

BULLETIN OF
THE CALIFORNIA INSECT SURVEY
VOLUME 13

CALIFORNIA BEMBICINE SAND WASPS

By
R. M. BOHART

and
D. S. HORNING, JR.

UNIVERSITY OF CALIFORNIA PRESS

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ESSIG MUSEUM OF
ENTOMOLOGY

Department of Entomological Sciences
University of California
Berkeley, CA. 94720 USA

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R. M. BOHART

(Department of Entomology, University of California, Davis)

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D. S. HORNING, JR.

(Department of Zoology, University of Canterbury, Christchurch, N.Z.)

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INTRODUCTION

THE BEMBICINE sand wasps are familiar inhabitants along large watercourses and in sandy canyons or dune areas. Their relatively large size, bright markings, and dazzling speed of flight make them favorites of the insect collector. Their ability to hang seemingly motionless in the air, while their wings are moving rapidly and giving off a high-pitched hum, is sometimes interpreted as threatening. Also, they may buzz about the head of an intruder, particularly if their nesting area has been invaded. If captured and handled carelessly, the females will sting but otherwise they are not at all dangerous.

All wasps of the sphecid tribe Bembicini have the ocelli deformed or reduced. In some genera only scars remain. This feature separates them from other Californian species of the subfamily Nyssoninae. The tribe is divisible into two subtribes, Bembicina and Stictiellina, on the basis of the ocellar formation. In the Bembicina the included genera, *Bembix*, *Bicyrtes*, *Rubrica*, *Stictia*, *Microbembex*, and others from South America, have the reduced ocelli or ocellar scars at approximately the same level as the surrounding integument. In the Stictiellina the included genera, *Stictiella*, *Steniolia*, *Glenostictia*, and *Xerostictia* have the ocelli reduced to flat lenses in depressed areas. Of the approximately 45 known species of Californian Bembicini, some 27 are in the genera with recessed ocelli, but these are still too poorly known to warrant their inclusion in a study of this sort. In *Bembix*, *Bicyrtes*, and *Microbembex*, which include many of the

more common wasps, there are 18 Californian species, and these are the subject of this bulletin.

Two additional species have been reported from California but we have not included them in the state fauna. *Bembix cameroni* J. Parker is found in Arizona and New Mexico. The female is quite similar to yellow forms of *comata*, and the male differs primarily by its yellow markings and the presence of a spicule beneath flagellomere IV. We have not been able to verify the presence of this species in California.

The occurrence here of *Stictia signata* (Linnaeus) is even more dubious. This species is common in the American tropics and ranges into eastern Mexico and as far north as Florida. W. Fox (1895:366) made the statement, "I have a specimen before me, the property of the United States National Museum, from Napa County, California, collected by D. W. Coquillett." The presence of *signata* in Napa County is highly questionable.

BIOLOGY

We have tried to give only synoptic information on biology since the subject has been rather fully treated by Evans (1966). Also, he gave many other references and summarized previous work on American species.

The bembicines are ground nesting, and they tend to be gregarious. Prey are predominantly Diptera in *Bembix*, but adult Lepidoptera and Heteroptera are used in genera such as *Stictiella* and *Bicyrtes*. In *Microbembex* a

wide assortment of dead or moribund arthropods may be provisioned. Further data will be found under the genera and species discussions.

The relatively long mouthparts make a variety of flowers accessible to them, and specimens of both sexes, liberally covered with pollen, are frequently collected. Some degree of preference is shown but there do not seem to be any close plant-insect relationships. Plant genera most frequently visited as indicated by host labels on mounted specimens are *Eriogonum*, *Gutierrezia*, *Melilotus*, *Croton*, *Solidago*, *Chrysothamnus*, *Tamarix*, *Heliotropium*, *Achillea*, and *Lotus*. The most commonly represented family by far is Compositae, followed by Polygonaceae and Leguminaceae.

DISTRIBUTION

Except for a large number of Old World species in the genus *Bembix*, the Bembicini is an exclusively New World tribe. The tribe is essentially Neotropical with most of the 16 genera best represented in South America. Exceptions are *Bembix*, *Steniolia*, *Stictiella*, *Glenostictia*, and *Xerostictia*. Genera which have most successfully penetrated more northern latitudes and the Canadian Life Zone are *Bembix* and *Steniolia*. The others are most abundant in numbers of species in subtropical areas of North America or in the southwestern desert areas of the United States.

TAXONOMIC METHODS

In keys and discussions the tergites and sternites are referred to by roman numeral, numbering from the base without regard to the propodeum. Thus, males have seven visible tergites and females have six. Male sternites VII and VIII are usually partly visible. They often exhibit good structural characters and can be extended in relaxed specimens, or completely removed for mounting on cards or on slides. Mouthparts and particularly the palpi are often obscured in pinned material. For generic determination it may be necessary to spread the mandibles and withdraw the tongue from beneath the labrum. At the specific level this is not necessary.

Keys have been based on structural characters as much as possible but in some cases it has been necessary to use color or color pattern, both somewhat variable within a population or between populations from different localities. Male structures on sternites II and VI are exceptionally useful but sometimes they are weakly developed, particularly in depauperate specimens.

In preparing genitalia mounts we followed the KOH-water-alcohol-cellosolve-balsam procedure which gives an acceptable slide in about 15 minutes from the time the genitalia are removed from the specimen. Two sorts of mounts have been made: (1) with the genitalia spread slightly and (2) with the parts dissected and mounted flat. Drawings of the digitus and cuspis were all made from the latter mounts. In fact, drawings of these two structures from the first sort of mount are of limited value.

Plant names in floral visitation records have been corrected to agree with Munz and Keck (1959).

Distribution maps are based on Californian material examined, which totaled about 7,500 specimens.

Illustrations were made by the authors, figures 1-70 by R. M. Bohart, and figures 71-74 by D. S. Homing.

We have departed from the nomenclature suggested by Evans and Matthews (1968) in recognizing two names, *Bembix dentilabris* and *B. pallidipicta* rather than their later synonyms, *B. u-scripta* and *B. pruinosa*. Our reasoning is that both species were described in available literature in such a way that their identity is virtually certain, even without examination of types. *B. dentilabris* was described by Handlirsch (1893) in a monographic revision of Nyssoninae from the world standpoint. For this reason alone the name deserves to stand. *B. pallidipicta* was more cursorily described by F. Smith (1873) but his type has been available for study at the British Museum since that time. It is difficult to understand how J. Parker in his two revisions (1917, 1929) could have overlooked these names.

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Material has been borrowed from the institutions listed below through the individuals indicated. The latter have also given freely of their time in answering questions and volunteering information of importance. To all of these we are grateful.

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are H. E. Evans, Museum of Comparative Zoology, Har-
vard; J. E. Gillaspay, Texas A & I University, Kingsville;
and R. L. Matthews, University of Georgia, Athens.

We also acknowledge our debt to the systematics class
of 1968 at the University of California, Davis, who by
their intensive study of Californian *Bembix* stimulated
the present effort.

SYSTEMATICS

The tribe Bembicini is composed of 16 genera distinguished from other Nyssoninae by a combination of characters. The most salient of these are: (1) midtibia with one apical spur, (2) mesopleuron without an omaulus (a ridge which descends from beneath pronotal lobe), (3) ocelli reduced, (4) prestigmal length of first submarginal cell of forewing much more than length of wing beyond marginal cell, and (5) exposed area of labrum at least as long as broad. Other noticeable features are the streamlining of the notum with the scutellum overlapping the metanotum with a lamelliform expansion, and the propodeal enclosure (basomedian area of propodeum) extending far onto the vertical slope. There seem to have been three main lines of evolution from a stizine sort of ancestor. In the first of these, which included *Bicyrtes* and *Microbembex*, there are no spiracular lobes on male tergite VII. In the second, exemplified by *Bembix*, the basomedian area of the scutum has a longitudinal welt and the ocelli are not sunken in pits. The third line includes the genera related to *Stictiella*, which have the ocelli or their remnants sunken in pits, and the scutum unwelted. This study deals only with the first two lines, both of which have nonrecessed ocelli.

KEY TO THE GENERA OF BEMBICINI IN NORTH AMERICA

1. Midocellus with a distinct lens and somewhat translucent, not reduced to a transverse slit but sunken in a conspicuous pit 2

- Midocellus reduced to a transverse slit or scar, or sometimes with a lens-bearing semicircular crescent, but not in a conspicuous pit 5
2. Labial palpus with not more than 2 articles, maxillary palpus with not more than 4 articles; midocellar plane longer than broad 3
- Labial palpus with 4 articles, maxillary palpus with 6 ... 4
3. Labrum evenly convex toward base and about twice as long as its basal breadth, maxillary palpus with 4 articles; southwestern U.S. and Baja California *Xerostrictia* Gillaspay
- Labrum swollen toward base so that a cross section would be irregularly convex; maxillary palpus with 3 articles; North America and Ecuador *Steniolia* Say
4. Midocellar plane at least slightly broader than long; male midfemur with inferior edge serrate, emarginate or (in small species) rarely entire; clypeus moderately to strongly convex; North America *Stictiella* J. Parker (including *Microstictia* Gillaspay)
- Midocellar plane not broader than long; male midfemur with inferior edge smoothly rounded or (in 1 species) with a large subapical notch; clypeus rather low, convexity often irregular and beveled toward tentorial pits; North America *Glenostictia* Gillaspay
5. Propodeum markedly concave posteriorly or marginal cell bent away from leading edge of forewing (fig. 27) ... 6
- Propodeum essentially flat posteriorly, and marginal cell lying along leading edge of forewing (fig. 26) 7
6. Marginal cell in distal half bent away from wing margin (fig. 27); lateral angles of propodeum not projecting backward; maxillary palpus with 4 or apparently 3 articles, labial palpus with 2 articles or apparently a single tiny one (fig. 10); New World *Microbembex* Patton

- Marginal cell with entire length along wing margin (fig. 26); lateral angles of propodeum projecting backward; maxillary palpus with 6 articles, labial palpus with 4 (fig. 11); New World *Bicyrtes* Lepeletier
7. Midocellar area consisting of a nearly circular shiny black scar without a lens (fig. 18); maxillary palpus with 6 articles, labial palpus with 4; New World *Stictia* Illiger
- Midocellar area consisting of a transverse scar or a lens-bearing crescent (figs. 22, 6) 8
8. Maxillary palpus with 4 articles, labial palpus with 2 (fig. 9); markings not extensively reddish; worldwide *Bembix* Fabricius
- Maxillary palpus with 6 articles, labial palpus with 4; markings extensively reddish; Mexico to Argentina *Rubrica* J. Parker

Genus *Bembix* Fabricius

Bembix is the largest genus in the tribe and the only one which is cosmopolitan. About 300 species are known, of which 23 are North American. California has 11 species of which 3 are relatively abundant and widespread: *americana* Fabricius, *amoena* Handlirsch, and *occidentalis* W. Fox. Since these are large and brightly marked wasps, *Bembix* is relatively well known to those interested in natural history.

The revisions of Parker (1917, 1929) are now somewhat out of date, but the synopsis of the North American species by Evans and Matthews (1968) makes a fine systematic base for future work. We have followed their grouping and synonymy except for minor differences in nomenclature and recognition of subspecies. One species has been added to their list.

The combination of generic features which distinguish *Bembix* are: (1) midocellus greatly reduced and usually scarlike, (2) ocelli not definitely recessed, (3) palpi reduced to four maxillary and two labial articles, (4) scutum with a median welt, (5) marginal cell of forewing with its apex against the costa, and (6) propodeum not compressed laterally nor prominent medially. None of these is exclusive to *Bembix*.

Among the species groups considered by Evans and Matthews, the number of Californian forms we have assigned to each is as follows: *belfragei* group (5), *amoena* group (2), *cinerea* group (0), *texana* group (1), *americana* group (1), and *occidentalis* group (2).

A number of excellent biological studies have been published for various species of *Bembix*. The outstanding worker in this country has been Howard Evans (1957, 1961, 1966) who, in addition to detailing his own studies, has summarized those of others. In the Californian

species, significant biological information is available for *dentilabris*, *amoena*, *sayi*, *americana comata*, *pallidipicta*, and *occidentalis*. This is slightly more than half the known species, comparatively a large percentage for a group among the Sphecidae.

Habits generally applicable to *Bembix* are as follows: They nest gregariously in sand or sandy soil. Burrows slant into the ground for 6 to 9 inches and end in a rather horizontal terminal cell and a more vertical spur in which the female may rest. Males dig shallow burrows in which they pass the night. Mating, which may occur more than once, takes place on a plant or the ground after an aerial meeting. The nests are provisioned with flies, many of which are noxious species in the Tabanidae or one of the muscoid families. Cell provisioning is almost entirely progressive and the egg may be deposited on the first prey or in the empty cell. Flies are stung to paralysis and transported to the nest held by the middle legs of the wasp. The larva spins a cocoon with sand grains incorporated and becomes a prepupa. More than one brood during the summer is customary.

Reported parasites belong to the families Sarcophagidae, Bombyliidae, Conopidae, Rhipiphoridae, Mutillidae, and Chrysidae. Large asilids may act as predators.

KEY TO THE SPECIES OF BEMBIX IN CALIFORNIA

1. Seven visible tergites (males) 2
Six visible tergites (females)¹ 14
2. Sternite VI with an acutely angled, backward-pointing projection which is sharp, rounded or bifurcate at apex 3
Sternite VI with a transverse and often curved ridge, or with two small tubercles (fig. 14), or simple 8
3. Projection of sternite VI bifurcate at apex, rarely truncate (fig. 19). 4
Projection of sternite VI tapering to a sharp or narrowly rounded apex (figs. 17, 20, 23) 5
4. Midtibial spur reaching to or beyond middle of basitarsus *amoena* Handlirsch
Midtibial spur not reaching to middle of basitarsus *sayi* Cresson
5. Midfemur with inferior edge a little irregular but not conspicuously serrate *melanaspis* J. Parker
Midfemur with inferior edge conspicuously serrate (fig. 32) — *americana* Fabricius 6
6. Clypeus mainly yellow, basal margin rarely black; tergal pale markings almost always whitish *americana comata* J. Parker
Clypeus whitish or all black, basal margin, at least, black 7

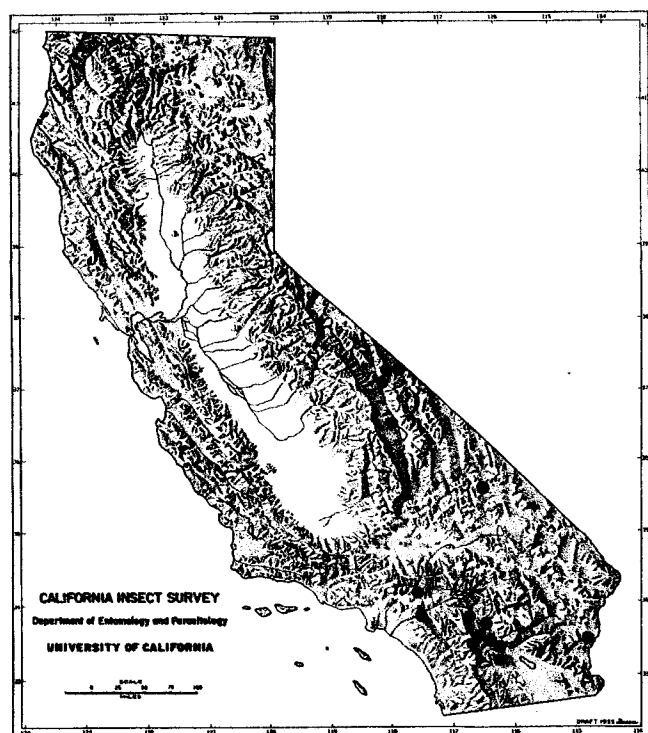
¹ The female of *B. frommeri* R. Bohart is unknown.

7. Tergal pale bands complete or narrowly broken medially on II-IV; clypeus and labrum not all black
americana hamata C. Fox
 Tergal pale bands absent or at extreme sides of II-IV; clypeus and labrum essentially all black (fig. 3)
americana nicolai Cockerell
8. Tergite VII angularly expanded toward base (fig. 33); midocellus with an obvious lens, short but not slit-like 9
 Tergite VII not angularly expanded toward base; midocellus usually slitlike and without an obvious lens .. 12
9. Both sternite VI and sternite II simple; basitarsus of midleg with a group of stout bristles toward inner middle 10
 Sternite VI with a somewhat curved, transverse ridge; sternite II normally with a prominent keellike projection; basitarsus of midleg without a group of stout bristles toward inner middle 11
10. Shiny tylus (welt) beneath terminal flagellomere extending well beyond middle; midfemur multispinulose along ventral edge; gonostyle narrowed straplike toward apex which is stoutly bristly (fig. 53)
dentilabris Handlirsch
 Shiny tylus (welt) beneath terminal flagellomere not extending beyond middle; midfemur a little irregular along ventral edge but not multispinulose; gonostyle tapering gradually to a narrow apex which bears fine hairlike bristles (fig. 54) *frommeri* R. Bohart
11. Labrum dentate near middle as seen in profile (as in fig. 8), middle basitarsus not bowed out in front, first intersubmarginal vein of forewing markedly sinuate (as in fig. 28) *gillaspyi* Evans and Matthews
 Labrum not dentate, middle basitarsus bowed out in front, first intersubmarginal vein of forewing nearly straight (as in fig. 26) *stenebdoma* J. Parker
12. Tergite VII with numerous longitudinal rugulae; labrum longer than eye height (fig. 7); sternite VI with a strong, curved, transverse ridge (fig. 16)
rugosa J. Parker
 Tergite VII not finely rugose; labrum shorter than eye height; sternite VI without a strong transverse ridge 13
13. Sternite VI simple; sternite II without a strong median carina or keel, flagellomere I nearly twice as long as scape *pallidipicta* F. Smith
 Sternite VI bituberculate or with two parallel submedian ridges, (fig. 14) sternite II with a sharp median carina or a small to moderate keel; flagellomere I only a little longer than scape *occidentalis* W. Fox
14. Scape considerably shorter than median length of clypeus (fig. 6) 15
 Scape nearly or as long as median length of clypeus (figs. 1, 4, 5) 18
15. Labrum dentate near middle as seen in profile 16
 Labrum not dentate 17
16. Basoposterior corner of second submarginal cell of forewing nearly a right angle (fig. 26), scutum with a prominent U-shaped discal yellow mark
dentilabris Handlirsch
 Basoposterior corner of second submarginal cell of forewing acutely prolonged basad (as in fig. 28), scutum black except laterally *gillaspyi* Evans and Matthews
17. Pygidium longitudinally rugose; labrum as long as eye height, basoposterior corner of second submarginal cell acutely prolonged basad (as in fig. 28)
rugosa J. Parker
 Pygidium not longitudinally rugose; labrum shorter than eye height; basoposterior corner of second submarginal cell nearly a right angle (as in fig. 26)
stenebdoma J. Parker
18. Mandible slender, nearly straight, subapical denticle very small 19
 Mandible moderate, distinctly curved, one or two well-developed subapical teeth (figs. 4, 9) 20
19. Tergal markings yellow, sometimes greatly reduced; when extensive, often enclosing black spots
occidentalis W. Fox
 Tergal markings whitish or very pale yellow, forming broad but simple bands which do not enclose black spots *pallidipicta* F. Smith
20. Wings clouded with brown *melanaspis* J. Parker
 Wings hyaline 21
21. Midtibial spur strong, about as long as clypeus at middle, reaching beyond middle of basitarsus; a large species about 20 mm long *amoena* Handlirsch
 Midtibial spur considerably shorter than clypeus at middle, not reaching beyond middle of basitarsus; body generally shorter than 20 mm 22
22. Scutum with discal yellow markings, tergite II often with enclosed black spots *sayi* Cresson
 Scutum without discal marks, tergites rarely with enclosed black spots — *americana* Fabricius 23
23. Labrum black laterally (fig. 2), abdomen mostly black in dorsal view *americana nicolai* Cockerell
 Labrum all pale, abdomen extensively maculate in dorsal view 24
24. Margin between clypeus and frons nearly always with a thin to thick black line (fig. 1), midtibia often with a black streak or spots on outer surface; comb of female front basitarsus usually with 7 well-developed setae; occurring on Santa Cruz, Santa Rosa, and San Miguel islands *americana hamata* C. Fox
 Margin between clypeus and frons nearly always pale (fig. 4); midtibia not black-marked; comb of female front basitarsus usually with 6 well-developed setae and sometimes a seventh one which may be weak and basal; occurring on mainland, Anacapa Island, and Santa Catalina Island ... *americana comata* J. Parker

Bembix stenebdoma J. Parker

(Figs. 6, 13, 46, 47; Map 1)

Bembix stenebdoma J. Parker, 1917:79. Holotype ♂, Florence, Arizona (ANSP).*Geographic range.* — Desert localities of southern California and western Nevada east to western Texas.*California records.* — INYO Co.: Big Pine (3 mi. w.), 1♀, VIII-10-62 (L. A. Stange, UCD). Deep Springs College, 11♀, 3♂, VII-11-67 (R. M. Bohart, R. O. Schuster, UCD). Lone Pine, 1♂, VI-10-37 (R. M. Bohart, UCD). Wyman Canyon —



Map 1. California distribution of *Bembix stenebdoma* J. Parker.

White Mountains, 1♀, VII-10-67 (Saul and Suzy Frommer, UCR). RIVERSIDE Co.: Anza, 1♂, VII-5-56 (R. M. Bohart, UCD). Blythe, 1♂, V-1948 (CIS). Blythe (18 mi. w.), 1♂, X-29-52, on *Larrea divericata* (P. H. Timberlake, UCR). Box Canyon, 2♂, IV-26-52 (P. D. Hurd, CIS). Deep Canyon, 2♀, 1♂, X-9-63 (M. E. Irwin, UCR). Mira Loma, 1♀, VIII-28-52 (J. Wilcox, UCR). Palm Canyon, 1♀, VI-18-52 (LACM). Palm Springs, 1♂, V-11-35 (P. H. Timberlake, UCR). San Jacinto Mountains, 1♀, VII-27-50, on *Bebbia juncea* (P. H. Timberlake, UCR). SAN BERNARDINO Co.: Desert Springs, 1♀, VI-22-58 (P. H. Arnaud, Jr., CSDA). Saratoga Spring, 3♀, 2♂, IV-5-58 (A. S. Menke, L. A. Stange, LACM). SAN DIEGO Co.: Borrego, 1♀, 2♂, IV-27 to 30-54, on *Chaenactis fremontii* (P. H. Hurd, P. H. Timberlake, CIS, UCR).

This is the smallest *Bembix* in California, rarely exceeding 15 mm in length in either sex. The markings are yellow on the thorax and sternites, but whitish, sometimes tinted with yellow on the tergites. The wings are nearly clear. The clypeus and frons are yellow in the female but whitish in the male. The labrum is yellow, the mesopleuron extensively so, and there are stripes across the scutellum and metanotum. Laterally, the propodeum is yellow, and in the enclosure it is mostly yellow in females but only sparingly in males. The yellow mark below the midocellus is transverse and limits the upper margin of a butterfly-shaped black mark on the frons.

Females have a nearly complete U-shaped yellow discal mark on the scutum, but in males it is usually represented by merely a pair of anterior longitudinal streaks. The tergal bands are complete as a rule, at least on tergites I and II, but on III and IV they may occasionally be narrowly broken medially.

The species is related to *gillaspyi* and *rugosa*, which share with it a transverse ridge on sternite VI of the male. It also has an affinity with *dentilabris* and *frommeri*, since all five have ocellar lenses partially present as translucent crescents, and the antennal scape is considerably shorter than the clypeus. From *rugosa*, *stenebdoma* can be separated by the labrum, which is not longer than the eye height (longer in *rugosa*). Furthermore, the labrum is simple in profile (medially dentate or humped in *gillaspyi*, *dentilabris*, and *frommeri*). Also, tergite VI in the female is punctate rather than longitudinally rugulose. The first intersubmarginal vein of the forewing is nearly straight, a peculiarity in *Bembix* but found also in *dentilabris* and *frommeri*.

Other distinguishing structural characters in the male are the basally angulate tergite VII, ventrally multi-spinulose midfemur, somewhat compressed midtarsus, with the basitarsus curved out in front, large bladelike and hooked keel on sternite II, distally rounded gonostyle (fig. 47), lamellate cuspis and bladelike digitus (fig. 46). In the female the fore basitarsus has six to seven rake setae.

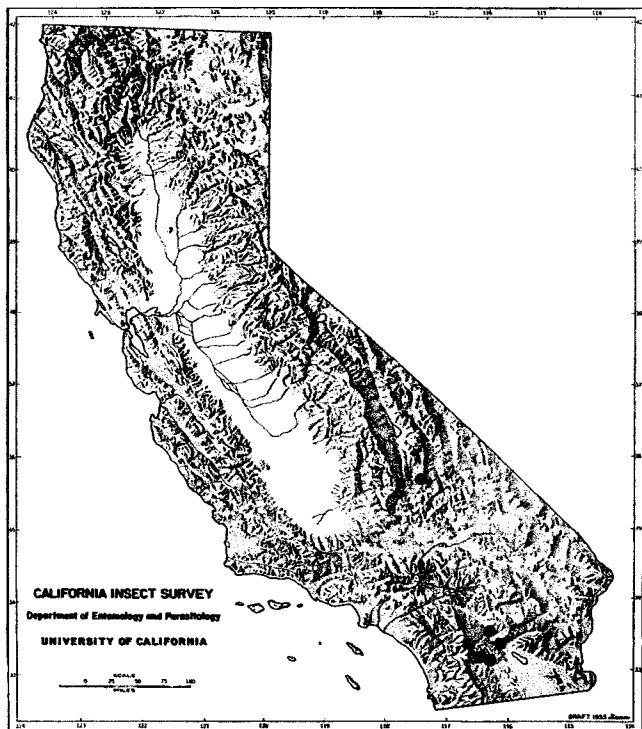
B. stenebdoma is infrequently collected but may be locally abundant. We have seen a total of 25 males and 23 females from California desert localities.

Bembix gillaspyi Evans and Matthews (Figs. 43, 48; Map 2)

Bembix gillaspyi Evans and Matthews, 1968:1290. Holotype ♂, Borrego Springs, San Diego Co., California (CAS).

Geographic range. — Desert localities from southern California to New Mexico.

California records. — INYO Co.: Homewood Canyon, 1♀, VII-14-62 (W. A. Foster, CIS). RIVERSIDE Co.: Magnesia Canyon, 8♀, VI-28-52 (S. Miyagawa, B. Tinglof, LACM, UCD). Devil Canyon (5 mi. s. La Quinta), 1♂, V-7-32 (UCD). SAN DIEGO Co.: Borrego Desert — near Narrows, 1♀, XI-12-45 (A. L. Melander, UCR). Borrego Palm Canyon, 1♂, VI-12-65 (J. L. Bath, UCD). Borrego Springs, 1♂, VI-11-65 (G. E. Wallace, UCR). Borrego Valley, 1♂, V-21-41 (E. C. Van Dyke, UCD).

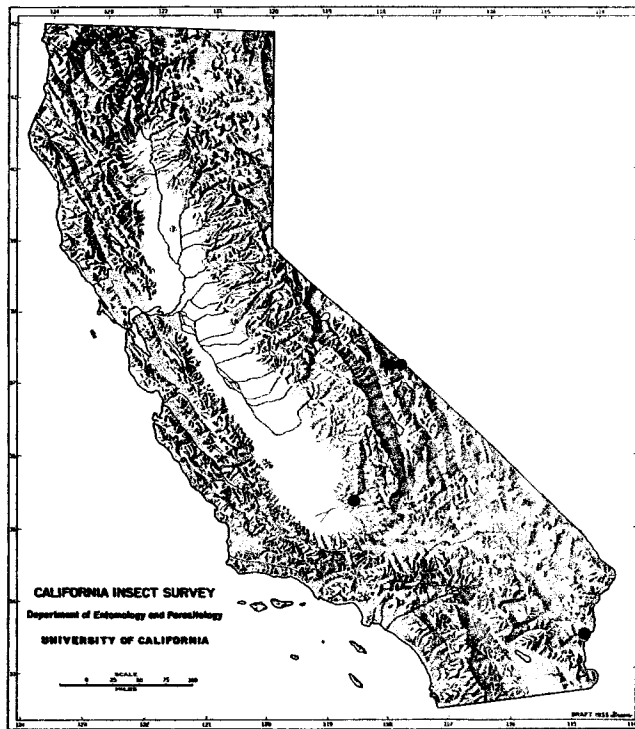


Map 2. California distribution of *Bembix gillaspyi* Evans and Matthews.

Although an abundantly yellow species, *gillaspyi* has no pale marks on the disc of the scutum. The body length of both sexes is about 20 mm. Principal yellow areas are the labrum; clypeus, except for a pair of median black spots in the female; frons laterally; prothorax and pleuron extensively; scutellum and more posterior parts of notum mostly; legs mostly; and broad abdominal bands which sometimes enclose black spots. The wings are faintly yellowed.

The short scape in relation to the clypeal length, and the partially developed ocellar lenses which appear as translucent semicircles (hindocelli) or narrowly arcuate (midocellus) ally this species with *dentilabris*, *frommeri*, *stenebdoma*, and *rugosa*. With the last two of these it shares a transverse ridge on male sternite VI; with the first three a longitudinally rugulose last tergite, and a basally angulate male tergite VII. It is further similar to *dentilabris* and *frommeri* in having a median hump on the labrum shortly above the middle. The first intersubmarginal vein is strongly sinuate as in *rugosa* and most other *Bembix*.

Other structural characters in the male are the ventrally serrate midfemur, the large bladelike and hooked keel on sternite II, the distally rounded gonostyle (fig. 48), the narrowly lamellate cuspis and the angularly



Map 3. California distribution of *Bembix rugosa* J. Parker.

bladellike digitus (fig. 43). In females the fore basitarsus has six rake setae and often a weak seventh.

B. gillaspyi is a large desert-dwelling species. It has not previously been recorded outside California but we have seen three females collected 23 miles southwest of Silver City, Grant County, New Mexico, August 25, 1969 (W. Hansen, T. Tsiao, Utah State U.). We have studied only three males and thirteen females, of which a few were part of the original type series of eight males and thirty-five females.

Bembix rugosa J. Parker
(Figs. 7, 16, 36, 55; Map 3)

Bembix rugosa J. Parker, 1917:95. Holotype ♀, Arizona (USNM).

Geographic range. — Desert localities from Utah and Arizona to southern California and Baja California.

California records. — IMPERIAL Co.: Imperial Co., 1♂, V-1919 (J. C. Bridwell, USNM). INYO Co.: Antelope Springs, 1♀, VII-9-66, VII-17-53, on *Chrysothamnus* sp. (H. K. Court, J. W. MacSwain, UCD, CIS). Deep Springs, 1♂, VII-17-53 (J. T. Brooks, CIS). KERN Co.: Kern River Canyon, 1♂, IX-8-51 (W. D. Murray, CIS). RIVERSIDE Co.: Blythe (18 mi. w.), 1♀, X-16-65 (R. M. Bohart, UCD). Blythe (15 mi. w.), 1♂, V-22-64 (A. E. Michelbacher, CIS). Blythe (22 mi. s.), 1♂, VI-1-59 (L. A. Stange, UCD).

Markings appear to be quite variable in *rugosa*, ranging from a deep yellow to nearly white on the face and abdomen. We have seen one female which is nearly all yellow, the principal dark markings being three longitudinal stripes on the scutum, a squarish spot on tergite II, and most of sternites IV and V. Some specimens of both sexes have black basal to subbasal marks on the clypeus. The tergal bands are continuous and anteriorly tri-emarginate on several segments. Most specimens have the scutum black or with only a pair of pale dashes in front. The wings are nearly clear and the body length is 17 to 20 mm in our material.

The long labrum (longer than the eye height) (fig. 7) distinguishes *rugosa* from all other American *Bembix* except *magdalenae* C. Fox from Baja California. From *magdalenae* it differs primarily by the simple rather than basally angled edge of male tergite VII. The short scape in relation to the clypeal length and the partially developed ocelli, which in *rugosa* are narrow and often difficult to discern beneath the pubescence, relate it to *dentilabris*, *gillaspyi*, and *stenebdoma*. It shares with *dentilabris*, *frommeri*, and *gillaspyi* the longitudinally rugulose last tergite, and with *gillaspyi* the sinuate first intersubmarginal vein.

Other structural male characters are the slightly irregular but not serrate ventral edge of the midfemur, the moderately developed but not always hooked keel of sternite II, and the transverse ridge of sternite VI, which is angled and farther posterior than in related species (fig. 16). The gonostyle is broadly and obliquely truncate toward the apex (fig. 55), the cuspis fingerlike, and the digitus slender but expanding gradually toward the apex (fig. 36). The female basitarsal rake has seven or eight setae.

We have seen fourteen males and twenty females of this species from California, Nevada and Baja California. Evans and Matthews (1968) reported it also from Arizona and southern Utah.

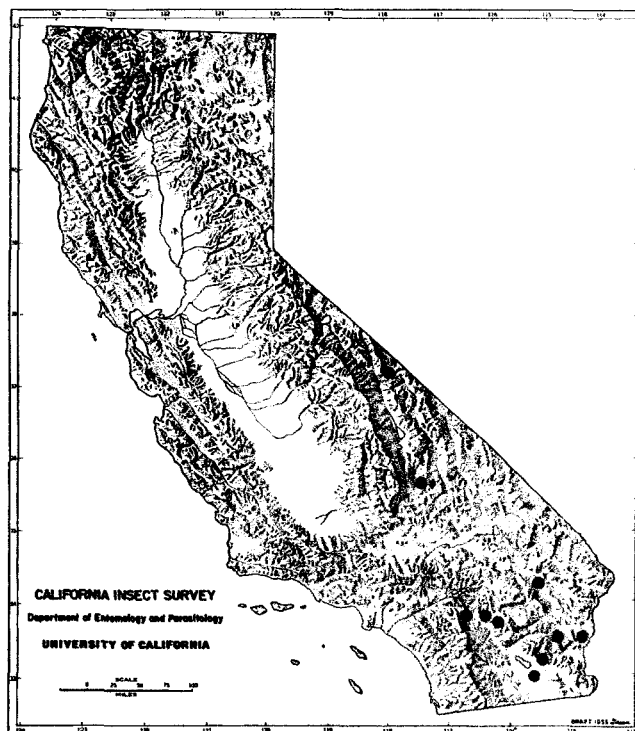
Bembix dentilabris Handlirsch

(Figs. 8, 26, 44, 53; Map 4)

Bembix dentilabris Handlirsch, 1893:794. Holotype ♀, Cape San Lucas, Baja California, Mexico (Luebeck Museum, type presumably lost).

Bembix u-scripta W. Fox, 1895:362. Lectotype ♂, Tucson, Arizona (ANSP).

Bembix arcuata J. Parker, 1917:81. Lectotype ♂, Cotulla, Texas (USNM).



Map 4. California distribution of *Bembix dentilabris* (Handlirsch).

Geographic range. — Southern California to southeastern Texas, south in Mexico to Morelos, Guerrero, Baja California, and the Revillagigedo Islands.

California records. — IMPERIAL CO.: Beal Well, 1 ♀, X-24-51, on *Hyptis emoryi* (P. D. Hurd, CIS). Westmorland, 1 ♂, V-31-30, on *Pluchea sericea* (P. H. Timberlake, UCR). INYO CO.: Homewood Canyon, 1 ♀, VII-6-62 (J. F. Lawrence, CIS). RIVERSIDE CO.: Blythe (18 mi. w.), 1 ♀, IV-29-52, on *Larrea divaricata* (P. H. Timberlake, UCR). Deep Canyon, 1 ♀, X-28-63; 3 ♀, XI-12-63; 2 ♀, XI-19-63 (M. E. Irwin, E. I. Schlinger, UCR). Desert Hot Springs, 1 ♀, XI-8-63 (LACM). Hopkins Well, 3 ♀, IV-16-58; 3 ♀, IV-29-52 (P. D. Hurd, J. G. Rozen, CIS). Joshua Tree National Monument — Lake Covington Flat, 1 ♀, VI-25-60 (E. L. Sleeper, LACM).

B. dentilabris is of average size for the genus, specimens ranging in body length from 14 to 19 mm. Californian specimens are more extensively yellow than those from the more eastern part of the range, as discussed by Evans and Matthews (1968). Characteristic is the squarely U-shaped mark on the scutal disc. The rest of the thorax and face are mostly yellow. The tergal bands are pale to deep yellow and anteriorly tri-emarginate as a rule. Tergites V and following are generally spotted rather than banded. Females often have a pair of black spots on the clypeus above the middle. The wings are nearly clear.

Comparisons with *stenebdoma*, *gillaspyi*, and *rugosa* are made under those species. The closest relative is *frommeri* with which it shares the short scape, the partially developed ocelli, the basally angled male tergite VII, the distinctively spinose male basitarsus of the midleg, the uneven labral profile, and the nearly straight first intersubmarginal vein. Only males of *frommeri* are known and *dentilabris* differs from them by the prominent U-shaped discal mark, much longer tylus beneath the terminal flagellomere, a multispinulose ventral edge of the midfemur, more arcuate basitarsus of the midleg, longer spiracular lobes on tergite VII, more ligulate gonostyle, and broader cuspis. Females of *dentilabris* have six or seven setae on the basitarsus of the foreleg.

We have seen twenty-six males and fifty-three females of this handsome, desert-inhabiting species.

A summary of biological studies of *dentilabris* (as *u-scripta*) was given by Evans (1966:317-321). A distinctive feature of the species is that females provision their nests during evening twilight. Evans suggested a correlation between these crepuscular habits and the partially developed ocelli. Prey is diverse, including Asilidae, Apioceratidae, Bombyliidae, Tachinidae, Sarcophagidae, Tabanidae, Stratiomyidae, and Syrphidae. Burrows sometimes end in more than one cell, and when the female is away there is always a strong inner closure but not always an outer plug. The tumulus is ordinarily pushed away from the entrance on completion of the burrow. The egg is attached to the base of the wing of the first fly provisioned. *B. dentilabris* has its nests so far apart as to be almost solitary.

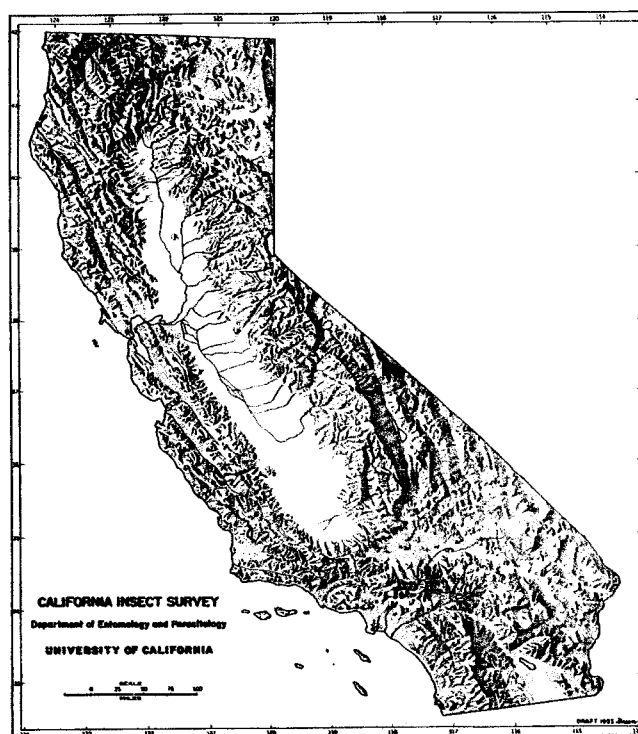
Bembix frommeri R. Bohart
(Figs. 33, 37, 54; Map 5)

Bembix frommeri R. Bohart, 1970:201. Holotype ♂, 5 mi. s. Deep Springs College, Inyo Co., California (UCR).

Geographic range. — Known only from eastern Inyo County, California.

California records. — INYO Co.: Deep Springs College (5 mi. s.), 1 ♂, VII-11-67 (Saul and Suzy Frommer, UCR). Wyman Canyon — White Mountains, 1 ♂, VI-25-66 (Saul and Suzy Frommer, UCD).

Bembix frommeri is a moderately large and robust species with a body length of about 18 mm. It is known only from the male, which is characterized by the extensively yellow face and pleuron; the cross stripes of yellow on the scutellum, metanotum, upper and lower propo-



Map 5. California distribution of *Bembix frommeri* R. Bohart.

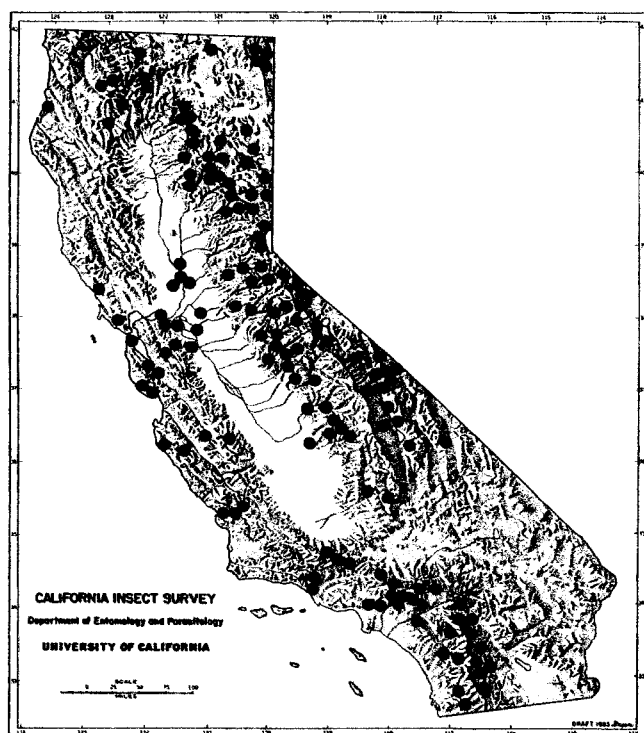
deum; and the whitish abdominal markings. The tergal bands are essentially tri-emarginate anteriorly. The scutal disc is dark except for a pair of short and faint lines in front. The legs are mostly yellow and the wings clear.

The species is closely related to *dentilabris* and shares with it the short scape, longitudinally rugulose last tergite, basally angulate male tergite VII, uneven labral profile, spinose midleg basitarsus, nearly straight first intersubmarginal vein, and the partially developed ocelli. Distinctions are the mostly dark scutal disc, short tylus on the terminal flagellomere, almost smooth ventral edge of the midfemur, less arcuate midleg basitarsus, shorter spiracular lobes (not attaining angle of tergite VII), conical gonostyle apex (fig. 54), and fingerlike cuspis (fig. 37). Since there are eight or nine setae on the basitarsus of the foreleg, this may also hold true for the female.

Bembix amoena Handlirsch
(Figs. 19, 42, 56, 71; Map 6)

Bembix amoena Handlirsch, 1893:769. Lectotype ♂, "Nevada" Vienna Museum, Austria).

Geographic range. — Pacific coastal states north to British Columbia and east to Alberta and New Mexico.



Map 6. California distribution of *Bembix amoena* (Handlirsch).

California records. — ALAMEDA Co.: Altamont, Arroyo Mocho (Livermore, 20 mi. s.). Livermore, Tesla. ALPINE Co.: Hope Valley, Woodfords (and 3 mi. ne.). AMADOR Co.: Silver Lake. BUTTE Co.: Butte Meadows, Feather River — Highway 24. CALAVERAS Co.: Arnold, Big Trees, Mokelumne Hill. CONTRA COSTA Co.: Antioch, Bethel Island, Pittsburg (4 mi. s.). EL DORADO Co.: Caldor, Chile Bar, Kyburz, Pollack Pines, Pyramid Ranger Station — Highway 50, White Hall. FRESNO Co.: Huntington Lake, Kings River Canyon, Shaver Lake, Trimmer (17 mi. w.). HUMBOLDT Co.: ARCATA. INYO Co.: Antelope Springs, Batchelder Spring, Big Pine (and 18 mi. s.), Birch Creek Canyon, Bishop (and 3 mi. e.), Glacier Lodge, Independence, Lone Pine (and 3 mi. n.), Lone Pine Creek, Owens Valley, Panamint Mountains, Westgard Pass, Whitney Portal, Wyman Canyon — White Mountains. KERN Co.: Frazier Park, Kernville, Walker Pass. LASSEN Co.: Bridge Creek Camp, Constantia, Doyle, Hallelujah Junction (and 3 mi. w.), Janesville, Litchfield (16 mi. n.), Ravendale (8 mi. s.), Standish (4 mi. w.), Westwood. LOS ANGELES Co.: Big Dalton Dam, Camp Baldy, Crystal Lake, Elizabeth Lake Canyon, Glendale, Gorman, Palmdale, Pine Canyon, South Gate, Tanbark Flat, Valyermo. MADERA Co.: North Fork. MARIN Co.: Alpine Lake, Fairfax, Kent Lake. MARIPOSA Co.: El Portal, Fish Camp, Givens Creek — Yosemite National Park, Indian Flat, Mariposa, Mariposa Grove, Vernal Falls — Yosemite National Park, Wawona, Yosemite Valley. MODOC Co.: Cedarville (and 6 mi. nw.), Cedar Pass, Davis Creek, Fandango Pass, Goose Lake, Lake City, Newell. MONO Co.: Cottonwood Creek — White Mountains, Crooked Creek — White Mountains, Leavitt Meadow, Lee Vining, Mammoth, Mammoth Lakes, Mill Creek, Monitor Pass (4 mi. ne.), Pickel

Meadow, Piute Mountain, Sonora Junction, Springs Canyon — Walker (3 mi. ne.), Tom's Place, Topaz Lake. MONTEREY Co.: Arroyo Seco, Big Sur. NEVADA Co.: Boca (and 3 mi. n.), Prosser Creek — Hobart Mills (3 mi. s.) Sagehen Creek near Hobart Mills, Truckee. PLACER Co.: Carmelien Bay, Lake Forest, Tahoe City. PLUMAS Co.: Blairsden, Chester (6 mi. e.), Elephant Butte, Keddie, Lake Almanor, Meadow Valley, Portola, Quincy (4 mi. w.), Snow Lake, Spencer Lakes Road — Johnsville (8 mi. sw.), Spring Garden. RIVERSIDE Co.: Anza, Banning, Cabazon, Corona, Hemet, Idyllwild — San Jacinto Mountains, Santa Ana River, White Water Canyon. SACRAMENTO Co.: Sacramento. SAN BENITO Co.: Idria (and 13 mi. sw.), New Idria, Pinnacles National Monument. SAN BERNARDINO Co.: Colton, Forest Home, Lake Arrowhead, Mouth Deep Creek, Snow Crest Camp, Wildwood Canyon — Calimesa (5 mi. e.), Yucaipa. SAN DIEGO Co.: Borrego, Culp Canyon — Anza State Park, Harbison Canyon, Laguna Mountains, Lyons Peak, Mount Laguna, Oak Grove (3 mi. s.), Palomar Mountain, Scissors Crossing, Warner Springs. SAN FRANCISCO Co.: Sand Dunes — San Francisco. SAN JOAQUIN Co.: Lodi, Stockton, Tracy. SAN LUIS OBISPO Co.: Creston (5 mi. s.), Morro Bay, Santa Margarita (5 mi. ne.). SANTA CLARA Co.: Palo Alto, San Jose. SANTA CRUZ Co.: Big Basin, Mt. Hermon. SHASTA Co.: Burney (6 mi. w.), Cassel, Cayton, Hat Creek, Lassen Volcanic National Park, Old Station. SIERRA Co.: Goodyear's Bar, Independence Lake, Lincoln Creek near Gold Lake, Little Truckee River, Sattley, Sierra Buttes, Sierraville, Stampede Valley near Russell Valley, Webber Lake (5 mi. e.), Yuba Pass. SISKIYOU Co.: Ash Creek — Mt. Shasta, Finlay Camp, Montague (10 mi. ne.), Sawyers Bar (8 mi. w.), Weed (and 8 mi. w.). SOLANO Co.: Ryer Island. SONOMA Co.: Duncan's Mills. SUTTER Co.: Robbins. TEHAMA Co.: Mineral. TRINITY Co.: Bully Chup Peak, Carrville (10 mi. n.), Coffee Creek Ranger Station, Trinity River Camp. TULARE Co.: Ash Mountain Reservoir, Ash Mountain — Sequoia National Park, General Grant Grove, Kaweah, Mineral King, Redwood Meadows, Three Rivers, Visalia. TUOLUMNE Co.: Browns Meadow, Dardanelles, Dodge Ridge, Eleanor Lake, Groveland, Kennedy Meadow, Long Barn, Mather, Pigeon Flat near Dardanelles, Pinecrest, Sonora Pass, Strawberry, Upper Baker Camp. VENTURA Co.: Foster Park, Sespe Canyon. YOLO Co.: Davis, Elkhorn Ferry.

The seasonal distribution, based on data from pinned specimens, is depicted in figure 71.

Bembix amoena is one of the two most common and widespread species of the genus in California. It is also one of the largest, and body length is about 20 ± 2 mm. The facial markings are yellow, and the dorsum of the thorax is all black. In the most frequently collected form the tergal markings are whitish, rather narrow and irregular, and often broken medially. About 40 percent of the females in California have yellow tergal markings, and this is the predominant form in the southern half of the state. Among the females with whitish tergal markings, 8 percent have enclosed black spots on tergite II, whereas the spots are enclosed in over 50 percent of the females with yellow-marked tergites. In most populations a melanistic form of the male occurs. This variety has the

abdomen all black dorsally or with traces of pale spots on one or two tergites. About 15 percent of the males we have seen fall into this category. The legs in *amoena* are extensively yellow and the wings are nearly clear.

Together with *sayi* this species forms a distinctive group whose principal characteristics are: ocellar lenses obliterated, labrum smooth in profile, scape fully as long as clypeus at middle, mandible relatively robust, first intersubmarginal vein sinuate, and female basitarsal rake usually with six setae. Male characters are: midfemur serrate beneath, tergite VII simple, sternite II with a usually low and not hooked keel, sternite VI with a median carina which is sometimes forked apically, dian projection which is posteriorly forked, sternite VII and digitus broadened to a truncate or emarginate apex. The most obvious structural difference from *sayi* is the midtibial spur which is at least half as long as the basitarsus. In *sayi* it is definitely shorter than this. In females the dark scutum of *amoena* contrasts with the discal yellow markings usually present in *sayi*.

We have studied 634 males and 595 females of *amoena*.

The most general account of biology is that of Evans (1966). Nests are typically in coarse sand, gravel or finely pulverized rock. Colonies are distinct, often with many individuals, and wasps are active during the day. The tumulus near the burrow entrance is never leveled. Burrows end in one or two cells. Both outer and inner closures may sometimes be omitted. Small accessory burrows are common, and these presumably serve to distract parasites. A great variety of large flies are used for prey, and the egg is attached to the wing base of the first one in a cell. Natural enemies are conopids, sarcophagids, bombyliids, mutillids, and probably chrysids.

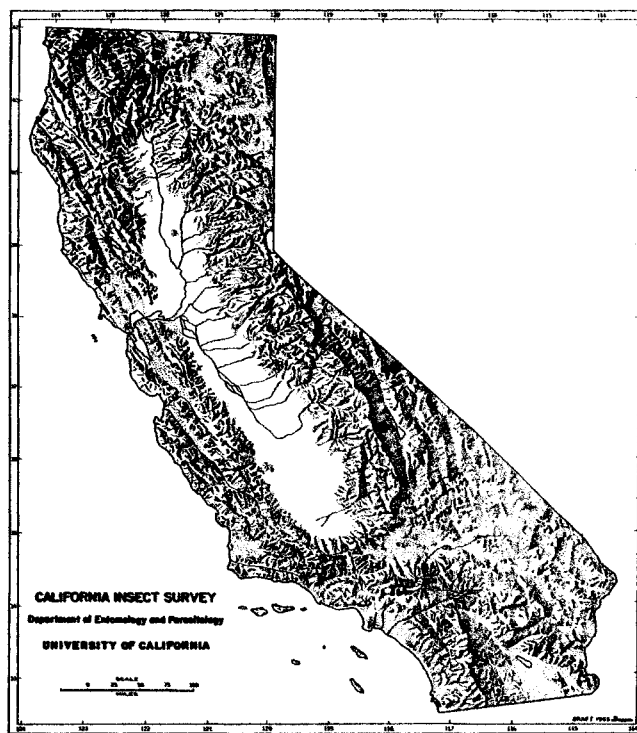
Bembix sayi Cresson
(Figs. 41, 57; Map 7)

Bembix sayi Cresson, 1865:467. Lectotype ♀, Colorado (ANSP).

Bembix latifrons J. Parker, 1917:116. Holotype ♀, Albuquerque, New Mexico (KU).

Geographic range. — United States as far north as Inyo County in California, South Dakota, Iowa, and Georgia; south to Hidalgo, Durango, and Baja California, Mexico.

California records. — INYO CO.: Lone Pine Creek, 1♀, X-15-67 (D. S. Horning, Jr., UCD). SAN BERNARDINO CO.: Van Winkle Mountains (19.5 mi. se. Kelso), 1♀, VI-10-65 (G. E. Wallace, UCR).



Map 7. California distribution of *Bembix sayi* Cresson.

This species is closely similar to more extensively maculate specimens of *amoena*. The size is a little smaller in *sayi*, the body length 19 ± 2 mm instead of 20 ± 2 mm. Tergal markings in the male are whitish but yellow as a rule in females, at least in western material. Enclosed black spots are commonplace on the tergum of females, especially on tergite II but also occasionally on I and III. Many females have a pair of yellow streaks toward the front of the scutum, but in some cases there may be a large discal U-shaped mark. This latter color form was called *latifrons* by Parker.

Structural features are about as described for *amoena*. The diagnostic difference in both sexes of *sayi* is the shorter and more slender midtibial spur which is obviously less than half as long as the basitarsus.

B. sayi is not a rare species in Arizona and New Mexico. More California records will likely result from additional collecting in the dry mountainous areas of the southwestern part of the state. We have seen only two females from California, both in the western edge of the Great Basin.

The biology has been summarized and reviewed by Evans (1957, 1966). In many respects the habits are similar to those of the closely related *amoena*. Accessory burrows are commonly made. The egg is glued to the

wing base of the first fly prey, inner and outer closures of the burrow are sometimes omitted during provisioning, a large variety of flies are used as prey, and the tumulus near the entrance is not leveled. Significant differences from *amoena* are that burrows are constructed in sand, they are unicellular, and the final closure is unique. This closure, as detailed by Evans (1966) begins with a reaming of the nest entrance, a filling of the resulting pit and construction of a back burrow which is left open with its tumulus intact. Evans suggested a possible relationship between the back burrow and *Dasymutilla* activities.

Bembix americana comata J. Parker

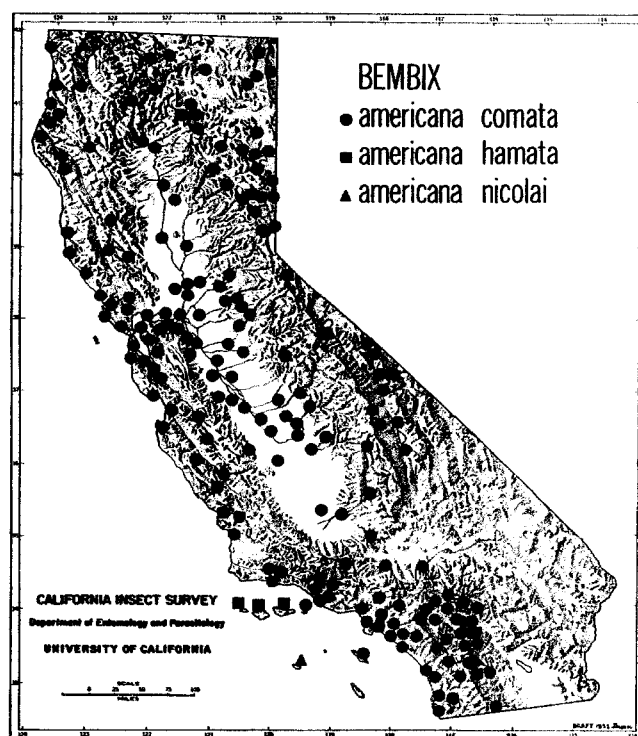
(Figs. 4, 9, 17, 22, 28, 32, 38, 50, 72; Map 8)

Bembix comata J. Parker, 1917:100. Lectotype ♂, California ("Cal.") (USNM).

Bembix comata nevadensis Rodeck, 1934:1. Holotype ♂, Fallon, Nevada (AMNH).

Geographic range. — Pacific coastal states north to British Columbia and south into northern Mexico. Some populations are found as far east as Idaho, Utah, and New Mexico.

California records. — ALAMEDA Co.: Alameda, Alameda Foot-hills, Berkeley, Emeryville, Oakland, Piedmont, Tesla. ALPINE Co.: Woodfords. AMADOR Co.: Ione, Jackson. BUTTE Co.: Chico. CALAVERAS Co.: Copperopolis, Mokelumne Hill, Murphys. COLUSA Co.: Colusa. CONTRA COSTA Co.: Antioch, Bethel Island, Brentwood, Mt. Diablo, Pittsburg (4 mi. s.), Point Molate, Richmond. DEL NORTE Co.: Crescent City. EL DORADO Co.: Caldor, Chile Bar. FRESNO Co.: Coalinga (3 mi. n.), Firebaugh, Fresno, Friant, Helm, Kerman, Kingsburg, Oxalis, Piedra, Raisin City, Selma, Trimmer Springs, Watts Valley. HUMBOLDT Co.: Arcata, Blue Lake, Eureka, Ferndale, Meyers Flat, Miranda, Orick (and 4 mi. s.), Orleans, Pepperwood, Phillipsville, Redwood Creek — mouth, Richardson Grove (5 mi. n.), Stone Lagoon, Trinidad. INYO Co.: Antelope Springs, Big Pine, Bishop, Cartago, Deep Springs, Deep Springs College (5 mi. s.), Deep Springs Lake, Lone Pine (and 3 mi. n.), Lone Pine Creek, Olancha (and 3 mi. s.), Onion Valley. KERN Co.: Kern River State Park, Kernville, Mojave, Shafter (and 15 mi. s.). KINGS Co.: Stratford (4 mi. s.). LAKE Co.: Lakeport, Lower Lake, Pillsbury Lake (and 15 mi. w.). LASSEN Co.: Bridge Creek Camp, Constantia, Doyle, Hallelujah Junction (and 3 mi. w.), Honey Lake — Milford (3 mi. ne.), Johnstonville, Litchfield (and 16 mi. n.), Milford (and 7 mi. nw.), Ravendale (4 mi. s.), Standish, Wendel. LOS ANGELES Co.: Alamitos Beach State Park, Avalon — Santa Catalina Island, Bellflower, Downey, El Segundo Sand Dunes, Glendora, Gorman, Huntington Park, Lancaster (8 mi. e.), Los Angeles, Pasadena, Redondo Beach, Reseda, Rio Honda — Whittier, Santa Monica, West Hollywood Hills, Westwood Hills. MADERA Co.: Madera. MARIN Co.: Alpine Lake, Bolinas, China Camp — Point San Pedro, Dillon Beach, Inverness (and 6 mi. w.), McClure's Beach, Point Reyes. MARIPOSA Co.: Yosemite National Park. MENDOCINO Co.: Navarro River — mouth, Point Arena (4 mi. e.). MERCED Co.: Atwater, Dos Palos, Gustine, Los Banos. MODOC Co.: Alturas,



Map 8. California distribution of *Bembix americana* sub-species *comata* J. Parker, *hamata* C. Fox and *nicolai* Cockerell.

Canby, Davis Creek (8 mi. n. and 8 mi. s.), Goose Lake, Lake City (and 19 mi. nw.). MONO Co.: Benton Station (and 7 mi. s.), Grant Lake, Hammil, Mammoth. MONTEREY Co.: Asilomar, Carmel, Moss Landing, Nacimiento, Pacific Grove, Paraiso Springs, San Ardo, Seaside. NAPA Co.: Duttons Landing. NEVADA Co.: Boca, Hobart Mills, Truckee. ORANGE Co.: Buena Park, Costa Mesa, Fullerton, Garden Grove, Irvine Lake, Laguna Beach, Newport Beach, Peters Canyon, Santa Ana Canyon, Seal Beach, Yorba Linda. PLUMAS Co.: Blairsden, Lake Almanor, Portola, Quincy (4 mi. w.), Vinton (5 mi. s.). RIVERSIDE Co.: Anza, Box Springs Mountains, Deep Canyon, Hemet, Herkey Creek (San Jacinto Mountains), Idyllwild, Riverside, Santa Ana River, Soboba Hot Springs, Strawberry Valley, Temecula (and 6 mi. e.), White Water, Winchester. SACRAMENTO Co.: American River, Carmichael, Grand Island, Sacramento, Sacramento River Levee, West Sacramento (4 mi. s.). SAN BENITO Co.: Paicines, Pinnacles National Monument. SAN BERNARDINO Co.: Big Bear Lake — Boulder Valley, Big Bear Valley, Colton, Lake Arrowhead, Lytle Creek, Morongo Valley, Redlands, Rialto, Victorville. SAN DIEGO Co.: Carlsbad, Coronado, Del Mar, Jacumba, Julian, Lake Henshaw, Lakeside, Oceanside, Palomar Observatory, Ponto, Ramona, Rancho Santa Fe, San Diego, Scissors Crossing, Solana Beach, Warner Springs. SAN FRANCISCO Co.: San Francisco — Ingleside, Laguna Puerca, Lands End, Lincoln Park, Lobos Creek, Lone Mountain, Sand Dunes. SAN JOAQUIN Co.: Bethany, Corral Hollow, Lodi, Stockton, Tracy (6 mi. w.). SAN LUIS OBISPO Co.: Black Lake Canyon, Grover City, Morro Bay, Oso Flaco Lake. SAN MATEO Co.: Brisbane, Colma, Daly City, Greco Island, Mill-

brae, Pacifica — Rockaway Beach, San Bruno Mountains. SANTA BARBARA Co.: Cachuma Lake (3 mi. w.), Goleta, Goleta Canyon, Los Prietos (and 4 mi. e.), Santa Barbara. SANTA CLARA Co.: Alviso, Palo Alto, Saratoga. SANTA CRUZ Co.: Felton, Mt. Hermon, Natural Bridges State Park, Santa Cruz, Zyante. SHASTA Co.: Burney, Cassel, Cayton, Old Station, Redding. SIERRA Co.: Sattley, Sierraville (and 7 mi. nw.). SISKIYOU Co.: McCloud, Montague, Mt. Shasta, Orr Lake. SOLANO Co.: Benicia, Rio Vista, Ryer Island. SONOMA Co.: Bodega Bay, Hacienda, Mesa Grande, Petaluma, Sonoma, Wrights Beach. STANISLAUS Co.: Ceres (and 4 mi. s.), Hughson, LaGrange, Newman, Oakdale, Turlock. TEHAMA Co.: Vina. TRINITY Co.: Mad River, Trinity Center (12 mi. s.), Trinity River Camp. TULARE Co.: Troy Meadows — Nine Mile Canyon, Visalia, Woodlake. VENTURA Co.: Anacapa Island, Foster Park, Ojai, Port Hueneme, Santa Paula, Saticoy, Sespe Canyon, Ventura. YOLO Co.: Davis (and 3 mi. s.). YUBA Co.: Marysville.

Seasonal distribution as taken from labels on pinned specimens is shown in figure 72.

Bembix americana comata is the most abundant and probably the most widespread species of the genus, if not the tribe, to be found in California. It is one of six *americana* subspecies now given names, and it was first treated as a subspecies of *americana* by Evans and Matthews (1968). The main species characteristics of *americana* Fabricius are as follows: greatly reduced and slitlike median ocellus, moderately long midtibial spur which does not reach beyond middle of basitarsus, relatively short and broad clypeus, relatively long scape which is nearly equal to median clypeal length, smooth and edentate labral profile, nonrugulose last visible tergite, clear wings, moderately stout mandible with a well-developed subapical tooth, sinuate first intersubmarginal vein of forewing, no more than seven fully developed setae in basitarsal rake of front leg. In addition, male species characters are a median keellike projection almost always present on sternite II, a stout and posteriorly directed median spine on sternite VI, gonostyle tapering rather evenly to a moderately narrow and rounded apex, digitus capitate, cuspis fingerlike.

The six subspecies of *americana* extend from the West Indian islands across North America to the offshore Channel Islands of California. Subspecies *comata*, as most recently defined by Evans and Matthews (1968) is an ordinarily recognizable entity. Yet, most populations exhibit degrees of variation toward one of its subspecific neighbors. To the east it intergrades with subspecies *spinolae* Lepeletier in Arizona, Nevada, and northwestern United States. Populations in extreme eastern and northern parts of California show the largest percentage of *spinolae* characteristics, as would be expected. Along the Pacific shore of California, populations trend in markings and minor structural characters toward subspecies

hamata, which inhabits several of the offshore islands. Subspecies *nicolai* is an extreme example of melanism on an isolated island. In order to appreciate the extent of the intergradation it is necessary to define an "average" *comata* with respect to certain variable characters and then to point out deviations from this "norm" in Californian populations.

Based on a study of 1,000 males of *comata* from California, the modal male specimen usually collected has the following subspecific characteristics: (1) clypeus yellow and without black even along basal suture, (2) mesopleuron yellow marked, (3) tibiae without black blotches, (4) tergal markings whitish and continuous or nearly so on I, (5) size moderate with length about 15 mm, (6) keel of sternite II moderately developed and resembling a bladelike hook, (7) tergite VI with a narrow median wedge-shaped projection but oblique lateral elevations slight or absent.

Except for the first character, all of the above vary within a given population or between populations. Some variations do not appear to have a geographical connotation within the range of *comata*. For instance, of 1,000 males examined, 65 or 6.5 percent had a more or less raised carina on sternite II rather than a bladelike keel. Most such specimens were unusually small and also exhibited a reduction of the projection on sternite VI toward a simple spine. Thus, small size and implied insufficiency of nutrition in the larval state may account for weak development of the characteristic sternal projections. Size itself is quite variable and specimens average about 15 mm (male) or 14 mm (female) in length but range from 12 mm to 18 mm without much correlation with geographical location. However, larger specimens are more frequently taken along the coast.

With respect to markings, there are differences between inland and coastal populations which can best be appreciated by considering the entire east-west variation from the eastern boundary of the state (Hallelujah Junction, for example) and the western boundary in the range of subspecies *hamata* on San Miguel Island. Thus, from east to west the thoracic yellow marks are progressively decreased, the tibiae become spotted with black, the markings of the abdominal tergites become yellow rather than white (but not in a gradual manner), the clypeus becomes increasingly black marked (in the range of *hamata*), the pale spots on tergite I become progressively smaller and farther apart, and the percentage of females with all black tergite VI decreases. The occurrence of yellow tergal markings is especially interesting since subspecies *spinolae* is distinguished from *comata* primarily on this point in the male. In 1,000 *comata* males

examined, the only ones with yellow-marked tergites were from Marin County: 2 of 2 specimens from Alpine Lake, 3 of 5 from Dillon Beach, 14 of 15 from McClure Beach, and 1 from Pt. Reyes beach. The percentage with yellow rather than white on the tergites from these areas considered as a unit was 87. The possibility that these populations represent isolated foci of *spinolae* is ruled out, among other things, by the females which agree in markings with typical *comata*. The absence of a ventral spicule on flagellomere IV, a condition found in males of *cameroni* J. Parker, removes this related and yellow-marked form from consideration. Males of *hamata* are commonly with yellow-marked tergites but in the Marin County specimens the unmarked yellow clypeus and other features place them in *comata*.

Although the 1,000 females of Californian *comata* studied do not have the range of structural variation seen in the male, the color variation is fully as pronounced, even though somewhat differently expressed. The modal specimen has the following subspecific characteristics: (1) clypeus whitish and not black marked, (2) mesopleuron yellow marked, (3) tibiae without black blotches, (4) tergal markings whitish and close together on I, (5) tergite VI spotted with white, (6) size moderate with length about 14 mm, and (7) rake of fore basitarsus with six elongate setae.

In all populations where enough specimens were studied, some females had the tergites yellow marked. In these specimens the clypeus was correspondingly yellow. Of 1,000 female *comata*, 56 (or 5.6 percent) had yellow-marked tergites. No special east-west orientation was detected in continental material, even including the Marin County populations with a high percentage of yellow-marked males. On the other hand, on Anacapa Island 13 of 15 females, or about 87 percent, were yellow on the tergites. Associated males, however, were white-marked.

Dark blotches on the foretibiae were found in all populations in varying degree. Table 1 shows 29 to 48 percent in females from three inland localities. In three coastal localities the percentages were 75 to 100 percent of the material studied. In all of these and on Anacapa Island the midtibiae were unspotted.

The rake of the fore basitarsus in *comata* females can be expressed as the number of fully developed and partially developed bristles: 5.5, 6.0, 6.5, and 7.0. Table 1 shows that the average number of bristles at three inland localities, three in the coast and on Anacapa Island range from 6.21 to 6.64. This compares with a range of 6.87 to 7.11 across the three islands harboring *hamata*.

In considering the variation in table 1, it may be significant that material from areas with a mild or warm sum-

Table 1
Variation in Tarsal Rake Components and Tibial Markings in Females of *Bembix americana comata* and *B. americana hamata* from Selected Localities in California

Location	N	Rake setae in ♀ fore basitarsus					Black maculation of ♀ tibiae		
		Percentage					Aver- age num- ber setae	Fore- tibia per- centage	Mid- tibia per- centage
		5.5	6.0	6.5	7.0	7.5			
<i>(comata)</i>									
Deep Springs, Inyo Co.	56	7	43	45	5	0	6.24	32	0
Davis, Yolo Co.	56	0	57	36	7	0	6.25	29	0
Antioch, Contra Costa Co.	100	3	51	46	0	0	6.22	48	0
Goleta, Santa Barbara Co.	48	0	59	41	0	0	6.21	75	0
Seaside, Monterey Co.	20	0	40	20	40	0	6.50	90	0
San Francisco, San Francisco Co.	28	0	14	43	43	0	6.64	100	0
Anacapa I., Ventura Co.	28	0	18	60	22	0	6.52	73	0
<i>(hamata)</i>									
Santa Cruz I., Santa Barbara Co.	100	0	3	28	61	8	6.87	86	36
Santa Rosa I., Santa Barbara Co.	8	0	0	0	100	0	7.00	100	100
San Miguel I., Santa Barbara Co.	18	0	0	17	55	28	7.11	100	100

mer climate (Deep Springs, Davis, Antioch, and Goleta) had an average of 6.25 or fewer setae in the fore basitarsal rake. From areas with a cool summer climate (Seaside, San Francisco, and Anacapa Island) there were 6.50 to 6.64 setae on the average. From areas with a very cool summer climate the means were 6.87 to 7.11.

Known biology was discussed by Evans (1957:36-48). Large colonies occur with several generations a year. Nests are in sandy soils ranging from sand dunes to driveways to dry sandy canyons. The tumulus is leveled when the burrow is complete. Nests are unicellular, prey consists of a great variety of larger flies, and the egg is glued to the wing base of the first fly prey. During final closure the lower part of the burrow is incompletely filled. A common chrysidid parasite as reported by G. Bohart and MacSwain (1940) is *Parnopes edwardsii* (Cresson).

Bembix americana hamata C. Fox, new status
(Figs. 1, 20; Map 8)

Bembix hamata C. Fox, 1923:6. Holotype ♂, San Miguel Island, California (CAS).

Bembix hamata lucida C. Fox, 1923:7. Holotype ♂, Santa Cruz Island, California (CAS).

Bembix sanctae-rosae Cockerell, 1940:135. Holotype ♂, Santa Rosa Island, California (LACM).

Geographic range. — Known only from three Channel Islands of California: Santa Cruz, Santa Rosa, and San Miguel.

California records. — SANTA BARBARA CO.: San Miguel Island, 9♀, 14♂, V-20 to VIII-1, 1919 to 1939 (C. L. Fox, E. P. Van Duzee, CAS, UCR, USNM). Santa Cruz Island: Canada del Medio, Cascada, Christi Beach, Coches Prietos, Fraser Point, Johnston Canyon, Prisoners Harbor, Sauces Canyon, South Ridge, 100♀, 150♂, IV-29 to IX-23, 1939 to 1969 (numerous collectors, CAS, CIS, LACM, UCR, UCD, UCR, USNM). Santa Rosa Island, 4♀, 3♂, VIII-6 to VIII-9-39 (LACM).

Evans and Matthews (1968) called attention to the synonymy of *hamata* from San Miguel Island, *sanctaerosae* from Santa Rosa Island and *lucida* from Santa Cruz Island. We agree entirely with this finding, even though small average differences seem to exist among populations from the three islands. Evans and Matthews also pointed out structural similarities between *hamata* and *nicolai*, the latter from rather isolated San Nicolas Island. These two forms were considered subspecies of *hamata*.

We have studied considerably more material than was available to Evans and Matthews, as well as specimens from Anacapa, the closest island (actually two islets) to the mainland. Considering the variation in mainland

comata, in the population on Anacapa, and among populations on the three other islands of the chain, Santa Cruz, Santa Rosa, and San Miguel, it is our opinion that all belong in *americana* along with *nicolai*. Small but constant color characters separate *hamata* from *comata*, at least in the male, as well as a number of average differences. The unusual markings of *nicolai* set it apart.

In males the whitish clypeus of *hamata* will distinguish them from both of the other subspecies. However, we have seen two males from Santa Cruz Island with slightly yellowed clypeus. In females the combination of black-lined clypeal base, seven instead of six rake setae on the front basitarsus, and reduced spots on tergite I will distinguish most specimens from those of *comata*.

Other characteristics of subspecies *hamata* lend support to its separate status from *comata* even though exceptions occur on both sides. In general, *hamata* are larger, darker, hairier, have tergal bands more frequently yellow in the male as well as considerably reduced on tergite I in both sexes, the projection of male sternite II is better developed, and oblique swellings of male sternite VI are more prominent. Each of these features merits some elaboration.

The average male *hamata* is about 18 mm long, and the average female is 16 mm. This compares with 15 mm and 14 mm respectively in *comata*. The observed range for *hamata* is 12 to 20 mm, and for *comata* it is 12 to 18 mm.

The thorax is often nearly all black in *hamata*, at least behind the prothorax. However, some coastal specimens of *comata* are similar in this respect. The face tends to be darker in *hamata* (fig. 1). Legs have more extensive black markings as suggested by data in table 1. Tergal pale markings are always greatly reduced on tergite I of the male, and the spots on II are usually separated by the width of a spot in dorsal view. In the female the spots on I are usually separated by the width of a spot. Tergal markings of *comata* are nearly always much more extensive in these areas.

Yellow tergal markings have been seen to occur in over 70 percent of male *hamata*. Except for Marin County populations of *comata*, male tergal markings are always whitish in that subspecies.

Sternite II of male *hamata* usually has a median keel-like projection of impressive size, outranking anything seen in *comata*. However, 13 percent of those studied have had a reduced or cariniform projection. Included are specimens with yellow as well as whitish tergal markings.

The oblique lateral swellings of male sternite VI are strong in most specimens of *hamata*. However, 15 percent

of Santa Cruz Island material have them weakly developed, and some mainland *comata* have noticeable swellings.

Although difficult to put in quantitative terms, *hamata* specimens are noticeably more hairy than those of *comata*, particularly on the legs.

Variation and overlapping in number of rake setae of the female front basitarsus is outlined in table 1 and has been discussed under *comata*. The rake is less well developed in males, but the generally larger number of rake elements in *hamata* seems to prevail.

It seems likely that specimens of *comata* have colonized the chain of islands from Anacapa to San Miguel over an extended period. Reference to a map suggests that island hopping would be difficult but not impossible for larger and stronger specimens. This may account in part for the essentially *comata*-like population on Anacapa, and the progressively more robust and distinctive populations from south to north on the other three islands. The generally colder climate of the islands, as compared with the adjacent mainland, may have had a molding effect on such characters as color and hairiness.

Altogether we have seen 166 males and 113 females of this subspecies, the majority from Santa Cruz Island.

Bembix americana nicolai Cockerell, new status

(Figs. 2, 3; Map 8)

Bembix nicolai Cockerell, 1938:135. Holotype ♂, San Nicolas Island, California (CAS).

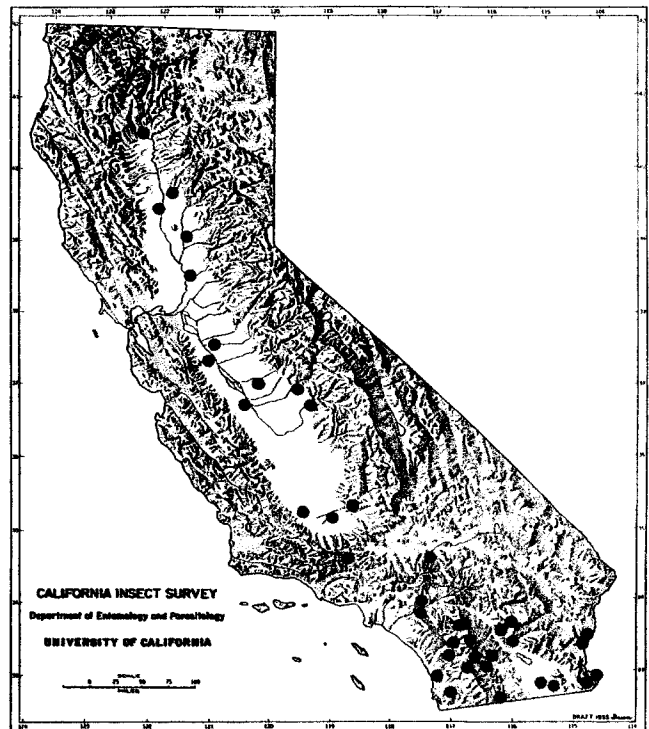
Geographic range. — Restricted to San Nicolas Island, California.

California records. — VENTURA CO.: San Nicolas Island, 4♂, VII-38 (T. D. A. Cockerell, CAS); 3♀, 1♂, IV-18-40 (C. Henne, LACM); 1♀, IX-14-62 (R. R. Sanders, LACM); 1♀, VII-25-39 (LACM).

The melanic aspect of *nicolai* rivals and in many ways surpasses the similar dark varieties in *occidentalis* and *amoena*. The interesting difference is that the dark specimens of the last two species occur as a percentage of the population whereas in *nicolai* they seem to be the sole color form.

Evans and Matthews (1967) related *nicolai* to *hamata*. We are considering both of these, along with *comata* as a part of the subspecies complex of *americana*.

We have studied only five males and nine females from San Nicolas Island, but considerably more material has been examined casually and the characters are remarkably constant.



Map 9. California distribution of *Bembix melanaspis* J. Parker.

The clypeus and labrum are practically all black in males (fig. 3). In females the clypeus is whitish with black mottling, and the labrum is black with the middle third to half whitish (fig. 2). The thorax is all black or with a complete outer black stripe. The gaster is black except for lateral sternal yellow spots which in females are continued as lateral spots onto the tergites. Tergite VI is all black.

The keel on sternite II of males is strong (except one specimen), oblique lateral ridges on male sternite VI are well developed, and the hindtibia has an unusual amount of long soft hair toward the inner base. Male genitalia fit well within the pattern of *americana*. There seems to be a slight tendency for development of a weak oblique emargination toward the inner gonostylar apex, but some *comata* and *hamata* show this also. The average size is slightly less than that of *hamata*. Female rake components on the fore basitarsus are about as in *hamata*. Out of eighteen female combs examined, seven had six setae plus a small seventh, and eleven had seven large setae.

Melanistic color characters of the face and abdomen separate this subspecies at once, but structurally it is close to *hamata*.

Bembix melanaspis J. Parker

(Figs. 5, 23, 45, 49; Map 9)

Bembix melanaspis J. Parker, 1917:109. Lectotype ♂, Los Angeles Co., California (USNM).*Geographic range.* — Arizona, California, and Baja California.

California records. — BUTTE Co.: Chico, 1♀, IX-21-65 (T. R. Haig, CSDA). FRESNO Co.: Firebaugh, 1♀, VII-8-47 (V. M. Stern, CIS). Friant, 1♀, IX-19-65 (J. Lillie, CSDA). Trimmer, 5♀, 2♂, VIII-12-51 (C. D. MacNeill, CIS). GLENN Co.: Glenn, 1♂, VII-23-60 (M. Wasbauer, CAS). IMPERIAL Co.: Experiment Farm, 1♀, 14♂, V-28 to VI-1912 (J. C. Bridwell, USNM). Haughtelin Lake — Bard, 2♀, VII-21 to 23-53 (LACM). Holtville, 2♂, VI-1936 (E. S. Ross, CAS). Laguna Dam, 1♀, VI-26-62 (J. F. Lawrence, CIS). Laguna Reservoir, 2♀, VI-9 to 11-50 (LACM). Palo Verde, 1♀, 1♂, VII-16-62, VII-29-46 (P. D. Hurd, P. H. Timberlake, CIS, UCR). KERN Co.: Bakersfield, 1♀, VIII-1938 (CIS). Buttonwillow, 1♀, 1♂, VII-21-57 (CIS). Kern Canyon, 2♀, 2♂, VII-28-46 (CIS). Kern River Canyon mouth, 1♀, 1♂, IX-8-51 (W. D. Murray, CIS). LOS ANGELES Co.: San Francisquito Canyon, 1♀, VII-15-56 (A. S. Menke, LACM). MADERA Co.: Chowchilla, 1♂, VII-29-50, 1♀, VIII-15-54 (W. E. Hazeltine, R. R. Snelling, CIS). RIVERSIDE Co.: Aguanga, 1♂, VII-8-56, on *Prosopis* sp. (P. D. Hurd, CIS). Anza, 1♂, VII-7-56, on *Eriogonum fasciculatum polifolium*, 1♂, VII-14-56, on *Croton californicus* (P. D. Hurd, M. Wasbauer, CIS). Blythe, 4♂, 5♂, VI-23 to VII-26, 1937 to 1959 (numerous collectors, CIS, UCR, UCD). Hemet, 1♀, VI-18-45; 1♀, VII-15-46, on *Vicia* (J. W. MacSwain, CIS). Indio, 1♂, VI-10-49; 1♀, VII-29-66 (C. R. Kovacic, CIS, UCD). Mecca, 2♀, 1♀, VI-12-56, on *Heliotropium curassavicum* and *Petalonyx thurberi* (M. Wasbauer, CIS). Palm Desert, 1♀, 1♂, VI-27-56, on *Tamarix gallica* (M. Wasbauer, CIS). Ripley, 2♀, VIII-16-46 (P. D. Hurd, CIS). Riverside, 3♀, 10♂, VII-2 to X-9, 1928 to 1936, on *Eriogonum fasciculatum*, *Senecio douglasii*, and *Tetradymia comosa* (C. M. Dammers, P. H. Timberlake, LACM, UCR). Thermal, 1♀, VI-27-37 (H. R. Moffitt, UCD). SAN BERNARDINO Co.: Hodge, 2♀, IX-14-35 (P. H. Timberlake, UCR). Rialto, 1♀, VII-12-38; 1♂, VIII-15-56 (E. G. Linsley, CIS). SAN DIEGO Co.: Borrego Valley — Coyote Creek, 1♀, VII-2-50 (G. A. March, CIS). Jacumba, 1♂, X-6-23 (J. D. Gunder, CAS). Lakeside, 1♀, VIII-21-51 (J. Powell, CIS). Mt. Palomar, 1♀, VII-31-54 (F. M. Hull, CIS). San Felipe Wash, 1♀, VI-5-36 (C. M. Dammers, LACM). Scissors Crossing, 1♀, 2♂, VII-4-56, VIII-2- to VIII-4-61 (J. E. Gillaspay, A. S. Menke, LACM, UCD). Del Mar, 1♂, VII-17-63 (J. C. Hall, UCD). Warner Springs, 4♂, VII-4 to VIII-15, 1956 to 1958, on *Asclepias erosa* (R. C. Bechtel, R. M. Bohart, P. D. Hurd, E. I. Schlinger, CIS, UCD). SHASTA Co.: Redding, 1♀, IX-26-59 (R. D. Browning, UCD). STANISLAUS Co.: Crow's Landing (5 mi. ne.), 1♀, VII-23-60 (R. W. Thorp, CIS). Modesto, 1♂, VI-24-33 (G. E. Bohart, CIS). YOLO Co.: West Sacramento, 2♀, VIII-14-56 (J. C. Downey, UCD). YUBA Co.: Marysville (and 12 mi. s.), 1♀, 2♂, VII-10-55 (P. D. Hurd, CIS).

The brownish cloud on the basal three-fourths of the forewing distinguishes *melanaspis* from other species in California. This cloud is more prominent in females but

males have it also, at least near the veins. *B. melanaspis* is moderately large, the body length about 17 ± 1 mm. Markings are yellow and the tergites are mostly this color with enclosed black spots commonly on tergites II and III. Some males and most females have discal yellow marks on the scutum. Females and a few males have dark clypeal markings. In all of our specimens the female tergite VI is black.

Evans and Matthews (1968) assigned *melanaspis* to the *texana* group with the comment that it was a "highly distinctive species." Characters it shares with the *americana* group are the simple labrum, rather robust mandible, short clypeus, obliterated ocellar lenses, sinuate first intersubmarginal vein, ordinarily stout and hooked projection on male sternite II, and a wedgelike projection on male sternite VI. We have seen three males with simply a smooth median line on sternite II in place of a projection. The male genitalia have the gonostyle rather slender apically, the cuspis fingerlike, and the digitus clublike. Features not characteristic of the group are the brownish wings, absence of spicules on the underside of the apical flagellomeres of the male, faint serrulation of the male midfemur, unusually broad base of the projection on sternite VI, and broad emargination toward inner apex of the male gonostyle. There is considerable resemblance to *nubilipennis* Cresson, which is not known to occur west of Arizona. The latter species is also abundantly yellow and has brown stained wings. However, *nubilipennis* is easily distinguished by the all yellow female clypeus, the conspicuously serrate male midfemur, and the spiculate male flagellomeres IV to VIII. The rake of the female front basitarsus of *melanaspis* bears six setae as in most other Californian *Bembix*.

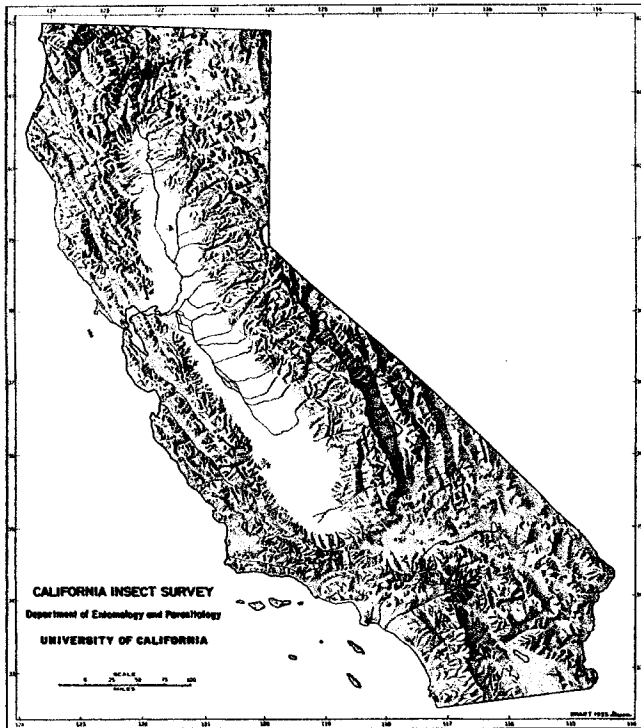
We have studied 66 males and 58 females of this handsome species.

Bembix pallidipicta F. Smith

(Figs. 39, 51; Map 10)

Bembex pallidipicta F. Smith, 1873:300. Holotype ♂, "Mexico" (BMNH).*Bembex pruinosa* W. Fox, 1895:361. Lectotype ♂, Oregon (ANSP).*Geographical range.* — United States north into Ontario, Manitoba, and Alberta, and south into Chihuahua and Veracruz.*California records.* — SISKIYOU Co.: "Mt. Shasta District," 2♀, (USNM).

The markings of *pallidipicta* are most often gray, with a tendency toward yellow on the thorax and face. Evans and Matthews (1968) reported that tergal markings may

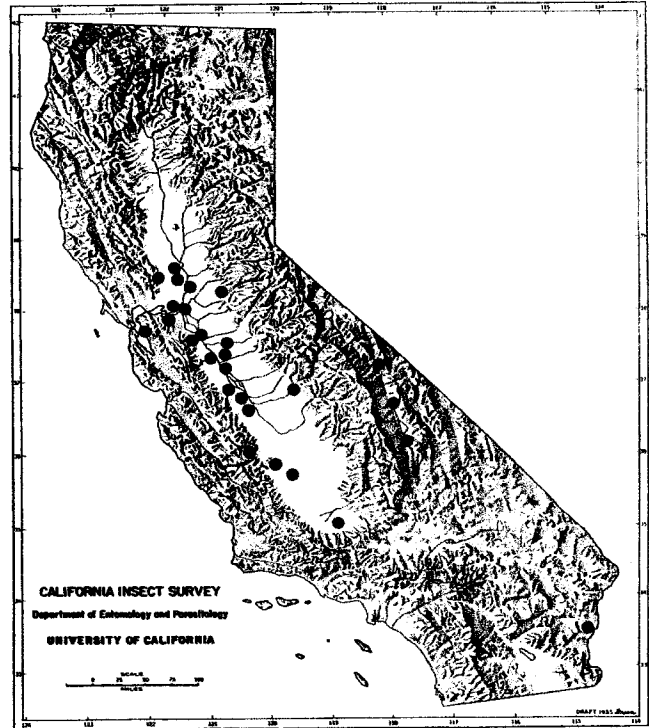


Map 10. California distribution of *Bembix pallidipicta* F. Smith.

also have a light yellowish appearance as observed in Alamosa County, Colorado and in Chihuahua, Mexico. In any case the only material reported from California is of the grayish sort. Tergal bands are broad, continuous on tergite II and often most of the other tergites, but there seems to be no tendency for the enclosure of black spots. Our material has the scutum uniformly black except for the spot above the wing base. Females may have tergite VI all black or somewhat maculate, and there is usually a basal dark spot on the clypeus. Wings are nearly clear.

The group characteristics and distinction from *occidentalis* are detailed under that species. It is undoubtedly a rare species in California, and we have seen only the two females in the United States National Museum from "Mt. Shasta District" mentioned by Parker (1929:130).

As would be expected from the structural similarity between *pallidipicta* and *occidentalis*, the biology is similar in many respects. However, there are important differences (Evans, 1957). Both species make large colonies in sand dunes, although the nests are more diffuse in *pallidipicta*. They are multivoltine, males perform a "hopping dance," burrows are one-celled with the egg laid in the empty cell, a great variety of flies are used for prey, cell cleaning is practiced by the wasp, and final cell closure involves particular motions as in *occidentalis*.



Map 11. California distribution of *Bembix occidentalis* W. Fox.

Differences are mainly in construction of the burrow, oviposition, and method of cell cleaning. The burrow has a nearly horizontal section, a deep and oblique section, and a long curved horizontal cell. The female ignores the first horizontal section and makes a new entrance opposite the oblique part. The original tumulus is partially removed. The egg is leaned against the end of the cell, and after the larva hatches, flies are placed in single file in front of it. Toward the close of provisioning, fly remains are swept to the end of the cell by the wasp and sealed off with sand.

Bembix occidentalis W. Fox
(Figs. 14, 31, 40, 52, 73; Map 11)

Bembix occidentalis W. Fox, 1893:10. Lectotype ♀, San Jose del Cabo, Baja California (CAS).

Bembix beutenmulleri W. Fox, 1901:83. Lectotype ♂, Fresno Co., California (AMNH).

Bembix obsoleta Howard, 1901:pl. 4, fig. 36.

Geographic range. — Pacific coastal states east through Arizona and New Mexico to western Texas, south to Colima and Chihuahua, and north to Utah.

California records. — ALAMEDA Co.: Berkeley. AMADOR Co.: Ione. CONTRA COSTA Co.: Antioch, Oakley. FRESNO Co.: Firebaugh, Friant, Jacalitos Canyon, Mendota, Oxalis. IMPERIAL Co.: "Imperial Co." INYO Co.: Bishop, Independence,

Olancha. KERN Co.: Arvin. KINGS Co.: Kettleman City. MERCED Co.: Dos Palos, Livingston, Santa Rita. RIVERSIDE Co.: Blythe (15 mi. w.), SACRAMENTO Co.: Brannan Island, Freeport, Grand Island. SAN JOAQUIN Co.: Manteca, Tracy. SOLANO Co.: Rio Vista. STANISLAUS Co.: Crows Landing (5 mi. ne.), Montpelier, Turlock. YOLO Co.: Davis, Putah Creek Canyon, Woodland.

Seasonal distribution is shown in figure 73.

The markings of *occidentalis* have the greatest range of any Californian *Bembix*. For example, the females of any general collection can be separated rather arbitrarily into three color forms: (1) mostly yellow, with a large U-shaped yellow mark on the scutum, the variety which includes the type specimen from Baja California; (2) extensively yellow but with the scutum dark discally or with small yellow marks; and (3) predominantly black, often appearing entirely so in dorsal view, the variety named *beutenmulleri* by W. Fox. Among the 360 females we have seen, 30 percent were of the yellow form, 23 percent were intermediate, and 47 percent were the melanic variety. These figures are a general indication only, since there may have been selective collecting for the rather unusual black form, or possibly for the very yellow one. Males have a similar color range but proportionately less of the very yellow one and more of the black variety (65 percent by our count). In any case, all three forms can be found in the same colony as pointed out by G. Bohart and MacSwain (1939). It is likely that the percentage of melanism varies greatly from colony to colony.

Other color features are: the labrum is all yellow, the clypeus may be mottled in melanic males but rarely so in females, there is an elongate yellow spot below the mid-ocellus in females and most males, enclosed black spots are common on tergites of the yellower varieties, and females of the melanic forms have tergite VI all black. Wings are nearly clear.

Evans and Matthews (1968) outlined the main features of the *pallidipicta* group (as "*pruinosa* species-group") to which *occidentalis* belongs. The mandibles are unusually slender and with the tooth on the inner margin only slightly indicated. The labrum is rather short, the frons narrower than usual, the scape is shorter than the median length of the labrum, ocelli are slitlike and the notum is somewhat flattened. The rake on the female fore basitarsus is usually composed of six large setae and a small seventh.

Important biological studies have been made by G. Bohart and MacSwain (1939) and Evans (1957). Colonies may be large and fairly concentrated in extensive sand dune areas. The species is multivoltine. Males commonly perform a "hopping dance" over the sand. Nests are deep

and the tumulus is dissipated by wind. Each burrow descends obliquely and has one or more blind spurs with the main tunnel branching off above but blocked by an inner closure. Outer closures are usually maintained. The egg is laid loosely in the empty cell. Prey flies are quite variable in size and type. Evidence indicates some cleaning of cells and removal of fly fragments to the outside by female wasps. Final closure results in a radiating pattern of straight lines and involves characteristic motions by the wasp which were well described by Evans (1957). MacSwain (1955) furnished information on *occidentalis* in an interesting article in Life magazine.

Parasites, as reported by G. Bohart and MacSwain (1939) near Antioch, California were *Villa* (as *Anthrax*) *atrata* (Coquillett), *Exoprosopa eremita* Osten Sacken, *Physocephala texana* (Williston) (as *affinis*), and *Dasy-mutilla sackenii* (Cresson).

Genus *Bicyrtes* Lepeletier

Only two species of this genus are known from California, and we are including these in a key to the ten species which we have recognized from North America. The Californian forms are medium-sized, robust wasps, easily identified to genus by the thin and backward produced propodeal angles as well as the completely developed palpi (fig. 11).

The habits of only a few species are well known but there is partial knowledge of the Californian species, particularly *ventralis*. Members of the genus seem to have similar habits, so far as is known and Evans (1966) has summarized the ethology. His main points are: (1) Adults are frequent visitors to flowers (2) Adults spend the night in short burrows in the sand (*ventralis*) or sleep on vegetation (*capnoptera*). (3) Nests are in sandy, frequently moist soil, often near water. They are shallow, simple, without a surface tumulus, and with from one to five cells. (4) The entrance is closed while the female is away. (5) Paralyzed prey, which is carried in flight by the middle legs, consists of immature and adult Heteroptera, particularly Pentatomidae and Coreidae. (6) Mass provisioning or delayed provisioning are practiced. (7) The egg is laid in a semierect fashion on the midventral line of the first bug in the cell.

KEY TO THE NORTH AMERICAN SPECIES OF BICYRTEs

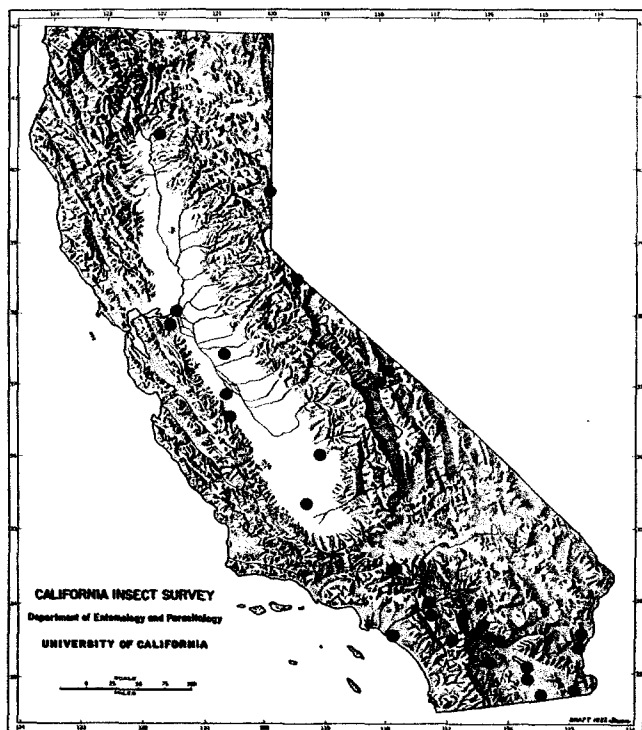
- | | |
|---|----|
| 1. Males; abdomen with 7 visible tergites; antenna with 13 articles | 2 |
| Females; abdomen with 6 visible tergites; antennae with 12 articles | 11 |

2. Sternite II without a bare median longitudinal line, carina or tooth; clypeus without a basal spot, upper margin of clypeus sometimes transversely darkened; no discal scutal stripes 3
Sternite II with a bare median longitudinal line (sometimes faint), carina or tooth (fig. 12); some with a basal triangular or rounded black spot on clypeus; one species with discal pale stripes or streaks on scutum 5
3. Midfemur with a prominent basoventral tooth (fig. 34); transcontinental in U.S. and southern Canada *ventralis* (Say)
Midfemur without a basal tooth 4
4. Legs almost entirely red; mesopleuron medially with setigerous punctation somewhat irregular, some punctures separated by several puncture diameters; eastern and southern U.S. west to Louisiana, Texas, and eastern New Mexico *insidiatrix* (Handlirsch)
Legs mostly black and yellow; mesopleuron medially with setigerous punctation regular, punctures separated by about a puncture diameter; southern Arizona and Mexico *affinis* (Cameron)
5. Hindcoxa with an inner posterior, backward-projecting tooth; median carina of sternite II strong, short and basal; central and southeastern U.S., Arizona and Mexico *fodiens* (Handlirsch)
Hindcoxa not toothed; carina of sternite II subbasal or near middle 6
6. First submarginal cell of forewing much darker than second or third, scutum usually with a pair of ovoid anterior discal spots; Utah, Arizona, New Mexico, Texas, and Mexico *viduata* (Handlirsch)
First submarginal cell not contrastingly pigmented .. 7
7. Flagellomeres IV and V somewhat expanded and deformed; median carina of sternite II often forming a backward pointing, thornlike tooth 8
Flagellomeres IV and V not differing much in outline from III or VI 9
8. Sternite VI with a basomedian tooth; midfemur serrate beneath; basitarsus of foreleg strongly flattened, posterior edge sharp and undulate; tergite I with pale band broadly interrupted medially; Mexico *diodonta* (Handlirsch)
Sternite VI without a tooth; midfemur not serrate; basitarsus of foreleg not unusually flattened nor undulate posteriorly; tergite I with basal band narrowly interrupted medially; Central and South America *discisa* (Taschenberg)
9. Scutum with a pair of discal, linear, yellow spots which resemble stripes and taper posteriorly; southwestern Texas to Argentina *variegata* (Olivier)
Scutum not striped discally 10
10. Spots on tergite V continuous or at least as close together as those on III; sternite II with a low subbasal median carina; transcontinental in southern U.S. *capnoptera* (Handlirsch)
Spots on tergite V, if any, much farther apart than those on III; sternite II with merely a smooth, raised, median line; U.S., mostly east of 100th meridian *quadrifasciata* (Say)
11. Tergite VI with a well-developed pygidial plate (fig. 30) 12
Tergite VI with pygidial plate not well developed (fig. 29) 13
12. Hindcoxa with an inner posterior backward-projecting tooth; sides of sternite VI strongly angled subapically; central and southeastern U.S., Arizona, Mexico *fodiens* (Handlirsch)
Hindcoxa without a tooth; sides of sternite VI rounded subapically; transcontinental in southern United States *capnoptera* (Handlirsch)
13. Clypeus mostly dark or with a rounded to triangular black basal spot 14
Clypeus mostly or all yellow or with dark markings apical, without a basal spot 17
14. Scutum with a pair of long, stripelike, tapering, discal yellow spots; tergite VI bimaculate; southwestern Texas to Argentina *variegata* (Olivier)
Scutum without stripelike discal spots 15
15. Sternite V all dark or practically so; U.S., mostly east of 100th meridian *quadrifasciata* (Say)
Sternite V with distinct lateral pale spots 16
16. Tergite I with pale band narrowly interrupted at middle; Central and South America *discisa* (Taschenberg)
Tergite I with pale band broadly interrupted; Mexico *diodonta* (Handlirsch)
17. First submarginal cell of forewing much darker than second or third; scutum usually with a pair of ovoid anterior discal spots; Utah, Arizona, New Mexico, Texas, and Mexico *viduata* (Handlirsch)
First submarginal cell not contrastingly pigmented; scutum dark discally or with small and slender spots 18
18. Legs almost entirely red; eastern and southern U.S. west to Louisiana and eastern New Mexico *insidiatrix* (Handlirsch)
Legs mostly black and yellow 19
19. Mesopleuron medially with setigerous punctation somewhat irregular, some punctures separated by several puncture diameters; transcontinental in U.S. and southern Canada *ventralis* (Say)
Mesopleuron medially with setigerous punctation regular, punctures separated by about a puncture diameter; southern Arizona and Mexico *affinis* (Cameron)

Bicyrtes capnoptera (Handlirsch)

(Figs. 12, 30, 35; Map 12)

Bembidula capnoptera Handlirsch, 1889:497. Lectotype ♀ "Kentucky" (Vienna Museum, Austria).*Bembidula capnoptera mesillensis* Cockerell, 1898:142. Holotype ♂, Las Cruces, New Mexico (USNM).*Bicyrtes annulata* J. Parker, 1917:67. Holotype ♀, Oak Creek Canyon, Arizona (KU).*Geographic range.* — Southern tier of states from Florida and Georgia to California, north to Idaho and Utah.



Map 12. California distribution of *Bicyrtes capnoptera* (Handlirsch).

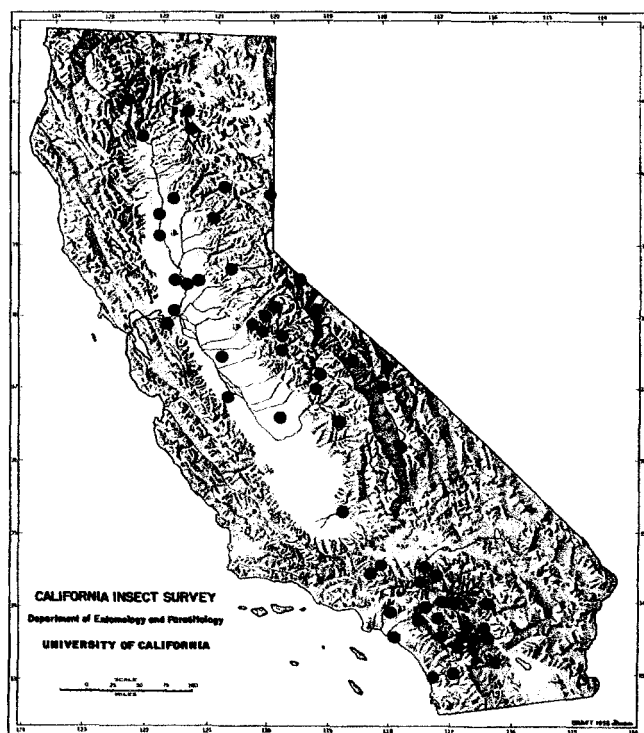
California records. — CONTRA COSTA Co.: Antioch, 2♂, V-24 to VI-29, 1949 to 1953 (P. D. Hurd, R. O. Schuster, CIS). FRESNO Co.: Panoche Creek, 3♂, VI-2-62 (A. S. Menke, UCD). IMPERIAL Co.: Calexico (29 mi. e.), 1♀, VII-12-61, on *Melilotus* sp. (R. W. Thorp, CIS). Gordons Well (3 mi. w.), 2♀, VII-19-56 (E. I. Schlinger, UCD). Kane Springs, 1♂, IX-7-36 (C. M. Dammers, LACM). Palo Verde, 1♂, VII-6-62, on *Tamarix gallica* (P. H. Timberlake, UCR). Palo Verde (3 mi. s.), 1♀, X-18-59 (J. A. Chemsak, CIS). Westmorland, 1♂, V-31-30, on *Aster spinosus* (P. H. Timberlake, UCR). INYO Co.: Big Pine (3 mi. w.), 1♂, VIII-10-62 (A. S. Menke, UCD). Antelope Springs, 1♂, VI-30-61 (D. R. Miller, UCD). Deep Springs, 4♂, VII-16 to VII-17, 1953 on *Chrysothamnus* sp. (1♂) (numerous collectors, CIS, LACM, UCD). KERN Co.: Shafter (13 mi. s.), 1♂, VI-3-62 (A. S. Menke, UCD). KINGS Co.: Kettleman City, 2♀, VI-18-69 (D. L. Briggs, UCD). LASSEN Co.: Hallelujah Junction, 5♂, VII-4 to VII-16, 1949 to 1961 (numerous collectors, CIS, UCD). LOS ANGELES Co.: Llano (8 mi. n.), 1♀, VII-21-58 (J. C. Hall, UCD). MERCED Co.: Dos Palos (and 5 mi. e.), 1♀, 1♂, IX-9 to IX-22, 1948 to 1949, on *Solidago* sp. (1♂) (J. E. Gillaspay, R. F. Smith, CIS). Turner Island — Dos Palos, 3♂, VI-18-50 (C. D. MacNeill, CIS). MONO Co.: Topaz Lake, 2♀, 2♂, VII-17-51 (A. T. McClay, J. W. MacSwain, CIS, UCD). ORANGE Co.: Newport Bay, 1♂, VII-17-41, on *Eriogonum* sp. (CIS). RIVERSIDE Co.: Anza, 1♂, VII-3-56 (A. S. Menke, LACM). Banning, 1♂, VII-16-50 (J. W. MacSwain, CIS). Blythe, 10♀, 4♂, VII-15 to XI-2, 1936 to 1959, on *Heliotropium curassavicum* (2♀), *Melilotus albus* (1♀), *Tamarix gallica* (2♀, 4♂) (numerous collectors, CIS, LACM, UCR). Coachella Valley, 1♀, VII-10-32 (CIS). Mecca (and 4 mi. e.), 2♀, 16♂, VII-16 to VIII-20, 1956, on

Croton californicus (M. Wasbauer, CIS). Palm Springs, 2♂, V-23 to VII-16, 1940 to 1950 (D. C. Blodget, W. L. Swisher, LACM). Ripley, 8♀, 4♂, VIII-19-46, on *Helianthus annuus* (1♂) (P. D. Hurd, CIS). Riverside, 11♀, 12♂, VII-19 to X-4, 1926 to 1936, on *Eriogonum fasciculatum* (1♂), *Gnaphalium beneolens* (1♀), *Gutierrezia sarothrae* (10♀, 8♂), *Lepidospartum squamatum* (1♂), *Tetradymia comosa* (2♂) (P. H. Timberlake, UCR). Sugarloaf Mountain, 1♀, IX-12-64 (C. E. Wallace, UCR). Tahquitz Canyon, 1♂, VI-8-57 (A. S. Menke, L. A. Stange, LACM). SACRAMENTO Co.: Grand Island, 2♂, VI-8-67 (M. Wasbauer, CSDA). SAN BERNARDINO Co.: Morongo Valley, 1♂, IX-24-44, on *Solidago confinis* (P. H. Timberlake, UCR). Rialto, 1♀, VII-25-58 (J. C. Hall, UCD). SAN DIEGO Co.: Borrego Valley, 6♀, 2♂, VIII-30-51 (E. I. Schlinger, UCD). SHASTA Co.: Round Mountain, 1♀, IX-10-69 (E. Grissell and R. Denno, UCD). SOLANO Co.: Rio Vista, 2♂, V-21 to VI-8, 1949 to 1950, on *Achillea millefolium* (1♂) (J. E. Gillaspay, P. D. Hurd, CIS). STANISLAUS Co.: Turlock, 5♂, V-5-55 (R. R. Snelling, LACM). Lindsay, 1♀, VI-19-33, on *Coreopsis tinctoria* (P. H. Timberlake, UCR).

The markings of *capnoptera* vary considerably and this accounts for the synonyms by Cockerell and Parker. Specimens from eastern United States tend to be darker than those from the west. However, Californian material shows nearly the entire range of variation. The darker individuals have all or most of the tergal bands and the female pygidium dark. The more yellow specimens, called *annulata* by Parker, have the pleuron and abdomen mostly yellow, and large anterior discal spots on the scutum. Females tend to be yellower than males. Our most extreme examples in this respect are from Borrego Valley, Imperial County, and Topaz Lake, Mono County. Even more extensively yellow forms have been seen from Utah and Idaho. In many males we have seen, the clypeus and labrum have been irregularly spotted with black. Occasionally, as in specimens from the San Joaquin and Borrego valleys, the clypeus and labrum may be nearly all black. Body length is about 14 ± 3 mm.

The two Californian species are not readily distinguished by their markings although *capnoptera* tends to be more extensively yellow. Structural characters separate them easily, the toothed midfemur of male *ventralis* (fig. 34) and the well-developed pygidial plate of female *capnoptera* (fig. 30) being diagnostic for our material. Another feature in the male is the low subbasal median carina on sternite II (fig. 12). The only other species with a well-developed female pygidial plate is *fodiens* which occurs as far west as Arizona. It is distinguished by the toothed hindcoxae.

Biology of *capnoptera* has been sparingly reported and it seems to agree with that summarized for the genus. The few records discussed by Evans (1966:171-173) were all made on non-Californian material. Among these were observations by Evans and Linsley (1960) on



Map 13. California distribution of *Bicyrtes ventralis* (Say).

sleeping behavior. We have seen a female *capnoptera* from Llano, Los Angeles County, collected by J. C. Hall and carrying an adult pentatomid, *Carporis sulcatus* Van Duzee. This agrees with previous records of adult prey and contrasts with the habits of *ventralis* which is reported to use immature prey exclusively.

Bicyrtes ventralis (Say)

(Figs. 11, 29, 34; Map 13)

Monedula ventralis Say, 1824:336. Holotype ♂, Pennsylvania (destroyed).

Bicyrtes servillii Lapeletier, 1845:53. Holotype ♀, Philadelphia, Pennsylvania (Univ. Torino, Turin, Italy).

Bembidula parata Provancher, 1889:416. Holotype ♀, Los Angeles, California (Laval Univ., St. Foy, Quebec).

Bembidula meliloti Johnson and Rohwer, 1908:376. Holotype ♂, Pecos, New Mexico (USNM).

Geographic range. — United States and southern Canada.

California records. — BUTTE Co.: Chico, 2♀, 1♂, VII-13-65 (T. R. Haig, CSDA). CONTRA COSTA Co.: Antioch, 15♂, 8♀, V-20 to X-24, 1936 to 1958, on *Eriogonum latifolium nudum* (1♀) (numerous collectors, CAS, CIS, LACM). COLUSA Co.: Colusa, 1♂, VIII-15-55 (R. O. Schuster, CIS). EL DORADO Co.: Chile Bar, 19♀, 20♂, VII-5-48 (numerous collectors, CIS). FRESNO Co.: Fresno, 1♂, V-24-37 (S. Soule, CSDA). HUNTINGTON Lake, 1♀, VII-15-19 (F. E. Blaisdell, CAS).

Shaver Lake, 2♂, VI-24 to VIII-8, 1956 to 1961 (R. O. Schuster, R. R. Snelling, G. I. Stage, CIS, LACM). GLENN Co.: Glenn, 2♂, VII-23-60, on *Heracleum lanatum* (M. Wasbauer, CSDA). INYO Co.: Big Pine (and 5 mi. w.), 3♀ 2♂, VI-13 to VIII-24, 1929 to 1965 (numerous collectors, CAS, UCD). Bridgeport (11 mi. n.), 2♀, VII-7-61 (R. M. Bohart, UCD). Cartago (2 mi. n.), 1♂, VII-15-53 (R. M. Bohart, UCD). Wyman Canyon — White Mountains, 1♂, VII-10-67 (Saul and Suzy Frommer, UCR). KERN Co.: Kern Canyon, 2♂, VII-28-46 (F. A. Ehrenford, CIS). LASSEN Co.: Hallelujah Junction (and 3 mi. w.), 7♀, 47♂, VI-28 to VIII-1, 1949 to 1968 (numerous collectors, CIS, CSDA, LACM, UCD, UCR). LOS ANGELES Co.: Huntington Park, 1♂, VII-28-40 (A. Bauman, LACM). Lake Elizabeth Canyon, 1♂, VII-4-50 (LACM). Lancaster, 1♂, VIII-17-54, on *Melilotus albus* (R. R. Snelling, CIS). MARIPOSA Co.: El Portal, 4♂, V-18, to V-30, 1948 to 1958 (R. M. Bohart, W. F. Hardman, CIS, UCD). MERCED Co.: Dos Palos (and 5 mi. e.), 20♀, 13♂, VIII-21 to IX-22, 1941 to 1948, on *Lotus purshianus* (9♀), *Solidago* sp. (10♀, 12♂) (J. E. Gillaspay, R. F. Smith, V. M. Stern, CIS). Turner Island — Dos Palos, 1♂, VI-18-50 (C. D. MacNeill, CIS). MONO Co.: Rock Creek Gorge, 1♀, VII-28-54 (J. Powell, CIS). Topaz Lake, 5♀, 5♂, VI-26 to VII-17, 1951 to 1957 (numerous collectors, CIS, UCD). UCR). ORANGE Co.: Newport Beach, 1♂, V-1941 (CIS). PLUMAS Co.: Quincy (4 mi. w.), 2♀, VII-2-49 (P. D. Hurd, L. W. Isaak, CIS, UCD). RIVERSIDE Co.: Anza, 1♂, VI-24-56 (A. S. Menke, LACM). Corona, 1♀, 2♂, IX-1920 (CIS). Hemet, 5♀, 7♂, VIII-24 to VIII-31, 1946, on *Eriogonum* sp. (1♀), *Melilotus* sp. (1♀) (J. W. MacSwain, CIS). Palm Springs, 1♂, VI-29-52 (S. Miyagawa, UCD). Riverside, 57♀, 52♂, VI-4 to X-5, 1921 to 1963, on *Brassica* sp. (1♀), *Croton californicus* (1♀), *Eriogonum fasciculatum* (5♀, 12♂), *E. gracile* (1♀), *Gnaphalium beneolens* (1♀, 1♂), *Gutierrezia californica* (8♀, 1♂), *G. sarothrae* (30♀, 18♂), *Hoplopappus venetus vernonioides* (1♀, 1♂), *Heterotheca grandiflora* (2♀, 1♂), *Lippia nodiflora* (3♀, 5♂), *Marrubium vulgare* (1♀), *Mentha* sp. (1♂), *Phacelia* sp. (1♀), *Polygonum lapathifolium* (2♂) (numerous collectors, LACM, UCR). Tahquitz Canyon, 4♂, VI-8-57 (A. S. Menke, L. A. Stange, LACM). SACRAMENTO Co.: Carmichael, 1♀, VI-25-60 (T. H. Gantenbein, CSDA). Sacramento, 4♀, 9♂, V-26 to IX-23, 1926 to 1961 (numerous collectors, CSDA, LACM, UCD). SAN BERNARDINO Co.: Apple Valley, 1♀, 1♂, VI-21-40, on *Melilotus albus* (P. H. Timberlake, UCR). Big Meadows — San Bernardino Mountains, 1♂, VII-8-50 (LACM). Cajon Wash — 100', 1♀, VI-16-28, on *Lotus scoparius* (P. H. Timberlake, UCR). Colton, 2♀, 1♂, V-28 to VII-25, 1917 to 1956 (J. C. Hall, E. P. Van Duzee, UCR, CAS). Hemet Reservoir — San Jacinto Mountains, 1♂, VI-13-39 (E. G. Linsley, CIS). Herkey Creek — San Jacinto Mountains, 1♂, VI-19-40 (C. D. Michener, CIS). Mill Creek Canyon, 1♀, 1♂, VIII-24-23 (E. P. Van Duzee, CAS). Morongo Valley, 1♂, IX-24-44, on *Gutierrezia microcephala* (P. H. Timberlake, UCR). SAN DIEGO Co.: Cardiff, 1♀, VI-19-40, on *Eriogonum fasciculatum* (P. H. Timberlake, UCR). Ramona Hot Springs, 1♀, VIII-30-57 (E. I. Schlinger, UCD). SHASTA Co.: Cassel, 2♀, 1♂, VII-15-55 (R. C. Bechtel, J. C. Downey, J. W. MacSwain, CIS, UCD). Hat Creek, 1♀, VI-21-55 (R. C. Bechtel, UCD). Redding, 1♂, VII-6-18 (E. P. Van Duzee, CAS). SOLANO Co.: Rio Vista, 1♀, 4♂, V-21-49, on *Achillea millefolium* (2♂) (P. D. Hurd, E. G. Linsley, CIS). STANISLAUS Co.: Turlock, 1♂, V-5-55 (R. R. Snelling, LACM). TRINITY Co.: Carrville (10 mi. n.), 1♀, VII-15-55 (K. Bowers,

UCD). TUOLUMNE Co.: Columbia, 1♂, X-8-67, on *Chrysanthamnus* sp. (R. W. Thorp, UCD). Long Barn, 1♂, VIII-14-51 (R. C. Bechtel, UCD). Mather, 2♀, 1♂, VIII-5-54 (R. H. Goodwin, CIS). Pinecrest, 2♀, VIII-4-48, on *Solidago* sp. (P. D. Hurd, J. W. MacSwain, CIS). Sonora, 1♀, 1♂, VIII-14-60 (R. W. Thorp, CIS). Strawberry, 1♀, VIII-27-60, on *Haplopappus bloomeri* (P. D. Hurd, CIS). TULARE Co.: General Grant Grove, 1♂, VIII-10-47 (W. D. Murray, CIS). YOLO Co.: Davis, 11♀, 22♂, V-27 to X-22, 1950 to 1960 (numerous collectors, UCD). YUBA Co.: Camptonville (3 mi. s.), 1♂, VI-19-66, on *Eriogonum latifolium* (M. Wasbauer, CSDA).

This is probably the most common and widespread species of the genus in the United States. It is less variable in markings than *capnoptera*, but yellower western material has usually been placed under the subspecific name, *parata*. There seems little reason for geographical division of the species. Generally speaking, the pale markings are less extensive than in *capnoptera* but there is much overlap. Tergal bands are continuous in most females and some males from California. The female pygidium is most often maculate in our material and all black in more eastern specimens. However, there are many intergrades. In most males and some females the clypeus is rimmed with black, the apical border being the broadest. Tergal bands are yellow in Californian material but show a tendency to become whitish in more eastern localities. The body length is about 13 ± 3 mm.

Biological observations were published by Parker (1917:132-133). These and others have been nicely summarized by Evans (1966:160-167). The ethology agrees with that we have reported for the genus. However, certain peculiarities were noted by Evans: nests were most frequently found in coarse-grained soil; orientation flights of females were of a low, circling type; prey seems to be exclusively immature bugs; and delayed provisioning (after the larva has hatched) is not uncommon. Two females collected in Davis, Yolo County, by E. I. Schlinger and R. C. Bechtel were transporting immature pentatomid prey.

Genus *Microbembex* Patton

About 20 species of the genus occur in North and South America. We have recognized 7 of these in continental United States and a key to them is presented. Members of the genus are easily recognized by their relatively small size, edentate mandibles, greatly reduced palpi (fig. 10), and partial removal of the marginal cell from the leading edge of the forewing (fig. 27). They appear to be related to *Bicyrtes* which share with them the absence of a median welt on the scutum, the nearly obliterated ocelli, and the absence of spiracular lobes on male

tergite VII. Male genitalia of *Microbembex* are remarkable for the small cuspis (figs. 66-70).

The species differ only slightly in structure, and this is especially true of females. Five species are now known in California according to R. Bohart (1970). All of these have been confused with *monodonta* (Say) at one time or another.

Biological information has been summarized by Evans (1966). It is based especially on *monodonta* from eastern United States. Essential points are: (1) Colonies, often large, occur in tracts of fine sand. (2) Adults spend periods of inactivity in short burrows in the sand. (3) Nesting burrows are less than a foot in depth and are usually simple, unicellular, and without tumulus at the entrance. (4) Nests are closed when the female is away and provisioning is progressive. (5) The egg is laid erect in the cell, and the first provisions are brought in shortly before eclosion. (6) Prey consists of a conglomeration of dead and moribund arthropods.

KEY TO MICROBEMBEX IN CONTINENTAL UNITED STATES

1. Forewing radius along front of first submarginal cell white or almost so (as viewed dorsally), contrasting strongly with more basal part of radius and at least as pale as adjacent part of costa (fig. 24); female mesopleuron laterally clothed with dense, appressed, silvery pubescence which entirely obscures punctation; male clypeus and all or nearly all of labrum black 2
- Forewing radius along front of first submarginal cell brown to dark brown, or at least not contrasting strongly with more basal part of radius, darker than adjacent part of costa (fig. 25); female mesopleuron with silvery hair laterally which does not entirely obscure punctation; male clypeus and labrum usually with considerable yellow 3
2. Male sternites with scattered hair, not densely furlike as seen in profile; keel of male sternite II small, slender, sharp, often nearly smooth (fig. 64); southern California, Arizona, Nevada, and western Utah *argyropleura* R. Bohart
- Male sternites with dense furlike pubescence as seen in profile; median projection of male sternite II small, often short, obviously hairy (fig. 62); western Texas and New Mexico *hirsuta* J. Parker
3. Punctation of scutum somewhat irregular, discal spots often long, somewhat shiny and with punctures more widely spaced; mesopleuron not evenly punctate, becoming more shiny at least in rounded area before anterior constriction; labrum mostly yellow, in any case rarely with a complete median black stripe 4
- Punctation of scutum even and moderately dense, discal pale spots usually absent or tiny; mesopleuron rather evenly punctate; labrum usually with a black median stripe, sometimes all black or nearly so 5
4. Sternites usually mostly black, yellow bands, if any, narrow or very irregularly margined, at least on sternite

IV; keel of male sternite II not reaching posterior margin of sternite as seen in profile (fig. 60); flattened median area of mesopleuron rather evenly and densely punctate; west of 100th meridian in U.S. and Mexico....

nigrifrons (Provancher)

Sternites mostly yellow, the bands rather evenly margined; keel of male sternite II unusually large and reaching or surpassing posterior margin of sternite as seen in profile (fig. 65); flattened median area of mesopleuron shiny between scattered punctures; southern California to western Texas

aurata J. Parker

5. Apex of male tergite VII as broad as length of third hindtarsal article; mesopleuron all dark; female clypeus mostly pale; ground color of sternites light mahogany red; southern San Joaquin Valley, California

rufiventris R. Bohart

Apex of male tergite VII narrower than length of third hindtarsal article; mesopleuron usually spotted, but if all dark in females, labrum with a complete black median stripe; ground color of sternites usually dark brown to black

6

6. Male with last 4 flagellomeres shiny beneath (on incurved face of antenna in normal position); keel on male sternite II with ventral edge nearly always somewhat bent as seen in profile (fig. 63); west of Continental Divide in U.S.; Sonora and Baja California in Mexico

californica R. Bohart

Male with last 4 flagellomeres dull beneath; keel on male sternite II with ventral edge evenly rounded (fig. 61); east of Continental Divide, Canada to Panama

monodonta (Say)

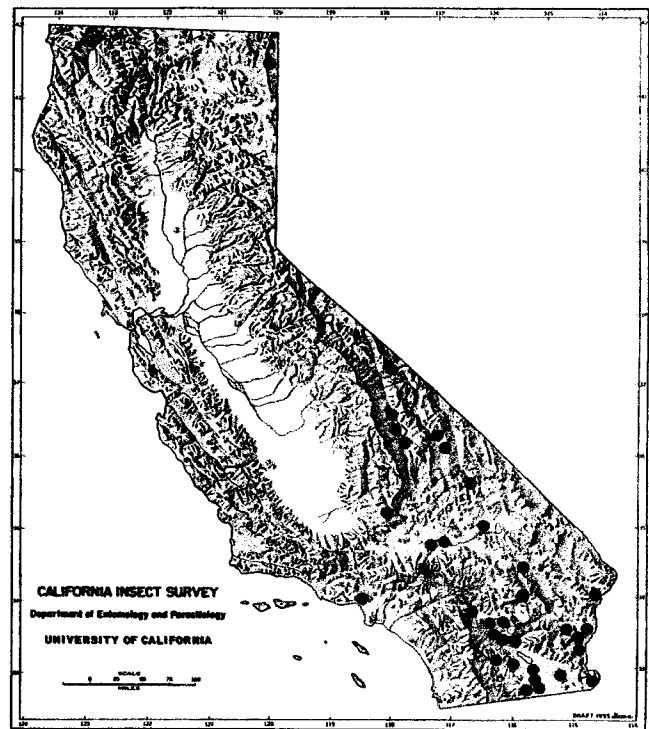
Microbembex argyropleura R. Bohart

(Figs. 24, 64, 68; Map 14)

Microbembex argyropleura R. Bohart, 1970:203. Holotype ♂, 18 mi. w. Blythe, Riverside Co., California (UCD).

Geographic range. — Baja California; San Diego County to San Bernardino County, Inyo County, and Modoc County in California; Yuma, Mojave, Navajo, Cochise, Coconino, and Pinal counties in Arizona; Washoe County, Nevada; and Juab County, Utah.

California records. — IMPERIAL Co.: Ocotillo Wells (13 mi. e.), Glamis (4 mi. w.), Bard, Calexico (10 mi. w., 14 mi. e., and 29 mi. e.), Experiment Farm, Heber (12 mi. e.), Imperial (4 mi. nw.), Laguna Lake, Mt. Signal (6 mi. w.), Palo Verde (and 2 mi. s.), Westmorland. INYO Co.: Antelope Springs, Lone Pine, Olancha (and 3 mi. s.), Owens Lake, Panamint Spring (15 mi. s.), Panamint Valley, Surprise Canyon — Panamint Mountains. KERN Co.: Red Rock Canyon. LOS ANGELES Co.: Westwood Hills. MODOC Co.: Cedarville. RIVERSIDE Co.: Banning, Blythe (and 15–20 mi. w.), Cathedral City, Coachella, Hopkins Well, Hunter's Spring, Indio (and 6 mi. w.), Magnesia Canyon, Mecca, Palm Springs (and 3 mi. sw., 6 mi. s.), Ripley, Salton Sea — north end, Thermal, Thousand Palms (15 mi. s.), Thousand Palms Canyon, Thousand Palms Oasis. SAN BERNARDINO Co.: Amboy Crater, Barstow (and 8 mi. w.),



Map 14. California distribution of *Microbembex argyropleura* R. Bohart.

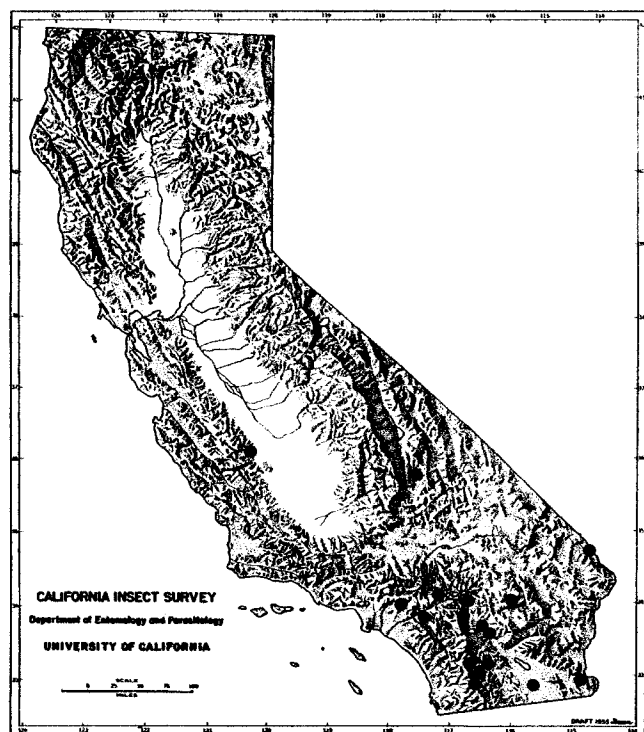
Cronise Valley, Four Corners, Hinkley, Saratoga Springs — Death Valley National Monument, Twenty Nine Palms (and 13 mi. w.), Victorville, Vidal (5 mi. s.). SAN DIEGO Co.: Borrego, Borrego Valley.

Seasonal distribution extends from May till October.

This species is a little smaller than *californica*, averaging 10 mm in length and with an observed range of 9 to 12 mm.

The extensively white-veined wings (fig. 24) and the striking silver mat of the female mesopleuron distinguish *argyropleura* from other Californian species but not from the more eastern *hirsuta*. Males of the two species are easily distinguished by the somewhat sparse, rather than densely furry, pubescence of the sternites in *argyropleura*. Females must be identified by locality and by association with males.

Markings are yellow in males but whitish in females. The latter may be tinted with yellow in more southern localities. The background is black in males and in females it varies from black to mahogany. Material from more southern localities are generally more reddish in the background shade. The clypeus and labrum of males are always black, whereas females have these areas nearly all whitish or very pale yellow. Females have the



Map 15. California distribution of *Microbembex aurata* J. Parker.

scutum rather densely silvery but the background is black in the discal area in both sexes. We have seen a very few specimens with spotted scutal disc from localities outside California.

Structural peculiarities are found in the male. The keel of sternite II is uniformly small, narrowly hooklike and moderately bristly (fig. 64). The last few flagellomeres are dull beneath as in most of the other species. The punctation on the disc of the scutum and on the mesopleuron is relatively even and close in both sexes.

We have studied a total of 545 specimens.

Microbembex aurata J. Parker
(Figs. 65, 69; Map 15)

Microbembex aurata J. Parker, 1917:121. Holotype ♂, Los Angeles Co., California (USNM).

Geographic range. — Desert localities from southern California to western Texas.

California records. — FRESNO Co.: Coalinga, 1 ♂, VII-22-60 (H. L. Wilson, CSDA). IMPERIAL Co.: Brawley (20 mi. w.), 1 ♂, VI-13-65 (J. L. Bath, UCR). Picacho Pass, 1 ♂, VIII-27-54, on *Cuscuta* sp. (UCR). INYO Co.: Argus Mountains, 1 ♀, VI-4-39 (R. M. Bohart, UCD). LOS ANGELES Co.: Claremont, 1 ♀

(UCR). RIVERSIDE Co.: Deep Canyon, 1 ♂, VII-1-64 (K. W. Brown, U.C.R.). Magnesia Canyon, 3 ♀, 6 ♂, VII-1-64, VII-21-51 (VI-22-58) (R. M. Bohart, E. I. Schlinger, J. J. Menn, CIS, LACM, UCD). Palm Springs, 1 ♀, 1 ♂, VII-20-34 (C. M. Dammers, UCR). Riverside, 1 ♀, VI-28-35 (C. M. Dammers, UCR). SAN BERNARDINO Co.: Lake Arrowhead (10 mi. n.) 1 ♀, VIII-17-60 (P. E. Paige, UCD). Needles, 1 ♂, VI-9-42 (E. C. Van Dyke, CAS). Valley of the Falls, 1 ♀, IX-7-35 (P. H. Timberlake, UCR). Vivian Camp, 1 ♂, X-1-32 (P. H. Timberlake, UCR). Yucca Valley — Twenty Nine Palms (19 mi. w.), 1 ♀, 1 ♂, VIII-3-33, VIII-30-36, on *Erigeron glaucus*, *Croton californicus* (P. H. Timberlake, UCR). SAN DIEGO Co.: Borrego Valley, 1 ♀, VI-12-65 (G. R. Ballmer, UCR); 1 ♂, VIII-20-55 (E. I. Schlinger, UCD). Mason Valley, 1 ♂, VIII-30-33 (C. M. Dammers, UCR). Culp Canyon, 1 ♂, VI-12-58 (H. R. Moffitt, UCD). Warner Springs, 1 ♂, IX-12-35 (A. J. Basinger, UCR); 3 ♂, VII-8-56 (R. M. Bohart, R. C. Bechtel, UCD). Scissors Crossing, 1 ♀, VII-4-56 (E. I. Schlinger, UCD). Yaqui Well, 2 ♀, VIII-12-57 (J. C. Hall, UCD).

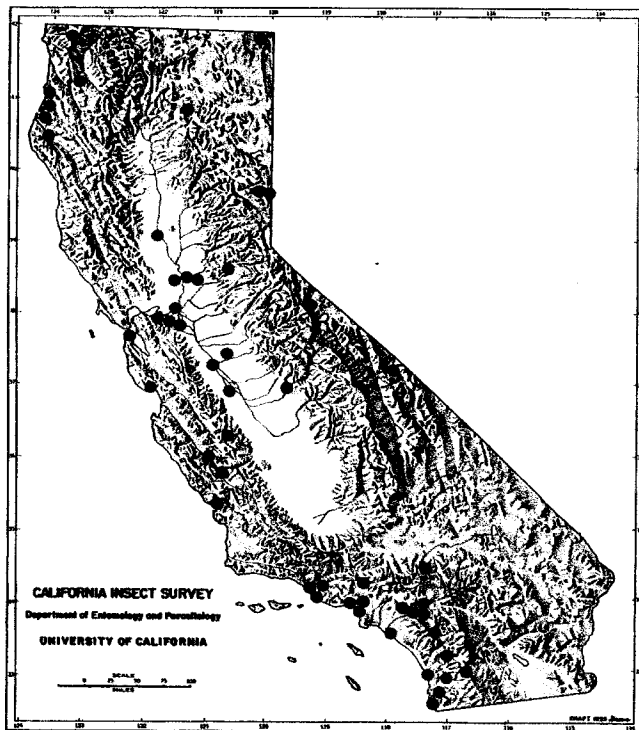
This is the largest and most extensively yellow-marked species in this country. Body length averages about 13 mm, with an observed range of 12 to 15 mm. The clypeus and labrum are all yellow, the mesopleuron and scutellum mostly so, large yellow discal spots are present on the scutum as well as broad lateral bands, the metanotum and propodeum have complete bands, and the abdomen is mostly yellow with basal segmental black areas. The broad yellow sternal bands have rather regular margins toward the base of each segment. Forewing veins are black to brown except for the yellowish costa on the basal half to third of the wing. Legs are nearly all yellow.

Punctation is more sparse than in other species, the punctures separated by up to four diameters in the yellow spots of the scutal disc and up to three diameters toward the middle of the mesopleuron. The terminal flagellomeres in the male are dull beneath.

The outstanding structural characteristic is the large keel of male sternite II (fig. 65), which often exceeds the posterior margin of the segment. Also, the digitus is peculiar in having a subapical dentiform ridge (fig. 69).

This species has been generally misunderstood during the period since it was described by Parker. Confusion has especially involved *nigrifrons* and the more yellow forms of *monodonta* and *californica*. The broad yellow sternal bands and large keel on male sternite II (fig. 65) should distinguish *aurata* readily from other Californian species. However, we have seen female *nigrifrons* from Baja California with nearly as much yellow on the sternites as in *aurata* and with large yellow discal spots on the scutum. Since associated males were clearly *nigrifrons*, it appears that such females will have to be distinguished by minor differences in color pattern and punctation.

We have studied a total of 46 specimens.



Map 16. California distribution of *Microbembex californica* R. Bohart.

Microbembex californica R. Bohart
(Figs. 10, 15, 25, 27, 63, 67, 74; Map 16)

Microbembex californica R. Bohart, 1970:202. Holotype ♂, Davis, Yolo Co., California (UCD).

Geographic range. — United States west of the Continental Divide; Sonora and Baja California, Mexico.

California records. — CONTRA COSTA Co.: Antioch, Bethel Island, Oakley. COLUSA Co.: Colusa. DEL NORTE Co.: Klamath. EL DORADO Co.: Chile Bar. FRESNO Co.: Kennedy Meadow. HUMBOLDT Co.: Arcata, Eureka, Orleans, Pepperwood, Mad River Beach, Samoa Dunes, Trinidad. INYO Co.: Deep Springs. LASSEN Co.: Hallelujah Junction. LOS ANGELES Co.: El Segundo Sand Dunes, Hermosa Beach, Los Angeles, Playa del Rey, Redondo Beach, San Fernando Valley, Santa Monica. MADERA Co.: Lake Millerton. MERCED Co.: Delhi, Hatfield State Park, Turner Island — Dos Palos. MODOC Co.: Willow Ranch. MONO Co.: Convict Lake. MONTEREY Co.: Bradley, San Lucas. ORANGE Co.: Balboa Island, Corona del Mar. PLUMAS Co.: Vinton. RIVERSIDE Co.: Mira Loma, Riverside, Santa Ana River, Winchester. SACRAMENTO Co.: Carmichael, Grand Island, Ryde (5 mi. s.), Sacramento. SAN BENITO Co.: Idria (13 mi. s.). SAN BERNARDINO Co.: Apple Valley, Chino, Colton, Victorville. SAN DIEGO Co.: Coronado, Del Mar, Encinitas, Mission Valley, Pala, Poway, San Diego, San Felipe Creek. SAN FRANCISCO Co.: San Francisco — sand dunes, Sunset Hills. SAN LUIS OBISPO Co.: Morro Bay. SANTA CRUZ Co.: Santa Cruz. SHASTA Co.:

Cassel. SOLANO Co.: Rio Vista. STANISLAUS Co.: San Joaquin River — Newman, Turlock. VENTURA Co.: Foster Park, Port Hueneme, Saticoy, Ventura. YOLO Co.: Davis, West Sacramento.

Seasonal distribution embraces the months of April through October (fig. 74).

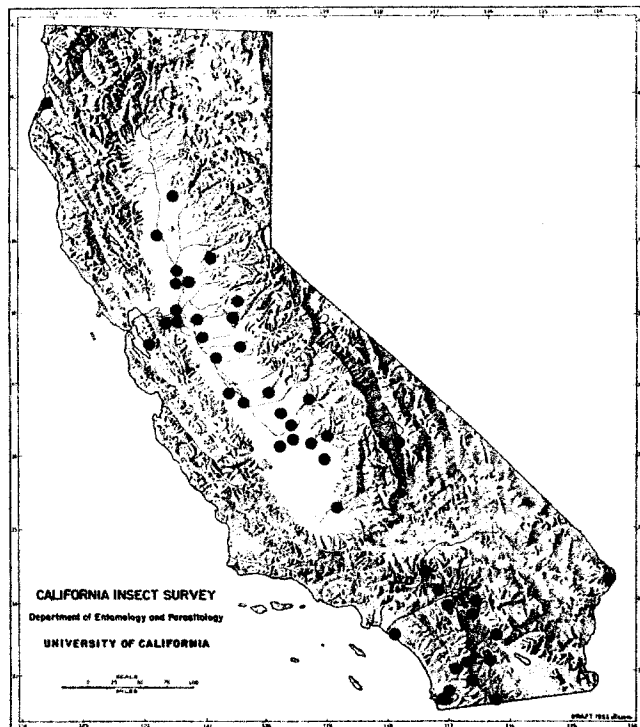
M. californica is a medium-sized *Microbembex*, the length averaging about 11 mm with an observed range of 9 to 14 mm. Markings are yellow in the male and whitish to yellow in the female.

In males the clypeus is usually at least spotted with yellow, and the labrum is usually yellow laterally. Perhaps a third of the males have both clypeus and labrum all black. Exceptionally, the male labrum may be all yellow. The scutum is generally all black discally, but a few males have a pair of small yellow discal spots. The scutellum is two-spotted, both metanotum and propodeum are yellow banded, and there is usually a small yellow mesopleural spot. We have seen a specimen from Humboldt County with the dorsal surface entirely yellow on the scutellum, metanotum, and propodeum. The tergites are generally mostly yellow, tergite I usually having a pair of black dots toward the base of its yellow band. The sternites are yellow laterally, or there may be complete but irregularly margined yellow bands. Forewing veins in both sexes are brown to black except for the basal half to two-thirds of the costa.

In females the clypeus is apically pale and the labrum is pale laterally, occasionally all pale. The scutum hardly ever has discal spots, at least in Californian material. The mesopleuron and notum beyond the scutum may be nearly all dark or may be variously pale spotted. Tergal pale bands may be narrow to broad but are nearly always less extensive than in males. The sternites may be all dark or with lateral spots or occasionally with irregular maculation tending toward bands. Femora basally, trochanters and coxae are usually mostly black. About 80 percent of females from California have the markings whitish instead of yellow, but both colors generally occur in each population.

Punctuation in both sexes is close on the scutum and mesopleuron, the punctures usually nearly contiguous but occasionally separated by 0.5 to 1.0 puncture diameter. The last four articles of the male flagellum are conspicuously shiny beneath. Mesopleural pubescence in males is fulvous and inconspicuous. In females it is silvery and moderately thick but not totally obscuring the punctuation.

Structurally, the most obvious feature is the keel on the male sternite II. In nine out of ten specimens the keel is somewhat flattened on the ventral surface (fig. 63). Exceptions are mostly small specimens. The digitus has



Map 17. California distribution of *Microbembex nigrifrons* (Provancher).

the inner (dorsal) edge hardly expanded apically (fig. 67).

M. californica is distinguished from other species in California by its densely punctate scutum and mesopleuron in combination with the nearly or entirely unspotted scutal disc, the moderately silvery female mesopleuron, and the apicoventrally shiny male flagellomeres. Useful additional characters are the mostly dark wing veins, oddly shaped keel on male sternite II, and the lateral pale stripes usually present on the female labrum. We have seen a total of 805 specimens.

Goodman (1970) has studied a colony of *californica* near Samoa, Humboldt County, California. In general the habits are as reported for the genus and for *monodonta* by Evans (1966). No chrysidids of the genus *Parnopes* were observed.

Microbembex nigrifrons (Provancher)
(Figs. 60, 66; Map 17)

Bembex nigrifrons Provancher, 1888:415. Lectotype ♀, Los Angeles, California (Laval University, St. Foy, Quebec, Canada).

Microbembex monodonta neomexicana Johnson and Rohwer, 1908:375. Lectotype ♂, Las Cruces, New Mexico (USNM).

Microbembex monodonta deltaensis Johnson and Rohwer, 1908:375. Lectotype ♂, Delta, Colorado (USNM).

Geographic range. — West of 100th meridian in United States and Mexico, including the full length of Baja California.

California records. — ALAMEDA Co.: Emeryville, 1♀, VIII-31-38 (J. W. MacSwain, CIS). BUTTE Co.: Chico, 2♀, VII-13-62 (T. R. Haig, CSDA). CALAVERAS Co.: Copperopolis, 1♀, 1♂, VIII-29-60 (A. S. Menke, UCD). Mokelumne Hill, 2♀ (F. E. Blaisdell, CAS). CONTRA COSTA Co.: Antioch, 52♀, 10♂, VI-30 to X-24, 1932 to 1949, on *Eriogonum* sp. (1♀) (numerous collectors, CAS, CIS, LACM, UCR). Oakley, 1♂, IX-6-36 (E. C. Van Dyke, CAS). COLUSA Co.: Colusa, 1♀, IX-1-57 (M. Wasbauer, CIS). Colusa (2 mi. e.), 5♀, 2♂, V-30-60 (M. Wasbauer, CSDA). FRESNO Co.: Firebaugh, 2♀, VIII-25-68 (T. R. Haig, CSDA). Fresno, 3♀, 4♂, VI-7-15, VI-1938 (CAS, UCR). Selma, 1♀, VI-1932 (CIS). Trimmer, 1♂, VIII-17-51 (C. D. MacNeill, CIS). HUMBOLDT Co.: Arcata, 1♀, VII-4-40 (CAS). INYO Co.: Olancho, 1♀, 2♂, (F. A. Eddy, CIS). KERN Co.: Kern River State Park, 3♀, 13♂, VI-21 to 28-46 (H. E. Cott, L. W. Isaak, CIS, UCD). KINGS Co.: Hanford (4 mi. se.), 1♀, X-7-59 (R. R. Snelling, CIS). Lemoore, 1♀, VIII-6-32 (CIS). MADERA Co.: Madera 1♀, VI-5-42 (E. G. Linsley, CIS). MENDOCINO Co.: Mendocino Co., 1♂, IX-1917 (C. L. Fox, CAS). MERCED Co.: Dos Palos, 7♀, 9♂, VI-27 to IX-22, 1947 to 1949, on *Heliotropium* sp. (3♀, 4♂), *Lotus purshianus* (1♀) (J. E. Gillaspay, C. A. Hanson, V. M. Stern, CIS). Turner Island — Dos Palos, 2♂, VI-18-50 (C. D. MacNeill, CIS). ORANGE Co.: Corona del Mar, 1♂, VII-25-48 (USNM). PLACER Co.: Auburn (5 mi. s.), 1♂, VIII-25-48 (P. D. Hurd, CIS). RIVERSIDE Co.: Coachella, 1♂, V-17-17 (E. P. Van Duzee, CAS). SACRAMENTO Co.: Grand Island, 3♀, X-15-67 (M. Wasbauer, CSDA). Ryde (5 mi. sw.), 1♀, 1♂, VIII-1-61 (M. Wasbauer, CSDA). Sacramento, 4♂, V-28 to VII-28, 1918 to 1941 (W. Travioli, E. P. Van Duzee, F. H. Wymore, CAS, CIS, CSDA, UCD). SAN BERNARDINO Co.: Mill Creek Road, 1♀, V-18-34 (A. J. Basinger, UCR). Morongo Valley, 3♀, 3♂, VII-27 to IX-26, 1936 to 1944, on *Croton californicus* (1♀ 2♂), *Gutierrezia microcephala* (1♀), *Lepidospartum squamatum* (1♀, 1♂) (P. H. Timberlake, UCR). Parker Dam, 1♀, XI-23-36, on *Aster spinosus* (P. H. Timberlake, UCR). Redlands, 1♀, 1♂ (F. R. Cole, USNM). Victorville, 2♀, 1♂, IX-29-65 (R. R. Snelling, LACM). SAN DIEGO Co.: Scissors Crossing, 2♀, VII-4-56 (R. W. Bushing, R. C. Bechtel, UCD). Borrego, 2♀, 18♂, V-3 to VIII-4, 1956, on *Croton californicus* (2♀, 18♂) (numerous collectors, CIS, UCR). Jacumba, 1♂, X-3-25 (J. D. Gunder, CAS). Julian, 1♂, VIII-8-57 (H. R. Moffitt, UCD). Mission Valley, 9♀, 1♂, IX-11-27 (J. C. VonBlocker, USNM). San Diego, 2♀, VIII-25-27 (F. E. Blaisdell, J. C. VonBlocker, CAS, USNM). San Felipe Creek, 1♀, IX-2-35 (F. T. Thorne, UCR). San Felipe Wash, 3♂, VIII-19-19 (E. P. Van Duzee, CAS). Weston, 2♂, VII-15-09 (CAS). SOLANO Co.: Rio Vista, 8♂, V-21 to VI-8, 1949 to 1950, on *Achillea millefolium* (4♂), *Heliotropium* sp. (3♂), (J. E. Gillaspay, P. D. Hurd, J. W. MacSwain, CIS). STANISLAUS Co.: La Grange, 1♂, V-30-62 (R. P. Allen, CSDA). Turlock, 10♀, 34♂, V-5 to IX-1, 1955 to 1961 (R. R. Snelling, CSDA, LACM). TULARE Co.: Lindsay, 1♀, 6♂, VI-6 to VIII-28, 1909 to 1911, on *Asclepias* sp. (6♂) (W. A. Davidson, J. C. Favre, USNM). Visalia 2♂, VI-27-09 (P. R. Jones, USNM). Woodlake, 2♀, VI-21 to X-15, 1947 to 1951, on *Hemizonia* sp. (1♀) (N. W. Frazier, R. F. Smith, CIS). YOLO Co.: Davis, 38♀, 16♂, VII-9 to IX-11, 1952 to 1964 (numerous collectors, UCD). Freeport, 1♀, 2♂, IX-1-41 (K. O. Snyder, LACM).

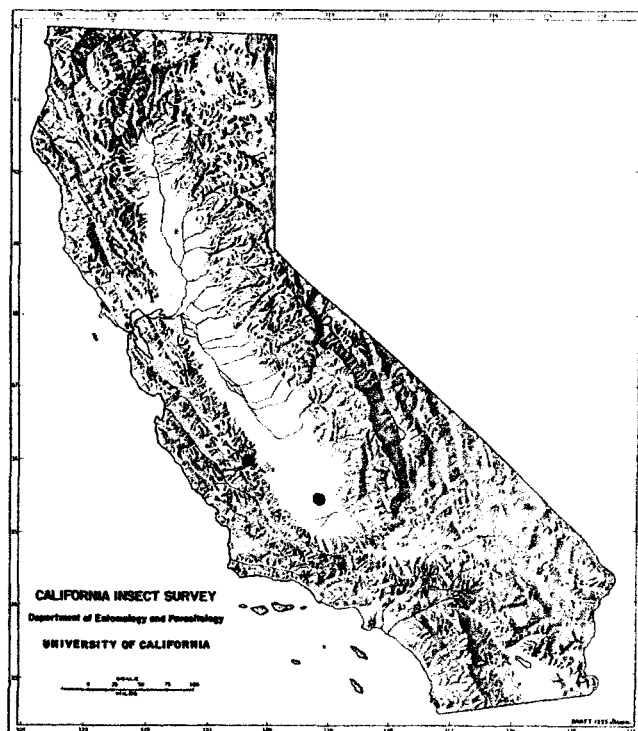
Since the average length of the *nigrifrons* specimens is about 12 mm and the observed range is 8 to 14 mm, the species is intermediate in size between *californica* and *aurata*. Markings are black and yellow in both sexes of all Californian material studied. However, occasional females from northwestern United States may have the pale markings tending toward whitish.

The clypeus is all yellow or mostly so, and the same generally applies to the labrum. However, there are tendencies toward a partial or rarely a complete dark median line on the labrum. A pair of yellow discal spots on the scutum is nearly universal. The mesopleuron usually has a moderately large spot roughly in the form of a triangle. Scutellar spots are ordinarily large, and there are yellow bands across the metanotum and propodeum. The tergal yellow bands cover most of the abdominal dorsum, that on I frequently enclosing or partly outlining a basomedian black spot. Occasionally, this spot is double or absent. Sternites are yellow spotted laterally but some specimens, particularly those from Baja California, may be extensively yellow in the form of irregular bands or partially connected spots. Except for the pale basal half of the costa, forewing veins are brown to black. Sometimes, veins near the base of the first submarginal and first discoidal cells may be light brownish.

Punctuation of the scutum and mesopleuron is considerably more sparse than in *californica* or *argyropleura* but not as sparse as in *aurata*. Punctures within the yellow spots of the scutal disc are mostly 1 to 3 diameters apart. Those in the flattened area at the middle of the mesopleuron are 0.5 to 1.5 diameters apart, but in the curved area just anterior they may be separated by 2 to 3 diameters. The last few male flagellomeres are dull beneath. Pubescence of the mesopleuron is moderate, off-silvery in the male to silvery in the female but not obscuring the punctuation.

Structurally, the most important feature is the keel on male sternite II. It is evenly rounded ventrally, usually larger than in *argyropleura* or the eastern *monodonta*, but considerably smaller than in *aurata* (compare figs. 60 to 65). The digitus is intermediate between those of *monodonta* and *californica* (compare figs. 66 to 70).

M. nigrifrons is best separated in the male by the smooth areas of the scutal disc, dull terminal flagellomeres, moderately large and rounded keel on sternite II (fig. 58), extensively yellow labrum and clypeus, and mostly dark forewing veins. The same punctuation and color characters separate females from those of *argyropleura* and *californica* but not from *aurata*. From the last species the best character seems to be the nature of the sternal bands which are very regular in *aurata* but not so in *nigrifrons*. We have studied a total of 615 Californian specimens of *nigrifrons*.



Map 18. California distribution of *Microbembex rufiventris* R. Bohart.

G. Bohart and MacSwain (1940) reported on a chrysidid parasite of *nigrifrons* (as *aurata*). Several hundred cocoons were gathered at Antioch, California, and were found to be 20 percent parasitized by *Parnopes fulvicornis* Cameron (as *westcotti*). The parasite reached the host cells by tunnelling into the sand.

Microbembex rufiventris R. Bohart
(Figs. 58, 59; Map 18)

Microbembex rufiventris R. Bohart, 1970:204. Holotype ♂, Coalinga, Fresno Co., California (UCD).

Geographic range. — Southern San Joaquin Valley, California.

California records. — FRESNO Co.: Coalinga, 2 ♀, 2 ♂, V-22-36 (R. M. and G. E. Bohart, UCD). KERN Co.: Cawelo Junction (e. of Shafter), 1 ♂, VII-24-52 (T. R. Haig, UCD).

M. rufiventris is one of the larger species of the genus, the body length of males ranging from 12 to 13 mm and of females from 9 to 11 mm. In the male the face, including clypeus and labrum, is all black. The male markings are yellow and include large scutellar spots, a metanotal stripe, a transverse propodeal band, the tergites mostly, and small lateral sternal spots. The legs of the male are extensively dark including practically all of the foreleg.

Both sexes have the mesopleuron and scutal disc all black. Also, the ground color of the sternites is a reddish mahogany. The female differs from the male in having the pale maculation whitish (in the two females known), only the foretarsi all black, no spots on the scutellum or propodeum, restricted tergal pale bands which are quite narrow except laterally, and a mahogany infusion of the black on the tergites. Also, the scape and clypeus are partly pale, and the labrum mostly so. Forewing veins in both sexes are mostly black to brown except at the base of the first submarginal cell and on the basal half of the costa where the veins are yellowish.

Punctation is essentially close, punctures on the scutum and mesopleuron rarely more than a diameter apart and mostly almost contiguous. The terminal flagellomeres in the male are not polished beneath.

The main structural characters of the male are the relatively broad apex of tergite VII (fig. 58) and the

cariniform median projection of sternite II (fig. 59). Since only three males are known, the latter structure may not always be of this form. The digitus is similar to that of *californica* (fig. 68) but considerably stouter. Sternite VIII is pale except at the tip, whereas that of *californica* is usually all dark.

The above features will readily distinguish males from those of other *Microbembex*. Both sexes have the mesopleuron all dark but this may be found also in some *argyropleura* and *californica*. The darker forewing venation and less dense silvery pubescence on the mesopleuron distinguish females of *rufiventris* from those of *argyropleura*. Distinction from *californica* is less obvious. It is only rarely that *californica* females have the mesopleuron all dark in combination with unusually narrow pale tergal bands. In these cases the labrum seems always to be extensively dark, whereas in the known females of *rufiventris* the labrum is nearly all pale.

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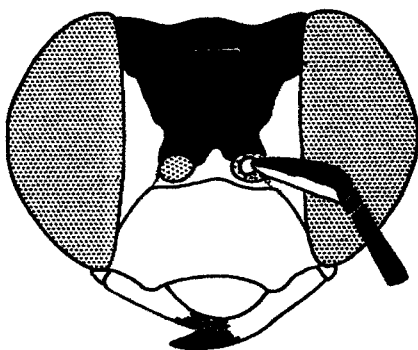
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PLATES

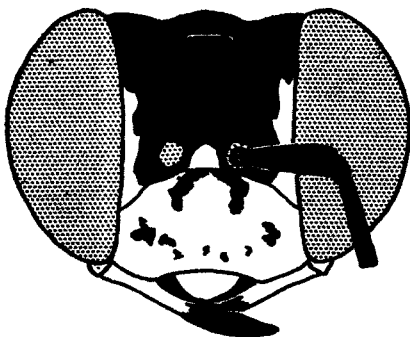
PLATE I

Figs. 1-6. *Bembix*, facial markings.

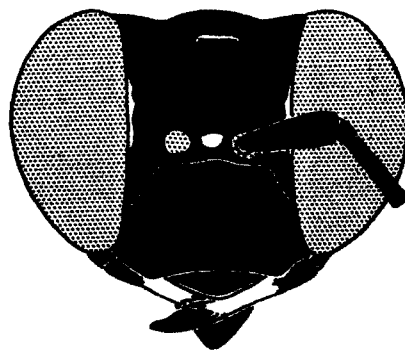
Figs. 7-9. *Bembix*, side view of head.



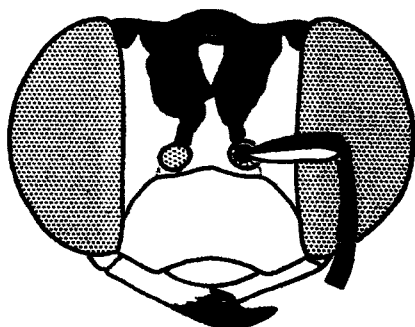
1. *hamata* ♀



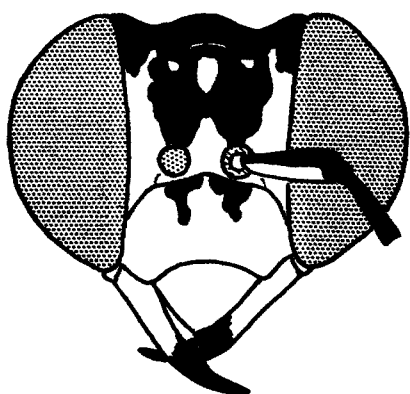
2. *nicolai* ♀



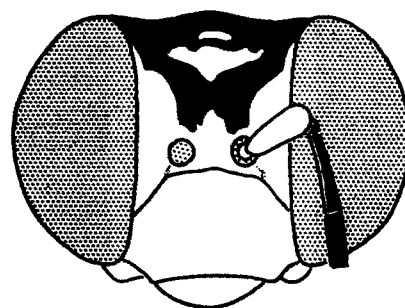
3. *nicolai* ♂



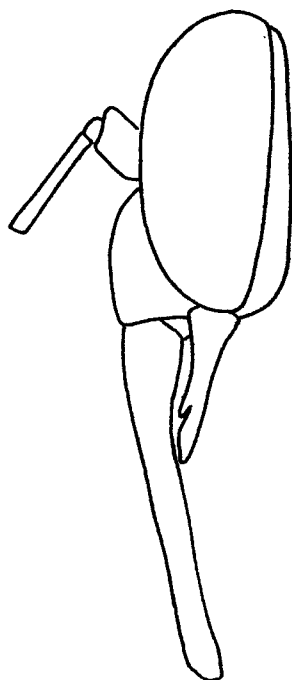
4. *comata* ♀



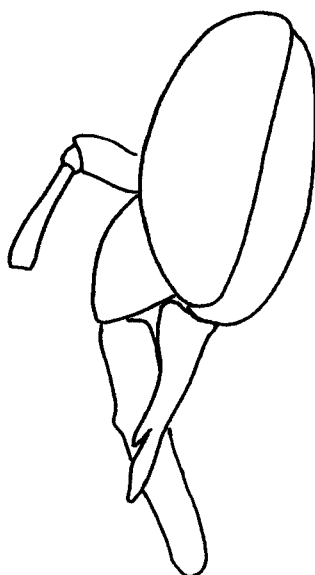
5. *melanaspis* ♀



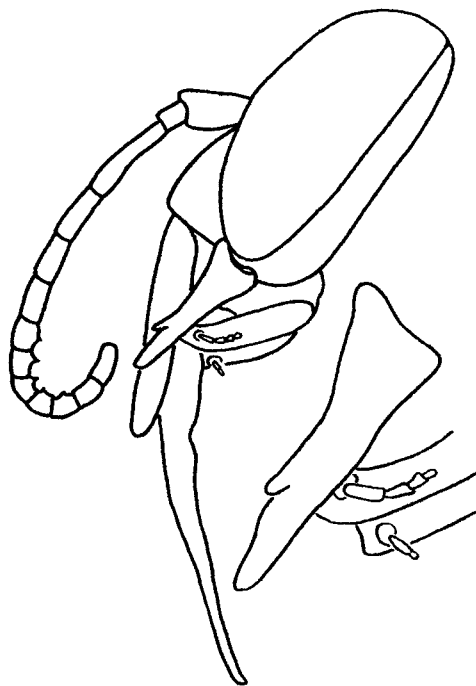
6. *stenebdoma* ♀



7. *rugosa* ♂



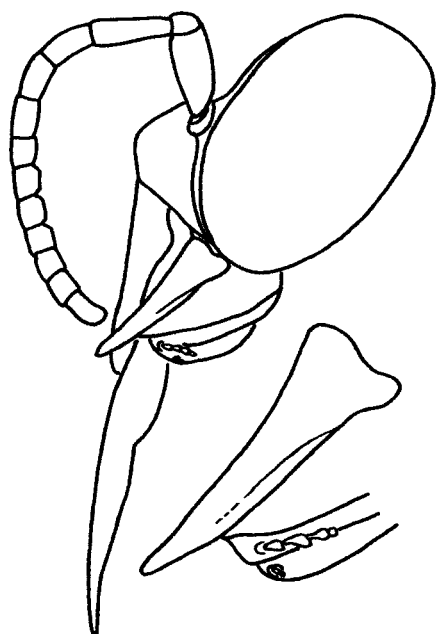
8. *dentilabris* ♂



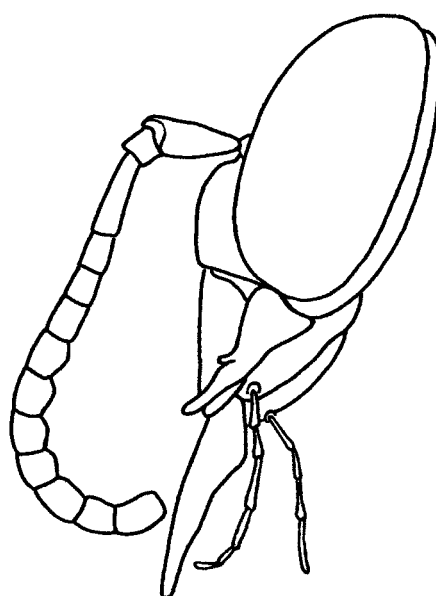
9. *comata* ♂

PLATE II

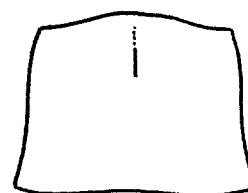
- Fig. 10. *Microbembex*, side view of head.
Fig. 11. *Bicyrtes*, side view of head.
Fig. 12. *Bicyrtes*, sternite II.
Figs. 13, 14. *Bembix*, sternite II.
Fig. 15. *Microbembex*, top view of head.
Figs. 16, 17. *Bembix*, sternite II.
Fig. 18. *Stictia*, head in dorsal view.
Figs. 19, 20. *Bembix*, sternite II.
Fig. 21. *Stictiella*, head in dorsal view.
Fig. 22. *Bembix*, head in dorsal view.
Fig. 23. *Bembix*, sternite II.



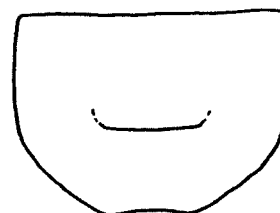
10. *californica* ♂



11. *ventralis* ♂



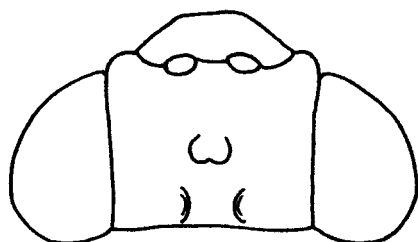
12. *capnoptera* ♂



13. *stenebdoma* ♂



14. *occidentalis* ♂



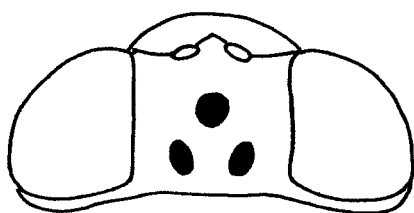
15. *californica* ♀



16. *rugosa* ♂



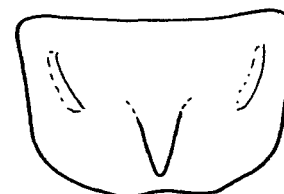
17. *comata* ♂



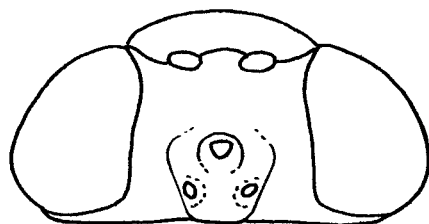
18. *signata* ♀



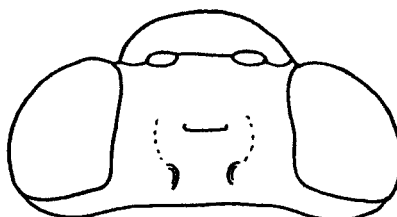
19. *amoena* ♂



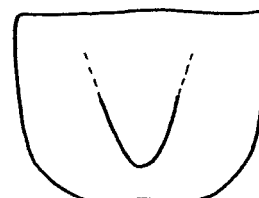
20. *hamata* ♂



21. *pulchella* ♀



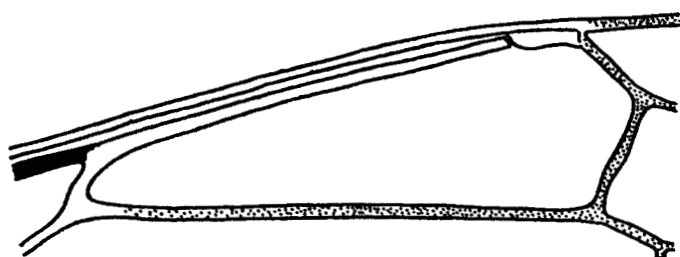
22. *comata* ♀



23. *melanaspis* ♂

PLATE III

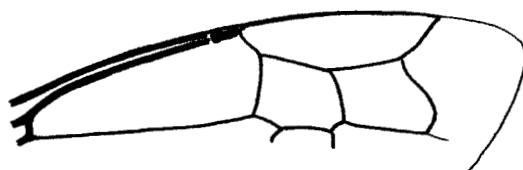
- Figs. 24, 25. *Microbembex*, first submarginal cell of forewing cell of forewing.
Fig. 26. *Bembix*, submarginal cell area of forewing.
Fig. 27. *Microbembex*, submarginal cell area of forewing.
Fig. 28. *Bembix*, submarginal cell area of forewing.
Figs. 29, 30. *Bicyrtes*, tergite VI.
Figs. 31, 32. *Bembix*, profile of midfemur.
Fig. 33. *Bembix*, tergite VII.
Figs. 34, 35. *Bicyrtes*, profile of midfemur.



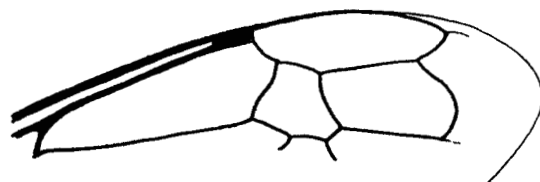
24. *argyropleura* ♂



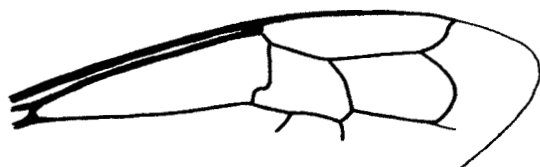
25. *californica* ♂



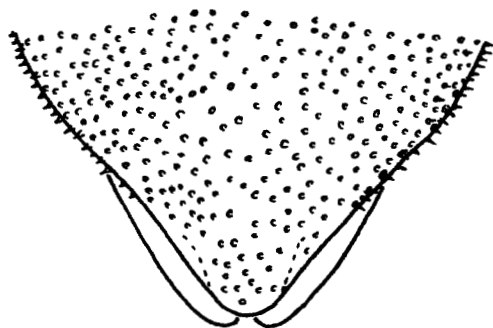
26. *dentilabris* ♂



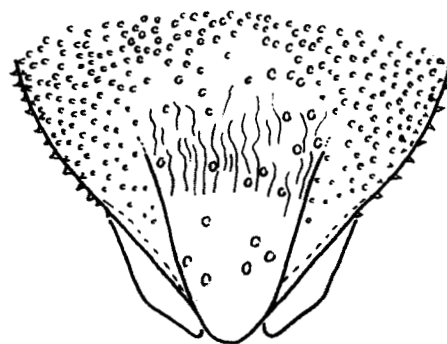
27. *californica* ♂



28. *comata* ♂



29. *ventralis* ♀



30. *capnoptera* ♀



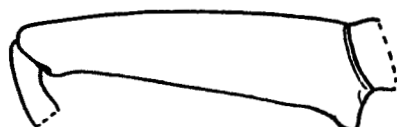
31. *occidentalis* ♂



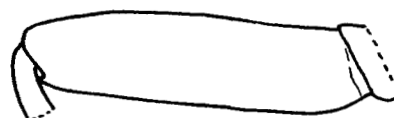
33. *frommeri* ♂



32. *comata* ♂



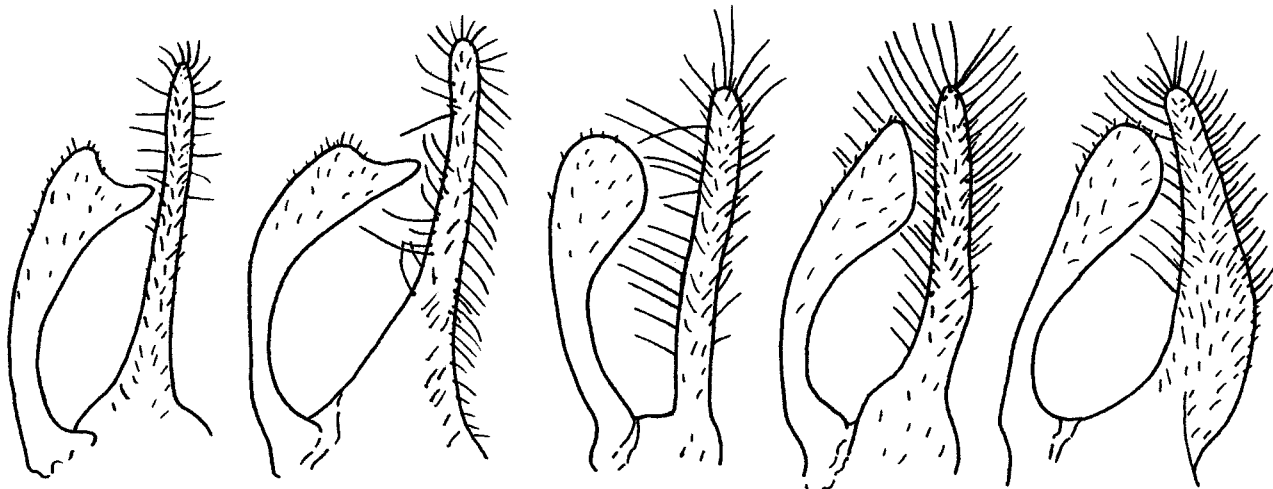
34. *ventralis* ♂



35. *capnoptera* ♂

PLATE IV

Figs. 36-46. *Bembix* digitus (at left) and cuspis. Figures are comparative and not drawn to scale.



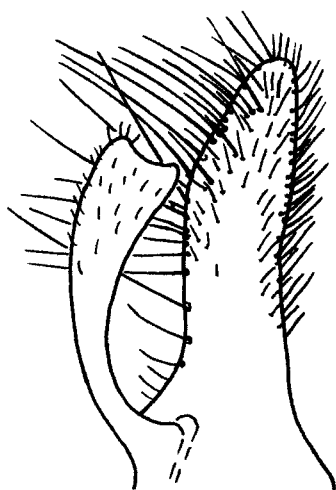
36. *rugosa*

37. *frommeri*

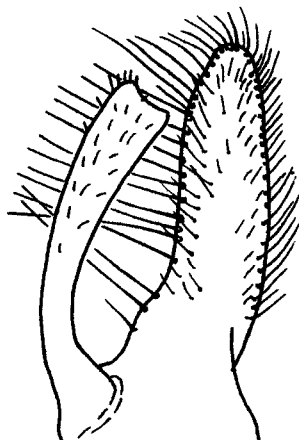
38. *comata*

39. *pallidipicta*

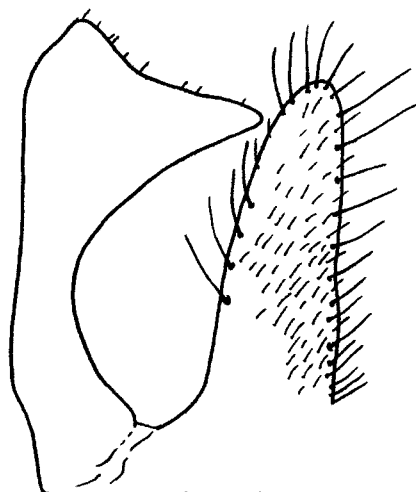
40. *occidentalis*



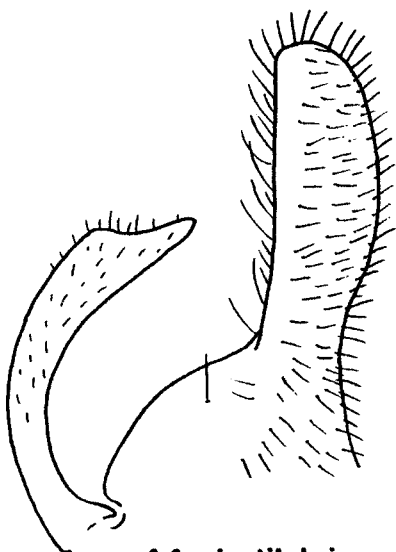
41. *sayi*



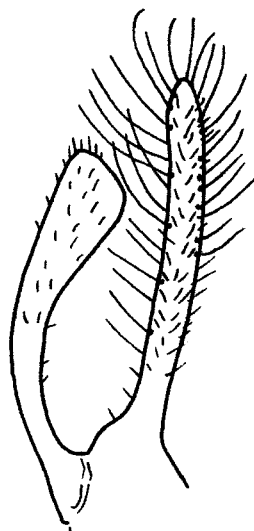
42. *amoena*



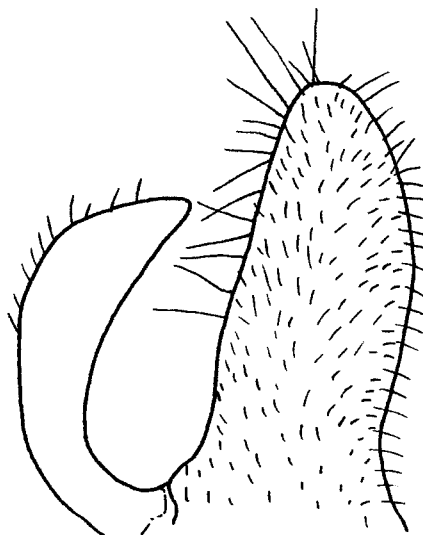
43. *gillaspys*



44. *dentilabris*



45. *melanaspis*



46. *stenebdoma*

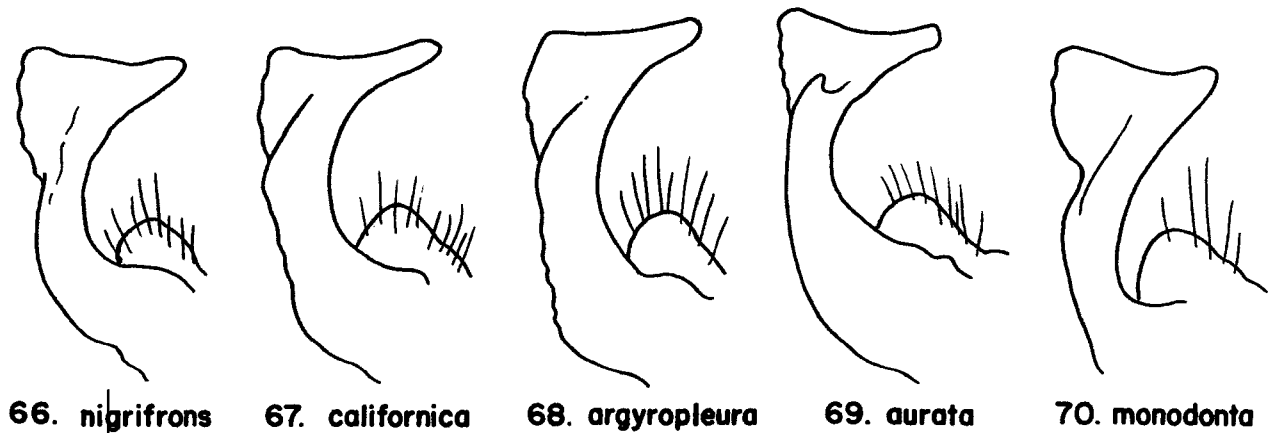
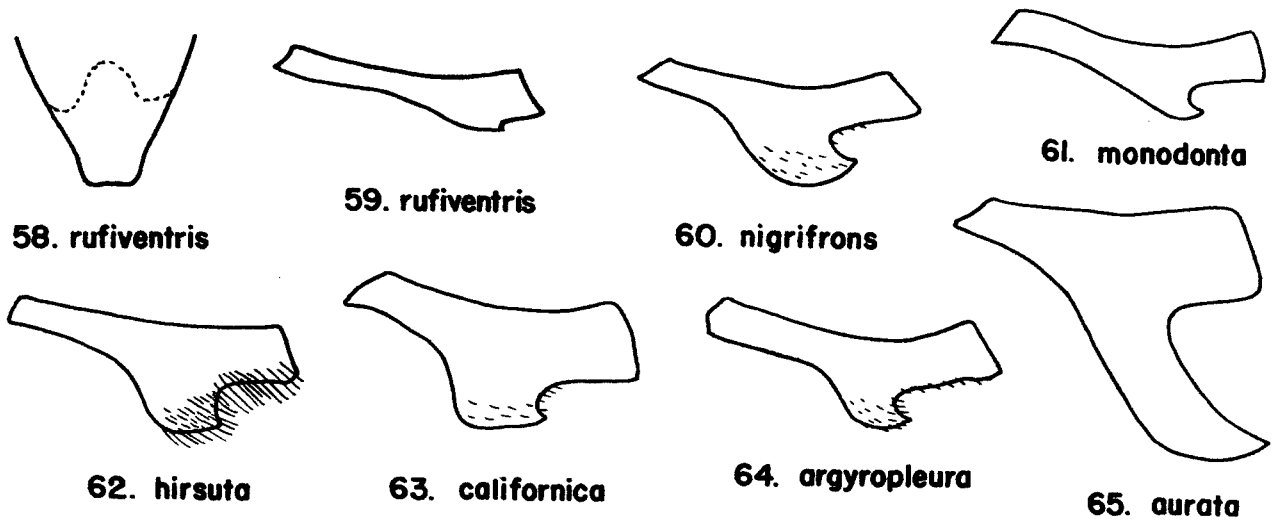
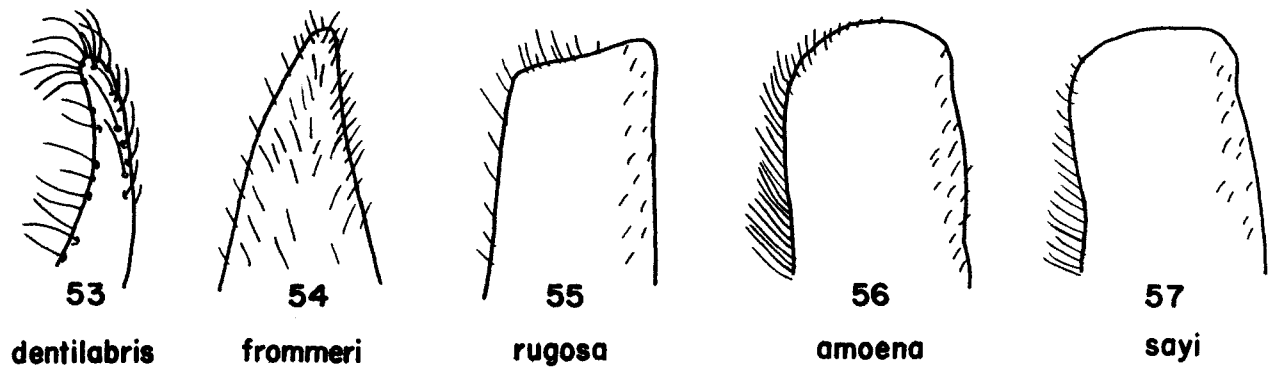
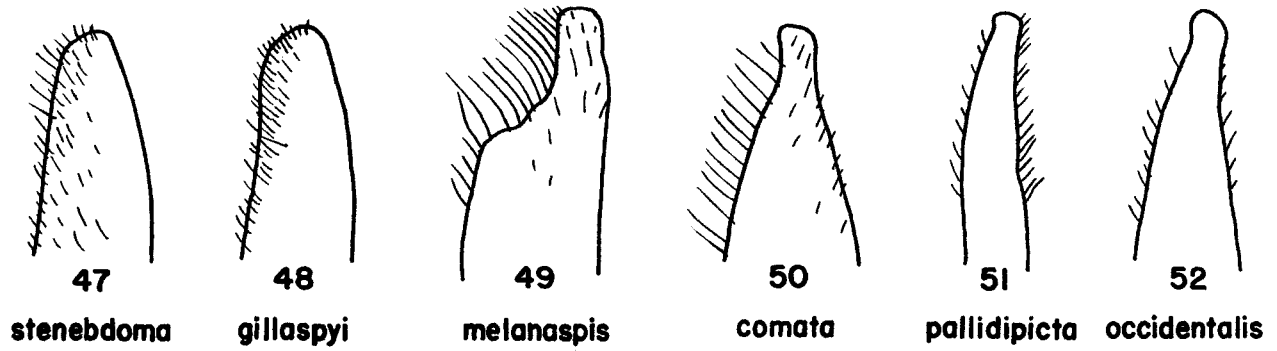
PLATE V

Figs. 47-57. *Bembix*, apex of gonostyle, right ventral.

Fig. 58. *Microbembex*, male tergite VII.

Figs. 59-65. *Microbembex*, median keel of male sternite II in profile.

Figs. 66-70. *Microbembex*, digitus (at left) and cuspis.



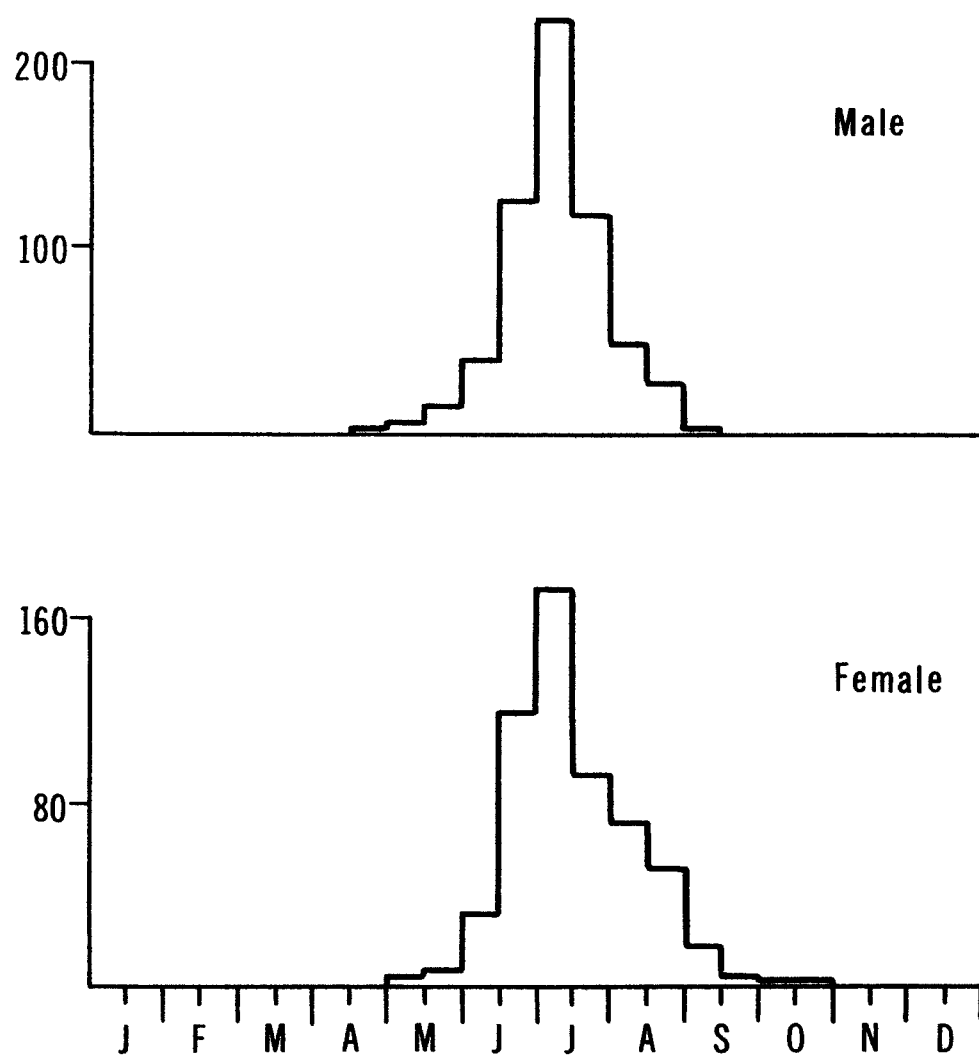


Fig. 71. Seasonal distribution of *Bembix amoena* (Handlirsch).

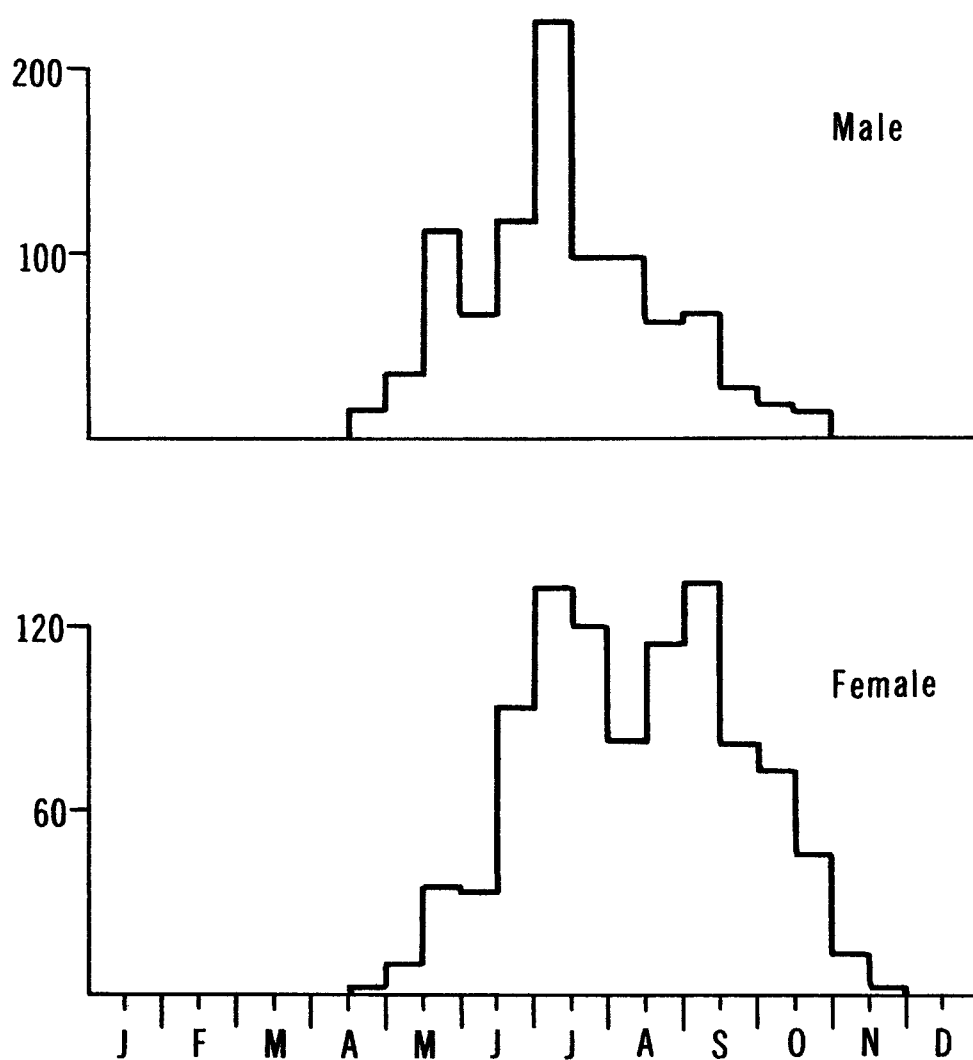


Fig. 72. Seasonal distribution of *Bembix americana comata* J. Parker.

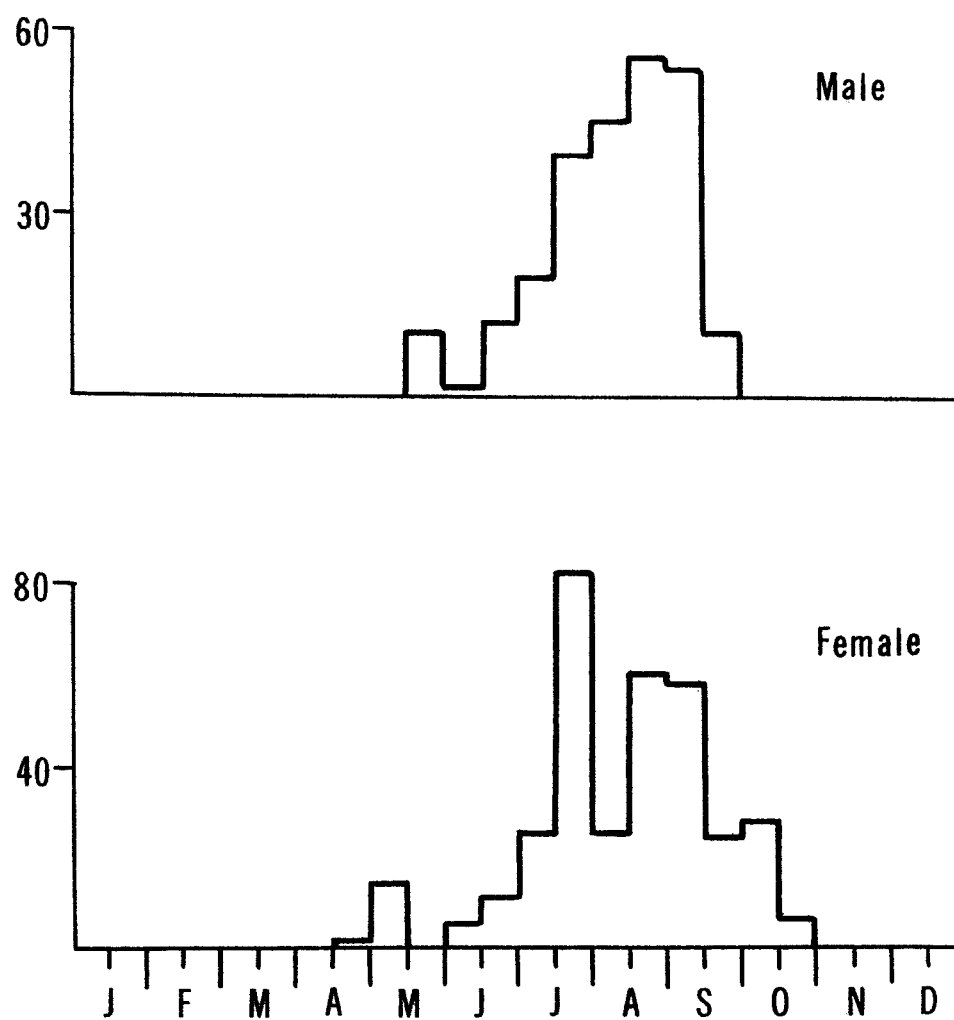


Fig. 73. Seasonal distribution of *Bembix occidentalis* W. Fox.

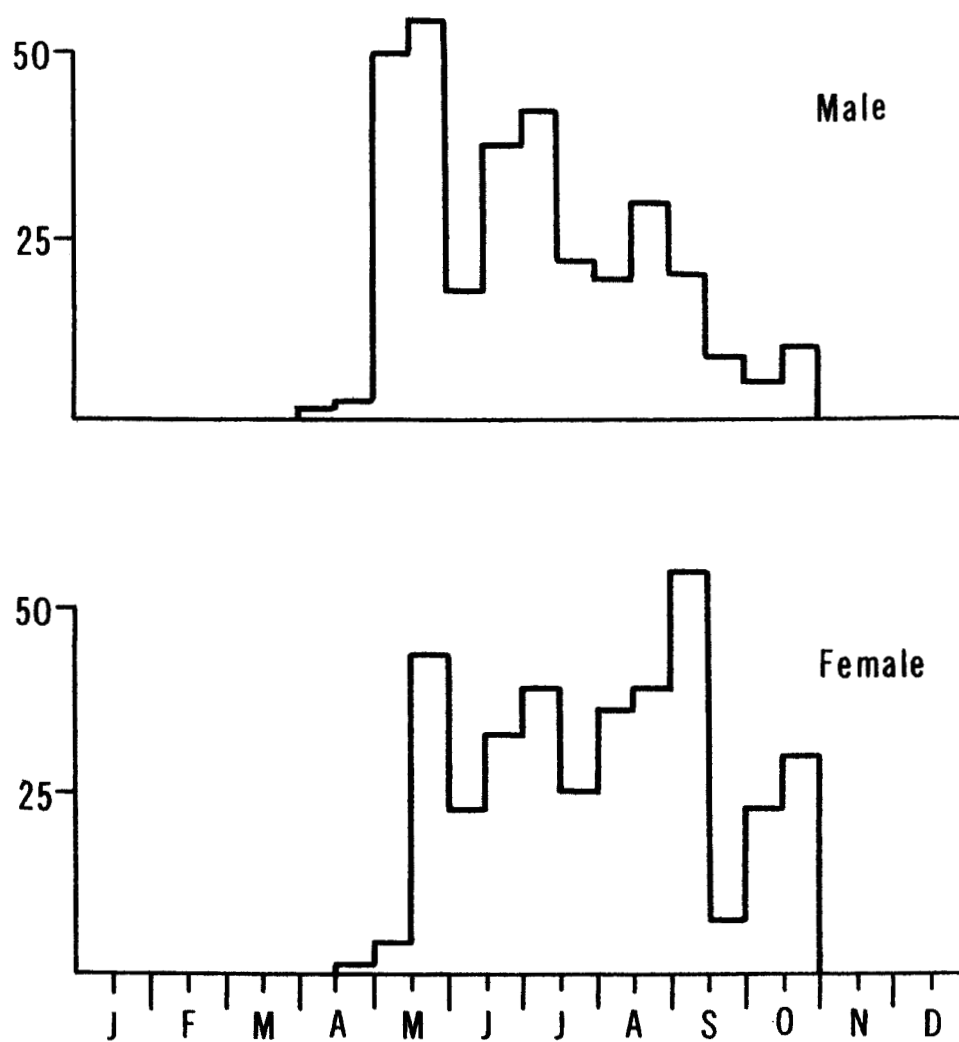


Fig. 74. Seasonal distribution of *Microbembex californica* R. Bohart.

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