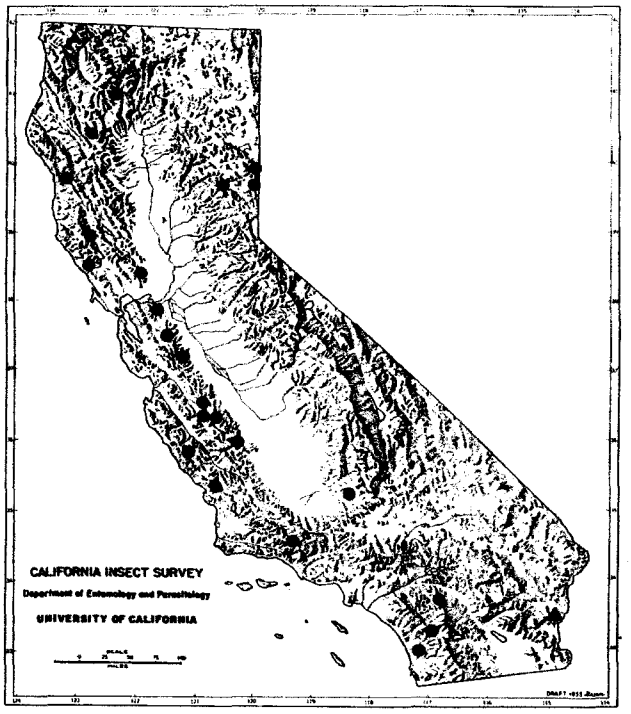
Easily distinguished from *notatus* on the basis of the somewhat triangular rather than rectangular basal callus; the broad gray lines on mesonotum; abdominal pattern with less contrast and the scape with all pallid hairs. The wing pattern is basically the same as *notatus* but is somewhat paler. A single male from Santa Paula, Ventura County, has an identification label by Philip '39 as *notatus*. It is not *notatus* but quite likely *abdominalis*.

*Biology*—This species has been found primarily near water in hot, dry desert valleys. Many specimens collected in the Death Valley area are in the collections at the Los Angeles County Museum and University of California, Riverside.

Females commonly bite humans. Members of a California Insect Survey trip collected large numbers of *abdominalis* in the Baker area of San Bernardino County in late April 1977, and reported them annoying by their persistent attacks.

## *Silvius* (*Griseosilvius*) *notatus* (Bigot) (Figs. 10, 20, 29, 78, 80, 124, 126, 128; Map 11)

*Diachlorus notatus* Bigot, 1892:623. Type, ♀, California.
*Silvius laticallus* Brennan, 1935:353. Type, ♀, Hermiston, Oregon.




MAP 11. Distribution in California of: *Silvius notatus* (Bigot) ●; and *S. pollinosus jeanae* Pechuman ▲.

*Geographic range*—California, Oregon, Washington.

*California distribution*—Map 11. *S. notatus* occurs in the coastal mountains and foothills from Trinity County in the north, south to San Diego County, with several isolated records from southeastern Lassen and Plumas counties. It is absent from the Sierra Nevada, and the central and eastern desert areas of southern California.

*Seasonal occurrence*—Frequently collected from late April through mid-August, with one late March and one early September record.

*Discussion*—Length: Female 7-8 mm.

A distinctive gray and black species with grooved apical palpi, which separates it from all other California black and gray species except *abdominalis*.

*Biology—S.* x x x x x x x x x x x

*Biology—S. notatus* was the most abundant of 14 tabanid species trapped with $CO_2$-baited insect flight traps during the late spring at Hopland, California (Anderson et al., 1974). On days when maximum air temperatures ranged between 23.3° and 32.8°C, most *notatus* females were caught between 1100 and 1400 h. On hot days when maximum air temperatures reached 40.0-42.8°C, flies exhibited a uniform level of activity throughout the day. Females were observed feeding on black-tailed deer, especially the rear legs. Although attracted to humans, it has not been reporting biting man.

Lane (1975) collected and described larvae and pupae from damp sand and silt along the banks of the Russian River in Mendocino County. Of 6 tabanid species collected as immatures from the banks of the Russian River, *notatus* ranked first in relative density (Lane, 1976).

Lane (1975) reported that the anal pubescence of *notatus* larvae has 2-3 isolated small spots laterally. There are usually 2 dorsolateral spots and 1 ventrolateral spot on each side. In some larvae, however, 1 or both of the 2 dorsolateral pairs are absent or inconspicuous.

Besides character differences given by Lane (1975)[12], pupae of *notatus* have a rugose area and usually a vestigial or minute tubercle laterad of each large frontal tubercle, whereas those of *philipi* have a small tubercle (0.04-0.07 mm tall) laterad of each prominent frontal tubercle. Pupae of *notatus* also have wider frontal plates and greater distances between the bases of the callus tubercles, the anterior orbital tubercles, and the posterobasal angle of the antennal sheaths and the anterior orbital tubercles (Table 3). Further, the callus tubercles of *notatus* are shaped as in Fig. 124, and the callus setae nearly always arise from a conspicuous central concavity, whereas those of *philipi* usually are semiglobose (Fig. 125) and the callus setae may or may not arise from a central concavity. In both species, the abdominal fringe spines on all sclerites of segments 2-7 become progressively longer posteriorly and those on sterna 2-4 or 5 are generally reduced and may appear uniseriate (especially in *philipi*) in contrast to the biseriate spinous fringes on all other sclerites of segments 2-7. In *notatus*, the spines are absent or greatly reduced sublaterally on sterna 2-4 or 5 (Fig. 128); in *philipi*, they are much reduced or absent (on 1 or both sides) sublaterally on sterna 2-3, 4, or 5 (Fig. 131), and the spines typically are much shorter than they are in *notatus* (Table 3). The mesothoracic spiracles of *notatus* (Fig. 126) and *philipi* (Fig. 127) are pale colored and usually either evenly bowed or bent more sharply inward in approximately the posterior one-third.

### *Silvius* (*Griseosilvius*) *pollinosus jeanae* Pechuman (Map 11)

*Silvius pollinosus jeanae* Pechuman, 1960:793. Type, ♀, Corpus Christi, Texas.

*Geographic range*—California, Texas.

*California distribution (counties)*—Map 11. Riverside. The only specimens from California are one ♀ (paratype), and one ♂ from

12. The collection data and discussion for *Silvius notatus* In Lane (1975) were inadvertently omitted. These were subsequently published in *Ann. Ent. Soc. Amer.* 69(3):441.

TABLE 3. SOME FURTHER DIFFERENCES BETWEEN PUPAE OF *SILVIUS (G.) NOTATUS* AND *S. (Z.) PHILIPI*[1]

| Structure | Measurement (mm)[2] *notatus* | *philipi* |
|---|---|---|
| length of f.p. | 2.94 (2.8–3.1) | 2.67 (2.5–2.9) |
| width of f.p. | 2.22 (2.15–2.30) | 1.84 (1.68–2.08) |
| height of c.t. | 0.21 (0.16–0.24) | 0.15 (0.11–0.19) |
| basal diameter of c.t. | 0.38 (0.26–0.48) | 0.31 (0.28–0.36) |
| distance between bases of c.t. | 0.16 (0.09–0.21) | 0.025 (0.01–0.04) |
| distance between posterobasal angle of a.s. and a.o.t. | 0.13 (0.09–0.16) | 0.06 (0.03–0.075) |
| distance between a.o.t. | 1.36 (1.31–1.39) | 1.17 (1.06–1.25) |
| distance between p.o.t. | 1.06 (1.00–1.16) | 0.92 (0.81–1.00) |
| distance between a.o.t. and p.o.t. on each side | 0.21 (0.13–0.27) | 0.25 (0.09–0.37) |
| lengths of longest fringe spines on: | | |
| sternum 2 | 0.28 (0.21–0.38) | 0.19 (0.09–0.26) |
| sternum 3 | 0.31 (0.27–0.35) | 0.21 (0.09–0.28) |
| tergum 7 | 0.54 (0.44–0.64) | 0.41 (0.34–0.54) |

1. N=10.
2. The mean value is followed by the range in parentheses.

Terminology: a.o.t. = anterior orbital tubercles; a.s. = antennal sheaths; c.t. = callus tubercles; f.p. = frontal plate; p.o.t. = posterior orbital tubercles (after Teskey, 1969).

Blythe. These specimens are in the Pechuman collection at Cornell University.

*Seasonal occurrence*—The California ♀ paratype was taken on July 4, 1947.

*Discussion*—Length: Female 9-10 mm.

The male is undescribed, but there are two in the Pechuman collection, one of which was taken close to the type locality in Texas.

*Biology*—Unknown.

### *Silvius (Griseosilvius) quadrivittatus* (Say) (Fig. 81; Map 12)

*Chrysops quadrivittatus* Say, 1823:33. Syntypes, unstated number of ♀♀, near the Rocky Mountains (lost).

*Geographic range*—California east to Tennessee, south to Mexico* and Mississippi.

*California distribution*—Map 12. IMPERIAL Co.: *Winterhaven*, 1 ♀, VII-1-60, argon lite trap (Harrison, CDA). *Hot Mineral*, 3 ♀♀, IV-30-52 (CAS); 1 ♀, 12 mi *W Glamis*, west side Algodones Dunes, V-27-71 (M. E. Erwin, UCR). SAN BERNARDINO Co.: *Afton Cyn.*, 3 ♀♀, V-5-60 (F. D. Parker, UCD). SAN DIEGO Co.: *Desert edge*, 5 ♀♀, IV-17-15 (M. C. Van Duzee, CAS).

*Seasonal occurrence*—All California specimens have been taken between the second week of April and first week of July.

*New record.

*Discussion*—Length: Female 7-10 mm.

This species, *philipi*, and *pollinosus jeanae* are the only black and gray *Silvius* species in California with ungrooved palpi. Subapical wing spots on veins $R_5$ and $M_1$ are not present in *jeanae*.

*Biology*—*S. quadrivittatus* can be abundant locally, particularly in arid and semi-arid areas along large rivers, where they are sometimes bothersome to boaters and fishermen (Burger, 1974).

Burger (1977) described larvae and pupae from Arizona. Larvae were found in damp silt along the steep banks of desert rivers from 0.9-1.5 m above the water's edge.

### *Silvius (Zeuximyia) philipi* Pechuman (Figs. 21, 47, 82, 125, 127, 131; Map 12)

*Silvius philipi* Pechuman, 1938:165. Type, ♀, near Lebanon, Oregon.

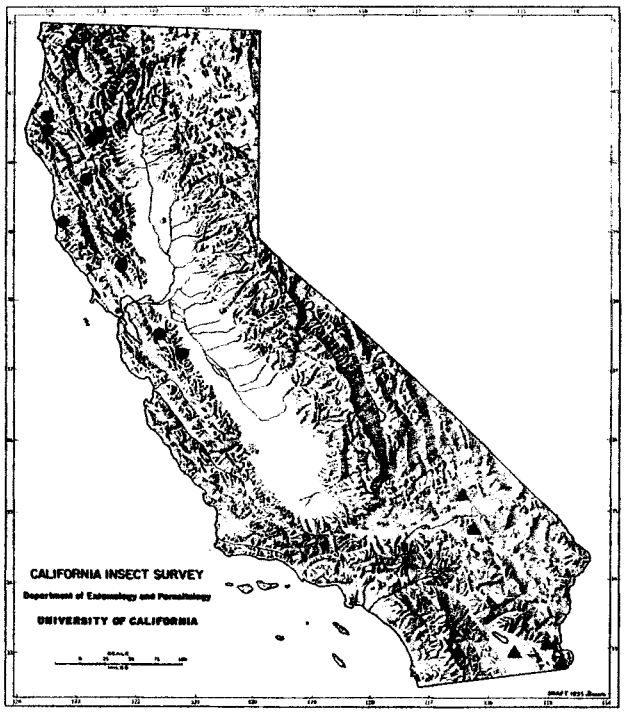
*Geographic range*—California, Oregon.

*California distribution (counties)*—Map 12. Alameda, Humboldt, Lake, Mendocino, Napa, Stanislaus, Trinity.

*Seasonal occurrence*—Adults have been taken from the third week in May through the last week in August.

*Discussion*—Length: Female 8-9 mm.

The elongated pedicel, which is subequal to the third segment (flagellum), is a feature unique to *philipi*. Pechuman (1960) described the male.




MAP 12. Distribution in California of: *Silvius philipi* Pechuman ●; and *S. quadrivittatus* (Say) ▲.

*Biology*—This species attacked humans on several warm afternoons in mid-June in Del Puerto Canyon, Stanislaus County.

Larvae and pupae have been described by Lane (1975). In Mendocino County, immatures were found from 1.5-2.1 m above a permanent creek margin (i.e., Pieta Creek) in damp sand and silt in the shade of a willow, *Salix melanopsis* Nutt., and from similar soil along a bank of the Russian River. Creek margins yielded considerably greater numbers of *philipi* immatures than did river banks (Lane, 1976).

Larvae of *S.* (*Zeuximyia*) *philipi* are separable from those of *S.* (*Griseosilvius*) *notatus* Bigot and *S.* (*G.*) *quadrivittatus* (Say) by characters presented in the key. Since Lane (1975) collected only mature larvae of *philipi* above the edges of lotic habitats, this species may be aquatic for most of its larval development.

## Genus *Chrysops* Meigen

*Chrysops* Meigen, 1800:23. Suppressed by Int. Comm. Zool. Nomen., 1963:339.

*Chrysops* Meigen, 1803:267; Brennan, 1935:254; Philip, 1955:47; Mackerras, 1955:617; Mackerras, 1961:829.

*Type species*—*Tabanus caecutiens* L., 1758. Monotypic.

A fairly well-defined, world-wide genus of relatively small, slender flies with characteristic maculate eyes, long slender antennae, and usually banded wings. About 260 species have been described world-wide, with over 75 in North America of which 21 are found in California. There is a considerable range of variation in such characters as antennal length, relative length of antennal segments, swelling of the scape, development of shining facial calli, wing pattern, scutal ornamentation, and abdominal pattern.

All of the *Chrysops* species in California possess characteristic dark wing patterns which permit or aid species identification (Figs. 83-104). The abdominal patterns, albeit variable, are sometimes valuable in connection with other characters. In life the eyes are variable in color, frequently green, golden, or purple, and varying with both age and sex. Large, angular, dark spots are also present but these, as well as color, tend to disappear shortly after death. To some extent the eye patterns can be revived if the dry specimen is placed overnight in a humidifier. Ocelli are present; the female has a basal callus but no median callus; a prominent frontoclypeus; antennae with 5-segmented flagellum (4 annuli) with the long basal segment sometimes appearing to have additional annulations; scape swollen in a number of species in California and proboscis not exceeding the length of the head.

Most species of *Chrysops* suck mammalian blood; a few species reportedly attack birds. Two eastern U.S. salt marsh species, *C. atlanticus* Pechuman and *C. fuliginosus* Wiedemann, are autogenous, at least in the first gonotrophic cycle, and both species also bite man. Several California species are pests of man, particularly *C. noctifer* Osten Sacken and *C. surdus* Osten Sacken. On livestock, they generally prefer to feed on the head, neck, and withers.

The adults are most abundant in broken, wooded habitats with marshes nearby. Along the eastern seaboard some species are abundant in salt marshes, a habitat not favored by species in California. *Chrysops* species fly as early as mid-April at lower elevations. They are most numerous in June and July, and occasionally can be collected in early October.

Males usually are taken far less frequently than females and thus are poorly represented in collections. They do not suck blood and therefore are not collected by the usual techniques used for taking females. They will occasionally come to light traps, but are taken mostly from flowers.

The immature stages of 17 of the 21 *Chrysops* species known from California have been described (Table 1).

Descriptions of 3 species (*discalis* Williston, *fulvaster* Osten Sacken, *proclivis* Osten Sacken), however, are insufficient by present taxonomic standards. The eggs are usually laid in a single, overlapping layer on foliage overhanging or floating on water. The larvae are aquatic or semiaquatic. They have been recorded from various lentic and lotic habitats, including fresh and salt water marshes, ponds, lakes, rivers, streams, and seepages. Mature larvae and pupae have been taken mainly from soil or mud close to water, while the early instars of some species occur in bottom mud where they apparently feed on algae, organic debris, or the bacteria associated with organic decay. They are usually not predatory or cannibalistic.

The larvae (Fig. 115) are distinguished as follows: length of last instar usually less than 18 mm, cuticular striations at least dorsally and ventrally on all body segments; length of third antennal segment equal to or greater than second; 3 pairs of pseudopodia on each of 1st 7 abdominal segments; pubescence present on midlateral surfaces of anal segment.

The pupae (Figs. 116–119, 122, 123) usually have the following characteristics: length usually less than 15 mm; antennal sheaths projecting beyond epicranial suture, curved anterodorsally; frontal tubercles generally absent or small; 2 pairs of basal alar and callus setae (except in *brunneus*, *dixianus*, and *dorsovittatus* which have only 1 pair of callus setae); abdominal fringe spines uniseriate on segments 2–7; dorsolateral and lateral preanal combs absent.

## KEY TO CALIFORNIA SPECIES OF CHRYSOPS

1. Females; eyes widely separated ..... 2
   Males; eyes contiguous or nearly so ..... 23

*Females*

2. Apex of wing beyond crossband usually hyaline, sometimes just a trace of a cloud confined to cell $R_1$ (Fig. 86) ..... 3
   Apex of wing beyond crossband distinctly infuscated (Fig. 84) ..... 6
3. Femora banded in middle with reddish brown; abdomen greenish yellow with black markings ..... *hirsuticallus* Philip
   Femora black; abdomen otherwise ..... 4
4. Pile on pleurae golden yellow or orange; basal abdominal tergites orange laterally ..... *excitans* Walker
   Pile on pleurae white to gray; abdomen black with or without gray pile ..... 5
5. Base of cell $Cu_1$ with a small hyaline spot (Fig. 86); gray middorsal triangles absent ..... *ater* Macquart
   Base of cell $Cu_1$ infuscated; large, obscure, gray middorsal triangles usually present ..... *mitis* Osten Sacken
6. Basal callus entirely brownish orange or with lateral and upper margins black (Fig. 13) ..... 7
   Basal callus entirely black ..... 15
7. Hyalinge triangle enclosed, not attaining posterior margin of wing (Fig. 93); at least a faint infuscation beyond cell $R_5$ ..... *fulvaster* Osten Sacken
   Hyaline triangle attains posterior margin of wing (Fig. 89); apical spot not exceeding cell $R_4$ (except in *clavicornis*) .. 8
8. Knob of halteres brown or black above, golden beneath; scape and pedicel black dorsally, brown ventrally; scape not swollen (Fig. 8) ..... *coloradensis* Bigot
   Knob of halteres yellow; scape unicolorous brown, swollen .. 9
9. Scape and pedicel both swollen (Fig. 18) ..... 10
   Scape swollen, pedicel normal or nearly so (Fig. 22) ..... 11
10. Crossband of wing completely dark (Fig. 103) ..... *virgulatus* Bellardi
    Crossband of wing dilute, hyaline areas in discal cell and basal portions of cells $R_3$ and $R_5$ (Fig. 96) ..... *latifrons* Brennan
11. Apical wing spot extends across vein $R_5$ into cell $R_5$ ..... 12
    Apical wing spot terminates in cell $R_4$ ..... 13
12. Abdominal tergite II usually with a median, inverted V-shaped spot and sublateral spot; tergites III and IV with 4 spots (Fig. 34) ..... *clavicornis clavicornis* Brennan
    Abdominal tergites II–IV, each with only two black spots (Fig. 39) ..... *clavicornis brennani* Philip
13. Outer margin of crossband sinuous, a bulge towards the bifurcation, giving the apex of the hyaline triangle a somewhat parallel-sided appearance (Fig. 90) ..... *coquilletti* Hine
    Outer margin of crossband fairly straight, the apex of the hyaline triangle widely divergent (Fig. 104) ..... 14
14. Infuscation in 2nd basal cell about one-half that in 1st and sharply diagonal or semitruncated; median figure, on tergite II usually divided mesally ..... *pachycerus* Williston
    Infuscation in 2nd basal cell gradually sloping diagonally from base to anterior one-half, almost as far as that in 1st; median figure on tergite II geminate, occasionally divided ..... *wileyae* Philip
15. Second basal cell infuscated at least half its length; abdominal tergites without yellow on mid-line ..... 16
    Second basal cell hyaline, sometimes slightly infuscated at base and apex; abdominal tergites with yellow markings on mid-line and posterior margins ..... 17
16. Apical spot beyond crossband extending halfway across cell $R_4$; crossband usually without a toothlike projection in cell $R_3$ (Fig. 100) ..... *pechumani* Philip
    Apical spot beyond crossband barely crossing vein $R_4$ into upper distal portion of cell $R_4$; crossband with a toothlike projection in $R_3$ (Fig. 98) ..... *noctifer* Osten Sacken
17. First basal cell hyaline, sometimes slightly infuscated at base and apex ..... 18
    First basal cell infuscated for more than half its area ..... 19
18. Arms of inverted V-shaped black marking on 2nd abdominal tergite without lateral expansion (Fig. 40) *bishoppi* Brennan
    Arms of inverted V-shaped black marking on 2nd abdominal tergite expanded laterally (Fig. 36) ..... *aestuans* Wulp
19. Discal cell hyaline, may be infuscated around borders; apical palpal segment grooved (Fig. 30) ..... *discalis* Williston
    Discal cell (1st $M_2$) infuscated; apical palpal segment not grooved ..... 20
20. Second abdominal tergite yellow with a small, black, anteromedian quadrate or reniform spot, the remainder of the

segment yellow; face black with 3 yellow pollinose stripes (Fig. 4) ..... *asbestos* Philip
Second abdominal tergite otherwise marked; frons bare, not pollinose, yellow ..... 21
21. First basal cell with apical one-third hyaline (Fig. 94); fore coxae golden yellow ..... *furcatus* Walker
First basal cell with an infuscated band for its entire length, sometimes dilute toward outer two-thirds; a narrow hyaline line on posterior border, widest apically; fore coxae black ..... 22
22. Apical spot beyond crossband narrow, not wider than the basal width of cell $M_1$ (Fig. 102); yellow stripe on frontoclypeus narrow ..... *surdus* Osten Sacken
Apical spot beyond crossband wide, about twice the basal width of cell $M_1$ (Fig. 101); yellow spot on frontoclypeus wider than lateral brown lobes ..... *proclivis* Osten Sacken

*Males*[13]

23. Apex of the wing beyond the crossband hyaline, sometimes a narrow, indefinite trace of infuscation present along costa ..... 24
Apex of the wing beyond the crossband infuscated ..... 27
24. Basal abdominal tergite(s) with integumental red or yellowish gray areas; pleural pilosity sometimes pale .. *excitans* Walker
Basal abdominal tergites black; pleural and abdominal pilosity black ..... 25
25. Base of cell $Cu_1$ with a hyaline spot (Fig. 86) ..... *ater* Macquart
Base of $Cu_1$ infuscated ..... 26
26. Mid tibiae black; mid-facial pollinose stripe present; eyes contiguous, face not densely hirsute; face beneath antennae black ..... *mitis* Osten Sacken
Mid tibiae reddish brown; no mid-facial pollinose stripe; eyes narrowly separated; face densely hirsute and black with two submedian, dark yellow integumental stripes beneath antennae ..... *hirsuticallus* Philip
27. Apical spot a narrow band, approximately the same width for its entire length, including at most only apex of cell $R_4$ ..... 28
Apical spot variable, usually including nearly half of cell $R_4$, often extending considerably beyond ..... 32
28. Wholly black species including frontoclypeus; apical spot nearly separated from the crossband .. *noctifer* Osten Sacken
Not wholly black species; frontoclypeus yellow; apical spot distinctly united with the crossband ..... 29
29. Frontoclypeus and oral margins of genae yellow ..... 30
Frontoclypeus and oral margins of genae not entirely yellow, usually with a black spot on each side ..... 31
30. Wing infuscation dilute ..... *bishoppi* Brennan
Wing infuscation saturate ..... *aestuans* Wulp
31. Frontoclypeus black with a narrow yellow midstreak ..... *surdus* Osten Sacken
Frontoclypeus yellow with a black spot on each side ..... *proclivis* Osten Sacken
32. Scape distinctly swollen ..... 33
Scape not swollen ..... 39
33. Third antennal segment short, constricted, subequal to or slightly longer than pedicel (Fig. 18) ..... 34
Third antennal segment normal, elongate, nearly twice the length of the pedicel ..... 35
34. Discal cell fenestrate in the center ..... *latifrons* Brennan
Discal cell completely infuscated ..... *virgulatus* Bellardi
35. Apical spot of the wing extending at least into cell $R_5$ ..... 36
Apical spot of wing not extending beyond vein $R_5$, usually not even attaining this vein ..... 37
36. At least basal segments of antennae yellow, the scape distinctly swollen basally; 2nd abdominal tergite yellow with a broad, median black geminate figure, sometimes a black spot on each side ..... *clavicornis* Brennan[14]
Antennae black, scape not swollen; 2nd abdominal tergite not patterned as above ..... *fulvaster* Osten Sacken
37. Second basal cell with basal infuscation about one-half that of 1st basal cell and angled apically; midventral black stripe shining and contrasting ..... *wileyae* Philip
Infuscation in two basal cells subequal; midventral stripe dull, not contrasting ..... 38
38. Apex of hyaline triangle crossing vein $R_{2+3}$; hyaline spot in cell $Cu_1$ restricted, not reaching anterior margin; tergite I black, and II with double geminate spot ... *coquilletti* Hine
Apex of hyaline triangle not exceeding vein $R_{2+3}$; hyaline spot in cell $Cu_1$ usually reaching or crossing into cell $M_3$; tergites I and II broadly yellow laterally ..... *pachycerus* Williston
39. Discal cell hyaline ..... *discalis* Williston
Discal cell completely infuscated ..... 40
40. Body entirely black ..... *pechumani* Philip
Body not entirely black ..... 41
41. Tergite II yellow with a double geminate black spot ..... *coloradensis* Bigot
Tergite II yellow with a small, black, anteromedian quadrate spot ..... *asbestos* Philip

13. Male of *furcatus* not seen.

## *Chrysops aestuans* Wulp
## (Figs. 36, 83)

*Chrysops moerens* Walker, 1848:201. Type, ♀, Nova Scotia (preoccupied).

*Chrysops aestuans* Wulp, 1867:135. Type, ♀, Wisconsin.

*Geographic range*—A widely distributed boreal species, Alaska to California, eastward to Nova Scotia, south to Oklahoma and Pennsylvania.

*California distribution*—No California specimens seen, but has been recorded from an unspecified locality in the state by Philip (1965a).

*Seasonal occurrence*—Unknown.

*Discussion*—Length: Female 7-10 mm.

Body black; abdomen with gray or yellowish gray markings not in the form of stripes; both basal cells hyaline in female, partly infuscated in male; apical wing spot beyond crossband narrow; crossband often not reaching hind margin of wing. Similar in appearance to *callidus* Osten Sacken, a species which does not occur in California.

*Biology*—Hine (1906) and Cameron (1926) described the egg-laying habits of *Chrysops moerens* Walker ( = *C. aestuans*). Females deposited their single-tiered egg

14. Too few males of ssp. *brennani* are available to be certain of their separation from *clavicornis*.

masses on the undersides of leaves of various plant species overhanging water. Approximately 250 eggs were laid per mass in about 1 hour. Often several egg masses were deposited on the same leaf. The incubation period was 6–7 days, and the first instar moulted soon after hatching.

In Saskatchewan, egg masses were commonly infested by the hymenopterous parasites *Phanurus* ( = *Telenomus*) *emersoni* Girault (Scelionidae) and *Trichogramma minutum* Riley (Trichogrammatidae) (Cameron, 1926). *Diglochis occidentalis* Ashmead (Pteromalidae) was reared from pupae of *aestuans*. In Minnesota, *T. minutum* and *Anaphoidea* ( = *Patasson* Walker) sp. (Mymaridae) were obtained from eggs of *aestuans* (Philip, 1931). In Ontario, *Telenomus emersoni* and *Trichogramma minutum* were also reared from eggs, and *D. occidentalis* from pupae of *aestuans* (James, 1963).

Larvae and pupae were described by Cameron (1926), Philip (1931), and Teskey (1969). Larvae were collected along the banks of a temporary pond and beneath a frozen margin of a permanent pond in Minnesota (Philip, 1931). In Ontario, larvae were found in mud along stream banks and in moist loam along a lake shoreline (James, 1963), in cattail marshes, and in rotting vegetative debris bordering large bodies of water (Teskey, 1969).

The etiologic agent of tularemia, *Francisella tularensis* (McCoy and Chapin), was isolated from 1 pool of 3 *C. aestuans* in Utah (Cox, 1965).

### *Chrysops asbestos* Philip
### (Figs. 4, 37, 84; Map 13)

*Chrysops asbestos* Philip, 1950a:455. Type, ♀, Ravalli County, Montana. Allotype, ♂, Gold Lake, Sierra County, California.

*Geographic range*—Alberta, British Columbia, California, Idaho, Montana, Oregon, Washington, Wyoming.

*California distribution (counties)*—Map 13. A montane species. Alpine, El Dorado, Fresno, Inyo, Mendocino, Modoc, Mono, Nevada, Placer, Plumas, Shasta, Sierra.

*Seasonal occurrence*—First week in June to early August.

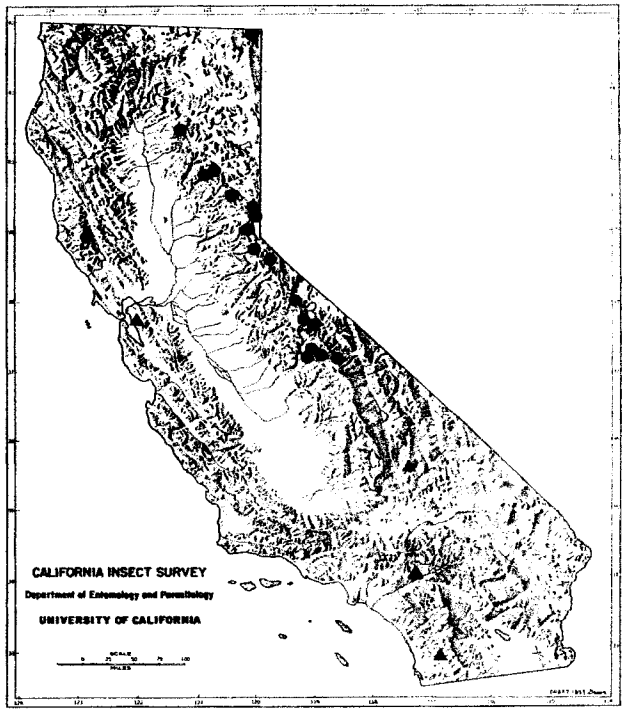
*Discussion*—Length: Female 9 mm.

This distinctive *Chrysops* is not likely to be confused with any other species in California.

*Biology*—Unknown. It has been taken at an elevation of 3,048 m in mid-July on the east side of Mono Pass in Inyo County.

### *Chrysops ater* Macquart
### (Fig. 86)

*Chrysops ater* Macquart, 1850:344. Type, ♀, Newfoundland.
*Chrysops fugax* Osten Sacken, 1875:375. Type, ♀, Maine.




MAP 13. Distribution in California of: *Chrysops asbestos* Philip ●; and *C. fulvaster* Osten Sacken ▲.

*Chrysops carbonarius nubiapex* Philip, 1955:92. Type, ♀, Little Valley, New York.

*Geographic range*—Newfoundland to eastern Idaho and Elko County, Nevada.

*California distribution*—No specimens from California seen. Philip (1965a) lists "*carbonarius*" from California. Pechuman (personal communication) considers *carbonarius* to be eastern, not occurring west of Wisconsin, and states that western records should refer to *ater*.

*Seasonal occurrence*—Unknown.

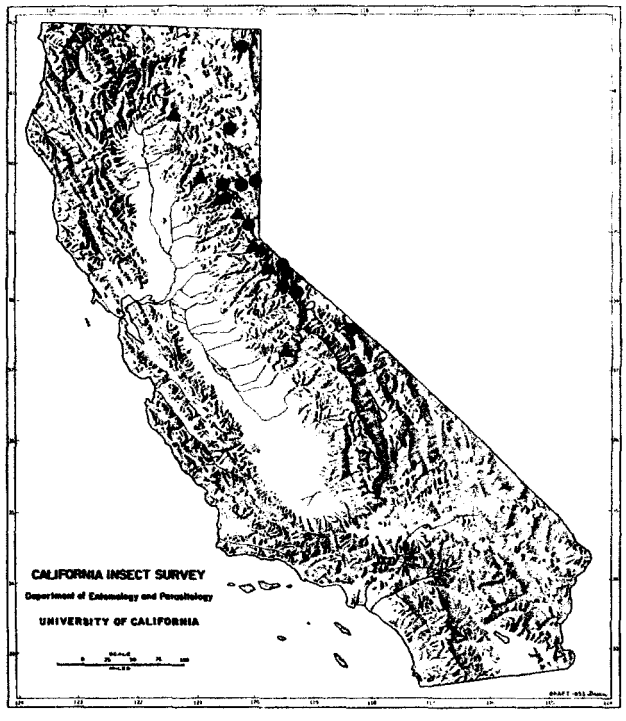
*Biology*—Teskey (1969) described the larvae and pupae of *Chrysops nubiapex* (=*Chrysops ater*). Larvae were found in organically rich soils bordering lotic habitats in Alberta, Manitoba, Ontario, and New York.

### *Chrysops bishoppi* Brennan
### (Figs. 8, 40, 85; Map 14)

*Chrysops bishoppi* Brennan, 1935:266. Type, ♀, Topaz, Mono County, California.
*Chrysops bishoppi* var. *gilvus* Philip, 1959:200. Type, ♀, Big Pine Creek, Inyo County, California. NEW SYNONYMY.

*Geographic range*—California, Nevada, Oregon, Utah.*

*New state record.




MAP 14. Distribution in California of: *Chrysops bishoppi* Brennan ●; and *C. excitans* Walker ▲.

*California distribution (counties)*—Map 14. A montane species. Inyo, Lassen, Modoc, Mono, Placer, Plumas, Sierra.

*Seasonal occurrence*—Last week of May to last week of July, most commonly mid-June to mid-July.

*Discussion*—Length: Female 8-10 mm.

The black basal callus, hyaline first basal cell, and the inverted V-shaped black mark on abdominal tergite II distinguish this species.

A female specimen in the collection of the University of California, Davis, collected by Bohart at Big Pine Creek, Inyo County, at the same time as the type and paratype of *C. bishoppi* var. *gilvus*, plus two other females from Big Pine Creek collected in 1953 by MacSwain, all appear to be *bishoppi*, albeit somewhat paler. Thus, the name *gilvus* does not appear to be warranted.

*Biology*—In Oregon, *C. bishoppi* is a persistent biter that attacks livestock anywhere on the body but seldom attacks man (Roth et al., 1952). We have no record of it biting man in California.

### *Chrysops clavicornis clavicornis* Brennan
### (Figs. 13, 19, 34, 87, 88; Map 15)

*Chrysops clavicornis* Brennan, 1935:277. Type, ♀, San Diego, California.

*Geographic range*—California, Baja California Norte (Philip, 1975b).

*California distribution*—Map 15. Lane has reared many larvae from Contra Costa County to adults. This species is also found commonly in the wooded areas of southwestern California and in the lower elevations of the west side of the Sierran crest in the Madera-Fresno areas. A few specimens have been taken in the Coast Ranges from Monterey County north to Mendocino County.

*Seasonal occurrence*—Last week in May to mid-September.

*Discussion*—Length: Female 7-8 mm.

The yellow and black body, orangish brown and black basal callus, swollen scape, and the apical infuscated spot of the wing extending into cell $R_5$ separate this species from the more widely distributed and related *wileyae*.

*Biology*—Larvae and pupae were described by Lane (1975). Immatures were found in saturated soil bordering a permanent pond polluted by cattle droppings and overgrown with common tule, *Scirpus acutus* Muhl., and from a permanent seepage area. Larvae are apparently aquatic because only mature larvae were collected above the pond margin.

More recently, Lane collected *clavicornis* larvae from wet silt and decaying vegetation along the margins of a sulfur spring colonized by cattail, *Typha* sp., in a woodland-grass vegetational type in Contra Costa County.

### *Chrysops clavicornis brennani* Philip
### (Figs. 13, 19, 39; Map 15)

*Chrysops clavicornis brennani* Philip, 1955:94. Type, ♀, Springdale, Nevada.

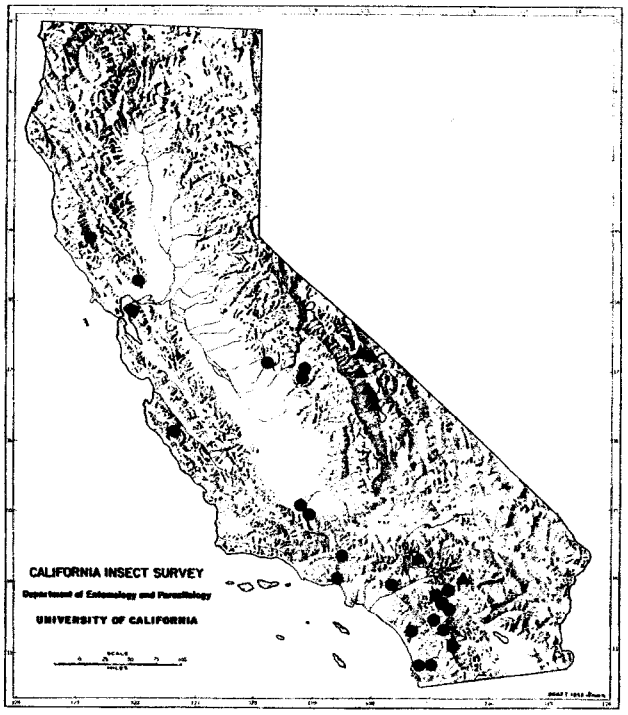
*Geographic range*—California, Nevada.

*California distribution*—Map 15. Inyo, San Bernardino. It is found east of Cajon Pass in San Bernardino County and in Inyo County (Map 15), areas where the nominate subspecies has not been taken. INYO Co.: *Lone Pine*, 1 ♀, VI-9-37 (N. W. Frazier, CIS); 1 ♂, VI-1-37 (Aitken, CAS); 1 ♀, VI-16-37 (L. R. Gillogly, CAS), *Lone Pine, 3 mi. N.*, 1 ♂, VII-3-53 (J. W. MacSwain, CIS). *Lone Pine, Alabama Hills*, 1 ♂, VI-16-37 (E. C. Van Dyke, CAS). *Bishop*, 1 ♀, VI-20-29 (E. P. Van Duzee, CAS). *Independence*, 1 ♂, VI-14-37 (L. R. Gillogly, CAS). *Deep Springs*, 3 ♀, VII-16-53 (UCR). *Antelope Springs, 7 mi. W. Deep Springs*, 1 ♀, VII-2-65 (UCR); 1 ♂, 1 ♀, VII-16-53 (UCR); 1 ♀, VII-21-67, 5500′ (UCR). *Antelope Spr., 8 mi. SW. Deep Spr.*, 21 ♀, 6 ♂, VI-29-61, VII-1-61 (G. W. Frankie, G. I. Stage, & J. Powell, CIS). *Antelope Springs*, 2 ♂ (J. W. MacSwain, CIS). *Bishop, 8 mi. NW.*, 1 ♀, VI-17-72 (UCR). *Bishop, 10 mi. N.*, 1 ♀, 1 ♂, VI-30-61 (G. W. Frankie, CIS). SAN BERNARDINO Co.: *Morongo Lake, Morongo Valley*, 1 ♀, VII-3-65 (UCR). *Victorville*, 1 ♀, VII-8-50 (Windsor, LACM).

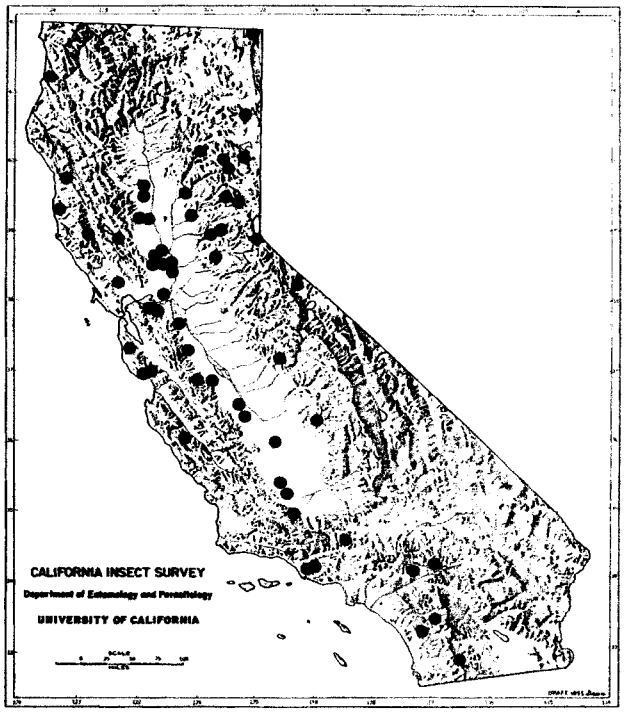
*Seasonal occurrence*—June through July.

*Discussion*—Length: Female 7.5 mm.

Philip described this somewhat smaller and paler subspecies. The female differs from typical *clavicornis*




MAP 15. Distribution in California of: *Chrysops clavicornis clavicornis* Brennan ●; and *C. clavicornis brennani* Philip ▲.




MAP 16. Distribution in California of *Chrysops coloradensis* Bigot.

in that the abdomen has only a double row of spots on tergites II-IV (Fig. 39), the infuscation in the second basal cell is often less than half that in the first basal cell and the infuscation in the discal cell is more dilute.

*Biology*—Unknown.

### *Chrysops coloradensis* Bigot (Fig. 89; Map 16)

*Chrysops coloradensis* Bigot, 1892:60. Lectotype, ♀, Colorado.

*Geographic range*—British Columbia south to Baja California Norte, Nevada, and Utah.

*California distribution*—Map 16. Except for Imperial County, and the desert areas of San Bernardino and Riverside, *coloradensis* is found in most counties of California. It is our most widely distributed *Chrysops*.

*Seasonal occurrence*—From early April to early October.

*Discussion*—Length: Female 8-10 mm.

Yellowish brown with black abdominal markings. The brown, black-bordered basal callus; characteristic wing pattern; knob of halteres brown to blackish above; and the dark line on dorsal surface of the scape and pedicel will easily distinguish this common species.

*Biology*—Although *coloradensis* is sometimes attracted to man, we have no records of it biting humans. It has been observed feeding on black-tailed deer in Mendocino County (Anderson et al., 1974).

In Mendocino County, *coloradensis* females laid single-tiered egg masses on floating leaves of pondweed, *Potamogeton nodosus* Poir., in permanent ponds from May to September (Lane, 1974). Egg masses contained from 71-289 eggs ($\bar{x}$ = 144.3) arranged in somewhat V-shaped rows. The incubation period in the laboratory was 5-6 days. The percentage of eggs in 21 masses that hatched was 79.3% (52.6-95.8%). One of 33 field-collected egg masses was parasitized by an apparently new species of Scelionidae (Hymenoptera) (L. E. Caltagirone, personal communication).

Although egg masses of *coloradensis* were associated with females on several occasions, egg mass data presented above are based on similar egg masses (i.e., color and shape) collected from the same plant species in the same habitat but usually not associated with a known adult. Thus, some of the eggs could have been laid by another *Chrysops* species having similar egg masses and ovipositional habits, but *coloradensis* was the only *Chrysops* observed breeding at the pond.[15]

15. Similar assumptions and procedures were used in gathering the egg masses of *C. hirsuticallus*, *C. pechumani*, and *Tabanus punctifer*.

Larvae and pupae were described by Lane (1975), who found the immatures along the margins of permanent ponds in saturated soil covered by moss and spikerush, *Eleocharis macrostachya* Britton. Larvae apparently are aquatic until mature when they migrate above water line to pupate.

### *Chrysops coquilletti* Hine
### (Figs. 30, 90, 122, 123; Map 17)

*Chrysops coquilletti* Hine, 1904:220. Lectotype, ♀, Los Angeles County, California.

*Chrysops robusta* Brennan, 1935:333. Type, ♀, Los Angeles, California. NEW SYNONYMY.

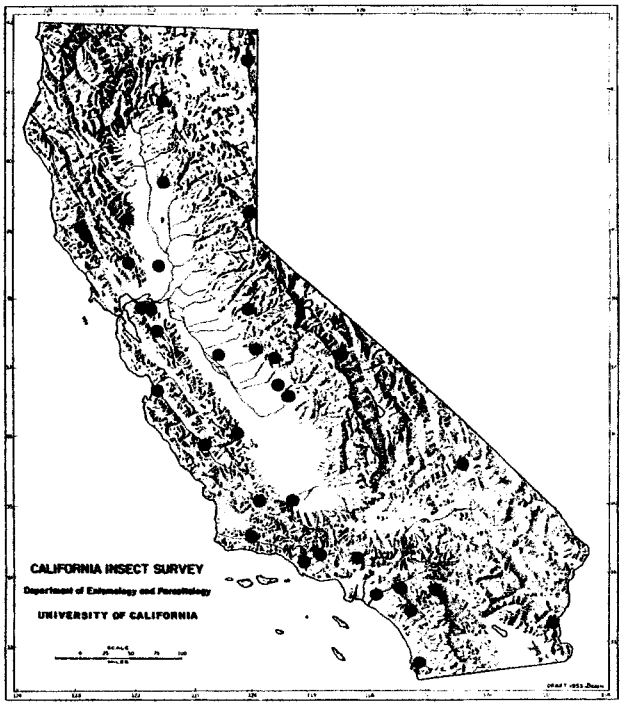
*Geographic range*—California, Utah, Baja California Norte.

*California distribution*—Map 17. Widely distributed in cismontane California, including several records from the floor of the Central Valley. Specimens have been recorded from 28 counties, from Modoc to San Diego and Imperial.

*Seasonal occurrence*—From late April to early September.

*Discussion*—Length: Female 8-9 mm.

Yellowish brown with black abdominal markings. The brown, black-bordered basal callus; characteristic wing pattern; denuded, yellow frontoclypeus with a yellow median pollinose stripe; distinctly swollen scape; and the grooved palpi in most specimens, distinguish this common and widespread species.




MAP 17. Distribution in California of *Chrysops coquilletti* Hine.

Philip (1955) considered *C. robusta* Brennan to be a melanistic variant of *C. coquilletti* but retained it as a variety in the Diptera Catalog (Philip, 1965a). Lane reared both the light and dark forms from larvae collected from the same substratum near Hopland, Mendocino County.

As noted by Brennan (1935) and Philip (1955), part of Hine's syntype series contained a pair of Brennan's *C. clavicornis*. A remaining female from Los Angeles County was designated as lectotype by Brennan (1935).

Reared males of *coquilletti* can be distinguished from those of *wileyae* by the following characteristics: ratio of pedicel length to width about 2.6:1 vs. 3.4:1; hairs on scape entirely black vs. mixed black and yellow; infuscation of second basal cell apically truncate vs. apically angled; dorsum of tergite I mostly black vs. presence of a pair of contiguous dark, submedian spots.

*Biology*—Larvae and pupae have been described by Lane (1975), who collected the immatures from damp sand and silt along the banks of the Russian River in Mendocino County. Comparison with the immatures of the closely related *C. wileyae* are given in the biology section for *wileyae*.

### *Chrysops discalis* Williston
### (Figs. 33, 91; Map 18)

*Chrysops discalis* Williston, 1880:245. Syntypes, 4 ♀♀, Como, Wyoming.

*Geographic range*—British Columbia east to Manitoba, south to California, Colorado, Nebraska, and Minnesota.

*California distribution*—Map 18. Most commonly found east of the Sierra crest in Owens Valley and the Great Basin area of Modoc and Lassen counties. A few scattered records south, west, and north of the Central Valley.

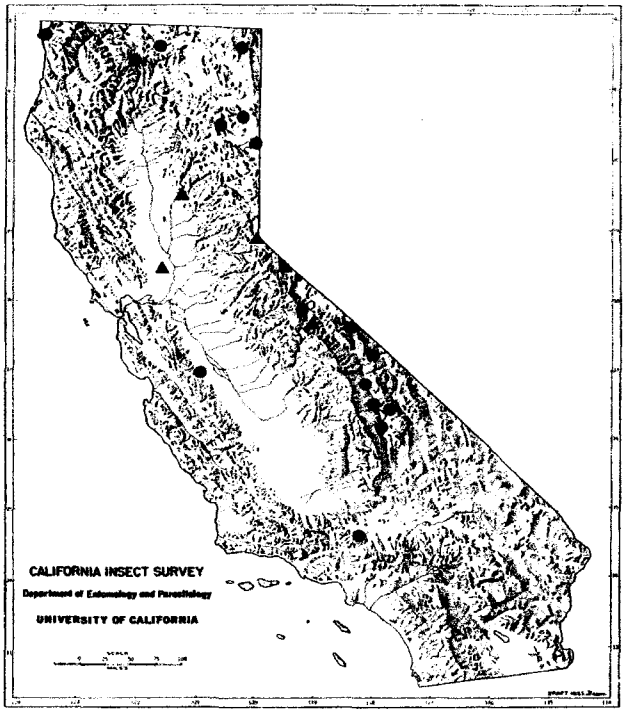
*Seasonal occurrence*—From late April to mid-August.

*Discussion*—Length: Female 8-10.5 mm.

A distinctive yellow and black species with characteristically fenestrate wings not likely to be confused with other *Chrysops* species. The black basal callus, unswollen scape, grooved apical palpal segment, and distinctive wing pattern will distinguish this pestiferous species.

*Biology*—*C. discalis* was the first tabanid to be incriminated in the transmission of a bacterium pathogenic to man by Francis and Mayne (1921), who demonstrated that *discalis* can transmit tularemia from infected to noninfected laboratory animals by the bite.

The biology of this species has not been studied in California. In Oregon and Utah, adults were active from June to September and reached peak abundance in July and August (Roth and Lindquist, 1948; Knudsen and Rees, 1968). "Stickem" traps baited with $CO_2$




MAP 18. Distribution in California of: *Chrysops discalis* Williston ●; and *C. furcatus* Walker ▲.

collected 53 times the number of flies taken in non-baited "stickem" traps (Knudsen and Rees, 1969).

Gjullin and Mote (1945) reported that *discalis* is a severe pest of cattle, horses, and humans in Oregon. Milk production on dairy farms reportedly decreased by 40–50% during the fly season (Roth and Lindquist, 1948). Females have also been observed feeding on jack rabbits (Roth et al., 1952), which has epidemiologic significance because lagomorphs are known reservoirs of tularemia (Jellison and Parker, 1945) and *discalis* can transmit tularemia to man by the bite (Klock et al., 1973). In Utah, the causative agent of tularemia was isolated from several pools of *discalis* (Knudsen, 1970).

*C. discalis* was observed mating from 0900 to 1130 h when air temperatures ranged between 56° and 78°F (Knudsen, 1970). Coupling lasted 10–70 minutes.

Gjullin and Mote (1945) observed a female ovipositing head down on a stem of *Scirpus americanus* Pers. along the shore of Rest Lake, Oregon. The mean number of eggs in 5 masses was 356. Roth and Lindquist (1948) reported that *discalis* oviposited on various artificial objects (e.g., boards, sticks, screen wire, glass) placed in water along the shore of Summer Lake, Oregon. A board 12 feet high and 6 inches wide was covered with up to 30,000 egg masses within a few days. Oviposition ranged from 25–50 minutes, and egg masses contained about 450 eggs. In Utah, *discalis* oviposited on 11 species of marsh plants that overhung water or saturated soil (Knudsen and Rees, 1967).

Larvae and pupae were described by Cameron (1926) and Philip (1941b). Cameron collected larvae from decaying vegetable matter washed up on the shore of an alkaline lake in Manitoba. Philip found immatures in wet sand bordering a saline lake in central Washington.

In Oregon, larvae were obtained from the mud bottom of 2 alkaline lakes as far as 100 feet from shore beneath water up to 2 feet deep (Gjullin and Mote, 1945). Larvae and pupae also were found from 50 feet to several hundred yards above water level and up to one-half mile or more from vegetation.

### *Chrysops excitans* Walker
### (Figs. 35, 92; Map 14)

*Chrysops excitans* Walker, 1850:72. Type, ♀, Cape Breton, Nova Scotia.

*Geographic range*—Alaska east to Labrador, south to California, Colorado and New Jersey.

*California distribution*—Map 14. A boreal species from Shasta County southward to Madera County.

*Seasonal occurrence*—From mid-June to third week in July.

*Discussion*—Length: Female 10 mm.

Black; abdomen with a yellow area laterally near base, and usually with pale median triangles on tergites II, III, and sometimes IV; pleurae with dense yellow pile; cell $Cu_1$ infuscated at base; both basal cells more than half infuscated; no apical wing spot. Male much darker than female, with pale abdominal markings reduced or obsolete. One of only 4 California species with wings completely hyaline beyond the crossband. Most likely to be confused with *C. mitis*, from which it can be separated by the presence of lateral spots on abdominal tergites I and II.

*Biology*—Adults have been collected while attempting to bite man near Buck's Lake, Plumas County. *C. excitans* is a pest of humans in the Adirondack Mountains of New York (Pechuman, 1972). In Ontario, females were collected from man, white-tailed deer, moose, and a captive robin (Smith et al., 1970).

Larvae and pupae were described by Cameron (1926), Philip (1931), and Teskey (1969). Cameron collected larvae along the shores of a lake in Manitoba. Philip found larvae under debris along a lake shore and along the margin of a temporary pond in Minnesota. Teskey obtained larvae from wet moss or other vegetation at the margins of a marsh lake, and of bog ponds, semi-woodland swamp pools, and several large lakes, in New York and Ontario.

*Diglochis occidentalis* Ashmead (Hymenoptera: Pteromalidae) has been reared from pupae of *excitans* (Cameron, 1926).

### *Chrysops fulvaster* Osten Sacken (Fig. 93; Map 13)

*Chrysops fulvaster* Osten Sacken, 1877:221. Lectotype, ♀, Denver, Colorado.

*Geographic range*—Alberta to Minnesota, south to California, New Mexico, and Oklahoma.

*California distribution*—Map. 13. ALAMEDA Co.: *Berkeley*, 1 ♀, XI-10-25 (W. W. Jones, CIS). SAN BERNARDINO Co.: *Garden City*, 1 ♂, VI-18-39 (G. Knowlton, LACM). *Camp O-Ongo* nr. *Running Springs, San Bernardino Mts.*, 3 ♀♀, IX-1-70, 6300′ elev. (C. L. Hogue, LACM). SAN DIEGO Co.: *Spring Valley*, 1 ♀, VII-4-56 (W. E. Simonds, CDA). The Berkeley specimen was identified by C. B. Philip as *fulvaster*, but the locality record is of doubtful validity.

*Seasonal occurrence*—June to September.

*Discussion*—Length: Female 7–8 mm.

Fuscous or brown with grayish yellow abdominal triangles; wing picture fenestrate with hyaline triangle faintly enclosed. The yellow frontal callus with brown lateral margins, swollen scape, and characteristic wing pattern will distinguish this small species.

*Biology*—Burger (1974) reports it to be a pest of man and livestock in the northern Rocky Mountains. In Utah, the causative agent of tularemia, *Francisella tularensis*, was isolated from 2 pools of *fulvaster* (Cox, 1965).

In Wyoming, male activity began on clear days from June to August when air temperatures reached approximately 72°F between 0745 and 0850 h (Lavigne et al., 1968). Females were active on clear days from about 0600 h to sunset. Host-seeking flies attacked humans throughout the day, but flower visitation usually did not begin until 1000 h.

Cameron (1926) described larvae and pupae from Saskatchewan, where this species was associated with swamps in ravines and the banks of small, sluggish streams.

### *Chrysops furcatus* Walker (Fig. 94; Map 18)

*Chrysops furcata* Walker 1848:199. Type, ♀, St. Martin's Falls, Albany River, Hudson's Bay, Canada.
*Chrysops lupus* Whitney, 1904:205. Type, ♀, Colorado.

*Geographic range*—Alaska to Labrador, south to California, Colorado, and North Dakota.

*California distribution*—Map 18. BUTTE Co.: *Oroville*, 1 ♀ V-10-21 (CAS). MONO Co.: *Topaz Lake*, 1 ♀, VI-26-57 (A. E. Pritchard, CIS). *June Lake, 0.5 mi. W.*, 5 ♀♀, VI-22-68 (USDAF). YOLO Co.: *Davis*, 1 ♀, V-10-38 (G. Spurlock, CAS). *Lake Tahoe (Cal.)* 1 ♀, VII-21-36 (G. M. Kohls, CAS).

*Seasonal occurrence*—May to third week in July.

*Discussion*—Length: Female 9–10 mm.

Characteristics distinguishing this species are as follows: basal callus black; frontoclypeus yellow, denuded, with brown lateral margins; unswollen scape; characteristic wing pattern; fore coxae orangish yellow; and the abdomen with a conspicuously yellow and black pattern. *C. furcatus* superficially resembles *C. noctifer* but the infuscated first and second basal cells and the abdominal pattern of the latter will easily separate them. No males from California are known.

*Biology*—Ovarian dissections of 3 females from Manitoba yielded an average of 281 (222–364) eggs (Miller, 1951). Larvae and pupae were described by Teskey (1969), who collected larvae from saturated peaty-clay soil beside a water-filled, man-made excavation in Ontario and from wet moss on the banks of frost ridges in open, grassy, swamp meadows in Manitoba.

### *Chrysops hirsuticallus* Philip (Figs. 38, 94, 107–109, 111, 112, 120; Map 19)

*Chrysops hirsuticallus* Philip, 1941a:126. Type, ♀, Woodland, Yolo County, California.

*Geographic range*—California.

*California distribution (counties)*—Map 19. Butte, El Dorado, Fresno, Lake, Mendocino, Merced, Placer, Sacramento, Yolo, Yuba.

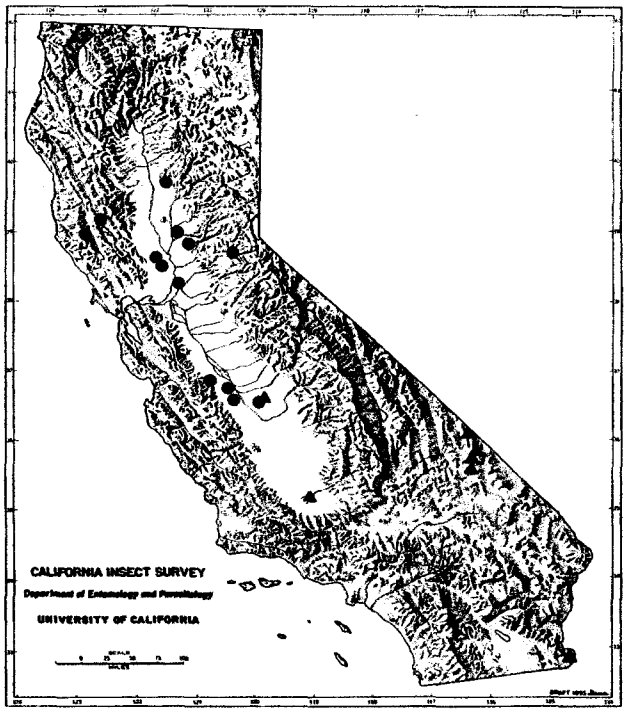
*Seasonal occurrence*—An early-season species appearing in north central California in mid-April and rarely seen after mid-June.

*Discussion*—Length: Female 7.5–10 mm.

Bodies of ♀♀ greenish gray, covered with golden yellow hairs, and with paired median and often lateral black dashes on the abdomen; wings lacking apical spot beyond crossband; crossband abbreviated and broken by fenestrated areas, especially in the discal cell, and margined outwardly by an irregular white halo. Males black; eye facets separated along frontal margins; wings more extensively infuscated than in females; fenestration much reduced in the crossband; antennae black.

A distinctive species not likely to be confused with any of the other *Chrysops* species in California.

*Biology*—Lane (1974) studied *hirsuticallus* breeding at a shallow, vernal pool near Hopland, Mendocino County, California (Fig. 110). Collections revealed a unimodal curve with a sharp mid-May peak in adult activity (Fig. 111). Adult activity was observed from 15 April to 21 June in 1972.




MAP 19. Distribution in California of: *Chrysops hirsuticallus* Philip ●; and *C. latifrons* Brennan ▲.

Male activity began between approximately 0700 and 0940 h as air temperatures reached 17.2–19.7°C. The male activity period continued for 2 to 4 hours and appeared to be inversely related to the rate of air warming. Most mating pairs were observed on the ground or on vegetation from 1.2–9.8 m above waterline.

The biting cycle (Fig. 112) was biphasic on a hot day (Tmax = 39.5°C) and monophasic on a warm day (Tmax = 26.7°C). On 17 May 1973, the biting cycle was biphasic with a sharp morning peak (0800–0900) and a smaller afternoon peak (1500–1700), whereas on 31 May it was monophasic with a truncated midday peak (1000–1300). Biting began when air temperature reached 18°C and ceased as light intensity diminished during late afternoon.

Flies preferred to attack the upper portions of man because 96.4% of all attacks occurred above the waist (Table 4). Of 252 recorded attacks, 47.2% involved the head and 25.0% the arms.

Oviposition was observed from 0938–1830 h when air temperatures ranged between 24.0 and 39.5°C. Flies laid their single-tiered egg masses (Figs. 107, 120) on the leaves or stems of 3 plant species growing in the pool: *Eleocharis macrostachya* Britton, *Eryngium aristulatum* Jeps., and *Juncus phaeocephalus* Engelm. The egg-laying rate (N = 41) averaged 12.0 seconds (3.6–18.1 sec)/egg, and egg masses contained an average of 119.9 (N = 31) and 150.5 (N = 13) eggs in 1972 and 1973, respectively.[16]

A larva of *Hippodamia* sp. probably *convergens* Guér. (Coleoptera: Coccinellidae) was the only predator observed eating an egg mass of *hirsuticallus* (Fig. 109). No parasites emerged from any of 57 egg masses held in the laboratory for several weeks following the hatch of *hirsuticallus* larvae.

Polovodova's (1949) age-grading technique was used to determine the parity profiles of flies collected by sweeping vegetation around the pool in 1972 and of flies obtained by sweeping vegetation or hand-captured while attacking man in 1973. Of 124 flies dissected in 1972, 70 (56.5%) were nullipars and 54 (43.5%) pars. Only 6 (11.1%) of the pars had oviposited twice and none 3 time (3 of the bipars, however, had partially developed eggs in their ovaries). Less systematic sampling in 1973 yielded 188 flies of which 78 (41.5%) were nullipars and 110 (58.5%) were pars. Of the pars, 78 (70.9%), 30 (27.3%), and 2 (1.8%) were unipars, bipars, and tripars, respectively. Egg retention was 15.4% by unipars and 43.3% by bipars. Females are anautogenous because none of the terminal follicles of 14 newly emerged flies held alive up to 8 days on a diet of sugar water developed beyond Christophers's stage II (Detinova, 1962).

Spiders appeared to be the most important predators of *hirsuticallus* adults. Five species were collected from emergent vegetation about the vernal pool: *Metaphidippus* sp. (Salticidae); *Oxyopes* sp. (Oxyopidae); *Tetragnatha* sp. (Tetragnathidae); *Araneus* sp. (Araneidae); and *Conepeira* sp. (Araneidae). *Tetragnatha* sp. was observed with *hirsuticallus* as prey more often than the other spider species. This spider was abundant in the *Juncus phaeocephalus* stand around the vernal pool.

An anthomyiid, *Scatophaga* sp., was observed feeding on a *hirsuticallus* male among vegetation just above the pool margin.

Larvae and pupae have been described by Lane (1975). Larvae seem to require nearly 2 years to complete development, with most growth occurring between December and April. Larvae moved horizontally inward with the receding pool margin in June and July. When water was present larvae were found within depths of about 2.5–5.1 cm. After fall rains refilled the pool in October or November, larvae were aquatic until late winter-early spring when mature larvae moved

16. The average number of eggs per mass may be much higher than reported here since many ovipositing flies were disturbed and flew away while being approached.

TABLE 4. ATTACKING SITES OF *CHRYSOPS HIRSUTICALLUS* ON A SLOWLY WALKING MAN, HOPLAND, CALIFORNIA, MAY 17 AND 31, 1973

| Body Region | Flies Attacking Total No. | Percent |
|---|---|---|
| Head | 119 | 47.2 |
| Neck | 6 | 2.4 |
| Shoulders | 16 | 6.3 |
| Chest & Stomach | 30 | 11.9 |
| Back | 9 | 3.6 |
| Arms | 63 | 25.0 |
| Buttocks | 0 | 0.0 |
| Thighs | 9 | 3.6 |
| Calves | 0 | 0.0 |

above water line to pupate. Late instars and pupae were obtained from damp soil bordering the pool margin in April and May. The mean density of immatures along the pool margin was 9.2/0.093 $m^2$ (= 1 $ft^2$) prior to most adult emergence on 23 April 1973.

The number of *hirsuticallus* larvae and pupae extracted from soil along the pool margin ranged from 0-53/0.093 $m^2$. In contrast, the mean density of *hirsuticallus* immatures, on an area-wide basis, was only 1.34/0.1 $m^2$ (Lane, 1976) because none of the other vernal pools (reported as temporary ponds) sampled at Hopland yielded immatures of this species.

### *Chrysops latifrons* Brennan (Fig. 96; Map 19)

*Chrysops latifrons* Brennan, 1935:213. Type, ♀, Ash Meadows (Amaragosa Desert) Nevada.

*Geographic range*—California, Nevada.

*California distribution*—Map 19. In California it is most commonly found in desert areas near surface water. FRESNO Co.: *Fresno, 15 mi. E.*, 2 ♀, VII-20,21-66 (CIS). IMPERIAL Co.: *Imperial Dam*, 2 ♀♀, V-3-57 (C. W. Schaefer, LACM); 1 ♀, VI-28-54 (W. McDonald, LACM). KERN Co.: *Bakersfield, 11.2 mi. N., 1.6 mi. E.*, 1 ♀, VII-13-66 (J. P. Bruen, CIS). INYO Co.: *Shoshone*, 1 ♀, VI-17-54 (LACM). *China Ranch*, 1 ♀, V-30-55 (J. N. Belkin, LACM); 1 ♀, VI-7-61 (R. P. Allen, CDA). *Death Valley Jct.*, 1 ♀, V-17-54 (J. N. Belkin, LACM); 6 ♀, IX-19-55 (C. B. Philip, CAS). SAN BERNARDINO Co.: *Saratoga Springs, Death Valley N.M.*, 6 ♀, V-30-40 (LACM); 1 ♀, VI-16, 19-54 (LACM); 1 ♀, VII-10,12-53 (LACM); 1 ♀, VII-27,29-55 (LACM); 1 ♀, V-4-57 (Menke & Stange, LACM); 3 ♀, IV-3-59 (Menke & Stange, LACM); 1 ♀, IV-24-55 (C. L. Hogue, LACM); 5 ♀, VI-14-64 (UCR); 2 ♀, IX-6-64 (C. W. O'Brien, CIS).

*Seasonal occurrence*—From early April to mid-September.

*Discussion*—Length: Female 7 mm.

Basal callus strongly convex, yellow, denuded, with brown lateral margins; frontoclypeus yellow, denuded, with a yellow median pollinose stripe; scape and pedicel swollen; crossband dilute with discal cell fenestrated; fore coxae orangish yellow; abdomen yellow with a black geminate spot on tergites II-IV, on each side of which may appear a small black spot.

Related to *pachycerus* from which it may be separated by the more dilute crossband with a toothlike projection along vein $R_4$ and $R_5$ towards the bifurcation.

*Biology*—Unknown.

### *Chrysops mitis* Osten Sacken (Fig. 97; Map 21)

*Chrysops mitis* Osten Sacken, 1875:374. Lectotype, ♀, Hudson's Bay, Ontario.

*Geographic range*—A widespread boreal species extending from Alaska to Labrador, south to California and Colorado in western United States and New York in the East.

*California distribution*—Map 21. SHASTA Co.: *Moose Camp*, 1 ♀, VI-19-54 (E. I. Schlinger, CAS). *Hat Creek*, 1 ♀, 24-?-51 (G. F. Pronin, CAS). EL DORADO Co.: *Meyer's Camp*, 1 ♀, VII-22-48 (H. E. Cott, CIS); 3 ♀, VII-27-52 (W. C. Bentinck, CIS). HUMBOLDT Co.: *Orick*, 2 ♀♀, VII-10-38 (E. C. VanDyke, CAS).

*Seasonal occurrence*—The only California records are in July.

*Discussion*—Length: Female 9.5 mm.

Body black except for mid-dorsal gray triangles on abdominal tergites; cell $Cu_1$ infuscated at base; no infuscation beyond the dark crossband; both basal cells infuscated over half their area. Male with considerable dilute infuscation in anal area of wing.

Among *Chrysops* species in California with hyaline wings beyond the crossband, only *ater* is likely to be confused with *mitis*. The latter is distinguished by having the base of cell $Cu_1$ infuscated, the discal cell somewhat fenestrate, and large, gray middorsal triangles usually present on the abdomen.

*Biology*—In the eastern United States this species is an abundant, early-season pest of man and other animals. In Ontario, females were collected from man, white-tailed deer, and moose (Smith et al., 1970).

The ovipositional behavior of *mitis* is similar to that of *Chrysops aestuans* (cf.), but egg masses of *mitis* are distinctive in having 3 or 4 tiers compared with 1 tier in *aestuans* (Cameron, 1926).

Egg incubation takes 6 or 7 days and hatching occurs uniformly throughout an egg mass within 10 minutes. In Canada, the hymenopterous parasites *Phanurus* (= *Telenomus*) *emersoni* Girault (Scelionidae) and *Trichogramma minutum* Riley (Trichogrammatidae) have

been reared from eggs, and *Diglochis occidentalis* Ashmead (Pteromalidae) and *Trichopria tabanivora* Fouts (Diapriidae) from pupae (Cameron, 1926). *D. occidentalis* and *T. tabanivora* also were reared from pupae in Minnesota (Philip, 1931).

Larvae and pupae have been described by Cameron (1926), Philip (1931), and Teskey (1969). In Saskatchewan, eggs, larvae, and pupae were collected around sloughs (Cameron, 1926). In Minnesota, Philip found larvae and pupae along a lake shore. Larvae also have been obtained from various wet habitats in New York and Ontario (Teskey, 1969).

## *Chrysops noctifer* Osten Sacken (Figs. 9, 32, 98; Map 20)

*Chrysops noctifer* Osten Sacken, 1877:220. Lectotype, ♀, Webber Lake, Sierra County, California.
*Chrysops noctifera*; Brennan, 1935:321, *lapsus*.
*Chrysops pertinax* Williston, 1887. Syntypes, 8 ♀♀, Washington Territory. NEW SYNONYMY.
*Chrysops nigriventris* Bigot, 1892:604. Type, ♀, Washington Territory.
*Chrysops noctifera pertinax*; Philip, 1947:278, *lapsus*.
*Chrysops noctifer pertinax*; Philip, 1965a:326.

*Geographic range*—A widespread, boreal species that is common from the Yukon south into California, and in the Rockies to New Mexico. It has also been recorded from Michigan.

*California distribution*—Map 20. A common mountain species, occurring in the North Coast, Klamath, and Cascade ranges, and south in the Sierra Nevada to Mariposa County and on the east side to Mono County.

*Seasonal occurrence*—Occasionally as early as late April and May, but usually June and July, at which times it may be abundant.

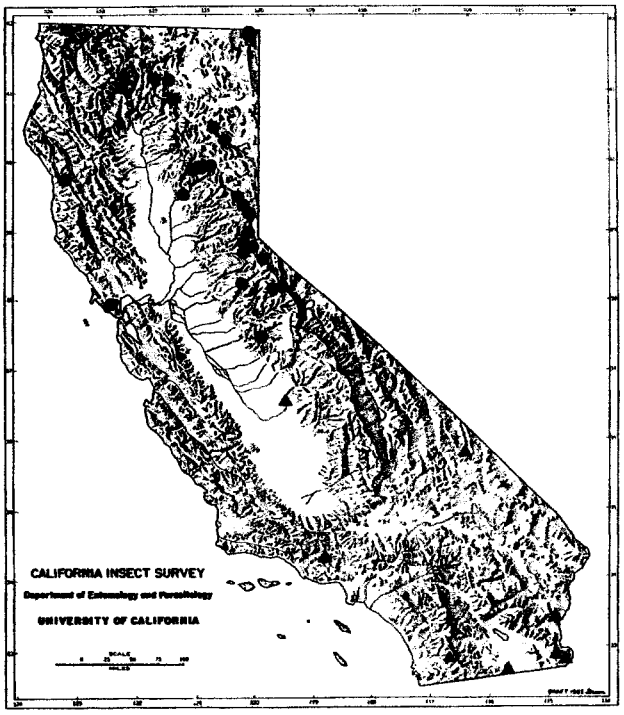
*Discussion*—Length: Female 8–9.5 mm.

Basal callus and frontoclypeus black, the latter with a yellow median pollinose stripe; apex of wing beyond crossband with a narrow infuscated band that barely crosses vein $R_4$; anterolateral margins of abdominal tergites I and II black or yellowish orange.

Williston described *pertinax* with the entirely black abdomen. Other workers, following Philip (1947), considered *pertinax* to be a subspecies of *noctifer*.

Since the "form" with the basal tergites orangish yellow (*noctifer*) and the "form" with the all black basal tergites (*pertinax*) plus intermediates coexist *viz.* Lily Lake and Buck Creek Ranger Station, Modoc County; Quincy, Plumas County; Hope Valley, Alpine County; Echo Lake, El Dorado County; there is no reason to maintain *pertinax* as a subspecies.

*Biology*—*C. noctifer* is reportedly a pest of man in the Sierra Nevada (Essig, 1928).




MAP 20. Distribution in California of: *Chrysops noctifer* Osten Sacken ●; and *C. pachycerus* Williston ▲.

## *Chrysops pachycerus* Williston (Fig. 99; Map 20)

*Chrysops pachycerus* Williston, 1887:134. Syntypes, 2 ♀♀ (lost), 1 ♂ (misidentified, not *pachycerus*). California.
*Chrysops hungerfordi* Brennan, 1935:306. Type, ♀, Blue Spring, Eddy County, New Mexico.
*Chrysops dilatus* Rowe and Knowlton, 1936:256. Type, ♀, Leeds, Utah.
*Chrysops pachycerus* var. *hungerfordi*, Philip, 1965a:327.

*Geographic range*—California to Utah, south to Mexico and Texas.

*California distribution*—Map 20. FRESNO Co.: *Centerville, 1 mi. E.*, 2 ♀, VIII-26-68 (J. B. Hoy, CAS); 2 ♀, VII-9-11-68 (J. B. Hoy, CAS). *Centerville, 2 mi. N.*, 1 ♀, VII-13-66 (J. B. Hoy, CAS). IMPERIAL Co.: *Laguna Lake*, 12 ♂♂, 33 ♀♀, VII-21,22-53 (LACM); 13 ♀♀, VI-9- to 11-50 (LACM); 1 ♀, same data (CIS). *Haughtelin Lake Bard*, 3 ♀♀, VII-21,22-53 (LACM). *Calexico*, 1 ♂, X-15-59, light trap (C. R. Waegner, CDA). RIVERSIDE Co.: *Blythe*, 1 ♀, VIII-1-60, argon light (K. Japport, CDA). SAN DIEGO Co.: *Desert Edge*, 1 ♂, IV-15-15 (M. C. Van Duzee, CAS). VENTURA Co.: *Piru*, 1 ♀, VIII-14-58 (Jarrity, CDA).

*Seasonal occurrence*—July to mid-August.

*Discussion*—Length: Female 7–9 mm.

A yellow and black species with markedly swollen scape; basal callus yellow, bordered dorsolaterally by black; the outer margin of crossband fairly straight

rather than sinuous; the infuscation in 2nd basal cell is about one-half that in the 1st basal cell and sharply diagonal or semitruncated; and the median figure on tergite II is usually divided mesally, not geminate.

Most likely to be confused with *coquilletti* or *wileyae*.

Brennan's (1935) *C. hungerfordi* is listed as a var. of *pachycerus* by Philip (1965a), who also indicates that it occurs in southwest California. In *hungerfordi*, there are 4 black spots on tergites III-V while in *pachycerus* there are 2. Although we have seen no specimens assignable to var. *hungerfordi* from California we believe its separation on such a tenuous basis to be needless as did Burger (1974).

*Biology*—Larvae and pupae (as var. *hungerfordi*) were described by Burger (1977), who collected larvae along the margins of lakes, ponds, cienegas, small streams, and a permanent creek in Arizona.

### *Chrysops pechumani* Philip
### (Fig. 100; Map 21)

*Chrysops pechumani* Philip, 1941a:128. Type, ♀, Niles, Alameda County, California (erroneously listed as Inyo County). Allotype, ♂, was taken at Pismo, San Luis Obispo County, California, not Posmo.

*Geographic range*—California.

*California distribution*—Map 21. Coast Range from San Luis Obispo to Humboldt County. One isolated record from Nevada County.

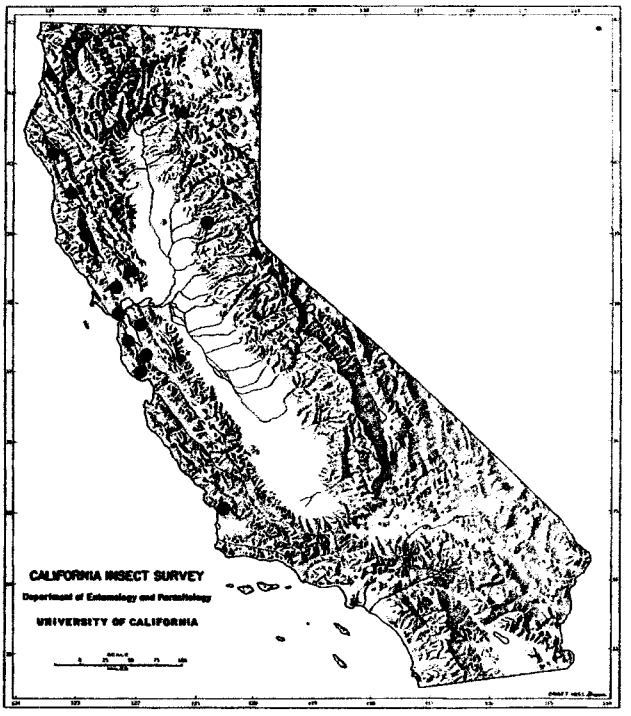
*Seasonal occurrence*—Mid-April to late May. This is one of the earliest *Chrysops* species occurring in the Coast Range.

*Discussion*—Length: Female 9-9.5 mm.

*C. pechumani* is a relatively large, black species with a characteristic wing pattern that readily separates it from *C. noctifer*. The broad, apical wing spot which extends halfway across cell $R_4$; the solid crossband that usually lacks a pronounced, toothlike projection in cell $R_3$; infuscated first and second basal cells; and the hyaline triangle that attains vein $R_1$ distinguish this species (Fig. 100).

*Biology*—In Mendocino County, females oviposited on the undersides of leaves of *Populus fremontii* Wats., *Typha* sp., and *Salix* spp. overhanging the margins of the Russian River at Hopland (Lane, 1974). Egg masses were usually 2-tiered and sometimes 3-tiered, and yielded an average of 400.1 (98-562) larvae (N=10).

A female was observed ovipositing on the underside of a shaded *Salix* leaf, 2 May 1972. The leaf was 10.2 cm from its branch tip. When the fly was first seen at 1248 h, it had laid many eggs. Eggs were deposited side-by-side in overlapping rows as follows: the abdominal tip was curved downward to contact the leaf surface and appeared to momentarily pulsate before an




MAP 21. Distribution in California of: *Chrysops pechumani* Philip ●; and *C. mitis* Osten Sacken ▲.

egg was extruded by a posteriorly directed stroke or by 2 strokes, a long and a short one, interrupted by a pause of about 1-3 seconds. Its abdomen was then moved anteroventrally and the next egg placed adjacent to the previous one. Each row was laid from 1 edge of the mass laterally toward the opposite edge or several half rows were laid on a side before the abdomen was shifted to the opposite side of the mass to complete the rows. When the fly began placing a second tier atop the first, however, it laid the first egg near the middle of the mass and subsequent eggs were laid diagonally toward 1 side. After oviposition was completed at 1342 h, the fly flew away immediately.

Larvae and pupae were described by Lane (1975). Mature larvae and pupae were found in damp sand and silt along the banks of the Russian River. Immature larvae were collected from the river bottom 1.2-2.4 m from shore beneath water 7.5-20 cm deep. Mature larvae moved up to 1.65 m above water line to pupate during early spring. The immature stages of *pechumani* ranked second in relative density among 6 tabanid species collected along the banks of the Russian River (Lane, 1976).

Only 1 of 21 *pechumani* pupae (12 ♂♂, 9 ♀♀) examined by Lane (1975, Fig. 18) had a tubercle anterolaterad of each lateral portion of the antennal ridges.

Thus, the presence of these tubercles should be considered aberrant.

Females reportedly feed on Columbian black-tailed deer at Hopland (Anderson et al., 1974).

### *Chrysops proclivis* Osten Sacken (Figs. 23, 101; Map 22)

*Chrysops proclivis* Osten Sacken, 1877:222. Lectotype, ♀, Marin Co., California.

*Chrysops atricornis* Bigot, 1892:603. Syntype ♀, Colorado. NEW SYNONYMY.

*Chrysops proclivis* var. *imfurcatus* Philip, 1936b:157. Type ♀, Sumner, Washington.

*Chrysops proclivis* var. *atricornis*, Philip, 1965a:327.

*Geographic range*—Alberta, British Columbia, Quebec, Yukon Territory, California, Colorado, Nevada, Oregon, Washington, Wyoming.*

*California distribution (counties)*—Map 22. Alpine, Butte, Del Norte, El Dorado, Marin, Mendocino, Modoc, Mono, Nevada, Plumas, Santa Cruz, Shasta, Siskiyou, Sonoma, Trinity, Tulare.

*Seasonal occurrence*—Late May through July. There is one late August record from Fallen Leaf Lake in the Lake Tahoe area.

*Discussion*—Length: Female 7.5–9 mm.

A black and yellow species. The apical wing spot is much wider than that of *surdus* (Figs. 101, 102), and the yellow portion of the frontoclypeus is wider than the adjacent lateral brown lobes. The yellow portion of the frontoclypeus area is quite narrow in *surdus*.

Philip (1936b:157) proposed the varietal name *imfurcatus* for a color variant of *proclivis* in which tergite II is entirely yellow. Osten Sacken's *proclivis* possesses a small, lateral black spot on each side of the midline. Later Philip (1965a) synonymized *imfurcatus* with Bigot's *atricornis*, which he recognized as a variety of *proclivis*. Since we have seen specimens with both a spotted and unspotted tergite I from the same localities we are not retaining *atricornis* as valid.

*Biology*—Unknown. Cameron (1926) described larvae and pupae of *proclivis* from Canada, but they were probably another species, since *proclivis* has not been recorded from Saskatchewan (Philip, 1965a).

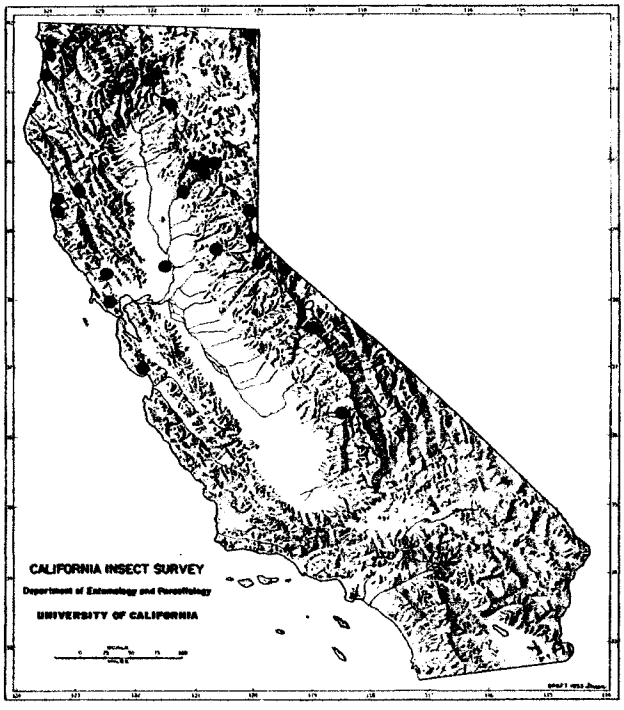
### *Chrysops surdus* Osten Sacken (Figs. 24, 63, 102; Map 23)

*Chrysops surda* Osten Sacken, 1877:223. Lectotype, ♀, Webber Lake, Sierra County, California.

*Chrysops proclivis* var. *piceus* Philip, 1936b:157. Type, ♀, Huntington Lake, California. NEW SYNONYMY.

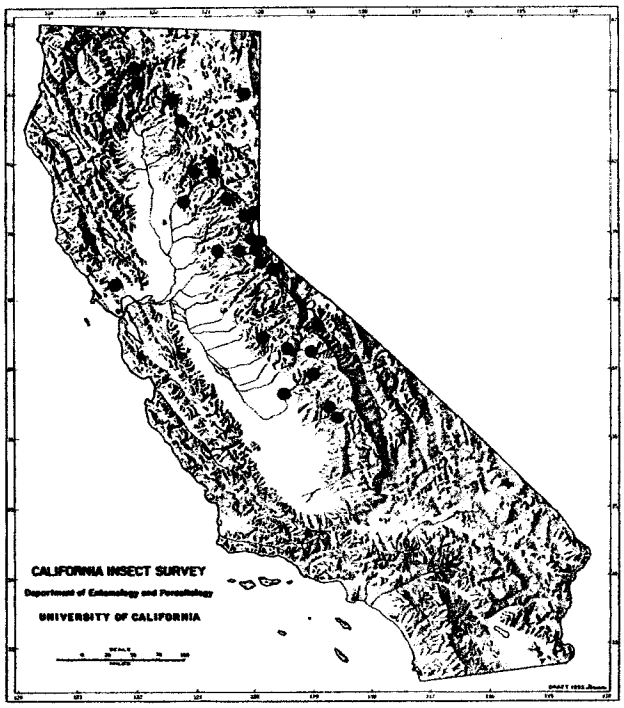
*Chrysops surdus* var. *piceus* Philip, 1965a:327.

*Geographic range*—British Columbia, California, Nevada, Oregon, Washington.




MAP 22. Distribution in California of *Chrysops proclivis* Osten Sacken.

*New state record.




MAP 23. Distribution in California of *Chrysops surdus* Osten Sacken.

*California distribution (counties)*—Map 23. Alpine, Butte, El Dorado, Fresno, Lassen, Madera, Mariposa, Mendocino, Mono, Nevada, Plumas, Shasta, Sierra, Siskiyou, Sonoma, Trinity, Tulare.

*Seasonal occurrence*—From early June through the third week of August. Most common in July.

*Discussion*—Length: Female 6.5-7 mm.

A black and yellow species sympatric with *proclivis*, with which it might be confused. A narrower yellow streak on the frontoclypeus, a narrower apical wing spot beyond the crossband, the predominantly black legs, and the generally smaller size distinguish *surdus* from *proclivis*.

Philip (1936b) first described *piceus* as a variety of *C. proclivis*, but later (Philip, 1947) considered it as a subspecies. In the Diptera Catalog (Philip, 1965a) it is listed as *C. surdus* var. *piceus*. The variety *piceus* is a melanistic form which appears to be most pronounced in males. A small collection of specimens from Shaver Lake has the males identified by Philip as *piceus*, the females as *surdus*.

*Biology*—This is a pest of man in the Sierra Nevada (Essig, 1928). In Mendocino County, females of *surdus* were observed feeding on deer (Anderson et al., 1974). Several collectors have taken specimens that were attracted to artificial lights in Butte and El Dorado counties.

At Hopland, females exhibited a unimodal (1100-1400 h) activity peak when mean temperatures were below 32.2°C (Anderson et al., 1974). On hot days (Tmax = 40.00-42.8°C) flies showed bimodal activity peaks (0800-1100, 1400-1700) with slightly greater activity in the first period. These patterns are similar to those reported above for *Chrysops hirsuticallus*.

Larvae and pupae were described by Lane (1975). Larvae were collected from saturated soil in permanent seepage areas, and pupae from moist soil along the margin of a permanent pond.

The anterior pubescence of the larvae encircles at least the first 4 body segments, becomes progressively reduced and paler on the remaining segments, and is absent on at least segments 9-10. The very short posterior extensions from the meso- and metathoracic annuli may be inconspicuous, especially on larval exuviae. Posterior pubescence is absent on all body segments; what appears to be a narrow band of posterior pubescence on abdominal segment 7 in Lane's (1975) figure of a *surdus* larva is actually a layer of closely adherent debris in the intersegmental area. The conspicuous pseudopodial and anal pubescence contrast with the paler anterior pubescence.

Pupae are distinguishable from those of at least 15 of the other 16 *Chrysops* species in California described previously by lacking antennal ridges. These may also be absent or vestigial in *C. fulvaster* (see Cameron, 1926, pl. III, Fig. 3).

## *Chrysops virgulatus* Bellardi
## (Figs. 18, 103)

*Chrysops virgulatus* Bellardi, 1859:71. Type, ♀, Cuautla, Mexico.
*Chrysops geminata*; Macquart, not Wiedemann, 1928:205.

*Geographic range*—Arizona, S.E. California, Texas, Mexico. An uncommon and localized species in areas where it occurs.

*California distribution*—No California specimens were seen in the present study, but it has been recorded from the S.E. part of the state by Philip (1965a).

*Seasonal occurrence*—July and August (Arizona).

*Discussion*—Length: Female 8-9.5 mm.

A yellow and black species with swollen scape and pedicel. It resembles *C. latifrons* in this regard, but differs in having the crossband of the wing entirely dark.

*Biology*—Larvae and pupae were described by Burger (1977). Larvae were found at or just below the margins of a large artificial lake and a natural desert spring in Arizona.

## *Chrysops wileyae* Philip
## (Figs. 22, 104, 115-119; Map 24)

*Chrysops wileyae* Philip, 1955:96. Type, ♀, Mt. Wilson, Los Angeles County, California.

*Geographic range*—California, Nevada, Oregon, Utah, Baja California Norte.

*California distribution*—Map 24. Widely distributed in the foothills and mountains of western California from San Diego north to Tehama County. Less commonly in the chaparral areas east of the San Joaquin Valley. One isolated record from Nevada County north of Lake Tahoe.

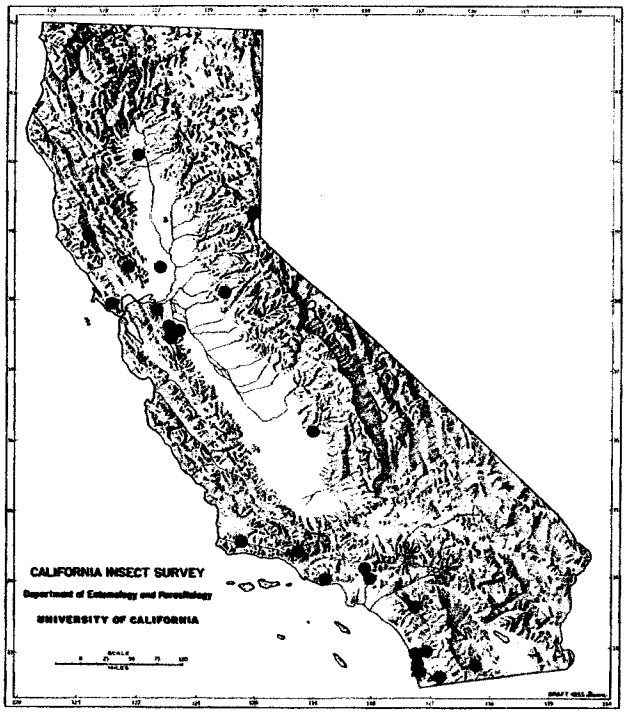
*Seasonal occurrence*—From mid-May to the end of August. One male from San Diego County was taken on April 12.

*Discussion*—Length: Female 7.5-9 mm.

A yellow and black species of the *pachycerus* group. Distinguishing features are: swollen scape; scape and pedicel combined slightly longer than the flagellum; front is broader than high; the wing pattern (Fig. 104) is characteristic.

*Biology*—Middlekauff was bitten by this species near Tracy, San Joaquin County.

Immatures have been collected from permanent seepage areas, temporary creek margins, and along sandy river banks in Mendocino County (Lane, 1975). One specimen was obtained from a filamentous green alga in an intermittent creek. The immatures of *wileyae* are similar to those of *Chrysops coquilletti*. Reared females of these species sometimes were difficult to dis-




MAP 24. Distribution in California of *Chrysops wileyae* Philip.

tinguish using Philip's (1955) diagnostic characters, but several morphological characters were found that separated reared males (Lane, 1975).

Lane (1975) was unable to separate the larvae and pupae of *wileyae* and *coquilletti* with certainty, but further study has disclosed slight differences that collectively may help to differentiate them. The greatest widths of the larval head capsules average slightly less in *wileyae* ($\bar{x}$ = 0.37 mm, r = 0.36–0.39 mm, N = 6) than in *coquilletti* ($\bar{x}$ = 0.42 mm, r = 0.38–0.44 mm, N = 8), and the head capsules are pale yellowish brown with posterior suffusions in *wileyae* whereas those of *coquilletti* are mostly light brown with posterior suffusions. Head capsule color in tabanids is subject to wide intraspecific variation. Teskey (1969) and Lane (1975) omitted head capsule color because of insufficient interspecific differences. Segment 8 in larvae of *wileyae* (Fig. 115) has a continuous, narrow band of posterior pubescence dorsally and laterally, and sometimes ventrally to encircle the segment, as compared with narrow bands laterally and dorsolaterally on each side in *coquilletti*. The posterior pubescent annulus on segment 10 has a short anterior projection laterally or none in *wileyae*, whereas it has a broad, short to moderately long, and sometimes roughly triangular-shaped anterior projection laterally in *coquilletti* (Lane, 1975).

No one morphological character was found that separated the pupae of *wileyae* (N = 6) (Figs. 116–119) and *coquilletti* (N = 8) (Figs. 122, 123), although together the following characters may prove useful for distinguishing them. In *wileyae*, the anterior and posterior orbital tubercles on each side of the frontal plate are separated by a gap of 0.26 mm (0.19–0.34 mm), whereas in *coquilletti* the distance between them is 0.15 mm (0.05–0.23 mm). Further, the anterior orbital tubercles are spaced 1.27 mm (1.23–1.31 mm) in *wileyae* and 1.15 mm (0.96–1.25 mm) in *coquilletti*.

In both species the mesonotum, orbital areas, vertex, and the frontal plate have brown suffusions. The suffusions on the ventral surface of the frontal plate of *wileyae* (Fig. 116) are generally much darker than those in *coquilletti* and usually contrast with large, pale sublateral patches and a pale median stripe on the frontoclypeus and with pale areas about the antennal ridges and antennal sheaths on the front. Suffusions on the frontal plate of *coquilletti* (Fig. 122) are normally most evident on the front, especially as a patch or stripe between the median portions of the antennal ridges. In one of 8 *coquilletti* pupae examined, however, the suffusions were inconspicuous.

## SUBFAMILY TABANINAE

### Tribe Diachlorini

### Genus *Stenotabanus* Lutz

*Stenotabanus* Lutz, 1913:487; Enderlein, 1925:354; Stone, 1938:31; Philip, 1941c:5; Fairchild, 1942:297.

*Type species—Tabanus taeniotes* Wiedemann. Monotypic.

In North America, this genus contains 2 subgenera, *Stenotabanus* Lutz and *Aegialomyia* Philip, and 7 species. Only the subgenus *Stenotabanus* extends as far north as southern California and Utah. The generic limits of *Stenotabanus* are ill-defined. Most species are found on ocean beaches or in xeric environments with a consequent graying or whitening of their color.

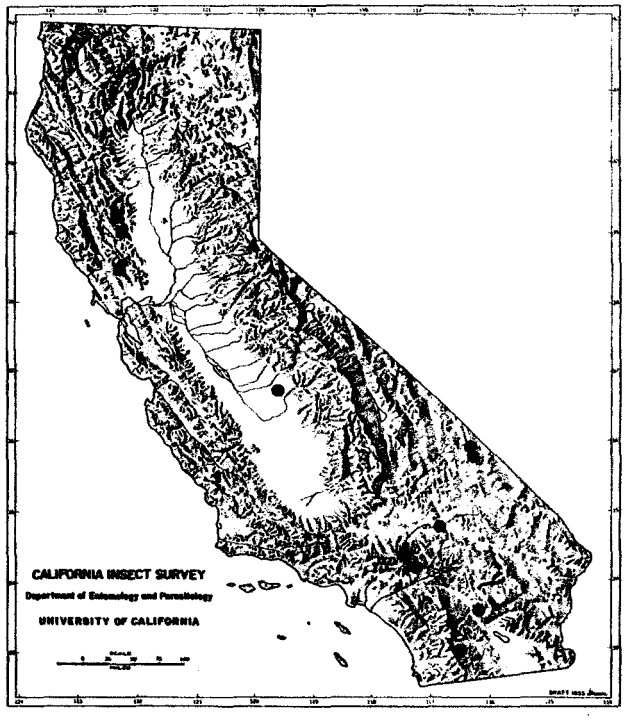
#### *Stenotabanus guttatulus* (Townsend)
#### (Fig. 46; Map 25)

*Diachlorus guttatulus* Townsend, 1893:134. Type, ♀, Las Cruces, New Mexico.

*Stenotabanus cribellum*; authors, not Osten Sacken.

*Geographic range*—Arizona, California, Nevada, New Mexico, Utah.

*California distribution*—Map 25. FRESNO CO.: *Fresno, 15 mi. E.*, 1 ♀, VII-23-66 (USDAF). INYO CO.: *Tecopa*, 1 ♂, 1 ♀, V-30-55 (Belkin, McDonald, LACM). *Shoshone*, 1 ♀, VI-17-54 (Belkin,




MAP 25. Distribution in California of: *Stenotabanus guttatulus* (Townsend) ●; *Haematopota americana* Osten Sacken ▲; and *H. willistoni* (Philip) ■.

McDonald, LACM); 1 ♀, VII-11-53 (LACM). Riverside Co.: *3.5 mi. S. Palm Desert*, 1 ♀, VII-3-69 (Frommer, Worley, UCR). San Bernardino Co.: *Victorville*, 2 ♀♀, VII-8-50 (D. Newby, LACM). *Yermo*, 1 ♂, 1 ♀, V-23-40 (Reeves, Cazier, Ting, CAS). San Diego Co.: *Banner, 6 mi. E.*, 1 ♂, VII-13-63 (P. Welles, CAS).

*Seasonal occurrence*—Last week of May to second week of July. Sporadic and uncommon.

*Discussion*—Length: Female 11–13 mm.

Most females are pale gray with abdominal tergites II–IV each with 4 small, round, brown spots on a gray to pink background. The bare basicosta (Fig. 1) will distinguish it from any of our *Hybomitra* or *Tabanus* species. The male has not been described.

*Biology*—It has been taken in canopy traps, especially when $CO_2$ was used as an attractant. It reportedly attacks humans in the same fashion as *Chrysops*.

## Tribe Haematopotini

## Genus *Haematopota* Meigen

*Chrysozona* Meigen, 1800:23. Suppressed by Int. Comm. Zool. Nomen., 1963:339.
*Haematopota* Meigen, 1803:267.

*Type species—Tabanus pluvialis* L., 1761. Monotypic.

Generally small and slender, uniformly blackish gray, 6.5–13 mm long. Eyes somewhat hairy (more so in the male), in life with several undulating bands; large eye facets in male sharply delimited from the lower, smaller ones. Frons almost square. Basal callus polished, narrow, usually occupying the lower one-fourth of frons (Figs. 48, 49). Paired velvety black spots above basal callus present. Ocellar tubercle and ocelli absent. Antennae usually longer than head (at least in female); scape oval as in *americana*, or slender and cylindrical as in *willistoni*; pedicel very small; no dorsal excision on basal part of segment 3; 3 terminal flagellar annuli. Wings brown to gray with numerous white maculae (Figs. 105, 106).

*Haematopota* is a large genus with over 380 species. Oldroyd (1964) believes that *Haematopota*, which feeds almost exclusively on Bovidae, has evolved along with its mammalian hosts. There are no flies of this genus in Australia, New Zealand, or South America, where native bovids are lacking; only 5 species occur in North America, where a depauperate bovid fauna existed. In contrast, 60, 83, and 238 *Haematopota* species have been reported from the Palearctic, Oriental, and Ethiopian regions, which have a rich bovid fauna (Chvala et al., 1972).

Little is known about the biologies of the 2 *Haematopota* species recorded from California. In the Old World many species are known for their attacks upon man and both domestic and wild mammals. Some also can transmit the filarial worm *Loa loa* (Guyot), or the pathogenic organisms which cause tularemia and anthrax (Krinsky, 1976).

Goodwin (1976b) characterized the known larvae and pupae of North American *Haematopota* species based on his descriptions of *H. punctulata* Macquart and on those of *H. americana* Osten Sacken by Cameron (1926, 1934). The integument of *H. punctulata* larvae lacks cuticular striations (Goodwin, 1976b), whereas larvae of *H. americana* reportedly have extremely fine, inconspicuous integumentary striae. We were able to confirm the presence of very fine, narrowly spaced striae on all aspects of the body in preserved larvae of *H. americana* from Alberta. This material was made available to us through the generosity of Dr. H. J. Teskey.

## KEY TO CALIFORNIA SPECIES OF HAEMATOPOTA

1. Two distinct, velvety black spots on frons (Fig. 49); wing maculae relatively large, contrasting faintly with lightly infuscated background; apical band of wing not reaching posterior border (Fig. 105); antennae short, stout, approximately 5X longer than width of scape (Fig. 49); scape not constricted near apex, conspicuously swollen . . . *americana* Osten Sacken

A small, round, velvety black spot, about one-half the diameter, above and between two larger spots on frons (Fig. 48); wing maculae small, contrasting markedly with darkly infuscated background; apical pale band of wing nearly reaching posterior border (Fig. 106); antennae long, slender, approximately 8X longer than width of scape (Fig. 48); scape markedly constricted near apex, not conspicuously inflated..... *willistoni* (Philip)

### *Haematopota americana* Osten Sacken (Figs. 49, 105; Map 25)

*Haematopota americana* Osten Sacken, 1875:395. Lectotype, ♀, Hudson's Bay Territory.

*Geographic range*—A boreal species occurring from Alaska to Ontario, south to California (Sierra Nevada), and in the Rocky Mountains to New Mexico. Also found in North Dakota and Minnesota.

*California distribution*—Map 25. The only known California specimen is a female collected July 10, 1958, Echo Lake, El Dorado County, 2256 m elevation (Middlekauff, CIS).

*Discussion*—Length: Female 9-11 mm.

A distinctive species easily separated from its congener *willistoni* on the basis of wing pattern (Fig. 105) and the short, stout antenna with swollen scape.

*Biology*—Cameron (1926) reported flies biting cattle, horses, and man. Females were frequently caught while resting on stable walls during warm, sunny days. He also collected the larvae of *americana* from soil along the banks of sloughs, and described the larvae and pupae.

### *Haematopota willistoni* (Philip) (Figs. 48, 106; Map 25)

*Chrysozona willistoni* Philip, 1953:249. Type, ♀, 5 mi. S.E. Wilbur Hot Springs, Colusa Co., California.

*Geographic range*—California.

*California distribution*—Map 25. COLUSA CO.: *Wilbur Hot Springs, 5 mi. S.E.*, 1 ♀, V-27-50 (L. Quate, CAS). *Lodoga*, 1 ♀, VII-12-55 (H. R. Moffitt, UCD). NAPA CO.: *Walter Springs*, 1 ♀, paratype, V-15-51 (E. Schlinger, UCD). *Pope Creek*, near *Walter Springs*, 5 ♀♀, V-19-76, $CO_2$-Malaise trap (R. S. Lane, C. B. Philip, CAS).

*Seasonal occurrence*—From mid-May to mid-July.

*Discussion*—Length: Female 6.5-9 mm.

Easily distinguished from *americana* on the basis of the following: antennae long, slender, approximately 8X longer than width of scape; scape not conspicuously swollen or bottle-shaped, noticeably constricted near apex; wing brown with numerous relatively small, white maculations and the apical pale band of wing reaches posterior border (Fig. 106).

Male: Unknown.

*Biology*—On 19 May 1976, Lane and C. B. Philip collected 5 ♀♀ in 2 $CO_2$-baited insect flight traps that were placed alongside Pope Creek near Walter Springs, Napa County.

Soil samples taken along the margins of Pope Creek produced larvae of *Chrysops wileyae* and *Tabanus punctifer*, but none of *H. willistoni*.

## Tribe Tabanini

### Genus *Atylotus* Osten Sacken

*Tabanus*, subg. *Atylotus* Osten Sacken, 1876:426.

Type species—*Tabanus bicolor* Wiedemann, 1821. Designated by Hine, 1900.

Small to medium-sized species, usually gray, yellow, or yellowish brown, and mostly finely pubescent. Head large, semi-globular; eyes bare or hairy, sometimes with one narrow band or a trace of one. Males with lower area of small facets sharply separated from upper, large-faceted area. Eyes in life yellow or green to grayish; dark brown in dried specimens. Ocellar tubercle present only in males. Median and basal calli present in most species. Wings hyaline; usually a stump vein at bifurcation. Abdomen with gray or yellow hair; a pattern, if present, seldom distinct and consisting of darker-haired patches or a vague median stripe.

The genus is mainly Holarctic and Ethiopian with about 60 species. Seven species are recorded from North America and 3 species from California. Philip (1960) records a ♂ *A. thoracicus* from Coleman, Mono County, but the specimen could not be located.

*Atylotus* is a difficult group since most of the species are variable, and the range of intraspecific variability has not been sufficiently studied. Males are especially difficult to distinguish. As noted by others, some of the so-called subspecies or varieties, usually sympatric with the nominate form, only demonstrate the range of variability within each taxon.

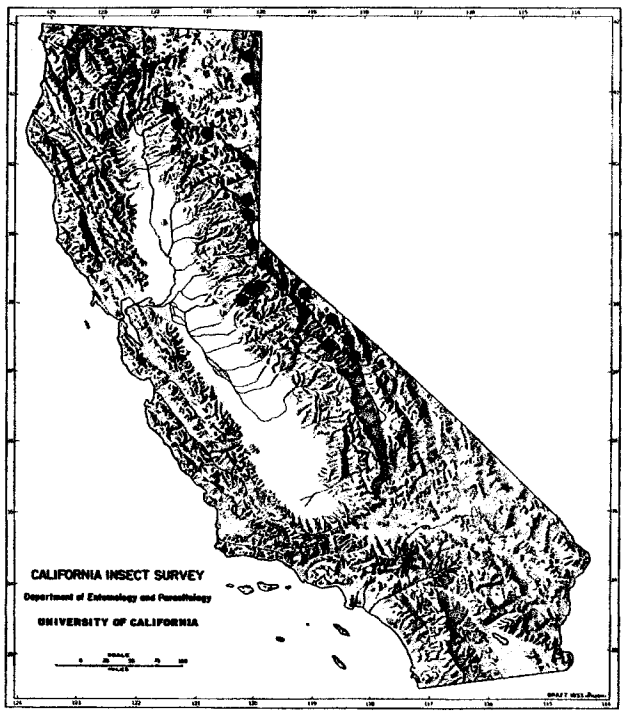
## KEY TO SPECIES OF ATYLOTUS IN CALIFORNIA

***Females***

1. A row of long, black hairs on postorbits and vertex ..... *tingaureus* (Philip)
   Hairs on postorbits and vertex mostly short and pale..... *incisuralis* (Macquart)

***Males***

2. Hairs of postorbits and on scape black, twice as long as those on eyes; femora entirely blackish; vestiture predominantly golden yellow; antennae entirely orange-red..... *tingaureus* (Philip)
   Hairs of postorbits short, usually pale, not protruding above those of the eyes; femora often extensively reddish apically; vestiture predominantly whitish; annuli of flagellum darkened ..... *incisuralis* (Macquart)




MAP 26a. Distribution in California of *Atylotus incisuralis* (Macquart).

### *Atylotus incisuralis* (Macquart) (Fig. 50; Map 26a)

*Tabanus incisuralis* Macquart, 1847:37. Type, ♀, America.
*Tebanus insuetus* Osten Sacken, 1877:219. Lectotype, ♀, Webber Lake, Sierra County, California.

*Geographic range*—Alaska to Ontario, south to California and Colorado.

*California distribution*—Map 26a. A montane species, most commonly found east and northeast of the Central Valley to 3000 m elevation from Inyo County north to Modoc.

*Seasonal occurrence*—From mid-June to mid-August.

*Discussion*—Length: Female (holotype) 12 mm.

Brown to yellowish brown. Frons rather broad, not narrowed above; basal callus very small, black, about one-half the width of frons; median callus oval, usually detached from basal callus, sometimes joined to it; scape and pedicel of antenna yellow to yellowish gray, basal plate of flagellum short, dark brown to reddish brown; annulate portion short, usually concolorous with basal plate.

Most likely to be confused with *tingaureus*, but the absence of a row of long, black, postorbital hairs will distinguish *incisuralis*.

Male: Differs from *tingaureus* as follows: vestiture predominantly whitish; annuli of flagellum darker than basal plate; postorbital hairs do not protrude above pile of the eyes and femora are often extensively reddish apically.

*Biology*—Webb and Wells (1924) reported that *Tabanus insuetus* ( = *A. incisuralis*) is a hard biter that is sometimes bothersome to livestock in Antelope Valley along the California-Nevada border. Horses were attacked primarily on the abdomen and legs. The sphecid wasp *Bembex* ( = *Epibembex*) *primaaestate* Johnson and Rohwer preyed upon adults of *incisuralis*.

Females were taken while biting livestock and humans in Saskatchewan (Cameron, 1926). Larvae and pupae were described by Webb and Wells (1924), Cameron (1926), and Burger (1977). Webb and Wells found larvae in wet soil and humus at the bases of grass roots. Cameron did not specify the larval habitat in Saskatchewan. Burger obtained larvae from wet moss (*Bryum* sp.) in high-mountain meadows or cienegas in Arizona.

### *Atylotus tingaureus* (Philip) (Map 26b)

*Tabanus insuetus* var. *tingaureus* Philip, 1936a:159. Type ♀, Libby, Montana.
*Atylotus insuetus* var. *tingaureus*; Stone, 1938:20.
*Atylotus incisuralis tingaureus*; Philip 1947:288.
*Atylotus tingaureus*; Philip, 1960:366.

*Geographic range*—Alaska south to California, Montana, and Nevada.

*California distribution*—Map 26b. A montane species, mostly north and west of the Central Valley. Several records from Mendocino and Sonoma counties in the North Coast Ranges.

*Seasonal occurrence*—Mid-May to late August.

*Discussion*—Length: Female 12-13 mm.

Resembles *incisuralis* as indicated by the above synonymy. The row of long, black hairs on postorbits and across the vertex will distinguish *tingaureus*.

Male: Vestiture predominantly golden yellow; hairs on eyes dense, yellow; hairs on postorbital row black, twice as long as hairs on the eyes; antenna entirely orange-red and femora entirely blackish.

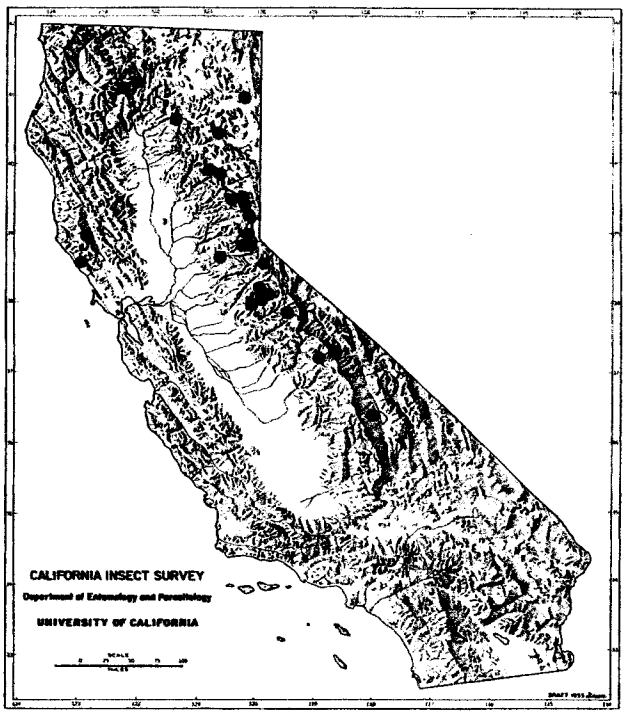
*Biology*—Unknown.

## Genus *Hybomitra* Enderlein

*Hybomitra* Enderlein, 1922:347; Enderlein, 1925:364; Stone, 1938: 36; Philip, 1941c:7; Philip, 1942:56; Fairchild, 1942:451.

*Type species—Hybomitra solox* Enderlein, 1922. Original designation ( = *T. rhombicus* Osten Sacken, 1876).

Thirteen species of *Hybomitra* are known from California. Members of the genus are more northern in distribution than are species of *Tabanus*. Only 2 species




MAP 26b. Distribution in California of *Atylotus tingaureus* Philip.

(*H. captonis* and *procyon*) occur south of the Tehachapi Mountains in southern California. Conversely, 6 of 10 *Tabanus* species recorded in California have been taken south of these mountains.

Only *phaenops*, *rhombica*, and *sonomensis* among species in California reportedly annoy man occasionally, but several additional species (e.g., *fulvilateralis* and *procyon*) are pests of livestock. Only 2 of 21 species of *Hybomitra* in New York are pests of humans (Pechuman, 1972).

*Hybomitra* is a convenient means of splitting the large and unwieldy genus *Tabanus*. All of the *Hybomitra* species in California have pilose eyes, except *H. phaenops* in which the eyes are bare or only have a few scattered, very short hairs. No *Tabanus* species in California has pilose eyes, but *T. laticeps* and *T. stonei* have eyes with a few scattered hairs similar to those in *H. phaenops*. A distinct, denuded ocellar tubercle distinguishes females of *Hybomitra* from those of *Tabanus*. Males of *Hybomitra* species possess an anteriorly shining ocellar tubercle. In male *Tabanus*, the ocellar tubercle, if present, is completely pollinose.

Teskey ( 969) characterized the immature stages of *Hybomitra*. Larvae and/or pupae of 5 *Hybomitra* species occurring in California have been described (Table 1). Additionally, Lane has reared the heretofore unknown immatures of *californica* and *sonomensis* to adults, the descriptions of which will be published elsewhere (Lane, *in press*).

## KEY TO CALIFORNIA SPECIES OF HYBOMITRA

1. Females; eyes not contiguous ..... 2
   Males; eyes contiguous ..... 14
2. Entirely, or mostly black (a small orange spot may be present laterally on tergite II) ..... 3
   Not entirely black ..... 4
3. Subcallus pollinose ..... *lanifera* (McDunnough)
   Subcallus bare ..... *procyon* (Osten Sacken)
4. Abdomen broadly and uniformly orangish brown laterally, always on tergite II, and usually also on tergites I, III, IV ..... 5
   Abdomen not broadly and uniformly orangish brown laterally, usually with sublateral pale spots bordered by black ..... 11
5. Hind tibial fringe well developed, mostly golden orange; a large, stout species, body length usually over 17 mm ..... *californica* (Marten)
   Hind tibial fringe black; smaller species, body length usually less than 17 mm ..... 6
6. Antennae black, rarely with a little orange on pedicel and/or extreme base of 3rd segment; stump vein usually present . 7
   Third antennal segment with at least the basal half orange; stump vein usually absent ..... 9
7. Vertex deeply notched; basal plate with a dorsal excision (Fig. 59) ..... *philipi* (Stone)
   Vertex flat or only shallowly notched; basal plate without a dorsal excision (Fig. 62) ..... 8
8. Eyes densely pilose; venter of abdomen with mostly long, dense yellow hair, although there may be some scattered black hairs on mid-venter; furcation usually with infuscated spot ..... *sonomensis* (Osten Sacken)
   Eyes bare or with a few scattered, short hairs; venter of abdomen with shorter and sparser hairs, many of which are black; furcation usually lacking infuscated spot ..... *phaenops* (Osten Sacken)
9. Subcallus pollinose ..... *fulvilateralis* (Macquart)
   Subcallus denuded, shiny ..... 10
10. Dorsal excision of 3rd antennal segment rounded (Fig. 53); frontal pollinosity gray; front femora pale brown ..... *aasa* Philip
    Dorsal excision angulate (Fig. 54); frontal pollinosity golden brown; front femora black ..... *captonis* (Marten)
11. Prescutal lobe black, concolorous with mesothorax ..... *rhombica* (Osten Sacken)
    Prescutal lobe pale, brownish orange ..... 12
12. Stump vein present ..... *tetrica* (Marten)
    Stump vein absent ..... 13
13. Costal cell faintly suffused with brown; a faint infuscated spot at bifurcation; subcallus denuded, shiny ..... *melanorhina* (Bigot)
    Costal cell as well as remainder of wing hyaline; subcallus pollinose ..... *opaca* (Coquillett)

***Males***[17]

14. Thorax, femora, body vestiture completely black ..... 15

17. ***philipi*** unknown.

Thorax, femora and/or body vestiture not completely black . 16

15. Subcallus pollinose, laterally hairless or with only 1 or 2 long hairs; tibiae pale; 2nd palpal segment brown; abdominal tergite II laterally with a slight reddish orange spot..... *lanifera* (McDunnough)

Subcallus denuded, shiny, laterally with numerous, long, black hairs; tibiae, 2nd palpal segment and abdominal tergites black..... *procyon* (Osten Sacken)

16. Abdomen broadly orangish brown laterally to margins, the median black area usually constricted on tergite III; sublateral pale spots, if present not conspicuous..... 17

Abdomen not broadly orangish brown laterally, usually an area of black hairs on margins; if paler laterally, the median dark area broad and not constricted on tergite III; sublateral pale spots, if present, distinct..... 22

17. Antennae red with black annuli..... 18

Antennae otherwise..... 19

18. Hind tibial fringe with a scattering of golden hairs; pilosity of pleura and lateral area of tergites golden yellow..... *californica* (Marten)

Hind tibial fringe entirely black; pilosity of pleura and lateral areas of tergites otherwise, not golden yellow..... *aasa* Philip

19. Antennae including annuli pale, reddish brown..... *captonis* (Marten)

Antennae with more than the annuli black..... 20

20. Venter, including the incisures with only black hairs..... *phaenops* (Osten Sacken)

Venter with some golden hairs; hairs on the incisures completely golden..... 21

21. Second sternite with a large, black median spot; scape and pedicel black..... *sonomensis* (Osten Sacken)

Second sternite with little black medially; scape and pedicel pale..... *fulvilateralis* (Macquart)

22. Prescutal lobe black..... *rhombica* (Osten Sacken)

Prescutal lobe pale, reddish orange..... 23

23. Subcallus denuded..... *melanorhina* (Bigot)

Subcallus pollinose..... 24

24. Stump vein present..... *tetrica* (Marten)

Stump vein absent..... *opaca* (Coquillett)

## *Hybomitra aasa* Philip
## (Fig. 53; Map 27)

*Hybomitra aasa* Philip, 1954:28. Type, ♀, Fish Lake, Jackson County, Oregon.

*Geographic range*—British Columbia south to California.

*California distribution (counties)*—Map 27. Butte, Mendocino, Merced, Nevada, Plumas, Stanislaus, Yolo, Yuba.

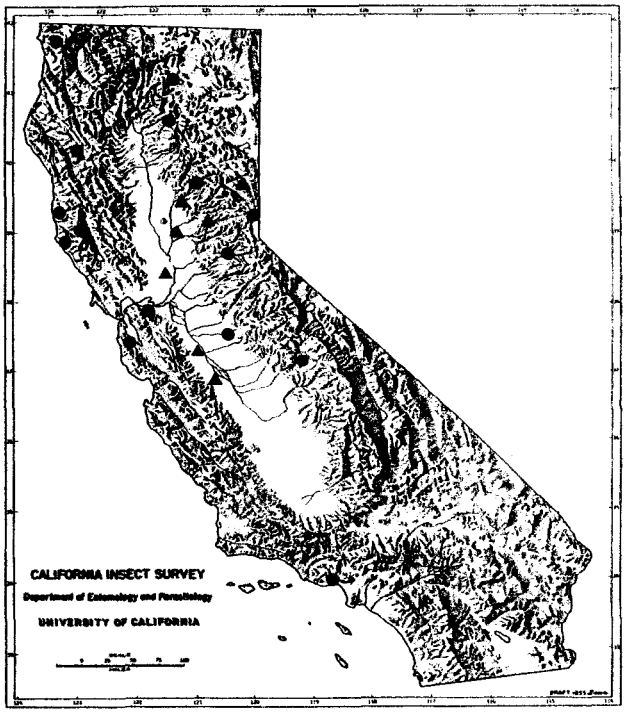
*Seasonal occurrence*—Third week in May to first week of September.

*Discussion*—Length: Female 13.5 mm.

This species superficially resembles *H. captonis* and *fulvilateralis*, but can be separated from *captonis* by the lined thorax; extensively reddish femoral hairs (especially the anterior ones); proximity of the basal callus to the eye; frons gray; golden yellow pollinosity on abdominal incisures; and much smaller tubercle. The shiny subcallus; darker, less contrasting abdominal pattern; smaller, less oval median callus; and less deeply excised dorsal plate of flagellum are some features which will separate *aasa* females from *fulvilateralis*.

Male: A little darker and more hirsute; frontal triangle distinctly swollen, shiny amber brown in center, gray pollinose laterally and basally; annuli of flagellum black, remainder of antenna red; abdominal incisures lacking pale hairs.

*Biology*—Unknown.




MAP 27. Distribution in California of: *Hybomitra captonis* (Marten) ●; and *H. aasa* Philip ▲.

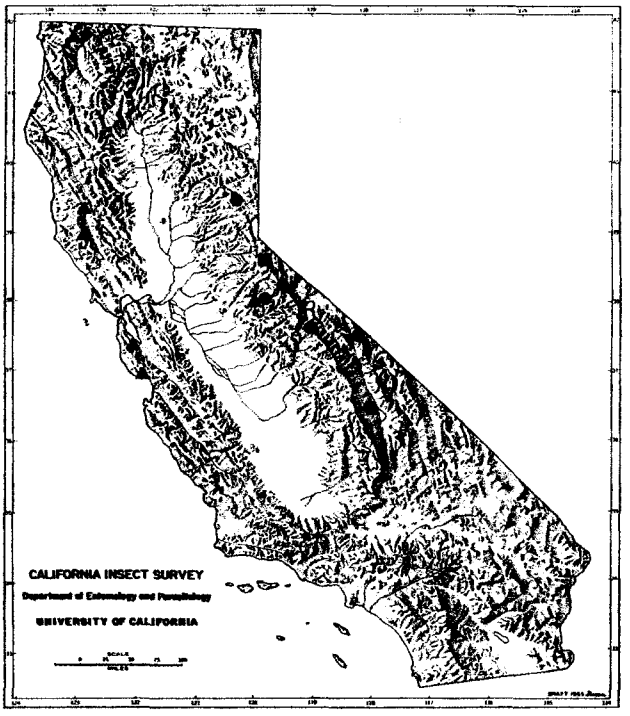
## *Hybomitra californica* (Marten)
## (Figs. 7, 52; Map 28)

*Tabanus californicus* Marten, 1882:210. Type, ♀, California. Destroyed.

*Geographic range*—Britih Columbia south to California and Idaho.

*California distribution*—Map 28. MENDOCINO Co.: *Ryan Creek*, 1 ♀, VI-8-38 (N. Hardman, CAS). *Middleridge Ranch*, 1 ♀, IX-11-69 (CIS). *Hopland Field Station*, 1 ♀, IX-2-69 (CIS); 2 ♂♂, VIII-11-75, VIII-19-75 (reared from larvae, R. S. Lane, RSL); 1 ♀, VIII-19-71 (R. S. Lane, RSL). SAN MATEO Co.: *Menlo Park*, 1 ♀, X-1944 (C. D. Duncan, LACM). SANTA CRUZ Co.: *Santa Cruz*, 1 ♀, VII-19-41 (J. W. Tilden, CIS). TUOLUMNE Co.: *Pinecrest*, 1 ♀, VIII-4-51 (S. M. Kappos, UCD).

*Seasonal occurrence*—A few scattered records report it on the wing from early June to early September.




MAP 28. Distribution in California of *Hybomitra opaca* (Coquillett) ●; *H. lanifera* (McDunnough) ■; and *H. californica* (Marten) ▲.

*Discussion*—Length: Female 17-19 mm.

One of the *Hybomitra* species with the abdomen broadly orangish brown laterally. Its large size and the well-developed, golden orange, hind tibial fringe separate it from other *Hybomitra* species in California with similarly colored abdomens. Eyes are moderately pilose; subcallus gray pollinose; basal portion of flagellum red, with a moderate dorsal excision, and the annuli black; bifurcation with a lightly infuscated spot; stump vein usually absent, but may be present on one wing or both; abdomen broadly pale orangish brown, with a median black spot on basal tergites I-III laterally.

Male: Similar in coloration to the female except that it has darker legs.

*Biology*—Several adults have been taken in $CO_2$-baited insect flight traps at the University of California, Hopland Field Station (HFS), Mendocino County, during August and September (Anderson and Lane, unpublished data).

Lane (1974) collected larvae along the margin of a small, shaded, woodland vernal pool at the HFS. In 1973, this pool dried by early July and remained dry for approximately 4 months until fall rains began refilling it.

Larvae were usually taken at or slightly above the water's edge in saturated, decaying organic matter or moss within about 2.5-5.1 cm below the surface. Two larvae were found in partially submerged, decaying logs and a third was taken beneath a log at the pool margin.

Larvae were difficult to rear to adults. None of 27 collected from 1972-74 was successfully reared, although 3 died in the pupal stage or while attempting to pupate. In 1975, 2 males were reared from 3 late instars taken in June.

### *Hybomitra captonis* (Marten)
### (Fig. 54; Map 27)

*Tabanus captonis* Marten, 1882:211. Type, ♀, California. Destroyed.
*Tabanus comastes* Williston, 1887:137. Lectotype, ♀, Washington Territory (Philip, 1975a).

*Geographic range*—Western North America from Yukon Territory south to California and Colorado.

*California distribution*—Map 27. Most commonly in northern California on both sides of the Central Valley, from San Mateo on the west to Fresno County on the east. One isolated record from the Santa Monica Mountains, Los Angeles County.

*Seasonal occurrence*—With the exception of an early record for the third week of April and a late one of September 2, the flight period in California is June through July.

*Discussion*—Length: Female 14-17 mm.

The following characteristics will serve to distinguish *captonis* females from related species: abdomen broadly orangish brown laterally; flagellum mostly red, suffused with black on the dorsal margin in the incised area; stump vein usually absent; subcallus denuded, shiny; dorsal excision angulate; frontal pollinosity golden brown and front femora are black.

Male: Similar to female except black markings on tergites II and III tend to be more quadrate and distinct; antennae pale reddish orange, the annuli more or less black; the frontal triangle is silvery pollinose.

*Biology*—Unknown.

### *Hybomitra fulvilateralis* (Macquart)
### (Fig. 55; Map 30)

*Tabanus fulvilateralis* Macquart, 1838:137. Type ♀, locality unknown (as Cayenne, in error).
*Tabanus recedens* Walker, 1854:201 (preoccupied, Walker, 1848). W. Coast America.
*Tabanus haemaphorus* Marten, 1882:210. Syntypes, 2 ♀♀, California. Destroyed.

*Geographic range*—British Columbia to Manitoba, south to California and New Mexico.

*California distribution*—Map 30. Eastern California from Lassen County south to Mono. One record from Del Norte.

*Seasonal occurrences*—From early June to the first week of August.

*Discussion*—Length: Female 14.5–17.5 mm.

Superficially resembling *H. captonis* from which it can be differentiated by the pollinose subcallus; more extensive black areas on tergites II and III; grayer pollinosity on frons; abdominal incisures with fewer and shorter golden hairs and these mostly lateral; and more distinct gray pollinosity on black background of abdominal tergites.

*Biology*—A specimen was captured in El Dorado County while feeding at the base of a dog's tail. Burger (1977) described larvae and pupae from Arizona. Larvae were obtained from wet moss in cienegas and from floating clumps of pondweed (*Potamogeton* sp.) in a small pond.

### *Hybomitra lanifera* (McDunnough) (Fig. 56; Map 28)

*Tabanus laniferus* McDunnough, 1922:239. Type, ♀, Banff, Alberta, Canada.

*Geographic range*—Alaska south to California* and Colorado.

*California distribution (counties)*—Map 28. Alpine. There are 3 female specimens in the CIS collection which may be from California, but the locality on the label, Paradice Valley (*sic*), cannot be located. Each bears a top label "Stan. Univ., Lot 601, Sub. 958" and a handwritten bottom label "7/19/22".

*Seasonal occurrence*—Only one specimen is definitely known from California. It is a male from Hope Valley, Alpine County, VI-29-57 (J. Powell, CIS).

*Discussion*—Length: Female 13–14 mm.

A rather small, black species, usually with a characteristic red area laterally on abdominal tergite II. Antennae, thorax, legs, and remainder of abdomen black; dorsal excision slight; subcallus pollinose, grayish black; abundant, long body hairs give it a hirsute appearance; wings hyaline; no stump vein.

*Biology*—Unknown.

### *Hybomitra melanorhina* (Bigot)

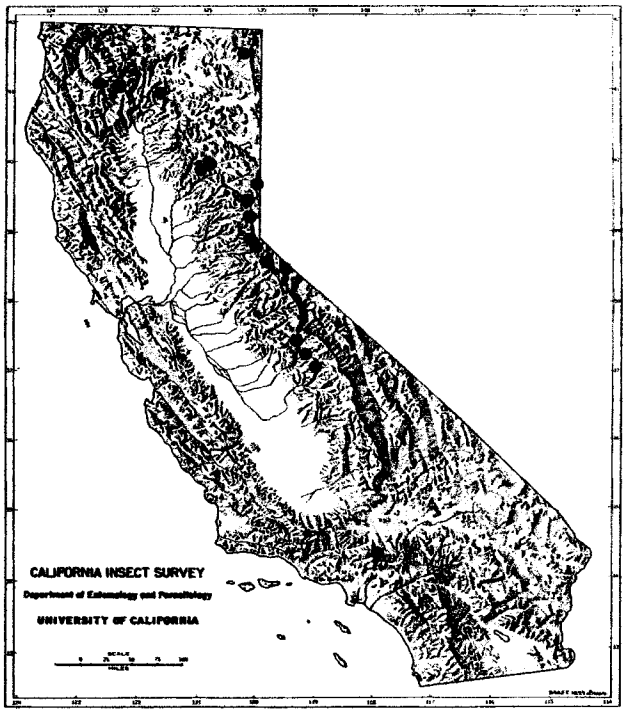
*Therioplectes melanorhina* Bigot, 1892:642. Type, ♀, Washington Territory.

*Geographic range*—British Columbia south to California and Colorado.

*California distribution*—Map 29. A mountain species occurring in the North Coast Range from Mendocino County north, across the Klamath and Cascade ranges, and south in the Sierra Nevada to Fresno County. One disjunct record from the Transverse Range in Los Angeles County.

*Seasonal occurrence*—From the first week in June to the last of July. Most commonly taken in July. There is one specimen from Fresno County taken August 22.

*New state record.




MAP 29. Distribution in California of *Hybomitra melanorhina* (Bigot).

*Discussion*—Length: Female 11–15 mm.

A small to medium-sized, distinctive species; eyes pilose; subcallus denuded, shiny brown; abdomen variable, each tergite with a lateral, oblique streak which is usually brownish orange, bordered by black, and a usually distinct, middorsal gray triangle; apical border of each tergite narrowly marked with gray; prescutal lobe pale, somewhat pink; stump vein absent; a faint infuscated spot at bifurcation; costal cell faintly infuscated; basal portion of flagellum red, with a moderate dorsal excision.

*Biology*—Unknown.

### *Hybomitra opaca* (Coquillett) (Fig. 57; Map 28)

*Tabanus opacus* Coquillett, *In* Baker, 1904:21. Lectotype, ♀, Ormsby County, Nevada.

*Geographic range*—Alberta, east to Saskatchewan, south to California and Arizona.

*California distribution*—Map 28. INYO Co.: *Inyo Craters*, 4 ♀♀, VII-21-64 (UCR). *Portal Campground*, 1 ♀, VII-11-65 (UCR). *Lone Pine, 7.3 mi. W.*, 1 ♀, VII-11-65 (UCR). MADERA Co.: *Mammoth*, 1 ♀, VII-13-40 (D. L. Dow, CIS). MONO Co.: *Lk. Mary, Mammoth Lks.*, 1 ♀, VII-14-61 (H. V. Daly, CIS). *Sonora Jct., 1 mi. W.*, 1 ♀, VII-8-68 (J. B. Heppner, CIS). *Rock Creek*, 1 ♀, VII-28-38 (C. Fleshner, LACM). *Leavitt Mdws.*, 1 ♀, VII-29-61 (R. P. Allen, CDA). SIERRA Co.: *Independence Lk.*, 1 ♀, VII-16-58 (R. M. Bohart,

UCD). TUOLUMNE Co.: *White Mt., Yosemite N.P.*, 1 ♀, VII-24-36 (W. T. McLean, CIS).

*Seasonal occurrence*—July.

*Discussion*—Length: Female 12–15 mm.

The gray black abdomen with 3 rows of pale spots; pale prescutal lobe; hyaline wings without a stump vein; and the pollinose subcallus will readily distinguish this species.

McAlpine (1961) discusses some relationships of this species with several closely related members of the *Hybomitra frontalis* complex.

*Biology*—In Montana, Philip (1936a) reared larvae of *Tabanus opacus* ( = *Hybomitra opaca*) to adults and gave some descriptive notes on pupae. Larvae were collected from grassy hummocks below a desert spring. Burger (1977) described larvae and pupae from Arizona. Larvae were collected from moss growing on partially submerged logs and stumps and from submerged, aquatic vegetation in a small pond.

## *Hybomitra phaenops* (Osten Sacken) (Fig. 58; Map 31)

*Tabanus phaenops* Osten Sacken, 1877:217. Lectotype, ♀, Webber Lake, Sierra County, California.
*Therioplectes phaenops*; Townsend, 1895:597.
*Tabanus sonomensis* var. *phaenops*; Stone, 1938.

*Geographic range*—British Columbia to California, Wyoming and Arizona.

*California distribution*—Map 31. A Sierran species from Inyo County to Modoc County.

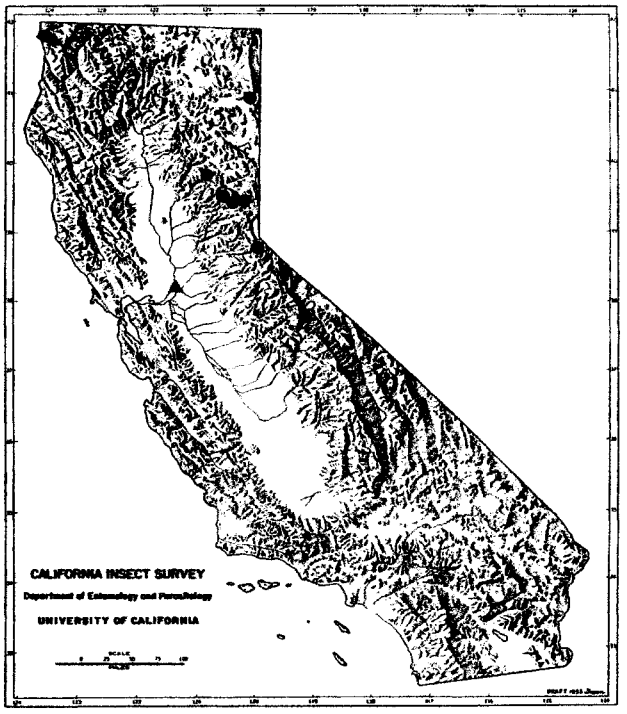
*Seasonal occurrence*—Last week in May through mid-August, with several collection records as late as September and October.

*Discussion*—Length: Female 14–16 mm.

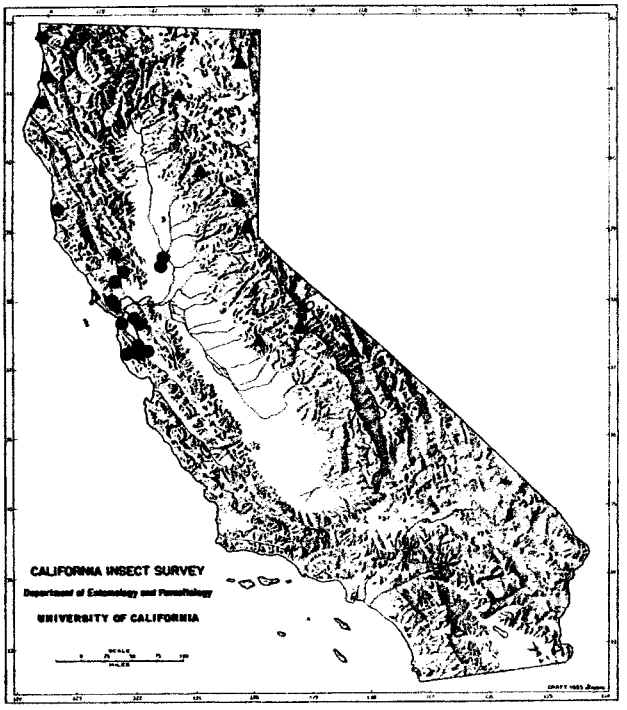
Osten Sacken (1877) described as species, *sonomensis* from Sonoma County and *phaenops* from Webber Lake. Stone (1938), however, considered *phaenops* to be a variety of *sonomensis* as did a number of subsequent authors including Philip (1965a). These 2 tabanids are sufficiently distinct morphologically to warrant returning *phaenops* to its original status.

Female *phaenops* can be distinguished from *sonomensis* by the following characteristics: eye bare or with only a few scattered hairs, lower half, in profile, more concave; tuft of hair on vertex around ocellar tubercle more dense; body more hairy and darker; no infuscation at bifurcation; prescutal lobe darker, almost black; palpus with few black hairs; basal callus and frons narrower; ocellar tubercle smaller (Fig. 58), and its allopatric distribution.

Male: Eyes densely pilose, areas of large and small facets moderately differentiated; thorax with dense,




MAP 30. Distribution in California of: *Hybomitra fulvilateralis* (Macquart) ●; and *H. philipi* (Stone) ▲.




MAP 31. Distribution in California of: *Hybomitra sonomensis* (Osten Sacken) ●; and *H. phaenops* (Osten Sacken) ▲.

erect black hairs dorsally; stump vein present or absent; venter with only black hairs.

*Biology*—Webb and Wells (1924) studied *phaenops* in Antelope Valley near Topaz, Mono County, California. It was found to be the most abundant horse fly there as well as at Bridgeport and Alturas. Flies were active from May to October with peak numbers from mid-July through August. Females fed on horses, mules, cattle, and occasionally man. Host-seeking began shortly after sunrise and continued throughout the afternoon. Hosts were attacked mainly around the breast, below the elbow, and on the shoulders, neck, and face.

Males were abundant in grass near marshy areas. Several pairs were observed *in copulo* between 0800 and 0900. The wasp *Bembex* ( = *Epibembex*) *primaaestate* Johnson and Rohwer preyed upon adults of *phaenops*.

Webb and Wells found a few egg masses on grass stems 2 to 4 inches aboveground in marshes. Egg masses were double-tiered and contained an average of 290 eggs. The incubation period ranged from 6-9 days.

One of 8 *phaenops* adults collected in the Gila National Forest, New Mexico, was infected with first stage larvae of *Elaeophora schneideri* Wehr and Dikmans (Nematoda: Filaroidea) (Clark and Hibler, 1973).

Larvae and pupae of *phaenops* were described as those of *Tabanus phaenops* by Webb and Wells and as *sonomensis* var. *phaenops* by Burger (1977). Webb and Wells found larvae in decaying vegetable matter in swampy areas overgrown with grass, in gravel along streams, and in humus along the margins of a lake. In Arizona, Burger collected larvae in fallen and dead culms of sedges in a boggy lake, in mosses around snowmelt pools, and in moss along the margins of cienegas. Cameron (1926) reared a male of *phaenops* from an undetermined larva from Saskatchewan, and gave a few descriptive details of the pupa.

## *Hybomitra philipi* (Stone)
## (Fig. 59; Map 30)

*Tabanus philipi* Stone, 1938:133. Type, ♀, Seattle, Washington.

*Geographic range*—British Columbia, California, Washington.

*California distribution*—Map 30. MONO CO.: *Coleville*, 1 ♀, VIII-1-33 (Simonds, LACM). SACRAMENTO CO.: *Sherman Island*, 1 ♀, III-1916 (L. S. Chiles, CIS). DEL NORTE CO.: no other data. Reported by Stone (1940:61). Specimen returned to Deutsch Ent. Inst. Based upon data from the few available specimens, the specimen from Sacramento County appears to be anomalous. Sherman Island is located in the delta of the Sacramento River a few meters above sea level, and the March collection date is the earliest known for any species of *Hybomitra* except *procyon*.

*Seasonal occurrence*—March (Sherman Island) to August. The holotype ♀ was collected in mid-July.

*Discussion*—Length: Female 12-15 mm.

Superficially the holotype of *H. philipi* resembles several other orange-sided species of *Hybomitra* but the following characteristics will serve to distinguish it: frons and subcallus with gray pollinosity; antenna black; ocellar tubercle prominent, yellow brown; prescutal lobe paler than thorax, tinged with red; wings hyaline, the costal cell and a small spot at bifurcation smoky brown; stump vein present; vertex deeply notched.

Male: Unknown.

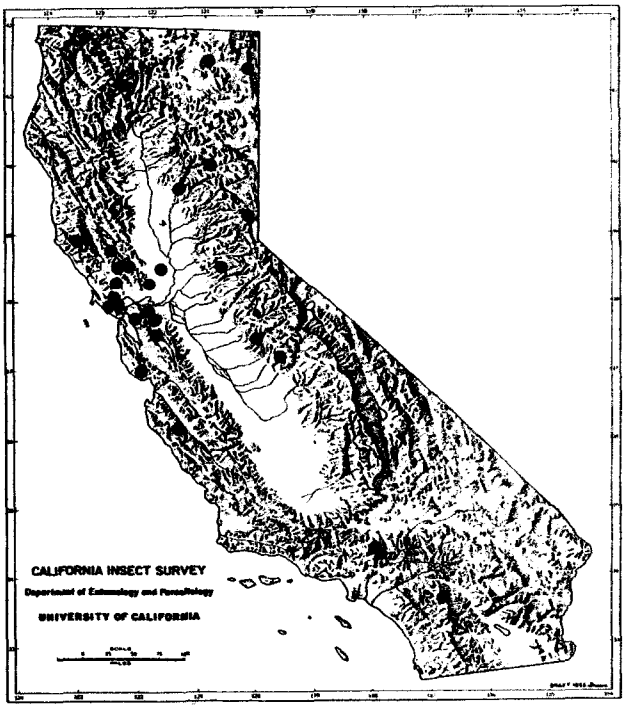
*Biology*—Unknown.

## *Hybomitra procyon* (Osten Sacken)
## (Fig. 60; Map 32)

*Tabanus procyon* Osten Sacken, 1877:216. Syntypes, 2 ♀♀, Sonoma, California.

*Geographic range*—British Columbia to California and Wyoming.

*California distribution*—Map 32. A fairly common and widespread species, especially in the Coast Ranges from Monterey to Trinity counties. A few records in southern California and a scattering of records in eastern California from Mariposa County to Modoc County.




MAP 32. Distribution in California of *Hybomitra procyon* (Osten Sacken).

*Seasonal occurrence*—An early season species, most common from the first week in March to early June, with a scattering of records to the third week of July.

*Discussion*—Length: Female 12-13 mm.

This rather small, stout, shiny black species is not likely to be confused with any other *Hybomitra* species. The eyes are densely pilose; the basal and subcalli are shiny black; antenna as in Fig. 60; the wing is infuscated in the costal cell, at the bifurcation, and on the crossveins; no stump vein present.

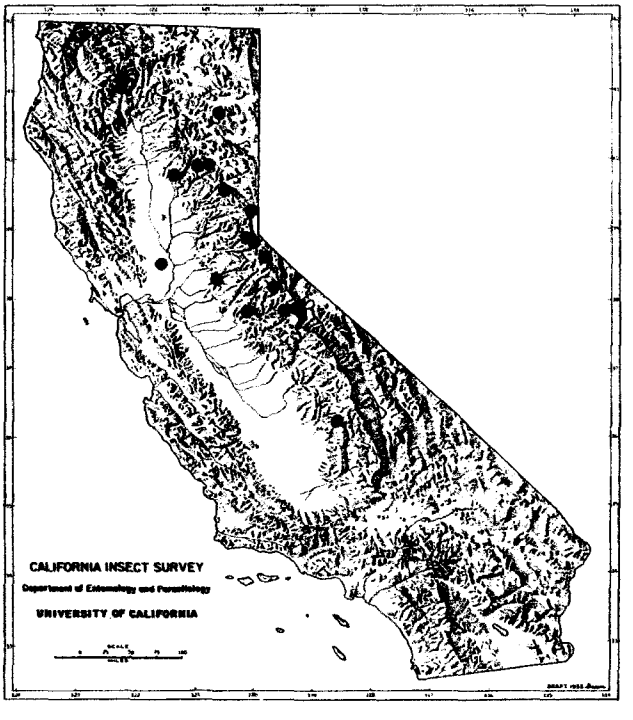
*Biology*—It has been reported feeding on the faces of deer in Mendocino County (Anderson et al., 1974).

Adults serve as vectors of *Elaeophora schneideri* to Columbian black-tailed deer, *Odocoileus hemionus columbianus* (Anderson and Weinmann, 1972). Nearly 30% of dissected parous females were infected with larvae of *E. schneideri*. Infective stage larvae were found only in flies that had completed 2 gonotrophic cycles.

### *Hybomitra rhombica* (Osten Sacken) (Fig. 61; Map 33)

*Tabanus rhombicus* Osten Sacken, 1876:472. Lectotype, ♀, Colorado.
*Tabanus centron* Marten, 1882:211. Type, ♀, Colorado.
*Tabanus solox* Enderlein, 1922:347. Type, Colorado.

*Geographic range*—Alaska to Saskatchewan and Wisconsin, south to California and Arizona.




MAP 33. Distribution in California of *Hybomitra rhombica* (Osten Sacken).

*California distribution*—Map 33. With the exception of an isolated record for Yolo County in the Central Valley, confined to the Sierra Nevada from Tulare County northward into the Great Basin area of Lassen County and westward into the Klamath Range.

*Seasonal occurrence*—A restricted flight period from the second week in June through July. Most common in July.

*Discussion*—Length: Female 14-15 mm.

A rather small, stout, grayish black species with 3 rows of distinctive gray triangles on each abdominal tergite, a black prescutal lobe, and a denuded subcallus.

Male: Areas of large and small facets not noticeably differentiated; frontal triangle grayish pollinose; scape and pedicel blackish, gray pollinose, scape with dense, long, black hairs dorsally; thorax densely clothed with erect black hairs, and abdomen with yellowish brown suffusion sublaterally of variable extent.

*Biology*—This species bites humans readily (Essig, 1928). In parts of the Rocky Mountains it is considered to be of economic importance. It commonly attacks dogs and frequently enters summer cabins in the Sierra Nevada.

A pupa, reared from a larva collected in a wheatfield in Saskatchewan, was described by Cameron (1926).

### *Hybomitra sonomensis* (Osten Sacken) (Fig. 62; Map 31)

*Tabanus sonomensis* Osten Sacken, 1877:216. Lectotype, ♀, Sonoma County, California.
*Therioplectes maculifer* Bigot, 1892:641. Type, ♀, Washington Territory.

*Geographic range*—Alaska south to Santa Cruz County, California, east to Wisconsin.

*California distribution*—Map 31. Coast Range from Santa Clara County north to Del Norte County, with the exception of several records from the Sacramento Valley.

*Seasonal occurrence*—From the second week in April to the third week of July. Most common in May and June.

*Discussion*—Length: Female 12-15 mm.

A small to medium-sized species with orange on sides of abdomen basally; antenna black, the basal segment sometimes ringed with red; eyes densely pilose; subcallus with gray pollinosity; basal segment of flagellum with little or no excision; vein $R_4$ frequently with a stump vein; furcation with infuscated spot.

Male: Eyes densely pilose, areas of large and small facets not greatly differentiated; thorax somewhat darker than that of the female; venter with both light and dark hairs.

*Biology*—This common species frequently enters parked automobiles. In Contra Costa County,

Middlekauff was bitten on the back through a cotton T-shirt.

Lane collected larvae and pupae in a salt marsh bordering San Pablo Bay, Contra Costa County. Immatures were found in moist gravel and sand about 15 m above shoreline in a denuded, slightly elevated area surrounded by glasswort, *Salicornia* sp., and cord grass, *Spartina foliosa* Trin.

The immatures of *sonomensis* reared by Lane are distinguishable from those of *phaenops* described by Burger (1977), thereby corroborating adult morphological evidence (cf. *H. phaenops*) that these forms are specifically distinct. Descriptions of the larvae and pupae of *sonomensis* will be presented elsewhere (Lane, *in press*).

### *Hybomitra tetrica* (Marten)
### (Fig. 67; Map 34)

*Therioplectes tetricus* Marten, 1883:111. Type, ♀, Montana. Destroyed.

*Tylostypia laticornis* Enderlein, 1925:363 (preoccupied, Hine, 1904). Type, ♀, Colorado.

*Therioplectes hirtulus* Bigot, 1892:641. Type, ♀, Washington Territory. NEW SYNONYMY.

*Tabanus opacus* Hine, 1904 (not Coquillett, 1904).

*Hybomitra tetrica* var. *rubrilata* Philip, 1937. NEW SYNONYMY.

*Hybomitra tetrica* var. *hirtula*; Philip, 1965a:341.

*Geographic range*—British Columbia to Ontario and South Dakota, south to California and New Mexico.

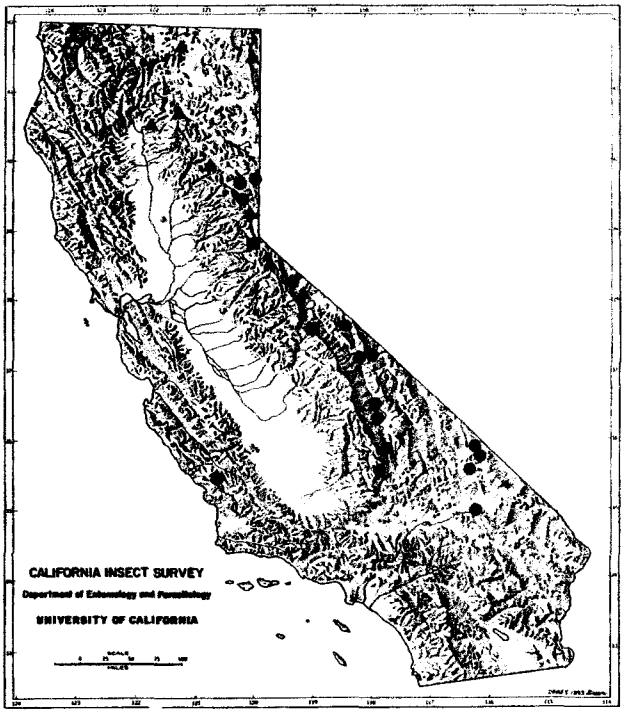
*California distribution*—Map 34. Confined to the mountains of eastern and northern California from Mono County north to Del Norte County.

*Seasonal occurrence*—Third week in May until third week in July. Most commonly in June.

*Discussion*—Length: Female 15–17 mm.

A medium-sized species; grayish black with three rows of gray spots on each abdominal tergite, the basal sublateral ones often tinged with brown; prescutal lobe pale, yellowish brown; subcallus variable, with gray pollinosity or denuded, shiny black; stump vein present.

Marten's type has been lost and since his description is inadequate, a taxonomic problem has existed for many years. Philip (1935) believed that even in the absence of the type he could recognize *Th. tetricus* from Marten's description. Stone (1938) disagreed with Philip, and having a specimen which had been compared with Bigot's type by Hine, accepted *hirtulus* as a valid name. Bigot's *hirtulus* possessed a pollinose subcallus whereas Marten's type had a bare subcallus. Based mostly upon the presence or absence of a pollinose subcallus, various workers have given them specific, subspecific, or varietal status.




MAP 34. Distribution in California of: *Hybomitra tetrica* (Marten) ▲; *Tabanus* (*Glaucops*) *fratellus* (Williston) ■; and *Tabanus tetropsis* Bigot ●.

We have been unable to find additional characters to separate them, and have found some specimens with a partial pollinose subcallus and have seen specimens with both bare and pollinose subcalli collected at the same time and locality. We therefore believe that these are variants from the same interbreeding population.

*Biology*—Cameron (1926) described the larva and pupa of *Tabanus hirtulus* ( = *Hybomitra tetrica* var. *hirtula*), but did not discuss the larval habitat. In his introduction, however, he states that: "The breeding-grounds of the prairie Tabanidae are to be found in the ponds or sloughs, which everywhere occupy the low-lying depressions."

## Genus *Tabanus* Linnaeus

*Tabanus* L., 1758:601; Stone, 1938:36; Philip, 1941b:11.

*Type species*—*Tabanus bovinus* L., 1758. Designated by Latreille, 1810.

Ten species of *Tabanus* have been found in California. Some, like *T. kesseli*, *T. laticeps*, and *T. punctifer*, are widely distributed and numerous. Others, like *T. stonei* and *T. subsimilis nippontucki*, are restricted in distribution and apparently not abundant in the state. All species suck blood and the more ubiquitous ones are pests of domestic livestock. Only 3 species

(*laticeps*, *monoensis*, *punctifer*) are known to bite humans in California.

Philip (1947) reduced this genus in size and complexity by splitting it into *Hybomitra* and *Tabanus*. The setulose basicostae of *Tabanus* species separate them from *Stenotabanus* species, while the absence of an ocellar tubercle on the vertex (which may have a flat denuded area) and the generally bare eyes distinguish *Tabanus* from *Hybomitra*.

Larvae and pupae of *Tabanus* have been characterized by Teskey (1969). The immature stages of 7 species in California are known: *aegrotus*, *laticeps*[18], *monoensis*, *punctifer*, *similis*, *stonei*, and *subsimilis*.

## KEY TO CALIFORNIA SPECIES OF TABANUS

1. Females; eyes not contiguous ..... 2
   Males; eyes contiguous ..... 11

*Females*

2. Flagellum short, with 2 or 3 indistinctly separated annuli (Fig. 77); vertex notched . . . (Subg. *Glaucops*) ..... *fratellus* Williston
   Flagellum normal, with 4 annuli (Fig. 6); vertex flat ..... (Subg. *Tabanus*) ..... 3
3. Eyes in profile sparsely pilose (30X) ..... 4
   Eyes bare ..... 5
4. Middorsal row of abdominal spots contiguous, forming a distinct, parallel-sided stripe (Fig. 64) ..... *stonei* Philip
   Middorsal row of abdominal spots form distinct triangles which are expanded on incisures (Fig. 65) ..... *laticeps* Hine
5. Furcation and base of vein $M_2$ distinctly infuscated; body gray and black ..... *monoensis* Hine
   Not with this combination ..... 6
6. Abdomen entirely black, rarely with a middorsal row of small white triangles ..... 7
   Abdomen otherwise ..... 9
7. Furcation usually with a distinct dark spot; mesonotum covered with creamy hair over a dark red background; fore tibiae bicolored (white basally, black apically) ..... *punctifer* Osten Sacken
   Furcation without a distinct dark spot, although entire wing may be infuscated; mesonotum and fore tibiae black .... 8
8. At least tergite I with an inconspicuous tuft of white hairs beneath the scutellum; frontal callosity subquadrate, the median callus narrow (Fig. 73) ..... *kesseli* Philip
   No abdominal tergites with median tufts of white hairs; frontal callosity merging broadly with median callus above (Fig. 68) ..... *aegrotus* Osten Sacken
9. Base of vein $R_4$ with a long, curved stump vein ... *tetropsis* Bigot
   Base of vein $R_4$ without a stump vein ..... 10
10. Outer hind tibial fringe mostly black; abdominal markings contrasting; a narrow median stripe (Fig. 64); sublateral patches not noticeably jagged and irregular ..... *similis* Macquart
    Outer hind tibial fringe mostly white; body color faded in appearance; the middorsal stripe not much paler than the sublateral ones; lateral patches jagged and irregular ..... *subsimilis nippontucki* Philip

*Males*

11. Abdominal tergites each with 3 small pale spots; flagellum modified, with 2-3 annuli . . . (Subg. *Glaucops*) ..... *fratellus* Williston
    Abdominal tergites otherwise patterned; flagellum normal, with 4 annuli . . . (Subg. *Tabanus*) ..... 12
12. Abdomen unicolorous, black, rarely with a middorsal row of small, white-haired triangles ..... 13
    Abdomen not unicolorous ..... 15
13. Mesonotum bordered by a band of white pile; infuscated spot at furcation ..... *punctifer* Osten Sacken
    Mesonotum black; no spot at furcation ..... 14
14. Eyes with a distinct area of enlarged facets on upper two-thirds; a tuft of white hairs beneath scutellum on tergite I, sometimes also on tergites II and III ..... *kesseli* Philip
    Eyes with upper facets only slightly differentiated from the lower ones; abdomen without tufts of white hairs ..... *aegrotus* Osten Sacken
15. Long, curved stump vein present on vein $R_4$; antennae mostly black ..... *tetropsis* Bigot
    Stump vein absent; at least the basal plate is partly pale ..... 16
16. Abdomen with narrow, middorsal pale stripe ..... 17
    Abdomen without a middorsal pale stripe ..... 18
17. Eyes bare; areas of large and small facets differentiated, but size diferences of the facets small, and line of demarcation often indistinct ..... *similis* Macquart
    Eyes pilose; area of large facets dark brown to yellowish brown, that of small facets black; a marked size difference of the large and small eye facets, the line of demarcation distinct ..... *subsimilis nippontucki* Philip
18. Furcation with a dilute, infuscated spot; area of large facets usually with a narrow, transverse black band; eyes bare .. *monoensis* Hine
    Furcation without an infuscated spot; eyes pilose, unbanded 9
19. Areas of large and small eye facets markedly differentiated, with a distinct line of demarcation ..... *laticeps* Hine
    Areas of large and small facets only slightly differentiated, no distinct line of demarcation ..... *stonei* Philip

18. Descriptions of the immatures of *laticeps* have not been published.

## *Tabanus aegrotus* Osten Sacken (Fig. 68; Map 35)

*Tabanus aegrotus* Osten Sacken, 1877:219. Type, ♀, Napa County, California.

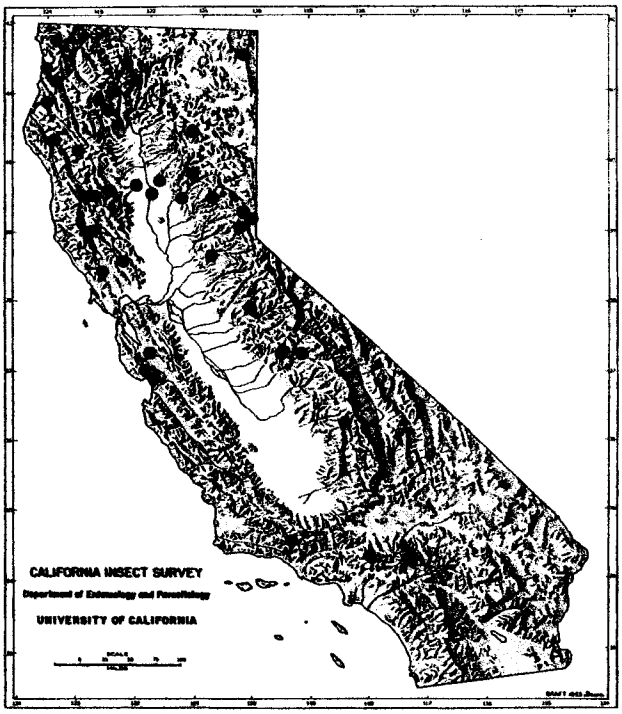
*Geographic range*—British Columbia to California and Utah.

*California distribution*—Map 35. A widely distributed cismontane species from Los Angeles and San Bernardino counties to Del Norte, Siskiyou, and Modoc counties in the north. Absent from all but the northernmost part of the Sacramento Valley. It is also absent from all counties east of the Sierra Nevada crest from Lake Tahoe south.

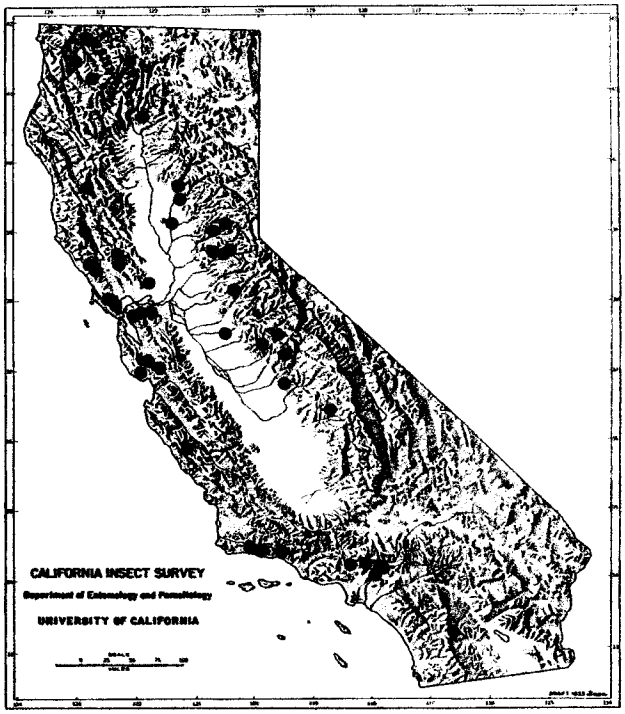
*Seasonal occurrence*—Most commonly during June and July with an early record of mid-May and one as late as mid-September.

*Discussion*—Length: Female 17-23 mm.

A large, entirely brownish black species superficially resembling *kesseli*. Eyes bare, basal callus flat, elongate, dull reddish brown to black, concolorous with and




MAP 35. Distribution in California of *Tabanus aegrotus* Osten Sacken.




MAP 36. Distribution in California of *Tabanus kesseli* Philip.

broadly joined to the median callus (*T. kesseli* has the median callus narrowly joined to basal callus); antennae black, basal segment of flagellum stout, with a distinct dorsal excision (Fig. 68); wings subhyaline, unspotted, costal cell yellowish brown.

Male: Line of differentiation between areas of large and small facets not sharp, although there is usually an extreme but not abrupt difference in facet size; second palpal segment short, stout.

*Biology*—Larvae and pupae were described by Lane (1975). Immatures were found in saturated gravel and sand bordering permanent and temporary creeks.

The integumentary striations of *aegrotus* larvae are greatly reduced or absent dorsally and ventrally on the thoracic segments except in the posterior 0.2-0.4, and slightly reduced medially on the ventral aspects of some or all of abdominal segments I-VII.

### *Tabanus kesseli* Philip
### (Figs. 6, 73; Map 36)

*Tabanus kesseli* Philip, 1950b:117. Type, ♀, Ravalli County, Montana.

*Geographic range*—British Columbia, California, Idaho, Montana, Oregon, Nevada, Utah, Washington, Wisconsin.

*California distribution*—Map 36. A widely distributed cismontane species with a distribution pattern in central and northern California similar to that of *T. aegrotus*. It differs in extending along the peninsular ranges to San Diego County.

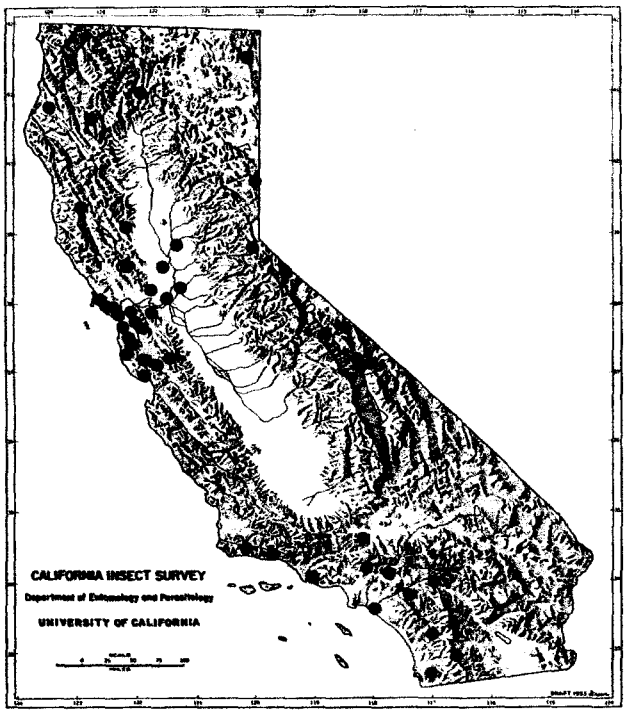
*Seasonal occurrence*—Most commonly collected throughout June and July. There is one early record in mid-May and a scattering of records in August, September, and two in early October.

*Discussion*—Length: Female 16-18 mm.

A large, essentially black species with subhyaline wings, superficially resembling and often confused with *T. aegrotus*. It averages smaller in size than *aegrotus*; the median callus is linear and narrowly joined to basal callus (*T. aegrotus* has the median callus broadly attached); an infuscated spot is present at the base of vein $R_4$, and in unrubbed specimens the abdomen has a middorsal row of small, pale triangles formed by patches of white hairs.

Male: Body and legs more mahogany brown than in the female; the area of enlarged eye facets sharply demarcated in the upper two-thirds; pale patch on tergite I prominent; other middorsal triangles usually distinct; the fork of veins $R_{4+5}$ and all basal veins distinctly margined with brown.

*Biology*—This species feeds on Columbian black-tailed deer at Hopland, Mendocino County. It prefers to feed on the neck, occasionally on the back, and rarely on the face (Anderson et al., 1974).




MAP 37. Distribution in California of *Tabanus laticeps* Hine.

## *Tabanus laticeps* Hine
## (Figs. 65, 72; Map 37)

*Tabanus laticeps* Hine, 1904:239. Syntypes, unstated No. ♂♂ and ♀♀, California and Washington.

*Geographic range*—British Columbia to Baja California Norte, Nevada,* and New Mexico.

*California distribution*—Map 37. Widely distributed in California except for the southeastern desert areas.

*Seasonal occurrence*—From the third week in May through August, with one record in the last week of October.

*Discussion*—Length: Female 12–14 mm.

A small to moderate-sized species. Abdomen variable, usually gray and black, the gray areas often suffused with brownish pink with an overlay of grayish white hairs; the median gray spot is narrow apically and expanded basally along the margin of the tergite (Fig. 65); the sparsely pilose eye condition is shared only with *T. stonei*, but the distinctive middorsal, inverted T-shaped triangles, and the large, flat, shiny-brown area on the vertex will distinguish *laticeps*.

Male: Eyes with dense, short pile; upper and lower facets nearly subequal and the areas sharply demarcated.

*New state record.

*Biology*—A male *laticeps* in the CIS collection was reared from a larva collected by A. L. Lopez from a mud flat near Albany, California. An unpublished M.S. thesis (Meadows, 1931) was based on studies of flies erroneously identified as *Tabanus gilanus* Townsend. Several reared females now in the collection of the California Academy of Sciences, one of which bears Meadows's name, were associated with his study and identified as *laticeps* by C. B. Philip. Adults were collected from cattle and horses along the Berkeley-Albany waterfronts between the latter part of May and mid-July. Immatures were found in clayey soils in a salt marsh bordering San Francisco Bay, Contra Costa County, where they were associated with larvae of the anthomyiid fly, *Fucellia costalis* Stein, and decaying roots of the glasswort, *Salicornia ambigua* Michx. ( = *S. virginica* L.). Many larvae were taken from soil in areas submerged by ordinary high tides for periods ranging from 20–60 minutes. Although larvae and pupae were described by Meadows, the descriptions are insufficient by current standards.

## *Tabanus monoensis* Hine
## (Fig. 69; Map 38)

*Tabanus monoensis* Hine, *In* Webb and Wells, 1924:29. Type, ♀, Topaz, Mono County, California.

*Geographic range*—California, Idaho, Oregon.

*California distribution*—Map 38. A widely distributed montane species.

*Seasonal occurrence*—With the exception of an unspecified June date, all California records are July to mid-September.

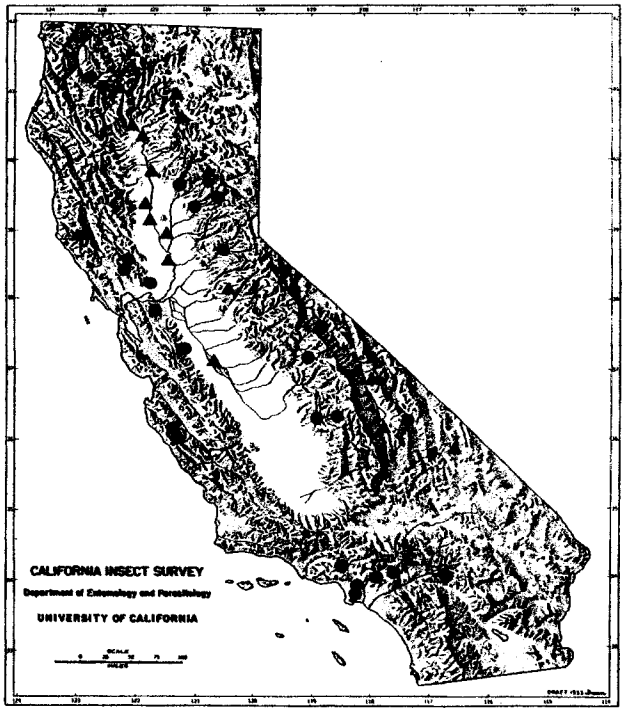
*Discussion*—Length: Female 13–14 mm.

A moderate-sized, grayish black species with bare eyes; a brown spot at furcation and the basal part of vein $M_2$ is margined with brown.

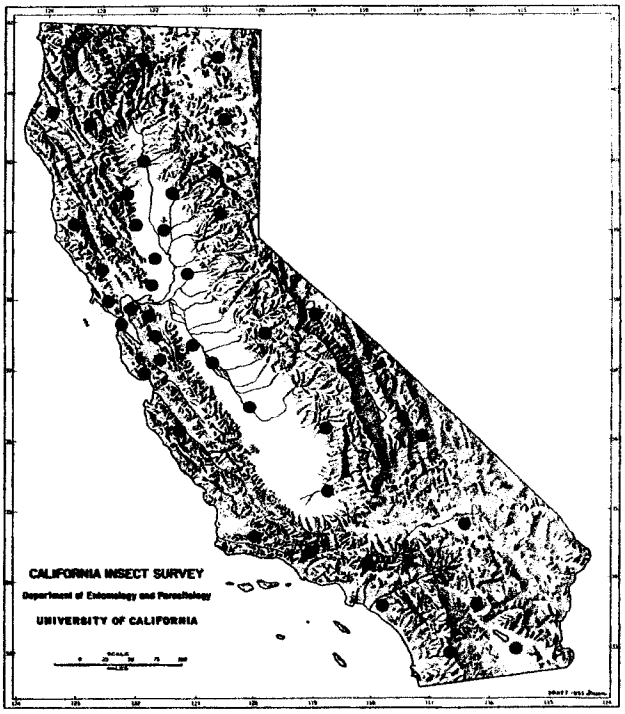
Male: Eyes bare; areas of large and small eye facets sharply differentiated, the basal part of the large, faceted area with a pale-colored transverse band usually visible; prescutal lobe nearly black.

*Biology*—A specimen in the collection of the Vector Biology and Control Section, California Department of Health, was taken while biting a human. In northern California, adults also attack deer and serve as vectors of the filarial worm, *Elaeophora schneideri* to Columbian black-tailed deer during the summer-fall months (Anderson and Weinmann, 1972). Approximately 20% of parous females harbored infective or developing-stage larvae of *E. schneideri*.

Webb and Wells (1924) and Lane (1975) described the larvae and pupae. Webb and Wells found larvae in




MAP 38. Distribution in California of: *Tabanus monoensis* Hine ●; and *T. similis* Macquart ▲.




MAP 39. Distribution in California of *Tabanus punctifer* Osten Sacken. (Only those counties from which there is at least one collection record are indicated by a dot.)

mud bordering mountain rivulets near Topaz, Mono County, California. Foote (1963) obtained *monoensis* larvae from wet soil beneath a small, partially shaded, permanent waterfall in Idaho. Lane collected larvae from various mud and moss habitats in Mendocino County. Seepage areas were the most productive habitats.

Lane (1975) reported that the median portions ( = lobes) of the antennal ridges of *monoensis* pupae have pointed crests. More precisely, the median lobes are somewhat sharply crested and rounded or slightly skewed laterally in outline. In addition, the abdominal fringe spines of the posterior series have basal diameters about 20–50% wider than those of the anterior series. Teskey (1969) characterized *Tabanus* pupae from eastern North America as having abdominal fringe spines of the anterior series shorter but of comparable basal diameter to those of the adjacent posterior series.

## *Tabanus punctifer* Osten Sacken
## (Figs. 5, 70, 110; Map 39)

*Tabanus punctifer* Osten Sacken, 1876:453. Lectotype, ♀, Utah.

*Geographic range*—Widely distributed and abundant from British Columbia to Kansas, south to California, Mexico, Texas, and Oklahoma.

*California distribution*—Map 39. *T. punctifer* is found throughout much of California except for higher elevations and in desert areas remote from free water. It has been collected or observed in nearly every county of the state.

*Seasonal occurrence*—From the second week of March through October with one record in late November.

*Discussion*—Length: Female 19–22 mm.

A large, dark-colored horse fly. Easily recognized by the following characteristics: mesonotum covered with creamy hair over a dark reddish background; remainder of thorax dark brown, with concolorous hair; wings brown, paler posteriorly, the cross-veins and furcation distinctly margined with brown; legs black, except basal third of fore tibiae, which are creamy white with long white hair; abdomen black.

Male: Color as in female except that the white of the mesothorax is confined to a lateral band and the outer margin of the scutellum, the rest being dark reddish brown; area of large eye facets extensive and sharply differentiated from area of small ones.

*Biology*—Webb and Wells (1924) studied the biology of *punctifer* in Antelope Valley along the California-Nevada border. They recorded adult activity between late May and the latter part of September. Flies were most numerous during July and the first 3 weeks of August. Cattle and horses were bitten on the backs,

TABLE 5. SEASONAL PARASITISM OF *TABANUS PUNCTIFER* EGG MASSES BY HYMENOPTEROUS PARASITES, HOPLAND, CALIFORNIA, 1971–1972[1]

| | 1971 (n=22) | | | 1972 (n=24) | | |
|---|---|---|---|---|---|---|
| | No. emerging | mean $\bar{x}$ | range r | No. emerging | mean $\bar{x}$ | range r |
| *punctifer* larvae | 6,046 | 274.8 | 122–446 | 6,636 | 276.5 | 55–526 |
| hymenopterous adults[2] | 2,874 | 130.6 | 0–336 | 3,442 | 143.4 | 3–324 |
| Total | 8,920 | | | 10,078 | | |
| Percent Seasonal Parasitism[3] | 32.2 | | | 34.2 | | |

1. In 1971, egg masses were collected between 19 August and 21 September, and in 1972 between 20 June and 25 August.
2. Representative specimens were identified as *Telenomus emersoni* (Scelionidae), but most hymenopterous adults were undetermined.
3. This must be considered only an approximation of the actual seasonal parasitism rate. It cannot be assumed that all nonparasitized or parasitized eggs of *T. punctifer* hatched.

jaws, and neck, and females were observed attempting to feed upon the carcasses of cows and a horse. Host-seeking activity was greatest between 1000 and 1500 h.

While it is apparently unusual for *punctifer* to bite humans, we have received reports of this species attacking man in Imperial, Marin, and San Bernardino counties.

Circumstantial evidence implicating a *punctifer* female in the transmission of tularemia to a ranch worker in northern Nevada was presented by Philip et al. (1955). These authors speculated that the mouthparts of this fly had been contaminated from having bitten an infected hare.

Webb and Wells (1924) did not observe *punctifer* ovipositing in nature, but egg masses were found attached to irrigation boxes and several plant species growing in or overhanging water. Egg masses were 3- to 5-tiered, pyramidal shaped, and contained from 200–800 eggs. The incubation period varied from 8–14 days. Three individuals reared from egg to adult each had a total developmental period of slightly less than 2 years. Nearly every egg mass collected was parasitized by *Prophanurus* ( = *Telenomus*) *emersoni* Girault (Hymenoptera: Scelionidae). The developmental period of this parasite took 22 or 23 days.

In Arizona, Burger (1977) found the egg masses of *punctifer* on cattail leaves and reared this species from egg to adult. He noted that *punctifer* is 1 of only 2 tabanid species in Arizona apparently not requiring exposure to cold temperature in the last instar before pupating.

Females have been observed ovipositing on stems of spike-rush, *Eleocharis macrostachya* Britton, along the margin of a permanent pond in Mendocino County, California (Lane, 1974). Flies faced head down while they placed their eggs near the shoot tips. Oviposition was observed between 1200 and 1400 h on 16 occasions from June to September, 1970–1972. The lengths of 4 complete ovipositions were 18, 29, 31, and 38 minutes.

Forty-five of 46 (97.8%) *punctifer* egg masses (Fig. 108) collected at Hopland were infested by hymenopterous parasites. In 1971, 21 of 22 egg masses collected were infested, the percentage parasitism ranged from 0–50.5% per egg mass, and the seasonal average was 32.2% parasitism (Table 5). In 1972, all 24 egg masses obtained were parasitized, the percentage parasitism ranged from 0.7–58.9%, and the seasonal average was 34.2% parasitism.

Herms (1927) reported that egg masses of *punctifer* taken from rice fields in Colusa County, California, invariably were heavily infested by hymenopterous parasites.

Larval Coccinellidae (Coleoptera) and adults of *Tanaops abdominalis* Leconte (Coleoptera: Melyridae) were observed eating *punctifer* egg masses (Lane, 1974).

Larvae and pupae have been described from California by Webb and Wells (1924) and from Arizona by

Burger (1977). Those workers and Lane (1975) found larvae along the margins of various aquatic habitats. In Mendocino County, California, larvae were most abundant along permanent pond margins and least abundant along creek margins (Lane, 1976). One mature *punctifer* larva obtained from a permanent seepage area was parasitized by a tachinid larva, which perished soon after killing its host. *T. punctifer* larvae also have been found beneath cattle droppings in a wet field in Arizona (Burger, 1975). Two of 3 *punctifer* larvae obtained from a sulfur spring in Contra Costa County were parasitized by a mermithid nematode, *Pheromermis myopsis* Poinar and Lane, as were several *punctifer* larvae collected from mud at the margin of a nearby stock pond (Poinar & Lane, 1978).

Webb and Wells (1924) found 2 pupae 1 inch below the surface in moist gravel about 8 feet above a lake shore. In British Columbia, Spencer (1942) collected a newly formed pupa beneath a small stone on a hillside 150 feet above and 200 yards from a lake. The range was heavily overgrazed and dry, but the soil beneath the stone was not as dry as the surrounding soil. An adult emerged 1 month later.

## *Tabanus similis* Macquart
(Figs. 64, 71; Map 38)

*Tabanus similis* Macquart, 1850:335. Type, ♀. Type locality unknown (as Tasmania, in error).
*Tabanus scutellaris* Walker, 1850:27. Type, ♀, North America.
*Tabanus lineola scutellaris*; Philip, 1947:309.

*Geographic range*—Widespread, British Columbia to Nova Scotia, south to California, Arizona, and Tennessee.

*California distribution (counties)*—Map 38. Calaveras, Colusa, Glenn, Inyo, Mendocino, Merced, Plumas, Shasta, Sutter, Tehama, Trinity, Yolo.

*Seasonal occurrence*—From late May to August.

*Discussion*—Length: Female 12–15 mm.

A small to moderate-sized, grayish black species which has, in common with *subsimilis nippontucki*, a narrow, medial, pale stripe on the abdomen. *T. similis* is generally a much darker species, with the posterior half of the scutellum red, contrasting with the dark anterior half, and the hind tibial fringe is black.

Male: Eyes normally bare but sometimes with a few scattered hairs; facets differentiated, but size difference small and line of demarcation often indistinct; much browner than that of the female.

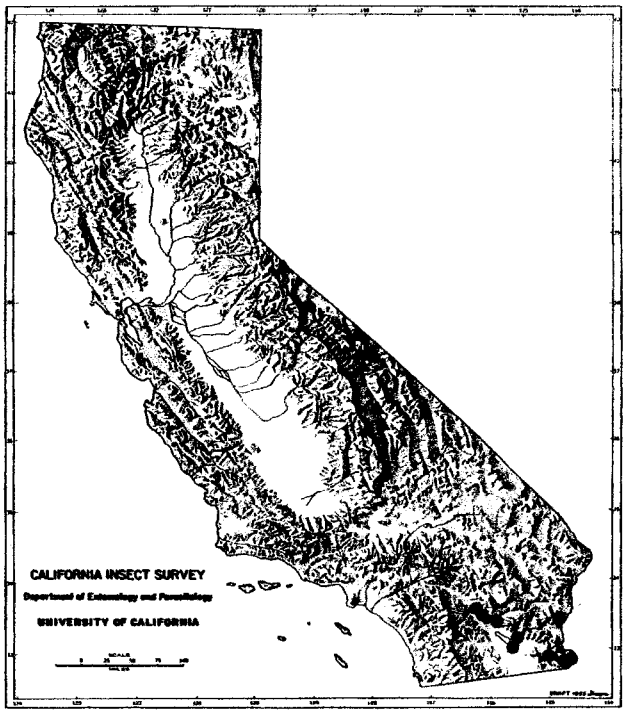
*Tabanus similis* has had a long history of taxonomic confusion. Stone (1938), Philip (1947), Middlekauff (1950), Pechuman (1957), and others considered it a subspecies or variety of *T. lineola* under Walker's name *scutellaris*. Philip (1965b) considered it to be a distinct species and thus reverted to Macquart's original name.

*Biology*—Although *similis* is often abundant and frequently a pest of livestock in the eastern U.S., it has only been reported biting deer in California.

This species ranked second in abundance among 14 tabanid species trapped in $CO_2$-baited insect flight traps during the late spring in northern California (Anderson et al., 1974). On days when maximum air temperatures did not exceed 32.8°C, flies exhibited a uniform level of activity between 1100 and 1700 h, whereas on days when temperatures reached 40.0°C, flies manifested bimodal activity curves with morning (0800–1100 h) and afternoon (1400–1700 h) peaks.

Roberts and Dicke (1964) found a *similis* egg mass on a cattail frond in Wisconsin. This egg mass yielded hymenopterous egg parasites tentatively identified as *Telenomus* n. sp. as well as larvae of *similis*. Larvae and pupae were described by Tashiro (1950), Roberts and Dicke (1964), Teskey (1969), and Burger (1977). In Wisconsin, Roberts and Dicke collected larvae from a marshy habitat. One reared male and female passed through 8 and 9 instars, respectively. In Ontario, Teskey collected larvae from various marsh and pool habitats, including types showing evidence of drying during the summer. Mature larvae are similar to those of *Tabanus lineola* Fabricius and their pupae are indistinguishable. In Arizona, Burger collected larvae from mud along the margin of a slough. In California, Lane (1975) found larvae in seepage areas and along the margins of permanent and vernal pools.

Larvae identified as *similis* from Hopland, Mendocino County (Lane, 1975; Lane, 1976) usually have posterior pubescence (post. pb.) present dorsolaterally on body segments 3 and 8 and encircling segments 9–11, which essentially agrees with Burger's (1977) description of *similis* from Arizona (i.e., except for the absence of dorsolateral patches on the metathorax in his material). In 3 of 10 larvae from Hopland, however, some post. pb. is also present on segments 4–7. One preserved larva (Fig. 13 *In* Lane, 1975) has post. pb. encircling all abdominal segments but much reduced laterally on segments I–IV and interrupted dorsolaterally on the metathorax; this condition is similar to, but more extensive than, the distribution of post. pb. reported for *similis* from Ontario (Teskey, 1969) and *subsimilis* from Sonora, Mexico (Burger, 1977). None of the 3 larvae from Hopland having post. pb. on segments 3–11 was reared to an adult. Further data are needed to confirm that the observed variation is within the normal range for *similis*. The only member of the *lineola* complex taken as adults at Hopland has been *similis*.




MAP 40. Distribution in California of: *Tabanus subsimilis nippontucki* Philip ●; and *T. stonei* Philip ▲.

## *Tabanus stonei* Philip
## (Fig. 74; Map 40)

*Tabanus stonei* Philip, 1941c:144. Type, ♀, Bozeman, Montana.

*Geographic range*—British Columbia and Alberta, south to California, Arizona, and Texas.

*California distribution*—Map 40. INYO Co.: *Olancha*, 2 ♀♀, VII-23-52 (LACM); 1 ♀, VII-4-55 (LACM); 1 ♀, VIII-3-52 (LACM). *S. Fork Kern R.*, 1 ♀, VI-16-45, 5500′ elev. (LACM). *Deep Springs*, 1 ♀, VII-6-53 (UCR). *Antelope Springs, 8 mi. S. Deep Springs*, 1 ♀, VI-21-64 (E. Riek, G. Stage, CIS). *Bishop, 10 mi. NW*, 1 ♀, VI-30-61 (J. Powell, CIS). LASSEN Co.: *Hallelujah Jct.*, 1 ♀, VII-4-52 (E. I. Schlinger, UCD). MONO Co.: *Benton*, 1 ♀, V-22-41 (W. M. Pearce, CAS). *White Mt.*, 1 ♀, VII-6-61, 10,000′ elev. (J. S. Buckett, UCD). *Crooked Creek, White Mts.*, 1 ♀, VI-25-61, 9500′ elev. (G. W. Frankie, CIS).

*Seasonal occurrence*—Late May, sporadically to late August.

*Discussion*—Length: Female 14–15 mm.

In size, general appearance, and the sparsely pilose eyes, *stonei* resembles *T. laticeps*. The parallel-sided, middorsal abdominal stripe will distinguish *stonei*.

Male: Eyes densely pilose, areas of large and small facets slightly differentiated, in life dark green above, with 2 narrow, light green bands.

*Biology*—Larvae and pupae from New Mexico have been described by Burger (1977), who collected larvae from inside rotting logs mired in a seepage area in the Transition Life Zone.

## *Tabanus subsimilis nippontucki* Philip
## (Fig. 75; Map 40)

*Tabanus vittiger nippontucki* Philip, 1942b:32. Type, ♂, Coachella, Salton Sea, California.
*Tabanus schwardti nippontucki*; Philip, 1965a:336.
*Tabanus subsimilis nippontucki*; Philip, 1965b:877.

*Geographic range*—Southeastern California to Texas and Mexico.

*California distribution (counties)*—Map 40. Imperial, Riverside. Normally restricted to low, hot, desert environments.

*Seasonal occurrence*—From mid-April sporadically to early August.

*Discussion*—Length: Female 13–14 mm.

A pallid species, the reddish brown of the abdomen faded dorsally, approaching yellowish orange; eyes essentially bare, only a few scattered hairs visible at 50X; posterior half of scutellar disc red; abdomen with a broad, median stripe and sublateral patches of buffy pollinosity bordered with dark brownish black. Resembles a pale *similis*.

Male: Eyes with area of large facets dark brown to yellowish brown, that of small facets black, strongly differentiated, moderately pilose; basal plate narrower and more elongate than in female, annuli pale, reddish orange, usually concolorous with basal plate; second palpal segment entirely white, pilose; thorax clothed with white, erect and gray, appressed hairs dorsally; hind tibial fringe with mixed gray white and black hairs; abdomen dorsally variable, from dark to light reddish brown to very pale yellow, sometimes hardly contrasting with median stripe.

*Tabanus subsimilis nippontucki* is best recognized by its pallid, faded appearance, particularly the faded abdominal pattern of the males. Although extremely pallid specimens of *subsimilis nippontucki* can be separated readily from *T. subsimilis subsimilis* Bellardi, which ranges through portions of the eastern and southern U.S. and Mexico, intermediate forms have been taken. Males tend to show the extreme pallid tones more than females. In a series of specimens reared from larvae collected near Agua Prieta, Sonora, Mexico (Burger, 1975) some males had the dark abdominal pattern of *T. subsimilis subsimilis*; others approached *subsimilis nippontucki* in the fading of the reddish brown abdominal pattern to light brown; females did not exhibit such variation. Philip (1965b), Burger (1975), and Pechuman (personal communication) consider *nippontucki* to be a pallid color variety of *subsimilis*, characteristic of arid desert environments.

Philip (1965b) studied type material of the "*lineola*" complex and clarified the taxonomic confusion in this widespread group. He showed that *nippontucki* Philip, 1942 is one of a trio of subspecies of *Tabanus subsimilis*

Bellardi, 1859 and not a subspecies of *vittiger* or *schwardti*. Both of these latter names are now considered to be synonyms of *subsimilis*.

*Biology*—Unknown. The biology and/or taxonomy of the immature stages of the nominate subspecies, *T. subsimilis subsimilis*, have been studied by Schwardt (1931, 1936) in Arkansas; Gingrich and Hoffman (1967) and Thompson (1975) in Texas; Goodwin (1973) in Tennessee; and Burger (1977) in Sonora, Mexico.

### *Tabanus tetropsis* Bigot
### (Figs. 66, 76; Map 34)

*Tabanus tetropsis* Bigot, 1892:681. Type, ♂, locality unknown (as Georgia, in error).

*Tabanus productus* Hine, 1904:242. Syntypes, unstated no. ♂♂ and ♀♀, Lander, Wyoming.

*Geographic range*—Montana to Oregon, south to California and New Mexico.

*California distribution*—Map 34. Primarily eastern, from Lassen County south to Death Valley and central San Bernardino County. One record from Paso Robles, San Luis Obispo County.

*Seasonal occurrence*—From early May through mid-August, with one record in the second week of September.

*Discussion*—Length: Female 10–12 mm.

A small, grayish species with a median, light gray stripe on abdomen (Fig. 66). The frons with distinctive calli (Fig. 76) and vein $R_4$ with a long, curving stump vein will distinguish it.

Male: Eyes with short, sparse pile; the areas of large and small facets sharply differentiated, with the latter extending around margin of eye to vertex; the area of large facets amber brown, contrasting with the black, small-faceted area.

*Biology*—This species (reported as *T. productus*) bothered livestock at Summer Lake, Oregon (Roth et al., 1952). Flies preferred to attack animals on the legs and under the belly. Ten-second counts of tabanids on one side of dairy calves showed averages of up to 30 *tetropsis*.

### *Tabanus* (*Glaucops*) *fratellus* Williston
### (Fig. 77; Map 34)

*Tabanus fratellus* Williston, 1887:140. Syntypes, 2 ♀♀, Washington Territory.

?*Diachlorus haematopotides* Bigot, 1892:624. Type, ♀, Washington Territory.

*Glaucops fratellus*; Philip, 1947:287.

*Tabanus* (*Glaucops*) *fratellus*; Philip, 1965a:337.

*Geographic range*—A boreal species, from Alaska and Yukon Territory* south to Idaho and California.

*California distribution*—Map 34. El Dorado Co.: *Uper Echo Lake*, 7400' elev., 5 ♀, VII-25-49 to VIII-7-49 (W. Middlekauff, CIS); 3 ♀, VIII-10-50 (S. B. Freeborn, CIS). Mono Co.: *Garnet L., Mammoth Lakes*, 1 ♀, VIII-9-58 (J. Northern, LACM).

*Seasonal occurrence*—Late July to mid-August. The Yukon specimen was collected Aug. 31, 1976. Middlekauff failed to take additional specimens at the same Echo Lake locality in 20 subsequent summers, the last in 1979.

*Discussion*—Length: Female 8–11 mm.

A small, black species with 3 small, gray spots on each abdominal tergite, the median spot indistinct; each abdominal tergite with a distinct, narrow, apical pollinose band; antennae with only 2 or 3 annuli rather than the usual 4 (Fig. 77). It is not likely to be confused with any other species.

*Biology*—Unknown.

*New locality record.

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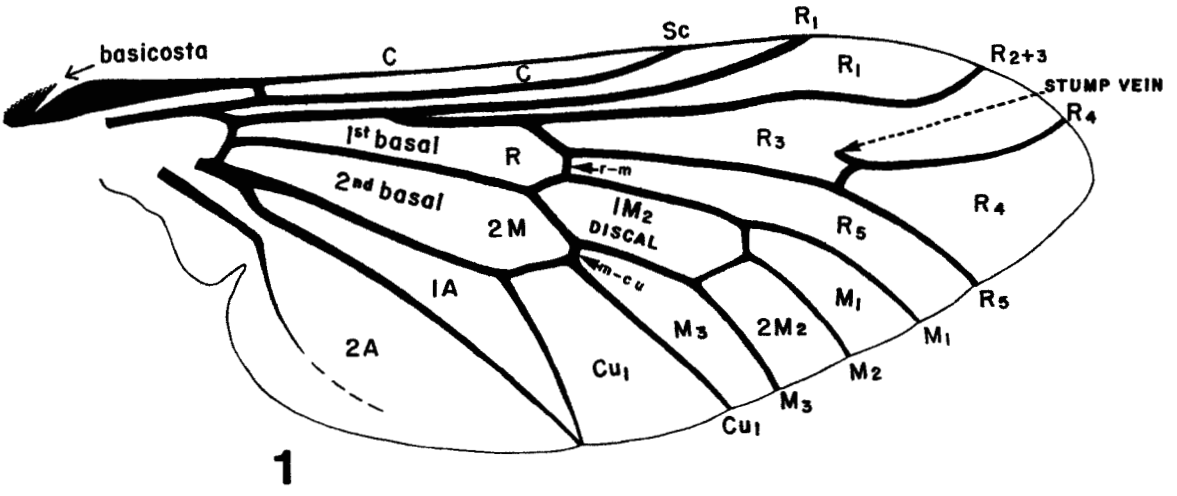
PLATES

## PLATE 1

FIGS. 1-5. Fig. 1, Generalized tabanid wing showing venational terminology; Fig. 2, Generalized wing of a *Chrysops* showing the terminology used; Fig. 3, Apical spurs on metatibia of *Pilimas californica* (Bigot); Fig. 4, Lower portion of face, *C. asbestos* Philip, ♀; Fig. 5, Front view of head, *Tabanus punctifer* Osten Sacken, ♂.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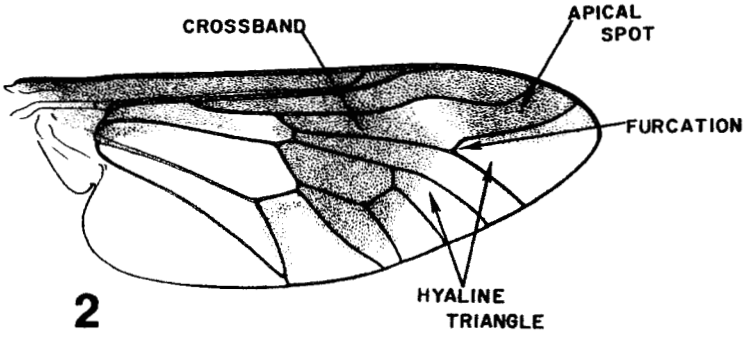
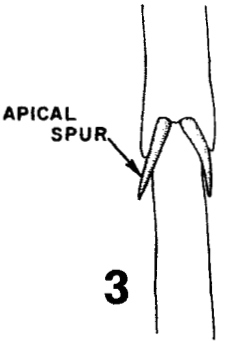

CROSSBAND
APICAL SPOT
FURCATION
HYALINE TRIANGLE

2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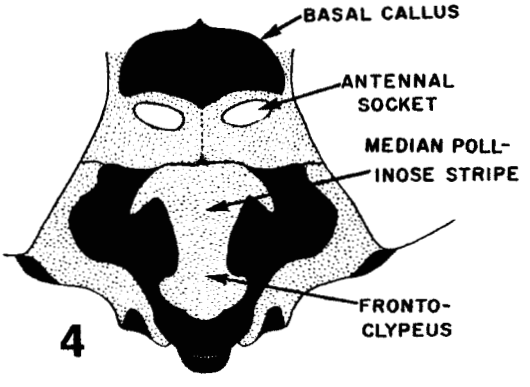
BASAL CALLUS
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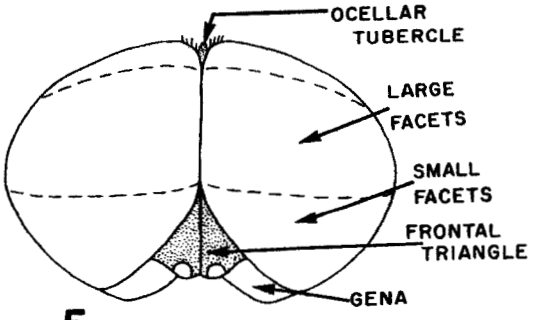
FRONTO-CLYPEUS

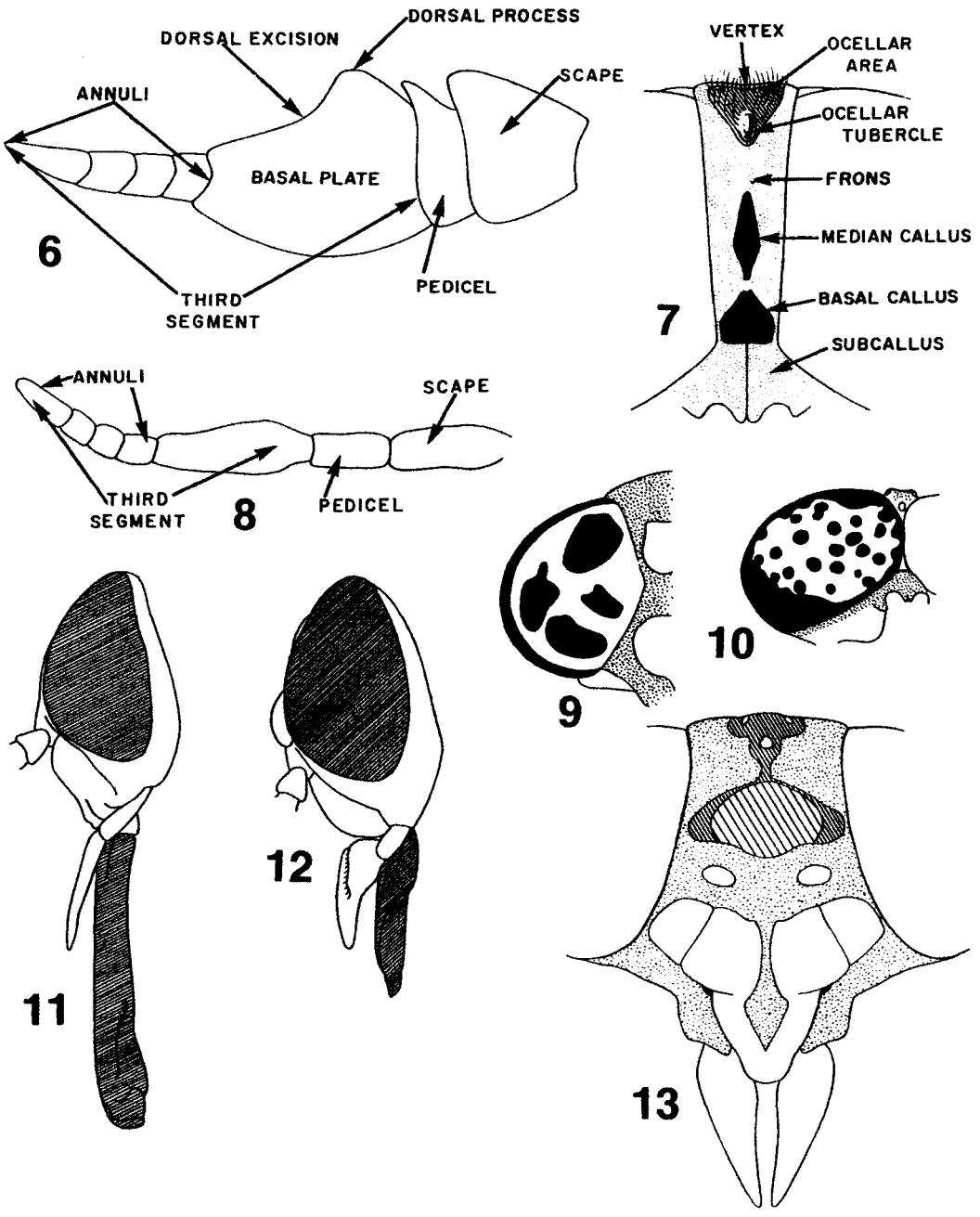
4


OCELLAR TUBERCLE
LARGE FACETS
SMALL FACETS
FRONTAL TRIANGLE
GENA

5

## PLATE 2

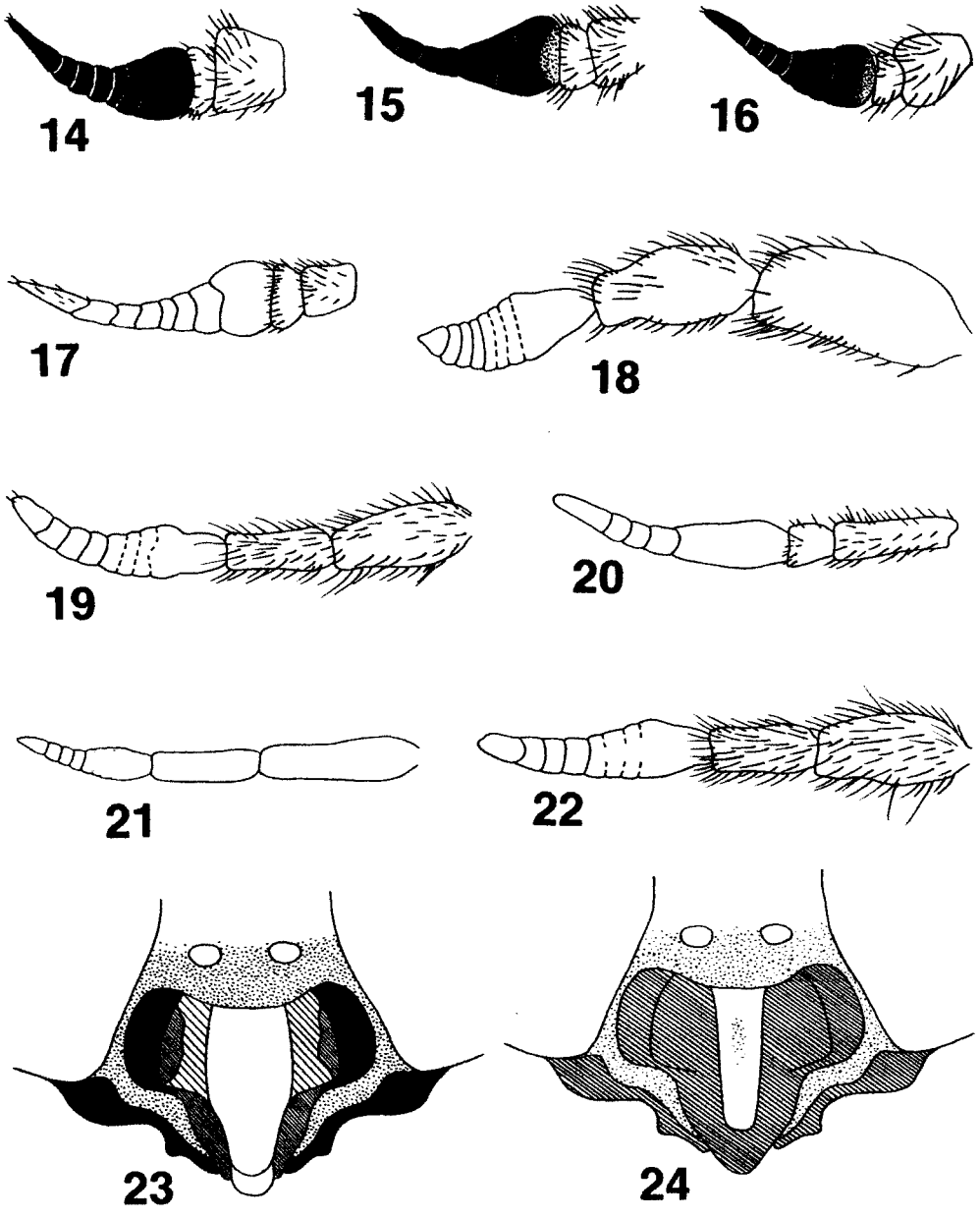
FIGS. 6–13. Fig. 6, Antenna, ***Tabanus kesseli*** Philip, ♀; Fig. 7, Front view of face, ***Hybomitra californica*** (Marten), ♀; Fig. 8, Antenna, ***Chrysops bishoppi*** Brennan, ♀; Fig. 9, Eye markings of *C. noctifer* Osten Sacken, ♀; Fig. 10, Eye markings of ***Silvius notatus*** (Bigot), ♂; Fig. 11, Lateral view of head, ***Stonemyia tranquilla fera*** (Williston), ♀; Fig. 12, Lateral view of head, ***Apatolestes willistoni*** Brennan, ♀; Fig. 13, Front view of head, *C. clavicornis brennani* Philip, ♀.


DORSAL EXCISION
DORSAL PROCESS
ANNULI
SCAPE
BASAL PLATE
6
THIRD SEGMENT
PEDICEL
VERTEX
OCELLAR AREA
OCELLAR TUBERCLE
FRONS
MEDIAN CALLUS
BASAL CALLUS
SUBCALLUS
7
ANNULI
SCAPE
THIRD SEGMENT
8
PEDICEL
9
10
11
12
13

## PLATE 3

FIGS. 14-22. Female antennae: Fig. 14, *Apatolestes actites* Philip & Steffan; Fig. 15, *Brennania hera* (Osten Sacken); Fig. 16, *Pilimas californica* (Bigot); Fig. 17, *Stonemyia velutina* (Bigot); Fig. 18, *Chrysops virgulatus* Bellardi; Fig. 19, *C. clavicornis brennani* Philip; Fig. 20, *Silvius notatus* (Bigot); Fig. 21, *S. philipi* Pechuman; Fig. 22, *Chrysops wileyae* Philip.

FIGS. 23-24. Front view of faces, female *Chrysops* spp.: Fig. 23, *C. noctifer* Osten Sacken; Fig. 24, *C. surdus* Osten Sacken.


14
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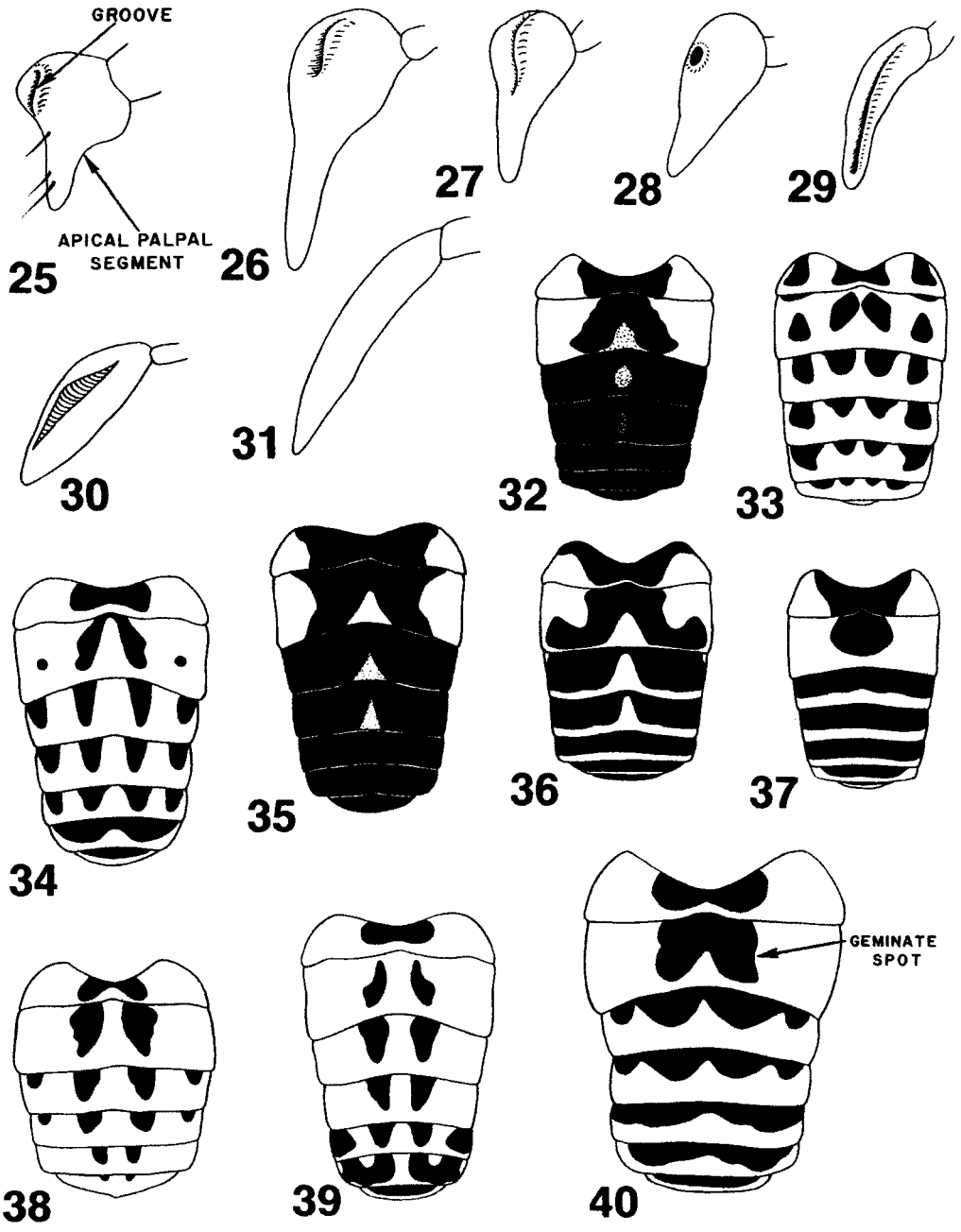
## PLATE 4

FIGS. 25–31. Apical palpal segment, females: Fig. 25, ***Apatolestes actites*** Philip & Steffan; Fig. 26, ***A. albipilosus*** Brennan; Fig. 27, ***A. parkeri*** Philip; Fig. 28, ***Brennania hera*** (Osten Sacken); Fig. 29, ***Silvius notatus*** (Bigot); Fig. 30, ***Chrysops coquilletti*** Hine; Fig. 31, ***Pilimas californica*** (Bigot).

FIGS. 32–40. Abdominal patterns of female ***Chrysops***: Fig. 32, ***C. noctifer*** Osten Sacken; Fig. 33, ***C. discalis*** Williston; Fig. 34, ***C. clavicornis clavicornis*** Brennan; Fig. 35, ***C. excitans*** Walker; Fig. 36, ***C. aestuans*** Wulp; Fig. 37, ***C. asbestos*** Philip; Fig. 38, ***C. hirsuticallus***; Fig. 39, ***C. clavicornis brennani*** Philip; Fig. 40, ***C. bishoppi*** Brennan.


GROOVE
APICAL PALPAL SEGMENT
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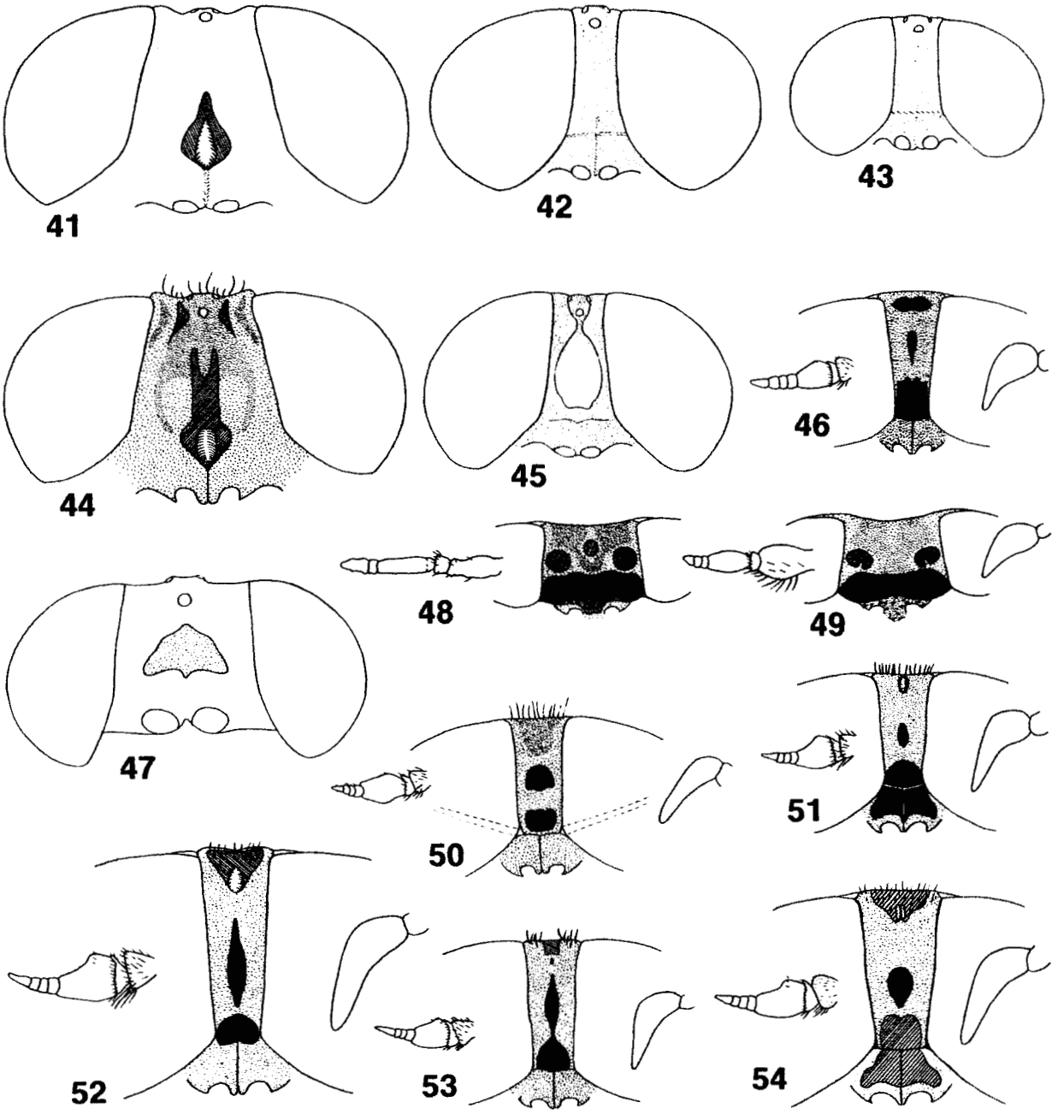
GEMINATE SPOT

## PLATE 5

FIGS. 41–54. Front view of faces, female tabanids: Fig. 41, *Apatolestes actites* Philip & Steffan; Fig. 42, *Pilimas californica* (Bigot); Fig. 43, *Stonemyia tranquilla fera* (Williston); Fig. 44, *A. colei* Philip; Fig. 45, *Brennania hera* (Osten Sacken); Fig. 46, *Stenotabanus guttatulus* (Townsend); Fig. 47, *Silvius philipi* Pechuman; Fig. 48, *Haematopota willistoni* (Philip); Fig. 49, *H. americana* Osten Sacken; Fig. 50, *Atylotus incisuralis* (Macquart); Fig. 51, *Hybomitra melanorhina* (Bigot); Fig. 52, *H. californica* (Marten); Fig. 53, *H. aasa* Philip; Fig. 54, *H. captonis* (Marten).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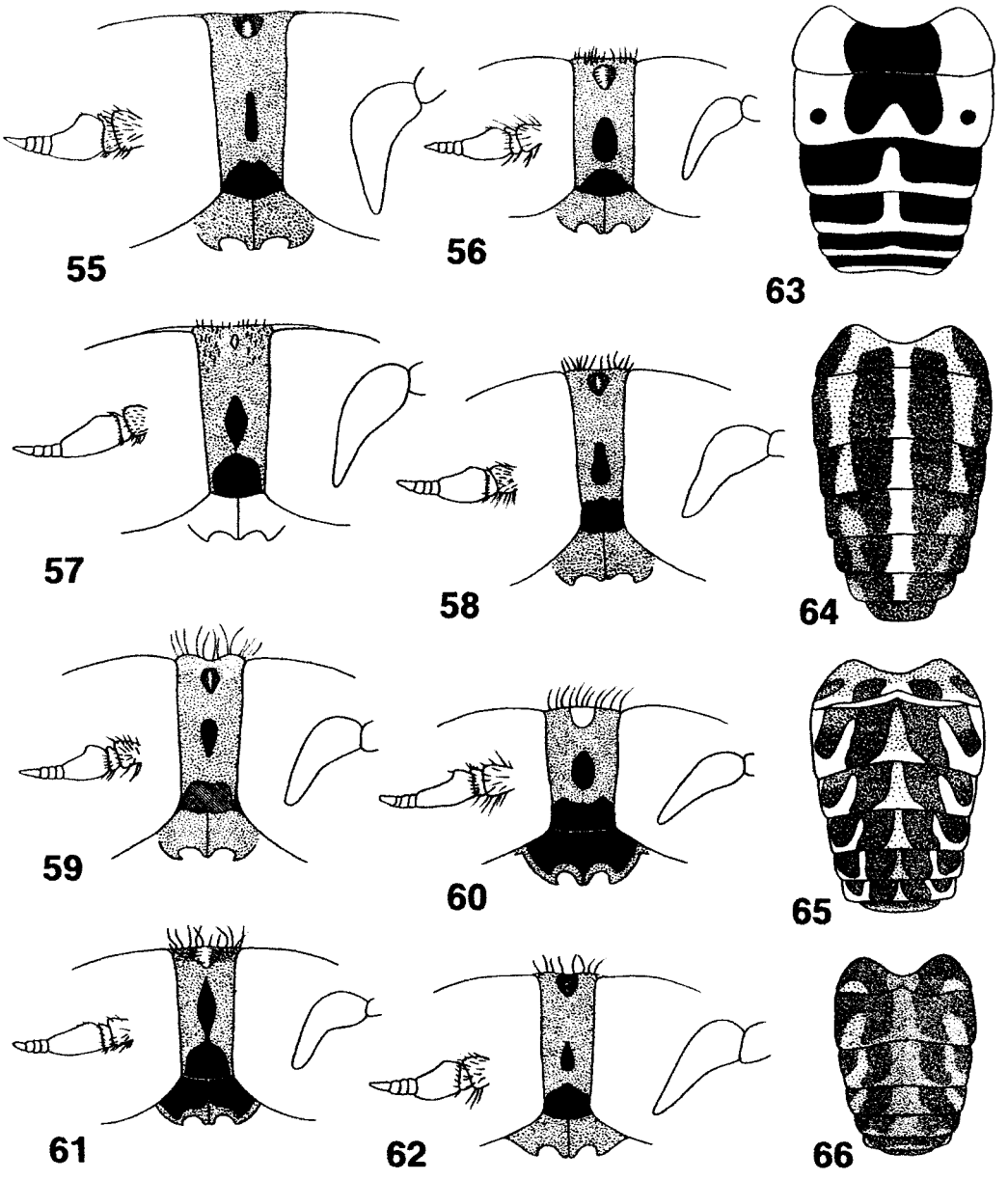
## PLATE 6

FIGS. 55–62. Front view of faces, female *Hybomitra*: Fig. 55, *H. fulvilateralis* (Macquart); Fig. 56, *H. lanifera* (McDunnough); Fig. 57, *H. opaca* (Coquillett); Fig. 58, *H. phaenops* (Osten Sacken); Fig. 59, *H. philipi* (Stone); Fig. 60, *H. procyon* (Osten Sacken); Fig. 61. *H. rhombica* (Osten Sacken); Fig. 62, *H. sonomensis* (Osten Sacken).

FIGS. 63–66. Abdominal patterns, females. Fig. 63, *Chrysops surdus* Osten Sacken; Fig. 64, *Tabanus similis* Macquart; Fig. 65, *Tabanus laticeps* Hine; Fig. 66, *Tabanus tetropsis* Bigot.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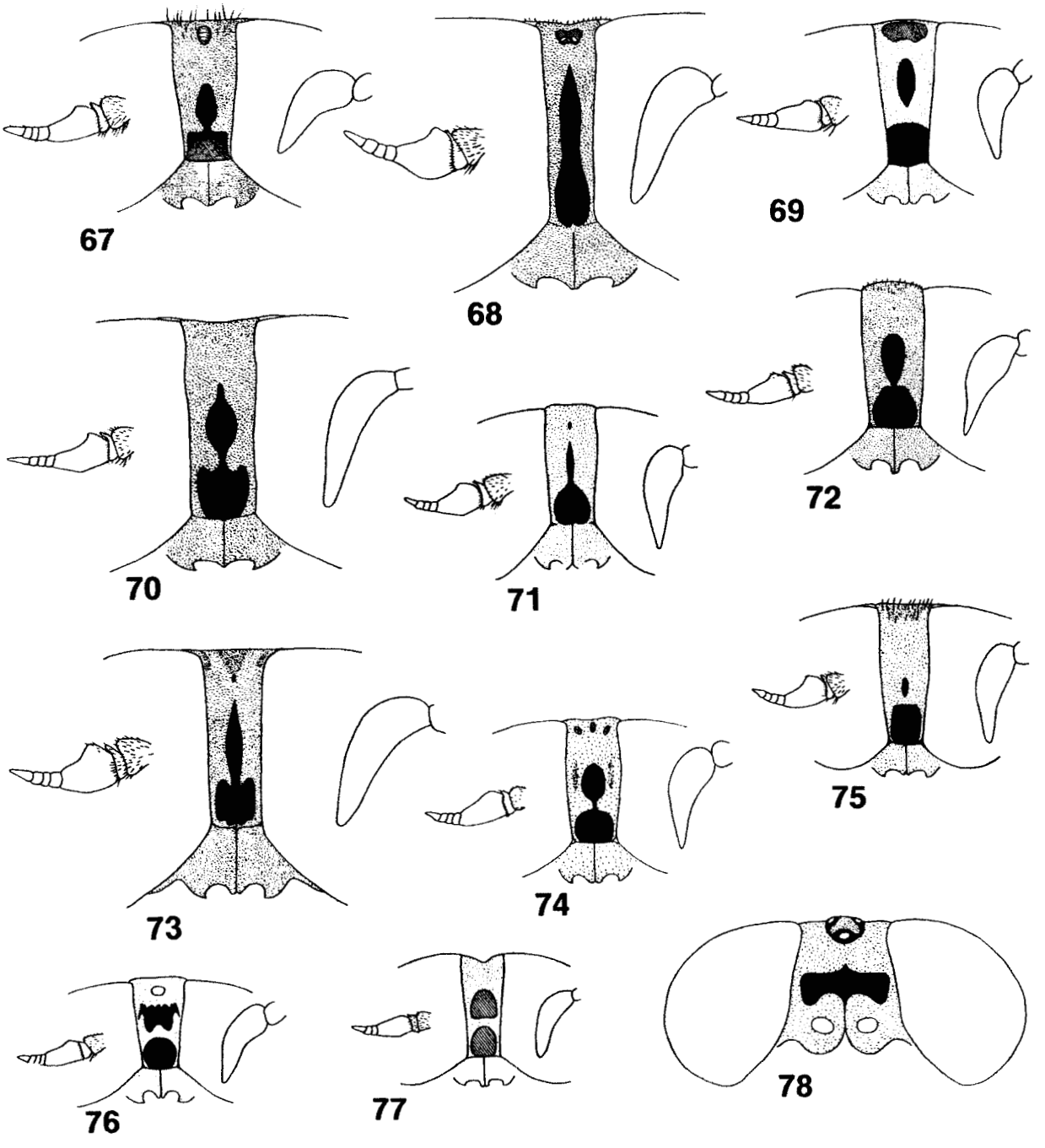
## PLATE 7

FIGS. 67–78. Front view of faces, female *Hybomitra*, *Tabanus*, and *Silvius*: Fig. 67, *H. tetrica* (Marten); Fig. 68, *T. aegrotus* Osten Sacken; Fig. 69, *T. monoensis* Hine; Fig. 70, *T. punctifer* Osten Sacken; Fig. 71, *T. similis* Macquart; Fig. 72, *T. laticeps* Hine; Fig. 73, *T. kesseli* Philip; Fig. 74, *T. stonei* Philip; Fig. 75, *T. subsimilis nippontucki* Philip; Fig. 76, *T. tetropsis* Bigot; Fig. 77, *T. fratellus* Williston; Fig. 78, *S. notatus* (Bigot).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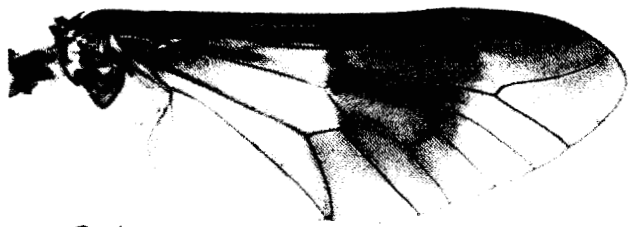
## PLATE 8

FIGS. 79–88. Wings of *Silvius* and *Chrysops*: Fig. 79, *S. abdominalis* Philip, ♀; Fig. 80, *S. notatus* (Bigot), ♀; Fig. 81, *S. quadrivittatus* (Say), ♀; Fig. 82, *S. philipi* Pechuman, ♀; Fig. 83, *C. aestuans* Wulp, ♀; Fig. 84, *C. asbestos* Philip, ♀; Fig. 85, *C. bishoppi* Brennan, ♀; Fig. 86, *C. ater* Macquart, ♀; Fig. 88, *C. clavicornis clavicornis* Brennan, ♂.

79



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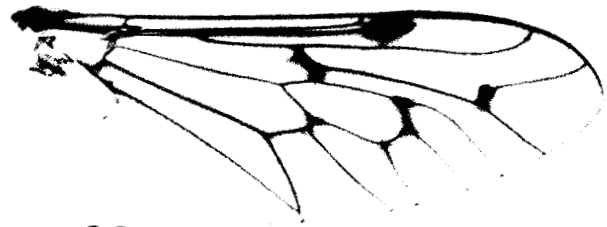

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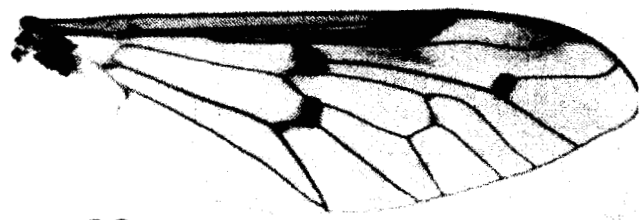

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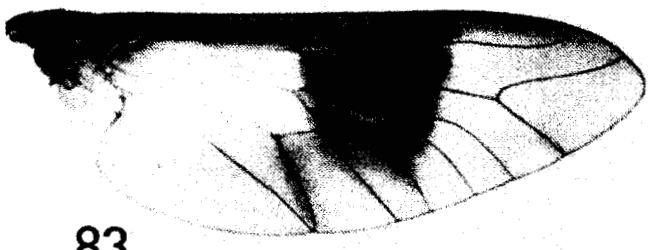


83

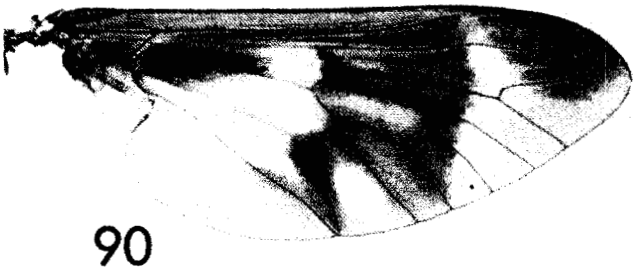
88

## PLATE 9

FIGS. 89–98. Wings of female *Chrysops*: Fig. 89, *C. coloradensis* Bigot; Fig. 90, *C. coquilletti* Hine; Fig. 91, *C. discalis* Williston; Fig. 92, *C. excitans* Walker; Fig. 93, *C. fulvaster* Osten Sacken; Fig. 94, *C. furcatus* Walker; Fig. 95, *C. hirsuticallus* Philip; Fig. 96, *C. latifrons* Brennan; Fig. 97, *C. mitis* Osten Sacken; Fig. 98, *C. noctifer* Osten Sacken.

89

94



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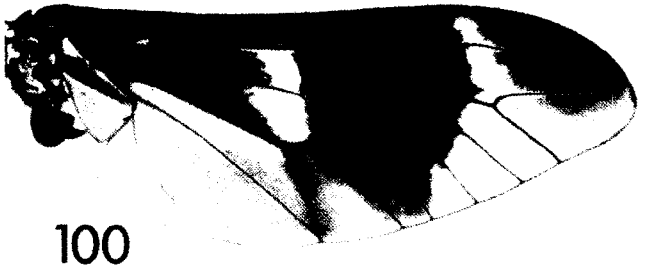
## PLATE 10

**FIGS. 99–106. Wings of female *Chrysops* and *Haematopota*: Fig. 99, *C. pachycerus* Williston; Fig. 100, *C. pechumani* Philip; Fig. 101, *C. proclivis* Osten Sacken; Fig. 102, *C. surdus* Osten Sacken; Fig. 103, *C. virgulatus* Bellardi; Fig. 104, *C. wileyae* Philip; Fig. 105, *H. americana* Osten Sacken; Fig. 106, *H. willistoni* (Philip).**

99

103



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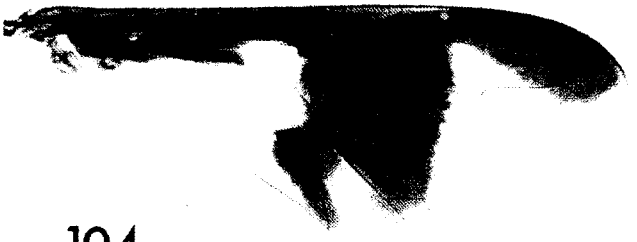

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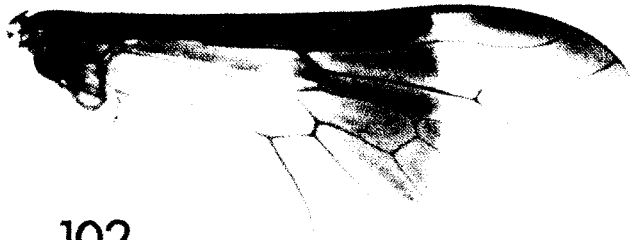
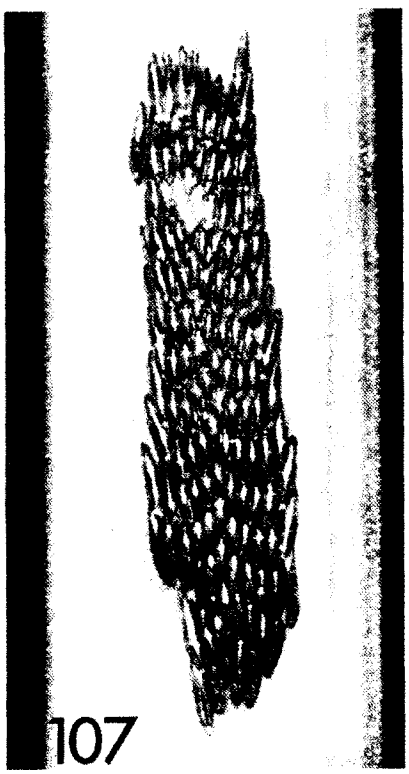


102

106

## PLATE 11

FIGS. 107–110. Fig. 107, Egg mass of *Chrysops* sp. probably *hirsuticallus*; Fig. 108, Egg mass of *Tabanus punctifer* showing emergence holes of hymenopterous parasites; Fig. 109, *Hippodamia* sp. probably *convergens* eating eggs of *C. hirsuticallus*; Fig. 110, Vernal pool where *Chrysops hirsuticallus* breeds at Hopland, California.



107

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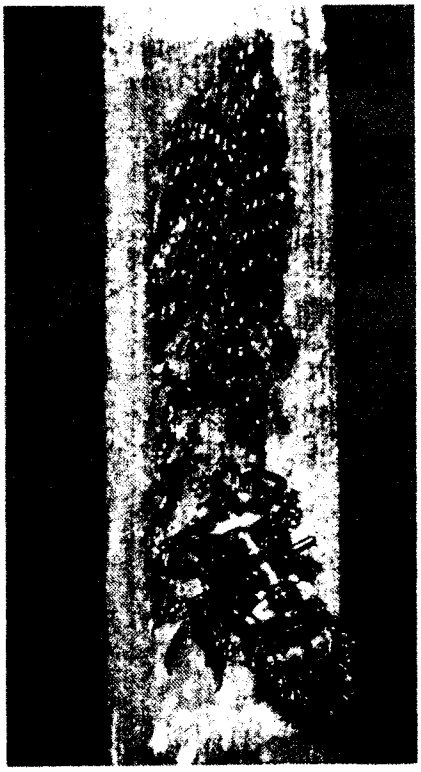
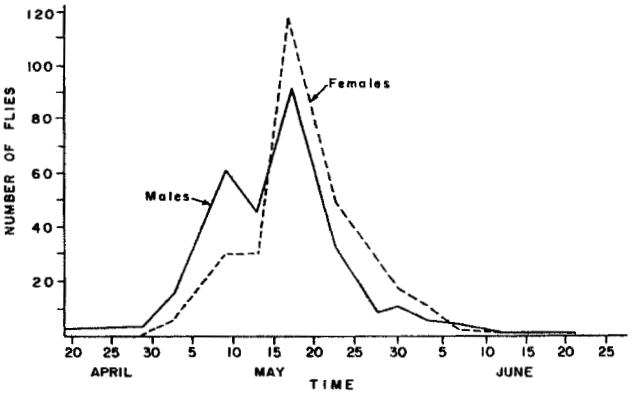


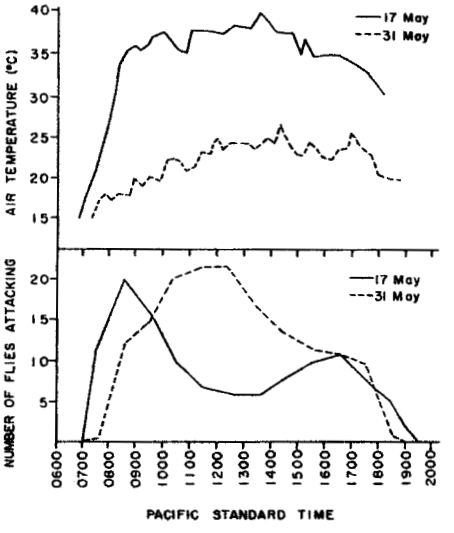
110

## PLATE 12

FIG. 111. Seasonal distribution and abundance of *Chrysops hirsuticallus* as determined by sweeping vegetation bordering a vernal pool, Hopland, California, 1972.

FIG. 112. Biting cycle of *Chrysops hirsuticallus* on a man walking slowly along the margin of a vernal pool, Hopland, California, 1973.


NUMBER OF FLIES
120
100
80
60
40
20
Females
Males
20 25 30 5 10 15 20 25 30 5 10 15 20 25
APRIL
MAY
JUNE
TIME

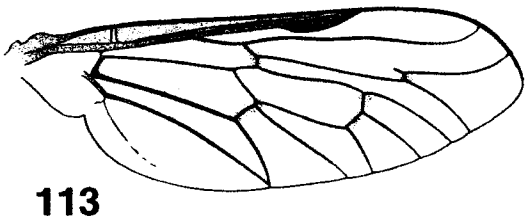

AIR TEMPERATURE (°C)
40
35
30
25
20
15
17 May
31 May
NUMBER OF FLIES ATTACKING
20
15
10
5
17 May
31 May
0600 0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
PACIFIC STANDARD TIME

## PLATE 13

FIGS. 113-114. Fig. 113, Wing of *Apatolestes rugosus*; Fig. 114, Head of *A. rugosus*, frontal view.

FIGS. 115-119. Larvae and pupae of *Chrysops wileyae*: Fig. 115, mature larva, lateral view; Fig. 116, Pupa, frontal plate, ventral view; Fig. 117, Pupa, abdominal segment VIII, posterior view; Fig. 118, Pupa, frontal plate, anterior view; Fig. 119, Pupa, mesothoracic spiracle.

Terminology: an.l.=anal lobe; an.r.=anal ridges; ant.pb.=anterior pubescence; a.o.s.= anterior orbital seta; a.r.=antennal ridge; a.s.=antennal sheath; c.s.=callus seta; c.t.=callus tubercle; d.t.=dorsal tubercle of aster; f.s.=frontal suture; l.t.=lateral tubercle of aster; p.o.s.= posterior orbital seta; post.pb.=posterior pubescence; pseu.=pseudopodia; pseu.pb.=pseudopodial pubescence; siph.=respiratory siphon; stig.sp.=stigmatal spine; v.c.=ventral preanal comb (♂); v.t.=ventral tubercle of aster (after Teskey, 1969).



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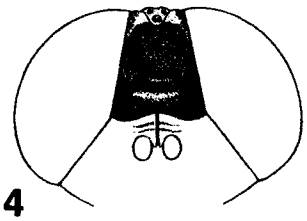

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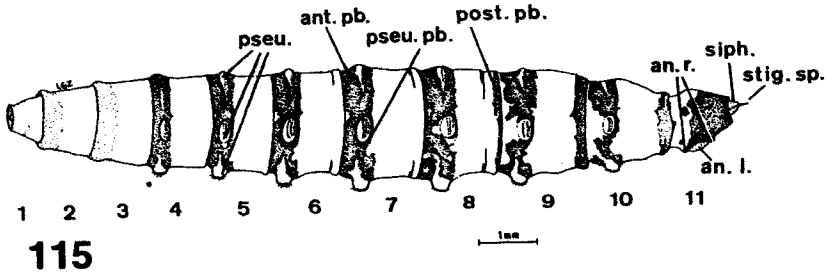


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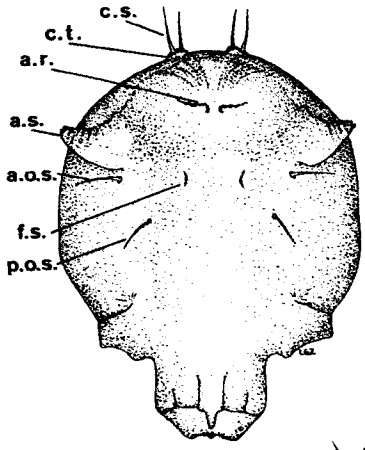


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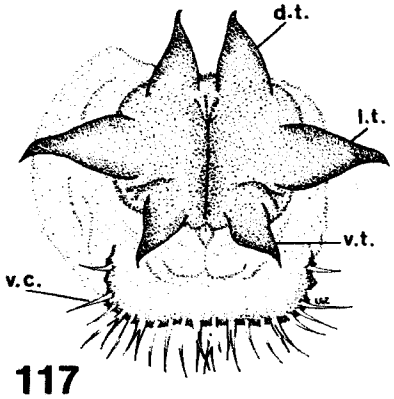


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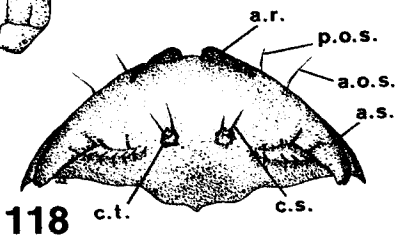


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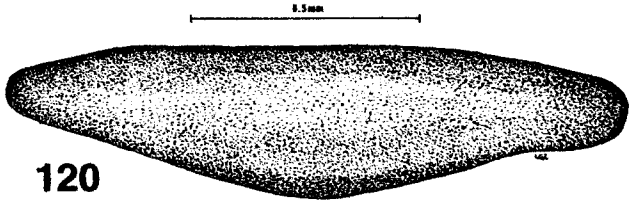
119

## PLATE 14

FIGS. 120-127. Fig. 120, Egg of *Chrysops* sp. probably *hirsuticallus*; Fig. 121, Mature larva, *Apatolestes actites*, lateral view of anal segment; Figs. 122-127, Pupae: Fig. 122, *Chrysops coquilletti*, frontal plate, ventral view; Fig. 123, *C. coquilletti*, abdominal segment VIII, posterior view; Fig. 124, *Silvius notatus*, frontal plate, ventral view; Fig. 125, *S. philipi*, frontal plate, ventral view; Fig. 126, *S. notatus*, mesothoracic spiracle; Fig. 127, *S. philipi*, mesothoracic spiracle.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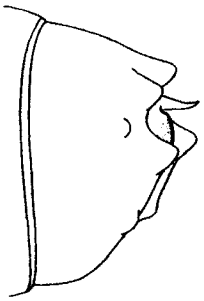
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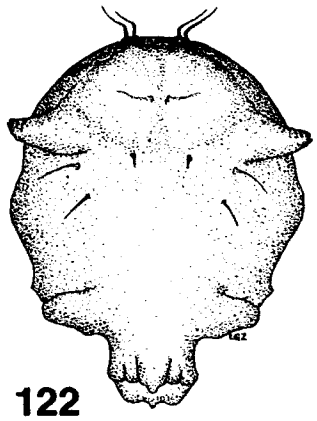
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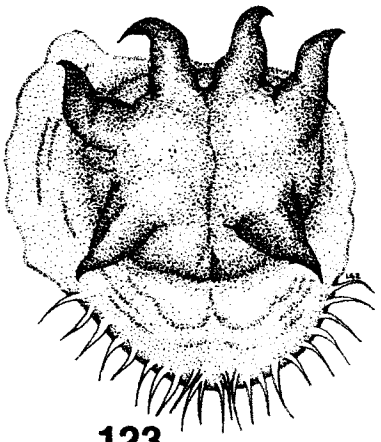
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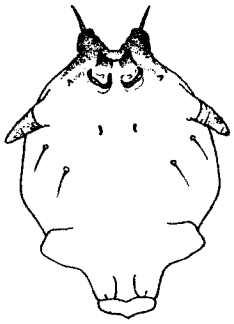
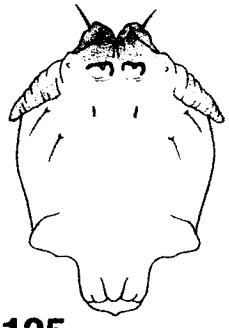

124


125

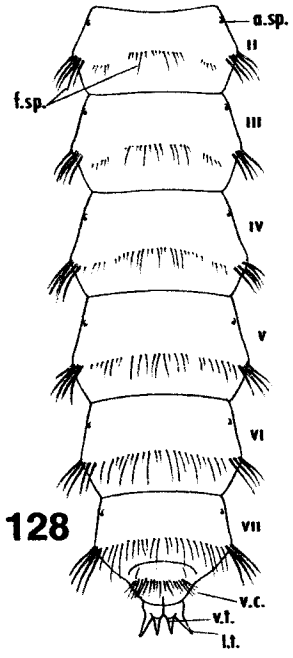

126


127

## PLATE 15

FIGS. 128–133. Pupae: Fig. 128, *Silvius notatus*, abdominal segments II-VIII, ventral view; Fig. 129, *Brennania hera*, mesothoracic spiracle; Fig. 130, *Apatolestes actites*, mesothoracic spiracle; Fig. 131, *Silvius philipi*, abdominal segments II-VIII, ventral view; Fig. 132, *A. actites*, head, thorax, abdominal segments I-II, dorsal view; Fig. 133, *Brennania hera*, head, thorax, abdominal segments I-II, dorsal view.

Terminology: a.sp.=abdominal spiracle; b.a.s.=basal alar seta; f.s.=fringe spines; l.t.= lateral tubercle of aster; m.s.=mesonotal setae; mt.s.=metanotal setae; tg.=tergum; tg.s.= tergal setae; th.sp.=thoracic spiracle; v.c.=ventral preanal comb; v.s.=vertical seta; v.t.=ventral tubercle of aster (after Teskey, 1969).

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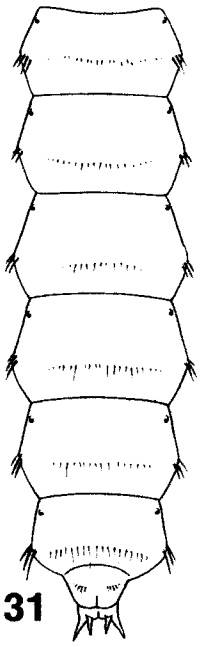
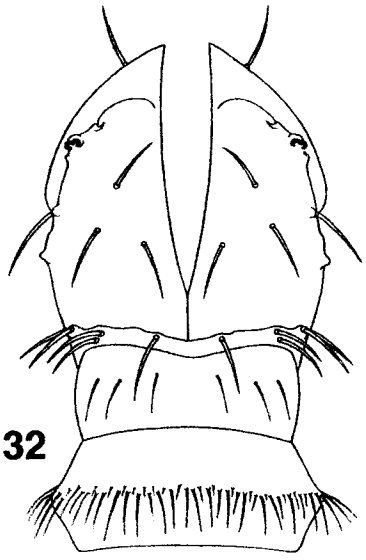


131



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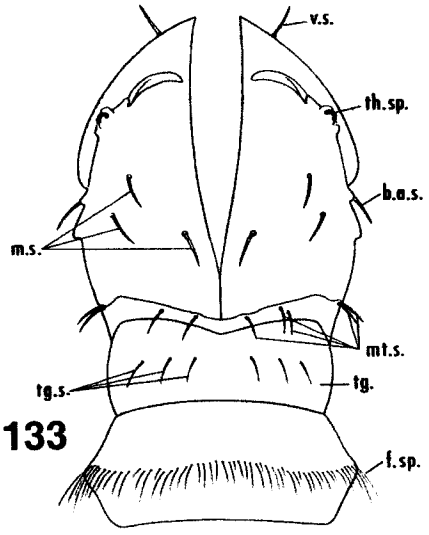


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(Synonyms are in *italics*. Boldface page numbers indicate primary discussion in text.)