A RECLASSIFICATION OF THE SPHECINAE

With a Revision of the Nearctic Species of the Tribes Sceliphronini and Sphecini

(Hymenoptera, Sphecidae)

BY

R. M. BOHART and A. S. MENKE

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ERRATA

p. 92, line 1: For Kuhlhorn read Kühlhorn.

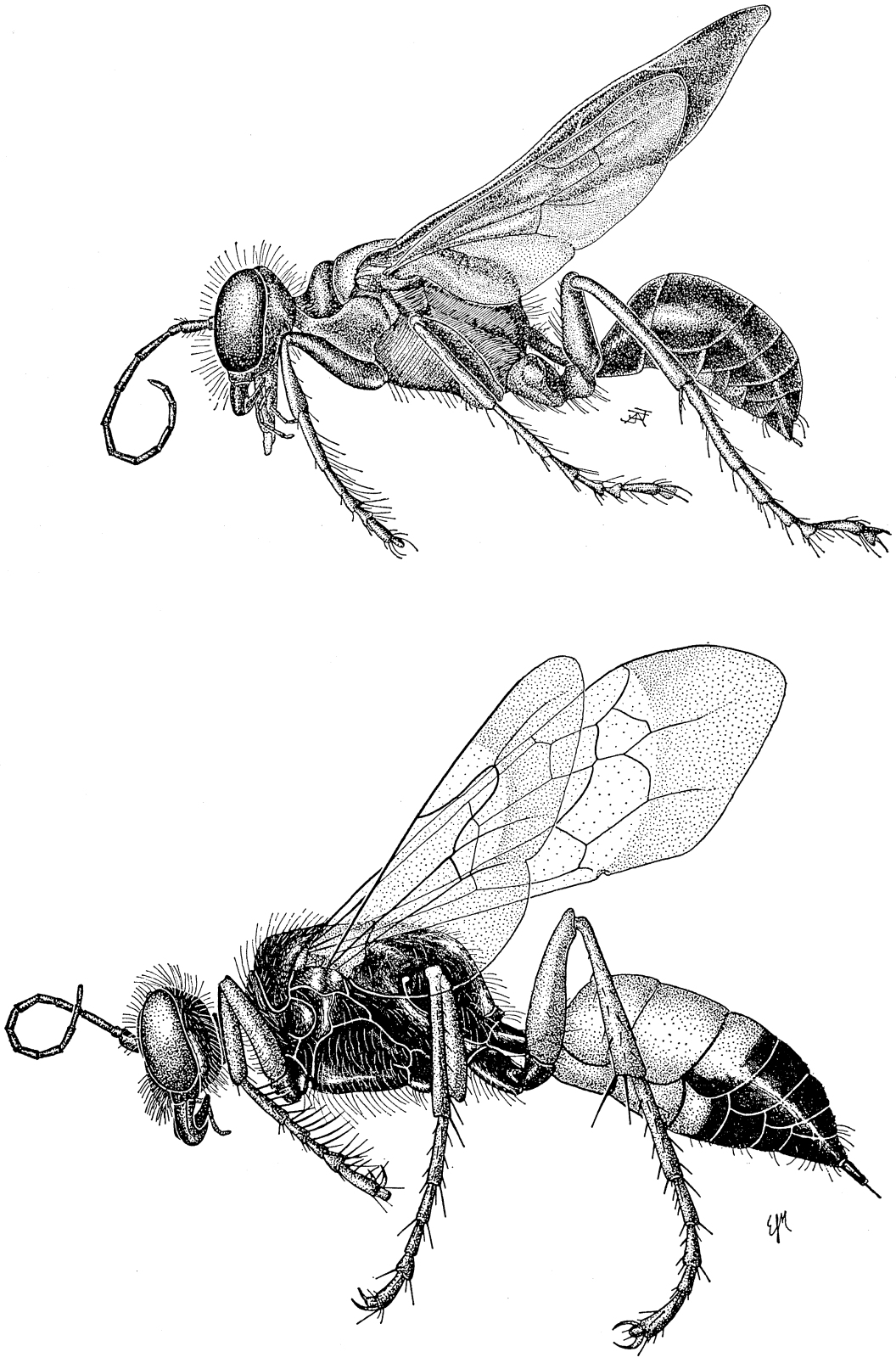
p. 92, line 19: For H. Leach read H. Leech.

p. 103, line 21: For Chlorion cyaeum Dahlbom read Chlorion cyaneum Dahlbom.

p. 119, line 37: For flagellomeres III or III and IV with fossulae (etc.) read flagellomeres IV or III and IV with fossulae (etc.).

p. 177, line 21: For author read autour.

p. 179, line 5: For Musebeck read Muesebeck.



Frontispiece. Upper figure: *Palmodes pacificus* Bohart and Menke, ♀ ; illustration by Miss Judy Jay. Lower figure: *Sphex ichneumoneus* (Linnaeus), ♀ ; illustration by Miss Ellen Montgomery.

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BY

R. M. BOHART and A. S. MENKE

(A contribution from the Department of Entomology and Parasitology, University of California, Davis)

INTRODUCTION

THE SUBFAMILY SPHECINAE includes the well-known mud daubers and thread-waisted wasps, species of which occur in nearly all parts of the world. Their large size and interesting habits have made them favorite subjects for biological investigations. The habits often involve complex instinctive mechanisms that indicate a high order of nervous organization. An intriguing example, which has stirred controversies of "reason versus instinct," is the use of a pebble as a "tamping tool" by species of *Ammophila* Kirby.

In this revision we are dividing the Sphecinae into three tribes and five subtribes, all of which have representatives in the New World. The seventeen genera recognized are *Ammophila* Kirby, *Podalonia* Spinola, *Eremochares* Gribodo, *Parapsammophila* Taschenberg, *Isodontia* Patton (with subgenus *Murrayella* Bohart and Menke), *Fernaldina* Bohart and Menke, *Sphex* Linnaeus, *Prionyx* Vander Linden, *Palmodes* Kohl, *Chlorion* Latreille, *Stangeella* Menke, *Trigonopsis* Perty, *Dynatus* Lepeletier, *Podium* Fabricius, *Sceliphron* Klug, *Chalybion* Dahlbom, and *Hemichalybion* Kohl. In the Nearctic fauna we include eleven genera and forty-six species, excluding those in the Ammophilini.

Much new synonymy has been given, some new names have been necessary, two new species and a new subspecies have been described, and a number of lectotypes have been established. This has been made possible by an examination of type specimens by one or both authors. A visit to most of the important European museums by Bohart in 1960 with the aid of a grant from the Guggenheim Foundation was an essential part of this investigation. We gratefully acknowledge the coöperation of the following individuals and the institutions with which they are connected (reference symbols for institutions are given in parentheses): Eric Kjellander, Naturhistoriska Riksmuseet, Stockholm (STOCKHOLM); Hugo Andersson, Lunds Universitets Zoologiska Institution (LUND); Børge Petersen, Universitetets Zoologiske Museum, Copenhagen [including the Fabrician Collection on loan from the University of Kiel (KIEL)] (COPENHAGEN); J. van der Vecht, Rijksmuseum van Natuurlijke Historie, Leiden (LEIDEN); J. Leclercq, Institut Agronomique de l'Etat Gembloux, Belgium; S. Kelner-Pillault, Museum National d'Histoire Naturelle, Paris (PARIS); G. Steinbach, Zoologischen Museum der Humboldt-Universität, East Germany (BERLIN); Director, Zoologisches Institut, Martin-Luther-Universität, Halle, East Germany (HALLE); L. Móczár, Magyar Nemzeti Múzeum, Budapest, Hungary (BUDAPEST); F.

Kuhlhorn, Zoologische Sammlung des Bayerischen Staates, Munich, West Germany (MUNICH); Max Fischer, Naturhistorisches Museum, Vienna (VIENNA); Claude Besuchet, Museum d'Histoire Naturelle, Geneva (GENEVA); J. de Beaumont, Musee Zoologique, Lausanne, Switzerland; Delfa Guiglia, Museo Civico di Storia Naturale, Genoa (GENOA); Leo Pardi, Instituto e Museo di Zoologia, Università di Torino (TURIN); M. Salfi, Museo Zoologico della Università di Napoli (NAPLES); I. H. H. Yarrow, British Museum (Natural History) (BMNH); W. R. M. Mason, Canadian Dept. of Agriculture (CANADA); A. Willink, Universidad Nacional de Tucumán, Argentina; K. V. Krombein, U. S. National Museum (USNM); J. A. G. Rehn, and H. J. Grant, Jr., Philadelphia Academy of Sciences (ANSP); J. Rozen, American Museum of Natural History (AMNH); H. E. Evans, Museum of Comparative Zoology, Harvard College (MCZ); H. Dietrich, Cornell University (CORNELL); S. W. Frost, Pennsylvania State University; T. Moore, University of Michigan Museum of Zoology (UMMZ); G. Byers, University of Kansas (KU); W. Atyeo, University of Nebraska (NEBR); J. A. Gillaspy, private collection; A. R. Gittins, University of Idaho; M. James, R. W. Dawson, Washington State University; R. C. Bechtel, Nevada State Dept. of Agriculture; M. Wasbauer, California State Dept. of Agriculture (CSDA); F. S. Truxal, Los Angeles County Museum (LACM); H. Leach, C. MacNeill, California Academy of Sciences (CAS); H. H. Ross, Illinois Natural History Survey, University of Illinois; H. Dybas, Chicago Natural History Museum; G. Wallace, Carnegie Museum, Pittsburgh; University of California: P. D. Hurd, Jr., U. C. Berkeley (CIS); P. H. Timberlake, U. C. Riverside; J. N. Belkin, U. C. Los Angeles; A. T. McClay, U. C. Davis (UCD).

Reference symbols for other depositories are: University of Uppsala, Uppsala, Sweden (UPPSALA); Musée de la Province, Quebec, Canada (QUEBEC); Museo Nacional de Buenos Aires (MNBA).

BIOLOGY OF THE SPHECINAE

The Sphecinae are solitary wasps that provision their nests with Orthoptera, spiders, or caterpillars. They may burrow in the ground, make mud nests above ground, inhabit twigs, or even act as inquilines. Nests may be solitary or in colonies, and mass or progressive provisioning in some of the higher forms indicates an approach to a social state. The principal parasites attacking this subfamily are miltogrammine Sacrophagidae and Strepsiptera of the family Stylopidae (*Pseudoxenos*). Summaries of the relationship between Sphecinae and stylopids have been given by Bohart (1937, 1941) and Beaumont (1955). The various papers of Rau, Evans, Krombein, Ferton, and Iwata that are cited in the bibliography present much of the known biology of the Sphecinae.

GEOGRAPHIC VARIATION

Like many other North American wasps, the widespread species of Sphecinae undergo color changes in different parts of their range. Specimens from the western United States tend to have lighter wings than those from the east, and body color is usually darker in the eastern United States. The dividing line between these two areas often corresponds roughly with the 100th meridian. Various

climatic factors, especially humidity, undoubtedly play a large part in the color differences in these wasps. In many species the change from light to dark is continuous but in some it is rather abrupt, leading some workers to give subspecific status to these geographic color forms. In the extreme southeast, e.g., Florida, specimens may be very dark. A north-south color change is seen in some United States species, especially *Sceliphron caementarium.* (For specific examples of color variation see the discussion under *S. caementarium* and *Sphex ichneumoneus.*)

Morphological variation apparently occurs below the species level in several cases. The antennal fossulae of the male are generally rather constant specific characters, but within some species they appear to vary in width and in number. Southward there is a gradual increase in the number of fossulae in *Isodontia fuscipennis:* in Mexico most specimens have two fossulae but a total of four or five is reached in different parts of South America. In *Sphex ichneumoneus* from the United States and parts of South America the fossulae are broad, but in specimens from the Guianas they may be narrow. This type of variation also occurs occasionally in *Prionyx thomae.*

HISTORY OF CLASSIFICATION

Modern classification of the Sphecinae dates primarily from the papers of Franz Friedrich Kohl, especially the several parts of his "Die Hymenopterengruppe der Sphecinen" (1890, 1902, 1907, 1918) and his "Die Gattungen der Spheciden" (1896). Although essentially conservative, these were monumental works of the highest caliber. In addition to bringing together scattered information on the subfamily, Kohl subjected it to critical evaluation. He recognized three genera, *Sphex, Sceliphron,* and *Ammophila.* These correspond roughly to the modern tribes, and the "groups" within each to the genera recognized in this paper.

In America, W. H. Ashmead (1899) made several changes in classification and nomenclature, the most important of which was the expansion of the Sphecinae into four subfamilies, Sphecinae, Sceliphroninae, Podiinae, and Ammophilinae.

The most recent comprehensive study of North American sphecine wasps is that of H. T. Fernald, "The Digger Wasps of North America and the West Indies belonging to the Subfamily Chlorioninae" (1906). This was a valuable contribution since it included keys and descriptions of all forms known at that time. Unfortunately Fernald showed dubious judgment in using the name *Chlorion* Latreille in place of *Sphex* Linnaeus, and *Sphex* in place of *Ammophila* Kirby. This action started a controversy that is still active. Except for the name changes, Fernald's arrangement followed that of Ashmead.

V. S. L. Pate's (1937) review of the generic names of the sphecoid wasps was a thorough compilation of existing genera and their type species. Honoré (1943) discussed the Palaearctic generic names. W. D. Murray in the Hymenoptera Catalog (1951) returned to a generic classification derived from Kohl. However, he retained the quadripartite division of Ashmead, reducing the subfamilies to tribes. J. van der Vecht (1957*b*) elevated some subgenera of *Sphex* to genera. In other papers (1954, 1957*a,* 1959, 1961*a*) van der Vecht contributed valuable type information and synonymical data for species described by early workers in the subfamily.

J. Leclercq (1955) in his fine work on African sphecine wasps essentially followed Kohl but was more liberal in his assignment of generic status to *Chlorion s.s.* and *Chalybion*. In the supplement to the Hymenoptera Catalog, Krombein (1958*a*) returned to Fernald's interpretation of *Chlorion* and *Sphex*. H. E. Evans (1958*b*) used the subgenera of *Sphex, sensu* Murray, in the generic sense, and in larval studies, Evans and Lin (1956) and Evans (1959*a*) contributed important phylogenetic information. The close relationship of the larvae of *Podium* and *Sceliphron* pointed out by Evans, agrees with our own ideas based on studies of adults.

Bohart (1958), Menke (1961), and Bohart and Menke (1961) in separate papers on *Prionony x, Chlorion,* and *Palmodes* accorded them generic rank.

In the present classification we have considered the various categories on a world basis and have attempted to assign a status to each commensurate with its structural and biological characters. This has resulted in the recognition of three tribes through the combination of Sceliphronini and Podiini. The Sphecini have been divided into two subtribes: Sphecina, including *Sphex s.s., Isodontia,* and *Fernaldina;* and Prionyxina, including *Prionyx* (instead of *Prionony x*) and *Palmodes*.

At the generic level we have placed *Chlorion* and *Stangeella* in the Sceliphronini and have given generic status to *Isodontia, Palmodes, Prionyx, Sphex s.s., Trigonopsis* and *Dynatus*. *Fernaldina* has been proposed for *Sphex lucae* Saussure. After studying the various entities related to *Prionony x* (e.g., *Prionyx, Calosphex, Harpactopus,* etc.), we have decided to treat them as species groups under the oldest name, *Prionyx*. Furthermore, a similar study of *Isodontia* has led to the description of a new subgenus, *Murrayella.*

The principal workers on North American species have been Fabricius (1775, 1793, 1804), Dahlbom (1843–1845), Smith (1856), Saussure (1867), Cresson (1865, 1872), and Fernald (1906, 1927, 1934). Faunal works useful in the study of the Sphecinae are those of Willink (1951), South America; Arnold (1928), Africa; and Kohl (1890–1918), a world revision. Dalla Torre's "Catalogus Hymenopterorum" (1897) listed approximately 650 species for the subfamily.

PHYLOGENY

The progenitor of the Sphecinae was presumably a black fossorial wasp with short mouthparts, a short petiole, and only one subsidiary tooth on the claw. The evolution of these wasps has evidently proceeded along several lines from a basic "primitive" cavity-nesting (*Parapsammophila, Podium, Isodontia*) or ground-nesting (*Sphex, Stangeella*) type to the specialized mud nesters (*Sceliphron* and *Trigonopsis*. The inquilinous habit of certain species of *Chalybion* which use *Sceliphron* nests could be considered specialized, but many species of *Chalybion* use cracks and other preëxisting holes, and those species using *Sceliphron* nests (e.g., *C. californicum* and *C. zimmermanni*) probably use other cavities for nests as well.

On the basis of our studies we have listed in table 1 the characters presumed to be unspecialized or primitive and those which are specialized or derived. Using these characters as a yardstick, it can be concluded that such genera as *Chlorion*

TABLE 1

STRUCTURAL CHARACTERS OF APPARENT PHYLOGENETIC SIGNIFICANCE IN THE SUBFAMILY SPHECINAE

Unspecialized or primitive	Specialized or derived
1. A single tooth on inner margin of claw.	1. Claw simple or with 2–6 teeth on inner margin.
2. Forewing with 3 submarginal cells.	2. Forewing with 2 submarginal cells.
3. Recurrent veins of forewing one each to second and third submarginal cells.	3. Recurrent veins of forewing both to second submarginal cell or one each to first and second.
4. Petiole about as long as hind coxa.	4. Petiole much longer than hind coxa.
5. No yellow or white markings.	5. With yellow or white markings.
6. Complete episternal suture and stigmatal groove.	6. Reduced episternal suture and obsolete stigmatal groove.
7. Short mouthparts.	7. Elongate mouthparts.
8. Metapleuron without a special groove.	8. Metapleuron specially grooved for reception of hind femur.
9. Psammophore present in female.	9. Psammophore absent.
10. No fossulae on male antenna.	10. Fossulae on one or more flagellomeres of male.
11. Abdominal sternites without cilia or velvety patches.	11. Abdominal sternites with cilia or velvety patches.
12. Pygostyles present on eighth tergite of male.	12. Pygostyles absent.

and *Parapsammophila* are relatively primitive whereas *Sceliphron, Ammophila, Prionyx, Isodontia,* and *Trigonopsis* are definitely specialized.

Changes in habits must have proceeded along with those affecting structure. Evans (1958*a*, 1958*b*) presented a series of steps representing levels of social evolution in the Sphecidae. Many of his conclusions are incorporated in our summary of ethological evolutionary features (table 2).

Additional studies of habits of several genera, especially *Parapsammophila, Fernaldina, Prionyx,* and those of the Sceliphronini, will have to be made before the relation of ethology to phylogeny can be fully understood. However, using all the known generic characters listed in tables 1 and 2, it is possible to con-

TABLE 2

ETHOLOGICAL CHARACTERS OF APPARENT PHYLOGENETIC SIGNIFICANCE IN THE SUBFAMILY SPHECINAE

Unspecialized or primitive	Specialized or derived
1. Prey captured before nest built.	1. Nest built before prey captured.
2. Nests in preëxisting holes or in ground, or no nest made.	2. Mud nests constructed.
3. Nest burrow with one cell.	3. Nest burrow with many cells.
4. Single provisioning of cells.	4. Progressive provisioning of cells.
5. Prey orthoptera.	5. Prey spiders or caterpillars.
6. Nesting solitary.	6. Nesting gregarious.
7. Prey dragged to nest.	7. Prey flown to nest.

struct a provisional dendrogram (fig. 1) that indicates some of the evolutionary steps as well as the relative specialization of the various genera. It must be pointed out that *Fernaldina, Dynatus,* and *Hemichalybion* have been placed on morphological characters only. Their biologies are unknown and must be inferred on the basis of morphological similarities to other genera.

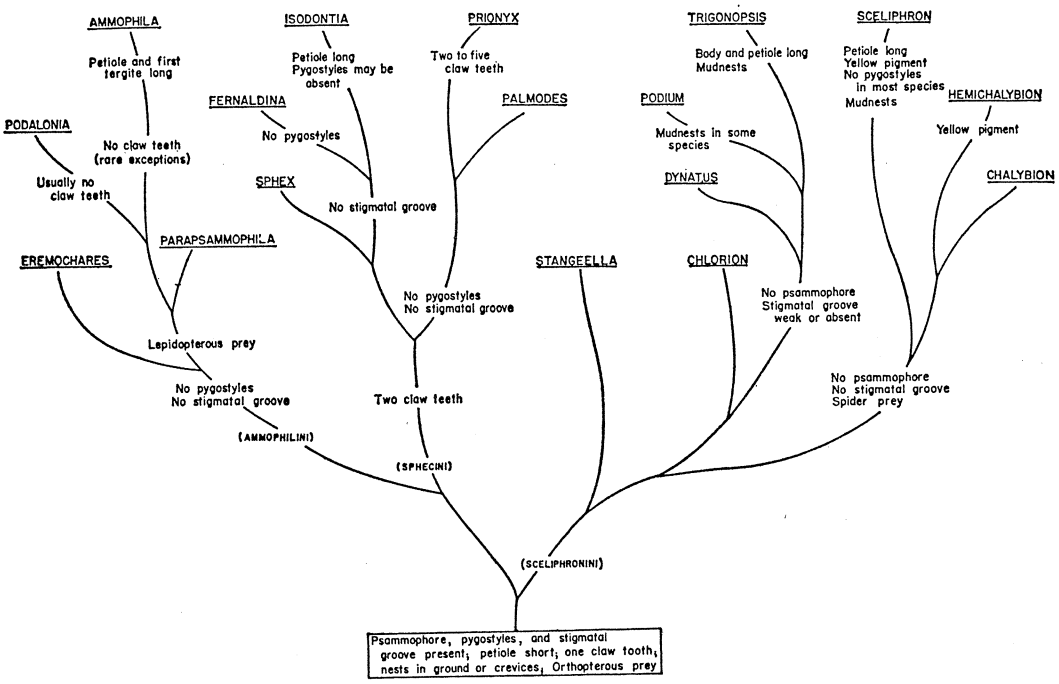


Fig. 1. Dendrogram of relationships in the Sphecinae.

In the *Sceliphron* line we have given considerable weight to the development of yellow coloration in *Sceliphron* and *Hemichalybion.* The importance of this pigment production as an evidence of specialization has been emphasized by Leclercq (1954).

Certain incongruities are apparent. For example, *Sphex* appears rather unspecialized morphologically, but the digging of the nest before obtaining prey, flying with prey, the gregarious habit, and the semiprogressive provisioning are an indication of advanced status. Even so, we have placed it below the longer-petioled, cavity-nesting genus, *Isodontia.* Furthermore, species groups within *Prionyx* exhibit different levels of nesting procedures, with the *pumilio* group the most advanced. According to Claude-Joseph (1928), the latter are gregarious, construct the nest before obtaining prey, and fly with the prey, whereas the opposite is true of the *thomae* group. The *kirbyi* group is intermediate, building the nest first but not flying with prey and not being gregarious. The related genus *Palmodes* occupies a position similar to the *kirbyi* group since it builds the nest first but is solitary. For this reason we have placed it slightly below *Prionyx.*

SYSTEMATICS

Terminology

The more unfamiliar terms used in the descriptions and keys, or those which need exact definition, are listed below:

abdominal segment, tergite, or sternite: apparent segment, tergite or sternite, without regard to propodeum.
clypeal length: distance from suture between tentorial pits and free apical margin of clypeus.
flagellomere: segment of the antennal flagellum.
fossulae: oblong or oval flattened areas bounded by ridges and found on flagellomeres of some male antennae.
gaster: swollen part of abdomen beyond petiole and including tergite of first apparent abdominal segment (except *Ammophila*—see *petiole*).
interocular space: area bounded laterally by inner eye margins, dorsally by a transverse line tangent to anterior margin of anterior ocellus, and ventrally by a line through clypeus tangent to lower eye margins.
palpomere: palpal segment.
petiole: long cylindrical sternite of first apparent abdominal segment; in *Ammophila* tergite of this segment also elongate, giving petiole a two-segmented appearance.
postoccipital ring or carina: circular ridge surrounding cervical opening.
propodeal enclosure: horizontal dorsal area of propodeum sometimes bounded by a carina or seam.
psammophore: "sand basket" formed by long, stout setae on outer margin of fore legs of female wasps; ventral margin of mandibles and postocular area of head may bear setae forming part of "basket"; psammophore sometimes feebly developed in males.
pygostyles: paired palpus-like appendages arising from base of tergite VIII in some males; appendages normally hidden beneath apex of tergite VII.
stigmatal groove: depression extending from base of hind coxa to metathoracic spiracle.
tarsomere: tarsal segment.

Publication Dates

We have exercised as much care as possible in citing publication dates of various works in this paper. In most cases we have followed either Horn and Schenklings' "Index Litteraturae Entomologicae" or Sherborn's "Index Animalium" for dates of the older works. Several publications have not been satisfactorily dated by these two bibliographies, however, and we have made reference to more recent discussion in these cases. We are summarizing these data here to avoid lengthy discussions later in the paper.

J. Bequaert (1926) gave a detailed coverage of the publication dates for Guérin-Méneville's Hymenoptera portion of Duperrey's "Voyage de la Coquille." The text was published after the plates, and the dates given in the work are 1830 and 1826 respectively. However, Bequaert has shown that plates VIII and IX (Hymenoptera) appeared in 1831, and that the text portion dealing with insects, pages 57–302 of volume 2, Zoology, was apparently published in 1838.

A second Guérin-Méneville work, the "Insectes" portion of Cuvier's "Iconographie du Regne Animal," volume 3, pages 1–576, is dated 1829–1838. The date on the title page of volume 2 of plates is 1829–1844. J. van der Vecht (1957*a*) has cleared up the publication dates. The plates dealing with Hymenoptera, 64 through 75, in volume 2 of "Planches des Animaux invertebres," were published in 1835. The text appeared in 1844.

Many new species were figured on the plates of these two Guérin-Méneville works, and under the International Rules of Zoological Nomenclature, the illustrations are valid descriptions, despite the fact that the text of the descriptions appeared later.

The date of volume 10 of the Zoology portion of "Encyclopedie Methodique" is usually cited as 1825 in bibliographies. However, Sherborn and Woodward (1906), in an excellent breakdown of the publication dates of the various volumes and livraisons (parts), stated that volume 10 appeared in two livraisons, numbers 96 and 100. Livraison 96 includes pages 1–344 and was published in 1825. Livraison 100 includes pages 345–832 and was published in 1828.

As Pate (1935) pointed out, this means that the well known Old World species *Prionyx albisectus* (Lepeletier and Serville) will have to be synonymized under the earlier name *Prionyx kirbyi* (Vander Linden). *P. albisectus* was described on page 462 (1828) of volume 10 of the "Encyclopedie Methodique." Vander Linden's name was published in 1827.

It is generally known that Dahlbom's "Hymenoptera Europaea," volume 1, *Sphex,* was published in three fascicles, but the dates and pages involved have never been determined satisfactorily. Usually the work is simply cited 1843–1845. Sherborn (1922, p. xli) gave the dates as 1844–1845 but was not sure of the pagination of the three fascicles. Dahlbom himself provided some of the answers to this problem in his introductory section "Ratio Operis," pages i–xliv, which also included four foldout table pages. On page xxvi the fascicle dates are given as follows: I, 1843, II, 1843–44; III, 1844–45. On page xv, fascicle III is said to be composed of pages 353–426. The pagination of fascicles I and II is not given by Dahlbom. Engelmann (1846) stated that fascicle I consisted of the families Sphegidae, Ampulicidae, Pompilidae, Larridae, and Nyssonidae. These "families" were covered on pages 1–172 of Dahlbom's work, and it seems safe to assume that this is the correct pagination for fascicle I. Therefore, pages 173–352 constitute fascicle II.

The data on Dahlbom's work can be summarized as follows:

Fascicle I: pages 1–172, 1843.
Fascicle II: pages 173–352, 1843–1844.
Fascicle III: pages 353–426, 1844–1845.
Ratio Operis: pages i–xliv, 1845.
Supplimentum I: pages 427–528, 1845.

Verhoeff (1948, p. 183) gave evidence to show that Lepeletier's 1845 work "Histoire Naturelle des Insectes, volume III, Hyménoptères" probably was published earlier than the 1845 section of Dahlbom's work. Still to be explained are the compound dates for fascicles II and III of "Hymenoptera Europaea."

Volume 1 of Drury's "Illustrations of Natural History" published in 1770 contains descriptions of species, but no names are given. The names applying to these descriptions were supplied later in the index to volume 1, published in volume 2, 1773. According to Opinion 474, page 7, in the "Official List of Works Approved as available for Zoological Nomenclature, First installment" (1958), 1773 is to be used as the date for these names, not 1770.

Subfamily SPHECINAE

Adults.—Abdomen petiolate; no scutal lamina over tegula; forewing usually with three submarginal cells, without appendiculate marginal cell; hindwing with large anal lobe reaching to apex of submedian cell or beyond; first and second anal folds convergent or parallel; eyes entire.

Larvae.—(According to Evans and Lin, 1956.) Integument spinulose or granulose; head setae short or absent; parietal bands well developed; antennal papilla absent; labrum biconvex; mandible stout, terminating in four teeth; galea as long as or longer than maxillary palpus; spinneret consisting of a transverse slit with prominent raised lips.

The transverse spinneret of the Sphecinae is unique in the family Sphecidae, but is similar to that of the Ampulicidae, thus linking the two families. Evans (1959*a*) inferred that the larvae of the Sphecinae are the most primitive of the family.

KEY TO TRIBES OF WORLD SPHECINAE

1. Tarsal claw without teeth along inner margin, *or* if one or two basal teeth present, then petiole longer than hind coxa, and gaster two or more times as long as broad; hind tarsomeres without lamellate oval intersegmental pads ventrally; second submarginal cell in North American species receiving both recurrent veins . . . . . Ammophilini

   Tarsal claw with one or more teeth along inner margin, at least on fore and mid legs; if gaster and petiole elongate, then claws of fore and mid legs each with a single *median* tooth on inner margin; hind tarsomeres with lamellate oval intersegmental pads ventrally, *or* one recurrent vein reaching first or third submarginal cell, or with both these characters 2

2. Tarsal claws of fore and mid legs each with two or more basal teeth along inner margin; ventral terminal bladelike setae of last tarsomere very broad, separated by not more than twice the width of one seta; tarsi beneath without oval intersegmental pads; second submarginal cell receiving first recurrent vein only . . . . . Sphecini

   Tarsal claws of fore and mid legs each with a single median or rarely subbasal tooth along inner margin; ventral terminal bladelike setae of last tarsomere narrow, separated by more than twice the width of one seta; tarsi beneath frequently with oval intersegmental pads; second submarginal cell receiving one or both recurrent veins . Sceliphronini

Tribe SCELIPHRONINI

Tarsal claw with single tooth toward middle of inner margin (subbasal in *Stangeella*), at least on front and middle legs; ventral terminal bladelike setae of fifth hind tarsomere narrow, separated by more than twice a setal breadth (fig. 112, *b*); tarsi ventrally with intersegmental pads (fig. 112, *a*) (except in *Hemichalybion* and some *Podium*); wing venation varying according to genus; third maxillary palpomere usually swollen asymmetrically.

KEY TO GENERA OF WORLD SCELIPHRONINI

1. Second submarginal cell receiving first recurrent vein only (second submarginal interstitial in *Stangeella*); psammophore present in female; male antenna frequently with fossulae . 2

   Second submarginal cell receiving both recurrent veins, or second only; psammophore absent; male antenna sometimes with fossulae 3

2. Claw tooth mesal; female clypeus transverse with a broad median truncation, the truncation bearing three or more teeth or lobes, or teeth lateral to truncation; female clypeal length equal to or less than one-half least interocular distance . . . . *Chlorion* Latreille

   Claw tooth subbasal; female clypeus produced, apex sinuate, without teeth; female clypeal length nearly equal to least interocular distance (Neotropical) . . . . *Stangeella* Menke

3. Antenna inserted at about lower one-third of interocular space, or at least below middle (except male of *Dynatus*, with clublike hind femur) 4

   Antenna inserted at about middle of interocular space or higher 6

4. Oral opening widely separated from postoccipital ring; head elongate, triangular; pronotum usually greatly elongate (Neotropical) . . . . . *Trigonopsis* Perty
   Oral opening adjacent to postoccipital ring; pronotum about as broad as long or shorter . 5
5. Male hind coxa greatly elongate; apex of male hind femur thickened, clublike; male clypeus with a strongly raised median projection, apex bifurcate; female clypeus with four equal lobelike teeth (Neotropical) . . . . . *Dynatus* Lepeletier
   Male hind coxa and femur normal; male clypeus with a U-shaped emargination bounded laterally by a sharp tooth, or without such an emargination but with two bifurcate lobes; female clypeus with five or more teeth, rarely four teeth in groups of two (New World) . . . . . *Podium* Fabricius
6. First flagellomere longer than second; clypeus flattened, with two large flat lobes in female set off laterally by a small V-notch, bidentate in male; body with yellow markings (except *S. hemipterum* (Fabricius) from Madagascar) . . . . . *Sceliphron* Klug
   First flagellomere about equal to second, clypeus swollen 7
7. Clypeus trilobate to pentalobate or with median notch; body usually completely metallic blue (*C. fuscipenne* (Smith) from Africa with black body and reddish legs) *Chalybion* Dahlbom
   Clypeus entire to bilobate, if bilobate not set off laterally by small V-notch; body metallic blue with yellow markings (Old World) . . . . . *Hemichalybion* Kohl

Genus *Stangeella* Menke

(Fig. 107)

Stangeella Menke, 1962, Proc. Biol. Soc. Washington, 75:303. Type: *Pelopoeus cyaniventris* Guérin-Méneville, 1831. Original designation.

Antennae inserted just below middle of interocular space in female, at middle in male; flagellomere I in female one and one-half times length of II, subequal to II in male; male antennae with fossulae; mouthparts short, third maxillary palpomere symmetrical; oral opening adjacent to postoccipital carina; free margin of female clypeus produced, sinuate, that of male similar but truncate at apex; female with a psammophore; pronotum short, flattened dorsally; second submarginal cell slightly higher than wide, receiving first recurrent vein, second recurrent vein interstitial between submarginal cells II and III; metapleuron without a curving ridge from base of mesocoxa to base of metacoxa; stigmatal groove present; tarsal claw with a subbasal tooth; petiole slightly longer than hind coxa; male sternites IV–VII with velvety pubescence; pygostyles present; intersegmental membranes of tarsi with minute, lamellate, oval pads ventrally; South America.

This monotypic genus appears most closely allied with the Sceliphronini on the basis of short mouthparts, the presence of pads on the intersegmental membrane of the tarsus, the narrow bladelike setae of the last tarsomere, and the single claw tooth. The presence of a subbasal rather than mesal claw tooth is the only important feature that sets it apart from the rest of the tribe, and it must be assumed that *Stangeella* is one of the most ancient members.

Biology.—Claude-Joseph (1928) gave a detailed account of this genus. These solitary ground nesters prepare a single-celled burrow before seeking prey. *Stangeella* provisions with Mantidae, *Coptopteryx gayi* (Blanchard) and *C. crenaticollis* (Blanchard), and walking sticks of the genus *Bacteria* (Bacteriidae). The prey is carried to the nest on the wing.

Distribution.—The single species, *cyaniventris* (Guérin-Méneville), is known from Chile, Argentina, and Brazil.

Genus *Chlorion* Latreille

Chlorion Latreille, 1802, Hist. Nat. Crust. Insect., 3:333. Type: *Sphex lobata* Fabricius, 1775. Monobasic.

Chlorium Schulz, 1906, Spolia Hymenopterologica, p. 193. Emendation.

Antennae inserted at about lower one-third of interocular space in female, at middle in male; flagellomere I about equal in length to II in male, longer than II in female; male antenna frequently with fossulae; mouthparts short to long, third maxillary palpomere sometimes swollen asymmetrically; oral opening adjacent to postoccipital carina; free margin of female clypeus with four to five lobes on median truncation, or truncation without teeth, teeth lateral to truncation, clypeus of male trilobate or merely truncate; female with a psammophore; pronotum short, flattened dorsally, frequently with a median depression; second and third submarginal cells each receiving a recurrent vein; second submarginal higher than wide, narrowing towards anterior margin of wing; metapleuron without a curving ridge from base of mesocoxa to base of metacoxa; stigmatal groove present; petiole one and one-half times length of hind coxa or less; abdominal sternites in both sexes without transverse bands or patches of velvety hairs; pygostyles present; intersegmental membranes of tarsi with oval lamellate pads ventrally.

Chlorion has generally been placed in the tribe Sphecini but the single median tooth on the tarsal claw places it in the Sceliphronini. Evans (in correspondence) has stated that the larva of *Chlorion* resembles the larvae of the Sceliphronini more closely than it resembles those of the Sphecini. Details of the adult head indicate that this genus is most closely allied to *Podium* and *Dynatus*.

The North American *Chlorion* do not have well-developed fossulae on the male antennae, but many of the Old World species do have this feature. The Nearctic *Chlorion* are metallic blue or green, but in other regions the thorax may be black or brown and the abdomen red.

Kohl (1890) revised the world species (as a subgenus of *Sphex*), and Menke (1961) and Beaumont (1962) have reviewed the Nearctic and Palaearctic species respectively.

Biology.—From the meager data available it is known that the Nearctic species of *Chlorion* usually dig single-celled nests in the soil and provision with Gryllidae. Rau and Rau (1918) reported a multicelled nest. In our species the nest apparently is dug prior to searching for prey. Peckham and Peckham (1898) reported that the wasp flies with the prey, but most observers have indicated that the crickets are dragged along the ground to the nest.

Accounts of the biology of two Old World species of *Chlorion* disclose striking differences when compared with ours. Hingston (1925, 1926) gave two interesting reports of *Chlorion lobatum* (Fabricius). On six different occasions he watched the wasp enter the burrow of *Brachytrypes achatinus* (Houttuyn) and chase the cricket out. The *Chlorion* then stung the cricket, and grasping it by the antenna, dragged it back into the burrow. A single egg was laid transversely on the venter of the thorax. Paralysis was only temporary. In one case the wasp could not find the cricket's burrow and instead placed the cricket in a three-inch deep crevice in the soil, laid an egg, and sealed the nest.

The biology of another Old World species, *Chlorion xanthoceros* (Illiger), was presented in detail by Valdeyron-Fabre (1952, 1955). Prey consisted of the large cricket *Brachytrypes megacephalus* Lefebvre, which lives in burrows in the soil. The wasp usually dug a tunnel which intersected that of the cricket so that the attack on it could be made from the rear. In some cases the cricket escaped or was chased from one of the burrow exits. In this case stinging and egg laying occurred on the soil surface. Sometimes the wasp met the cricket face to face at

the burrow entrance, and the large head and elongate mandibles of the cricket, which filled the burrow opening, presented a formidable defense. According to Valdeyron-Fabre the wasp under these circumstances advanced and retreated from the burrow, luring the cricket farther out with each retreat. In some cases the wasp gave up the game and flew away. Usually, however, the cricket advanced far enough from its refuge to enable the wasp to quickly run behind it, grasp the cricket's thorax with its especially long mandibles, and sting the prey on the venter near the hind pair of legs. After thus immobilizing the jumping legs, the wasp stung the cricket under the neck, totally paralyzing it. A third sting was placed at any spot on the body, following which an egg was attached to the pleural region of the first abdominal segment. In three or four minutes the cricket revived and dug a fresh burrow. About five hours later the wasp egg hatched and the larva bored partly into the abdomen of the host, remaining in this position until it spun a cocoon. The larva matured rapidly and was nearly full grown by the eighth day, at which time the cricket usually died (presumably in its burrow), the contents of its body largely consumed by the wasp larva. By the tenth day the larva pupated.

Chlorion xanthoceros could be termed a true parasitoid because it makes no nest and also because the host is mobile for a long period after oviposition. Certainly this species exhibits one of the most primitive biologies in the Sphecinae, very similar to that of the scolioid wasps.

Distribution.—The genus is world-wide and includes approximately twenty species.

KEY TO THE NEARCTIC SPECIES OF CHLORION

1. Males, antenna thirteen-segmented 2
   Females, antenna twelve-segmented 4
2. Face with silvery appressed pubescence . . . . . *cyaneum* Dahlbom
   Face without silvery appressed pubescence, hairs dark 3
3. Mesopleural surface along posterior margin smooth between punctures, without ridges; scutal and pronotal punctation fine, punctures widely spaced; petiole obviously longer than metacoxa . . . . . *aerarium* Patton
   Mesopleural surface along posterior margin ridged or wrinkled between punctures; scutal and pronotal punctation moderate, punctures very close together; petiole about equal in length to metacoxa . . . . . *boharti* Menke
4. Mesopleural surface everywhere smooth between punctures; pronotum and scutum with fine, widely scattered punctures . . . . . *aerarium* Patton
   Mesopleural surface ridged or wrinkled between punctures; pronotum and scutum with coarse, rather dense punctures, at least anteriorly 5
5. Head and scutum not densely hairy; scutum coarsely, densely punctate anterolaterally but with only fine, widely scattered punctures posteriorly . . . . . *cyaneum* Dahlbom
   Head and scutum densely hairy; scutum everywhere rather densely punctate . *boharti* Menke

Chlorion aerarium Patton

(Figs. 2, 47, 55, 104, 112)

Sphex caerulea Drury, 1773, Illus. Nat. Hist. 2: index, description p. 75, pl. 39, fig. 8. Type: presumed lost or destroyed. Preoccupied by *Sphex caerulea* Linnaeus, 1758.

Chlorion aerarium Patton, 1879, Canadian Ent., 11:133. Holotype ♀, Plainville, Conn. (ANSP).

Sphex nearcticus Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:186. Lectotype ♂, "America Borealis" (VIENNA). Designated by Menke, 1961.

The types of *aerarium* Patton and *nearcticus* Kohl have been studied by Bohart. This species has several color forms over its range. Specimens from the eastern United States are usually dark blue or purple whereas western specimens are commonly blue or green.

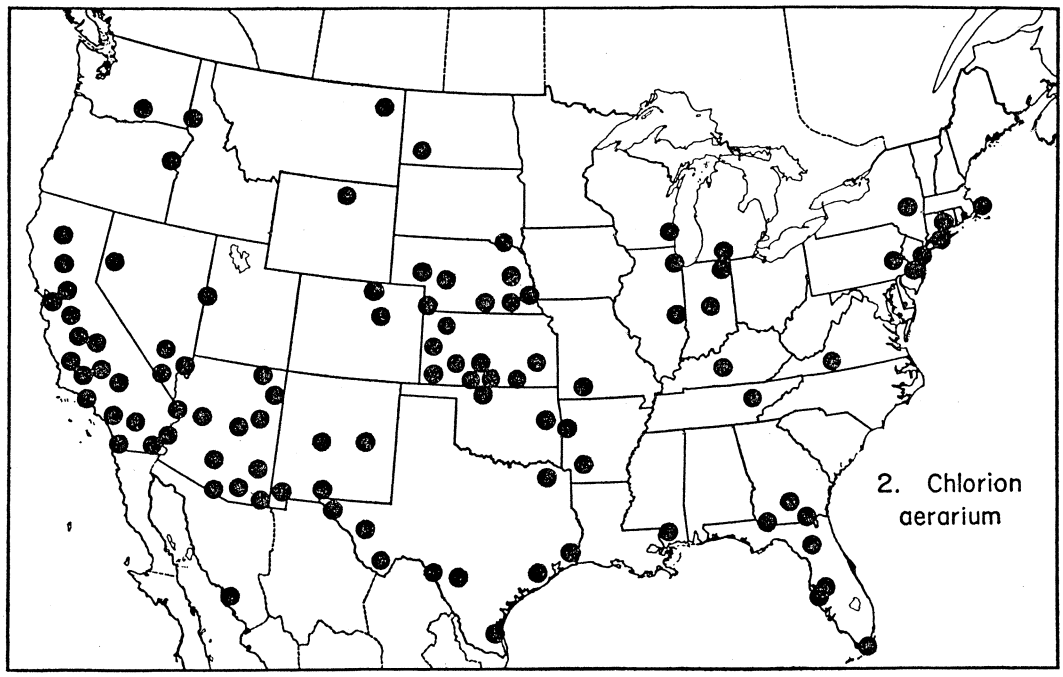


Fig. 2. Known distribution of *Chlorion aerarium* Patton in the United States and northern Mexico.

Biology.—Krombein (1953, 1958*b*, 1959) has presented most of what is known about the biology of this species. He reported single-celled nests provisioned with *Gryllus assimilis* Fabricius and *Anurogryllus muticus* (De Geer). Rau and Rau (1918), quoting Peckham, stated that *aerarium* nests may have several cells. *C. aerarium* stores more than one prey per cell. Hungerford and Williams (1912) recorded the gryllacridid *Ceuthophilus* as prey.

Distribution.—This species occurs throughout the United States, southern Canada, and as far south as the state of Puebla, Mexico (fig. 2).

Chlorion boharti Menke

Chlorion boharti Menke, 1961, Ann. Ent. Soc. Amer., 54:667. Holotype ♂, La Paz, Baja California (CAS).

This species can be recognized by the dense, long black hair that clothes most of the head and thorax.

Distribution.—This species is restricted to the southern part of Baja California.

Chlorion cynaeum Dahlbom

(Fig. 3)

Chlorion cyaneum Dahlbom, 1843, Hymen. Europaea, 1:22. Holotype ♂, Mexico (LUND).
Sphex occultus Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:187. Lectotype ♂, "America Borealis" (VIENNA). Designated by Menke, 1961.

The types of *cyaneum* and *occultus* have been seen by Bohart. The silvery face of the male and the coarse punctation on the anterolateral portion of the scutum in the female are diagnostic for this species.

Distribution.—This wasp is found in the southern parts of Arizona, New Mexico, and Texas, and ranges south into Mexico (fig. 3).

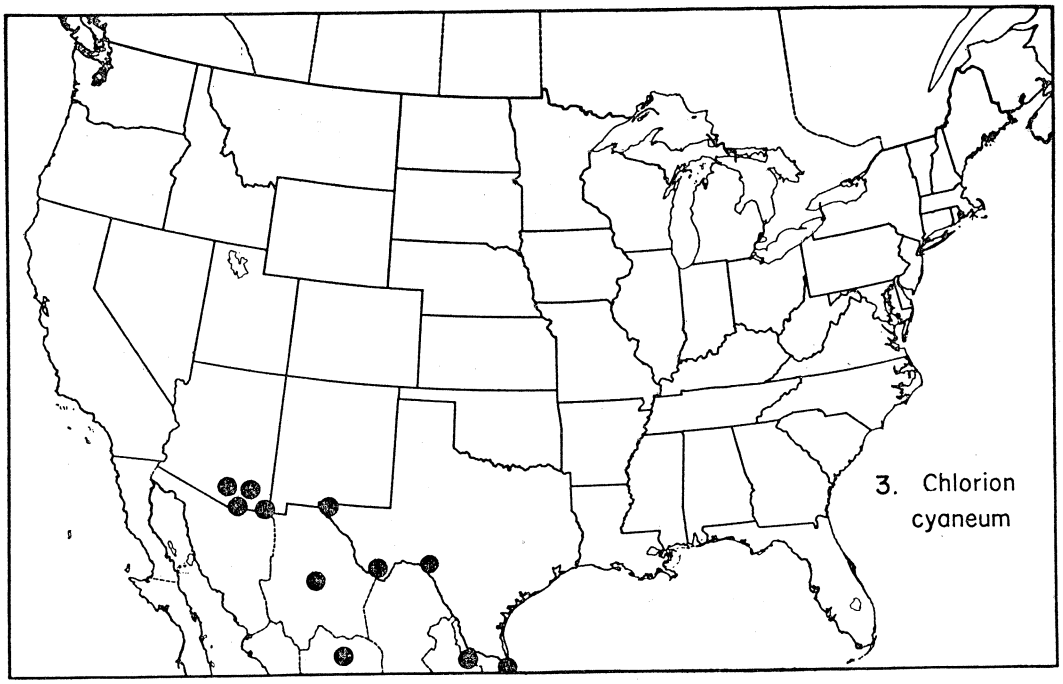


Fig. 3. Known distribution of *Chlorion cyaneum* Dahlbom in the United States and northern Mexico.

Genus *Dynatus* Lepeletier

Dynatus Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:332. Type: *Dynatus spinolae* Lepeletier, 1845. Monobasic.

Stethorectus Smith, 1847, Ann. Mag. Nat. Hist., 20:349. Type: *Stethorectus ingens* Smith, 1847 (= *Dynatus spinolae* Lepeletier, 1845). Monobasic.

Antennae inserted at about lower one-third of interocular space in female, only slightly below middle in male; flagellomere I longer than II; male antenna without fossulae; mouthparts short, maxillary palpomere III slightly asymmetrical; oral opening adjacent to postoccipital carina; free margin of female clypeus quadrilobate, that of male produced anteriorly, apex bifurcate; female without a psammophore; pronotum about one-half to three-fourths as long as wide, somewhat flattened dorsally, sloping upward to a polished posteromedian prominence; metapleuron with a curving ridge or groove from base of mesocoxa to base of metacoxa; stigmatal groove represented by a broad shallow channel; petiole one and one-half times length of hind coxa in females, three-quarters length of hind coxa in males; apex of male hind femur clublike; abdominal sternites with transverse bands of velvety pubescence; pygostyles present; intersegmental membranes of tarsi with lamellate oval pads ventrally; second submarginal cell receiving both recurrent veins; second submarginal cell wider than high.

Both Kohl (1902) and Schulz (1904) considered *Dynatus* a subgenus of *Podium*. However, the clypeus in both sexes and the unusual hind legs of the male warrant raising *Dynatus* to generic status. Kohl considered the blackwinged *spinolae* a

subspecies of the orange winged *nigripes* (Westwood), but details of the clypeus and hind legs separate the two. *Dynatus lindneri* (Schulthess) appears to represent a third species based on the illustrations in the original description.

Biology.—Nothing is known of the biology of this genus.

Distribution.—The genus is Neotropical. According to Richards (1937) who quotes Fahringer, 1922, *Dynatus* was introduced into Turkey.

Genus *Podium* Fabricius

Podium Fabricius, 1804, Systema Piez., p. 183. Type: *Podium rufipes* Fabricius, 1804. Designated by Latreille, 1810.

Talthybius Rafinesque-Schmaltz, 1815, Analyse Nature Tableau Univers Organises, p. 125. New name for *Podium* Fabricius.

Ammophilus Perty, 1833, Delect. Anim. Articul. Brasil., p. 141. Type: *Ammophilus fumigatus* Perty, 1833. Designated by Pate, 1937.

Parapodium Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:423. Type: *Parapodium biguttatum* Taschenberg, 1869 (=*Podium rufipes* Fabricius, 1804, *teste* Schulz, 1912). Monobasic.

Antennae inserted at lower one-third of interocular space or at least below middle; flagellomere I longer than II in females, either longer or shorter than II in males; male antenna sometimes with fossulae; mouthparts short, third maxillary palpomere asymmetrically swollen; oral opening adjacent to postoccipital carina or nearly so; free margin of female clypeus with four or more teeth, that of male bidentate or quadridentate; female without a psammophore; pronotum about one-half as long as wide or shorter, somewhat flattened dorsally with a longitudinal median impression, or with a posteromedian prominence; metapleuron with or without a curving ridge or groove from mesocoxa to metacoxa; stigmatal groove absent or poorly defined; petiole from one and one-half to two times length of hind coxa; abdominal sternites with or without velvety patches or bands of hair; pygostyles present; intersegmental membrane of tarsi with lamellate oval pads ventrally; second submarginal cell receiving both recurrent veins, or first recurrent sometimes interstitial or attached to first submarginal cell; second submarginal cell variable in shape; Western Hemisphere.

We have placed *Podium* in the Sceliphronini on the basis of the single median tooth on the tarsal claws. In addition, the pads on the venter of the tarsi, the details of the maxillary palpus, and the general structure of the body ally this genus with the tribe. We feel that the taxa interpreted as subgenera by Kohl (1902), *Trigonopsis* and *Dynatus,* display sufficient morphological difference to warrant generic status. Kohl's (1902) revision of the genus is the only comprehensive work on these wasps, although Schulz (1904) discussed synonymy of several species. The differences in morphology and biology indicate that *Podium* probably should be split into two subgenera.

Biology.—The adults are usually found running along the trunks and branches of trees. Williams (1928) has summarized much of what is known of the biology of these wasps. Cockroaches of the genus *Epilampra* are used as prey by many of the tropical species. Nests may be in the form of burrows in the ground, or of mud like those of *Sceliphron.* Ground nesters (*P. haematogastrum* Spinola) make single-celled nests and the wasps may nest in groups. Unlike most other Sphecinae, at least two species, *P. haematogastrum* and *luteipenne* (Fabricius), oviposit before dragging the cockroach into the burrow. In these species, the egg is laid on the last provision. *P. haematogastrum* has been observed nesting in active termite mounds. Richards (1937) reported *P. goryanum* Lepeletier nesting in old *Passalus*

holes in a tree stump. Rau (1937) reported *Podium* using the nest of *Sceliphron* after first sealing off the contents of the cell with mud. Krombein (1958c) reared *Podium* from trap nests made of wood.

Distribution.—Three species of this primarily tropical genus occur in the United States, one ranging as far north as Iowa and New York. About thirty-five species are known.

KEY TO THE NEARCTIC SPECIES OF PODIUM

1. Wings uniformly dark brown; erect hair of body black; first recurrent vein received by second submarginal cell . . . . . *luctuosum* Smith
   Wings clear but with second submarginal cell frequently cloudy; erect hair of body white; first recurrent vein received by first submarginal cell or interstitial between I and II . . 2
2. Basal one-fourth or more of femora black (occasional specimens have femora nearly all red); male antenna with weakly developed fossulae on flagellomeres III–VII or VIII (eastern United States, eastern Mexico, Central America, South America) *rufipes* Fabricius
   Femora all red, or with small amount of black basally; male antenna with weakly developed fossulae on flagellomeres III–VI (Texas, California, Mexico) *krombeini* Bohart and Menke

Podium krombeini Bohart and Menke, new species

(Figs. 4, 49, 60)

Male.—Length 19 mm; head, thorax, and abdomen black with bluish reflections; tegula, femora, tibiae, and tarsi reddish; wings clear except for clouding of second submarginal cell; erect hair of head and thorax white; genitalia as in figure 60.

Female.—Average length 19 mm.

Types.—Holotype ♂: Big Bend National Park, Brewster Co., Texas, June 19, 1937 (Rollin H. Baker, USNM type no. 66424); 6 ♂ and 8 ♀ paratypes as follows: UNITED STATES. TEXAS: Big Bend National Park, Brewster Co., June 19, 1937 (Rollin H. Baker, USNM);

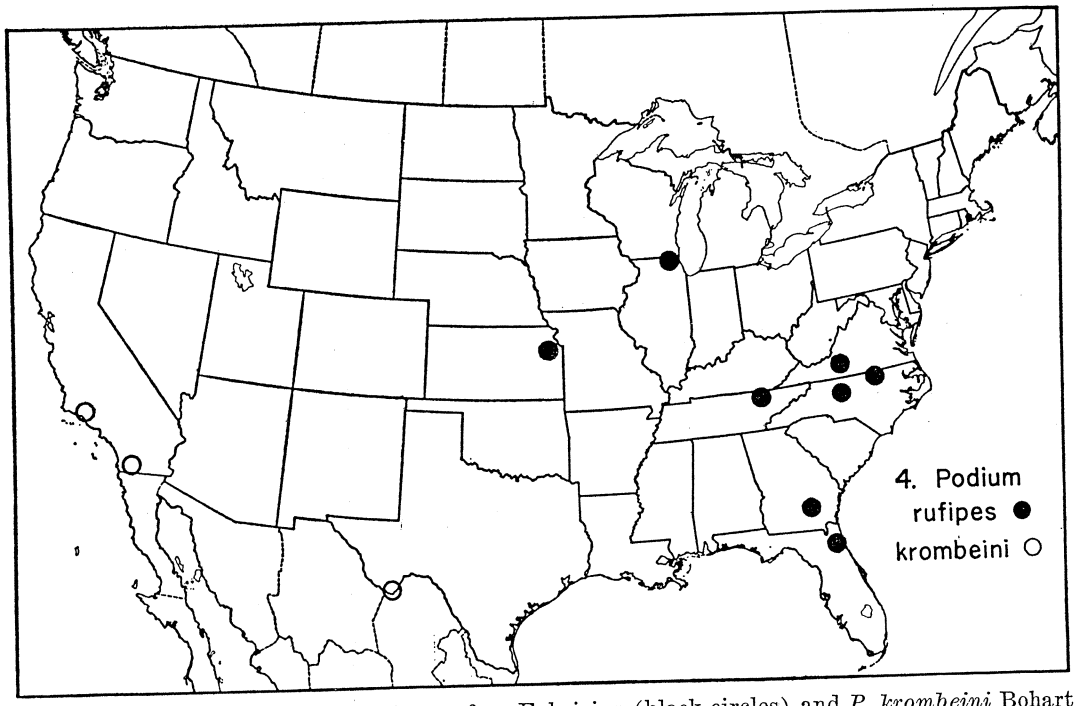


Fig. 4. Known distribution of *Podium rufipes* Fabricius (black circles) and *P. krombeini* Bohart and Menke (white circles) in the United States and northern Mexico.

Circleville, August 1, 1934 (J. E. Gillaspy, UCD); "Texas" (Belfrage, USNM). CALIFORNIA: Ojai, Ventura Co., August 11, 1939 (W. L. Swisher, LACM); Jacumba, San Diego Co., July 17, 1940 (E. E. Kenaga, KU); Rainbow Valley, San Diego Co., June 28, 1960 (C. Johnson [McPhail trap—orange] CSDA). MEXICO. MORELOS: 3 mi. N. Alpuyeca, April 18, 1959 (H. E. Evans, CORNELL). PUEBLA: 3 mi. N.W. Petlalcingo, April 2–3, 1962 (F. Parker and L. Stange, UCD). OAXACA: 23 mi. S. Matios Romero, April 6, 1962 (F. Parker and L. Stange, UCD).

Closely related to *rufipes,* this species is distinguished by details of leg markings, male antennae, and male genitalia (compare figs. 59 and 60).

Distribution.—The disjunct distribution pattern of this species, e.g., Texas, California, and southern Mexico (fig. 4), probably will fill in when more material has been seen. It is possible, however, that *krombeini* has been introduced into southern California from either Texas or Mexico.

Podium luctuosum Smith

(Figs. 5, 58)

Podium luctuosum Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:235. Holotype ♀, North Carolina (BMNH).

Male.—Average length 14 mm; head, thorax, and abdomen black; femoral apex, tibia, and tarsi reddish; wings uniformly brown; erect hairs of body black; genitalia as in figure 58.

Female.—Average length 21 mm.

The closest relatives of *P. luctuosum* are in Central and South America.

Biology.—Pate (1949) recorded catching a female carrying a female of *Parcoblatta virginica* (Brunner) near Ithaca, New York. Krombein (correspondence) has reared *luctuosum* from trap nests.

Distribution.—We have seen one male and five females from the following localities: TENNESSEE: Burrville, Morgan Co., June 17, 1957 (B. Benesh, COR-

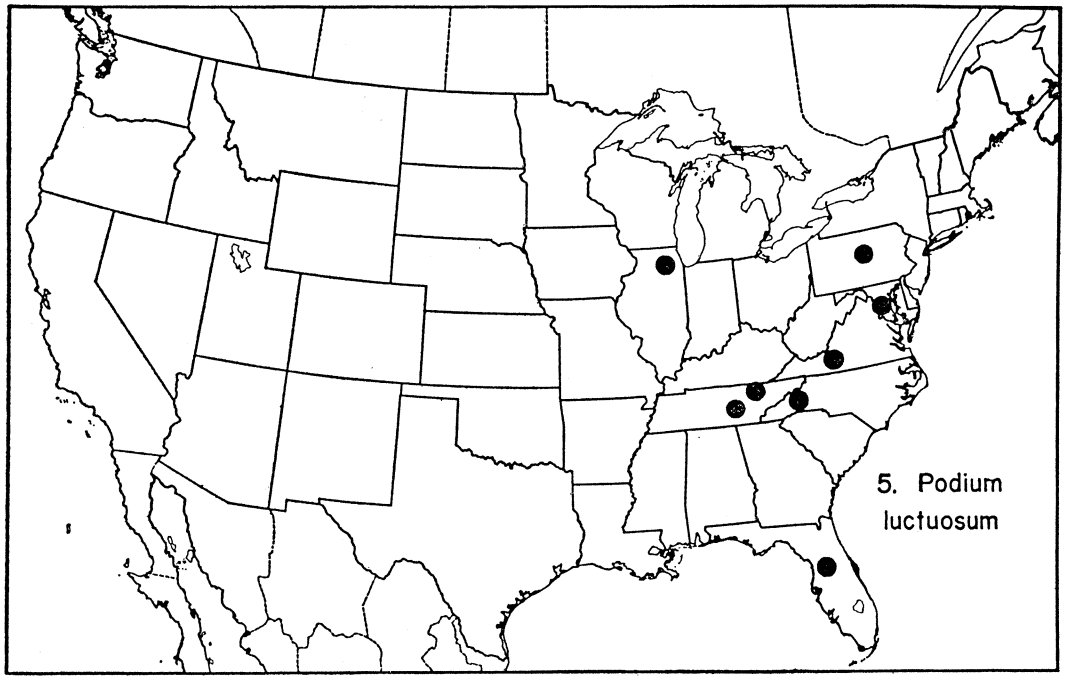


Fig. 5. Known geographic range of *Podium luctuosum* Smith.

NELL); Grassy Cove, Cumberland Co. (UMMZ). FLORIDA: Lake Co., March 27, 1922 (T. P. Winter, UMMZ). NORTH CAROLINA: Asheville (CORNELL). WASHINGTON, D. C.: June 13, 1944 (M. Vogel, UCD). PENNSYLVANIA: Heckton Mills, June 22, 1910 (W. S. Fischer, USNM). Krombein (correspondence) lists the following additional localities from specimens at the United States National Museum: NEW YORK: Ithaca. MARYLAND: Plummers Island. VIRGINIA: Great Falls. The distribution is plotted on figure 5.

Podium rufipes Fabricius

(Figs. 4, 59)

Podium rufipes Fabricius, 1804, Systema Piez., p. 183. Lectotype ♀, Essequibo, British Guiana (COPENHAGEN). Present designation.

Podium denticulatum Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:236. Syntypes ♂, ♀, Brazil (BMNH).

Parapodium biguttatum Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:423. Syntypes ♂, ♀, Venezuela (HALLE).

Podium carolina Rohwer, 1902, Proc. United States Natl. Mus., 40:556. Holotype ♀, Tryon, North Carolina (USNM).

Male.—Average length 19 mm; head, thorax, and abdomen black with bluish reflections; apical three-fourths or less of femora, tibiae, and tarsi reddish; wings clear except for clouding of second submarginal cell; erect hair of head and thorax white; genitalia as in figure 59.

Female.—Average length 19 mm.

This species is very similar to *krombeini* Bohart and Menke except for the differences noted under systematics of that species. The amount of black on the femora varies. Specimens from Florida have only a little darkening at the base. The syntypes of *rufipes* were seen by Bohart and one specimen was labeled as lectotype. We have not seen the types of *denticulatum* or *biguttatum,* and the above synonymy is tentative only. Schulz (1912) stated that *biguttatum* was synonymous with *rufipes.*

Biology.—Rau (1937) found Northern American examples of this species using *Sceliphron* nests. The original contents were walled off at the back of the cell with mud, the nest was provisioned with one to three immature cockroaches—*Parcoblatta pensylvanica* (De Geer)—and the nest was closed with a "clear resin-like gum." Williams (1928) reported South American *rufipes* making single-column mud nests on trees and provisioning with wood roaches. Williams also cited one female from Brazil making a nest by closing a hollow in a termite mound with mud. Krombein (1958*c*) reared *rufipes* from trap nests in Florida and North Carolina. the wasps stored their single-celled nests with four to six roaches, depositing the egg on the first roach. Blattid prey consisted of: *Chorisoneura texensis* Saussure and Zehntner, *Cariblatta lutea* (Saussure and Zehntner), *Parcoblatta* sp., and *Ishnoptera* sp. Krombein suggested that the wasps may nest in abandoned beetle burrows and natural cavities in dead wood. Two generations occur per year, and *Neochrysis panamensis* (Cameron) (= *Chrysis alabamensis Mocsáry*) is an important parasite.

Distribution.—This species is known from scattered localities in the eastern United States (Iowa, New York, North Carolina, Kansas, Georgia, Florida), and its range extends through Central America and South America (fig. 4).

Genus *Trigonopsis* Perty

Trigonopsis Perty, 1833, Delect. Anim. Articul. Brazil., p. 141. Type: *Trigonopsis abdominalis* Perty, 1833 (= *Podium rufiventre* Fabricius, 1804, *teste* van der Vecht, 1961*a*). Monobasic.

Antennae inserted at lower one-third of interocular space; first flagellomere one and one-half times length of II or greater; male antenna without fossulae; mouthparts short, third maxillary palpomere sometimes asymmetrically swollen; oral opening widely separated from postoccipital carina; free margin of female clypeus pentadentate, that of male bidentate; head elongate behind eyes; female without a psammophore; pronotum very elongate, as long as wide or longer and rounded from side to side, sometimes with a posteromedian prominence; metapleuron with a curving ridge or groove from base of mesocoxa to base of metacoxa; stigmatal groove represented by a broad, shallow channel, interrupted by transverse ridges; petiole very long, more than twice length of hind coxa; abdominal sternites with transverse bands of velvety hair in male; pygostyles present; intersegmental membrane of tarsi with lamellate oval pads ventrally, second submarginal cell receiving both recurrent veins or second recurrent interstitial between II and III; second submarginal cell about as high as wide, nearly square.

Kohl (1902) treated the known species (as *Podium*). Richards (1937) described several new ones and provided a key to the eight known species.

Biology.—These wasps are primarily arboreal and make mud nests on tree trunks or the undersides of leaves. Cockroaches usually serve as prey although Richards (1937) described one species, *T. grylloctonus* Richards, that provisions with crickets. Arle (1933) observed *Trigonopsis* females making mud nests in hollows on the face of ravines in dense forest. Prey consisted of immature roaches of the genus *Epilampra.* Arle also noticed parasitism by the ichneumonid *Distantiella apicalis* Schmiedekneckt.

Distribution.—This genus is strictly Neotropical.

Genus *Chalybion* Dahlbom

Chalybion Dahlbom, 1843, Hymen. Europaea, 1:21. Type: *Sphex cyanea* Fabricius, 1775 (*nec Sphex cyanea* Linnaeus, 1758) (= *Pelopeus californicus* Saussure, 1867). Designated by Patton, 1880.

Chalybium Schulz, 1906, Spolia Hymenopterologica, p. 192. Emendation.

Antennae inserted at about middle of interocular space; flagellomere I about equal in length to II; male antenna with fossulae; mouthparts short, third maxillary palpomere asymmetrically swollen; oral opening adjacent to postoccipital carina or nearly so; free margin of female clypeus with three to five teeth, rarely with a simple median notch, that of male tridentate; female without a psammophore; pronotum short, flattened dorsally with a longitudinal median impression; metapleuron without a curving ridge or groove from mesocoxa to metacoxa; stigmatal groove absent; petiole less than twice length of hind coxa; abdominal sternites frequently with velvety patches in female, with transverse bands of velvety pubescence on V-VI in male; pygostyles present; intersegmental membrane of tarsi frequently with lamellate oval pads ventrally; second submarginal cell trapezoidal in shape, receiving both recurrent veins.

The type designation is extremely involved as is the synonymy and homonymy of the type species. Three species were originally included in *Chalybion* by Dahlbom: *Pepsis violaceum* Fabricius, *Chalybion zimmermanni* (described as a new species), and *Sphex cyanea.* The last named is of special importance since it was selected by Patton (1880) as the type of the genus. The first complication is that Dahlbom did not clearly ascribe authorship of *Sphex cyanea,* although he did give five citations. The earliest of these was to *Sphex caerulea* Johansson and Linnaeus, 1763, which

was renamed *Sphex cyanea* by Fabricius in 1775; another was to *Sphex cyanea* Fabricius, 1793 (originally described in 1775). Because of homonymy, both *caerulea* Johansson and Linnaeus, 1763, and *cyanea* Fabricius, 1775, are unavailable, and the earliest available name is *californicum* Saussure as discussed under that species. A further complication is that Patton's designation was ambiguous: "Type: *Chalybion caeruleum*. (*Sphex caerulea* Linn. Syst. Nat. I, 941; *Chalybion cyaneus* Dahlb.)." Apparently, Patton intended to cite the twelfth edition since he gave the correct page number for that edition. He further stated, "As Dahlbom indicated no type, I select the common American species."

The two Nearctic species are distinctive in several respects. One species, *zimmermanni*, lacks the ventral intersegmental pads on the tarsi. Both are peculiar in having no tooth on the claw of the hind leg. In addition, both *zimmermanni* and *californicus* have only three lobes on the clypeus of the female (fig. 48).

Kohl (1918) revised the entire genus (as a subgenus of *Sceliphron*), Hutson (1919) treated the North American forms (as genus *Sceliphron*), and van der Vecht (1961*b*) summarized information on the world species (as a subgenus of *Sceliphron*).

The members of the genus are usually completely metallic blue, greenish blue, or violet blue. However, one African form, *C. fuscipenne* (Smith), is black with reddish appendages. According to van der Vecht (1961*b*), the world species total twenty-five.

Biology.—These wasps apparently do not build mud nests but instead utilize natural crevices and openings (Williams, 1919), or the mud nests of *Sceliphron* after first removing the builder's provisions (Rau, 1928*a*, 1928*b*). The commandeered nests are reprovisioned with spiders.

Distribution.—This genus is world-wide, except for South America.

KEY TO THE NEARCTIC SPECIES OF CHALYBION

Metapleuron depressed, channel-like; metanotal flange dilated posteriorly; tarsi ventrally with lamellate oval pads at intersegmental membrane . . . . . *californicum* (Saussure)

Metapleuron scarcely depressed below surrounding pleura; metanotal flange of uniform width; tarsi ventrally without pads . . . . . *zimmermanni* Dahlbom

Chalybion californicum (Saussure)

(Figs. 6, 48, 63, 94, 105)

Sphex caerulea Johansson and Linnaeus, 1763, Amoenitates Acad., 6:412. Philadelphia, location of type unknown. Preoccupied by *Sphex caerulea* Linnaeus, 1758, a pompilid of the genus *Priocnemioides, teste* van der Vecht, 1959.

Sphex cyanea Fabricius, 1775, Systema Ent., p. 346. New name for *Sphex caerulea* Johansson and Linnaeus, 1763; but preoccupied by *Sphex cyanea* Linnaeus, 1758, a *Trichrysis*.

Chalybion cyaneum Dahlbom, 1843, Hymen. Europaea, 1:22. Constitutes first placement in *Chalybion* (see generic type discussion).

Pelopeus (sic) *californicus* Saussure, 1867, Reise der Öst. Freg. Novara, Zool., 2:26. Lectotype ♂, California (GENEVA). Present designation.

Male.—Average length 14 mm; erect hair of body black; wings uniformly dark violaceous; flagellomeres VII and VIII with oval fossulae apically; lateral teeth of clypeus larger and longer than median tooth.

Female.—Average length 16 mm; clypeal free margin with spatulate median lobe and broad lateral lobe; abdominal sternite V with a median U-shaped patch of sericeous pubescence, IV sometimes with a tiny sericeous patch.

The tangled nomenclature of this species resulted from the use of the name *caerulea* by Linnaeus for two species of wasps. In an effort to correct the situation Fabricius renamed the latter of the two *cyanea,* which had unfortunately been used previously by Linnaeus for a *Trichrysis.* Dahlbom placed the species in the proper genus but attributed *cyanea* to Johannson and Linnaeus, 1763, and Linnaeus, 1767, instead of to Fabricius, 1775. The first available name for the species is Saussure's *californicum,* 1867, as has been pointed out by Pate (1943), and his paper should be consulted for a complete synonymical bibliography.

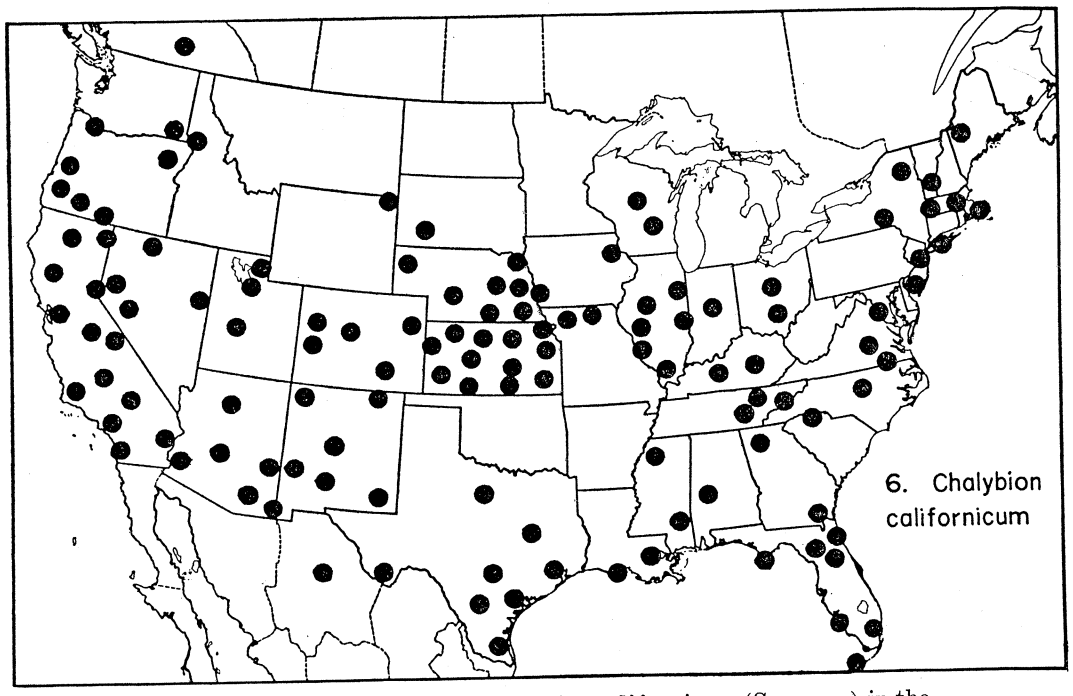


Fig. 6. Known distribution of *Chalybion californicum* (Saussure) in the United States and northern Mexico.

Biology.—Rau (1928*a*, 1928*b*) presented a full account of the biology of this species. *C. californicum* is an inquiline in the nest of *Sceliphron caementarium.* Since the *Sceliphron* often lays an egg on the first spider (Schafer, 1949, stated this is not always true), it is essential for the *Chalybion* to remove all of the spiders to be sure of ridding the nest of the egg which might otherwise produce a larva to devour the guest. Also, *Chalybion* may open either end of the nest. The *Chalybion* carries water to the nest to soften the mud prior to opening a cell. After all of the old spiders are removed, *C. californicum* restocks with fresh ones, lays an egg on the last, and plugs the nest with mud taken from the nest after moistening it with water. According to Rau these wasps frequently adorn the nest with mud pellets. Excellent photos of *Chalybion californicum* nests have been published by Rau and Rau (1916*b*) and Muma and Jeffers (1945). Irving and Hinman (1935) recorded *californicum* using the black widow spider (*Latrodectus mactans* Fabricius) as prey.

The cocoon of *C. californicum* has a white silky outer covering, differing in this respect from the cocoon of *S. caementarium,* which is uncovered and brown.

The gregarious nature of this wasp is indicated by the observations of Rau and Rau (1916*a*), who recorded clusters of both sexes at night or in cloudy daytime periods on the undersurface of overhanging rocks. Rau (1938) reported aggregations of a thousand specimens spending successive nights on the rafters of a house. F. D. Parker (conversation) observed about twenty of these wasps congregating each night for about two weeks under a porch roof at Reno, Nevada. The number of individuals congregating gradually diminished toward the end of the second week.

Distribution.—This species occurs throughout most of the United States and ranges south into Mexico (fig. 6). It has been introduced into the Hawaiian Islands and Bermuda.

Chalybion zimmermanni Dahlbom

(Figs. 7, 64)

This species is divisible into three subspecies, which can be recognized by means of the following key.

KEY TO THE SUBSPECIES OF CHALYBION ZIMMERMANNI BASED ON MALES

1. Erect hair of thorax mostly white 2
   Erect hair of thorax black; wings uniformly brown stained (Baja California) *peninsularum* Bohart and Menke
2. Wings uniformly brown stained (southeastern United States to central Texas) *zimmermanni* Dahlbom
   Wings clear in cellular area (Mexico to Arizona, Texas) . . . . . *aztecum* (Saussure)

Chalybion zimmermanni zimmermanni Dahlbom

Chalybion zimmermanni Dahlbom, 1843, Hymen. Europaea, 1:22. Holotype ♀, South Carolina (LUND).

Pelopoeus texanus Cresson, 1872, Trans. Amer. Ent. Soc., 4:210. Holotype ♂, Dallas, Texas (ANSP).

Male.—Average length 14 mm; erect hair of head mostly dark, that of thorax white; wings uniformly dark brown; flagellomeres V-IX (sometimes IV also) with irregular fossulae; median tooth of clypeus much larger and longer than lateral teeth.

Female.—Average length 18 mm; erect hair of body black; clypeal teeth similar.

Bohart has examined the type of *zimmermanni*. Also in the collection at Lund is a male labeled "N. Amerika, Zimmerman." The authors have examined the type of *texanus* Cresson.

Distribution.—The range of this subspecies extends from South Carolina through the southern states to Arizona (fig. 7).

Chalybion zimmermanni aztecum (Saussure)

Pelopeus (sic) *aztecus* Saussure, 1867, Reise der öst. Freg. Novara, Zool., 2:26. Lectotype ♂, Tampico, Mexico (GENEVA). Present designation.

Male.—Differing from typical subspecies as follows: wings clear except at apex.

Female.—Average length 20 mm; similar to female of typical subspecies.

The type of *aztecum* has been seen by Bohart.

Biology.—Rau (1940) found this subspecies in *Sceliphron* nests and also recorded one wasp using the nest of *Trypoxylon mexicanum* Saussure. Rau (1942)

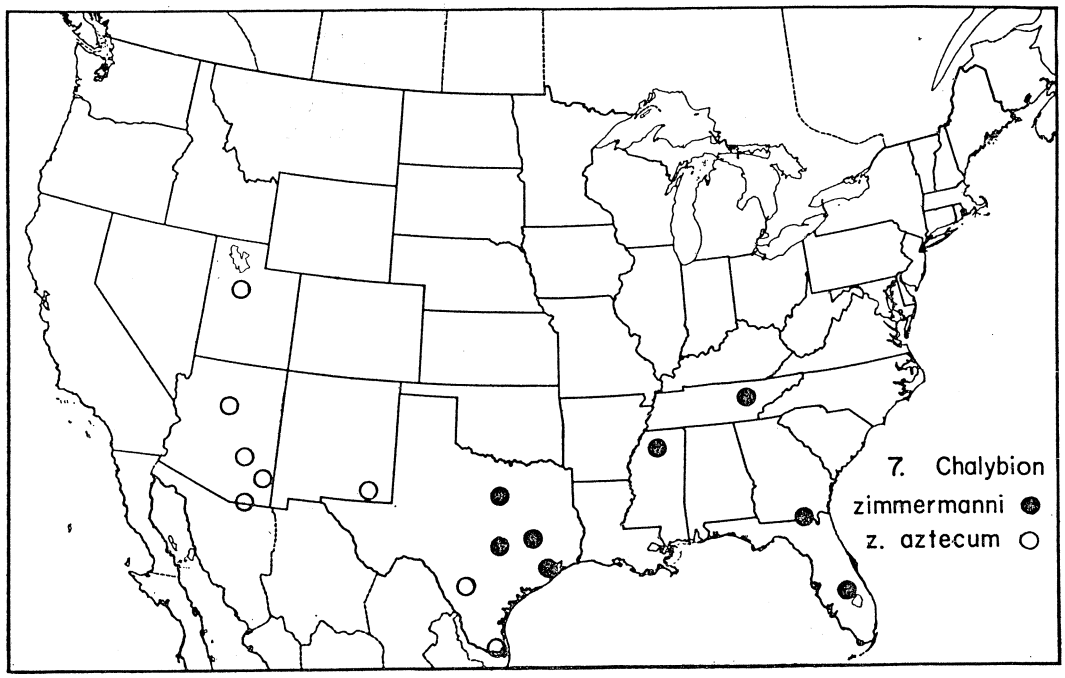


Fig 7. Known distribution of *Chalybion zimmermanni* Dahlbom, *sensu stricto* (black circles) and subspecies *aztecum* (Saussure) (white circles) in the United States and northern Mexico.

reported males and females clustering on a piece of hanging rope for three successive days.

Distribution.—This subspecies ranges from Mexico into Arizona, New Mexico, and western Texas (fig. 7).

Chalybion zimmermanni peninsularum Bohart and Menke, new subspecies

Male.—Differing from the typical subspecies as follows: erect hair of body black; wings uniformly brown.

Female.—Average length 16 mm; similar to female of typical subspecies.

Types.—Holotype ♂, Todos Santos, Baja California, Aug. 12, 1919, J. R. Slevin (CAS); 2 ♂ and 3 ♀ paratypes, same data as holotype except 1 ♀: Oct. 10, 1941 (E. S. Ross and G. Bohart). All CAS.

Distribution.—Known only from the type series; Baja California.

Genus *Hemichalybion* Kohl

Hemichalybion Kohl, 1918, Ann. K. K. Naturhist. Hofmus. Wien, 32:79. Type: *Pelopoeus eckloni* Dahlbom, 1845. Designated by Pate, 1937.

Antennae inserted at about middle of interocular space; flagellomere I about equal in length to II; male antenna without fossulae; mouthparts short, third maxillary palpomere swollen asymmetrically; oral opening adjacent to postoccipital carina; free margin of female clypeus entire to bilobate, if bilobate the lobes not set off laterally with a small V-notch, clypeus of male bilobate; female without a psammophore; pronotum short, flattened dorsally and with a longitudinal median impression; metapleuron without a curving ridge or groove from mesocoxa to metacoxa; stigmatal groove absent; petiole two times length of hind coxa; abdominal sternites with velvety patches in female, with transverse bands of velvety pubescence in male; pygostyles present; intersegmental membrane of tarsi without lamellate oval pads ventrally; second submarginal cell trapezoidal in shape, receiving both recurrent veins; Old World.

Kohl described *Hemichalybion* as a subgenus of *Sceliphron,* but the group seems sufficiently distinct to warrant generic status. The genus is structurally most closely related to *Chalybion,* but details of the clypeus and the lack of intersegmental pads ventrally on the tarsi separate the two.

These wasps generally are metallic blue with yellow and reddish-brown markings and superficially resemble *Sceliphron.*

Biology.—According to Arnold (1928) *H. eckloni* commonly builds mud nests inside houses.

Distribution.—According to Kohl (1918) the genus is found in the Mediterranean region, Africa, and the Orient. According to van der Vecht (1961*b*), there are five known species.

Genus *Sceliphron* Klug

Sceliphron Klug, 1801, Neue Schrift. Ges. Naturf. Freunde Berlin, 3:561. Type: *Sphex spirifex* Linnaeus, 1758 (= *Sphex aegyptia* Linnaeus, 1758). Designated by Bingham, 1897.

Pelopoeus Latreille, 1802, Hist. Nat. Crust. Insect., 3:334. Type: *Sphex spirifex* Linnaeus, 1758 (= *Sphex aegyptia* Linnaeus, 1758). Designated by Latreille, 1810.

Sceliphrum Schulz, 1906, Spolia Hymenopterologica, p. 192. Emendation.

Antennae inserted at about middle of interocular space; flagellomere I longer than II; male antenna without fossulae; mouthparts short, third maxillary palpomere swollen asymmetrically; oral opening adjacent to postoccipital carina; free margin of female clypeus with two broad, flat lobes set off laterally by a small V-notch, clypeus of male bilobate; female without a psammophore; pronotum short, somewhat rounded from side to side or flattened dorsally, frequently with a median longitudinal impression; metapleuron without a curving ridge or groove from mesocoxa to metacoxa; stigmatal groove absent; petiole more than two times length of hind coxa; abdominal sternites in male with transverse bands of velvety pubescence; pygostyles usually absent; intersegmental membrane of tarsi with lamellate oval pads ventrally; second submarginal cell trapezoidal, receiving both recurrent veins.

Schulz (1912) pointed out the synonymy of *aegyptia* and *spirifex.* He exercised poor judgment in selecting *aegyptium,* because of page priority, as the proper name for this well-known Old World species, even though *spirifex* had been in use for many years. Contemporary workers still use the name *spirifex,* and therefore an appeal should be made to the International Commission on Zoological Nomenclature for a decision on this problem.

Generally, *Sceliphron* are black with yellow markings, but *S. hemipterum* (Fabricius) from Madagascar is an exception, having no yellow.

Kohl (1918) reviewed the species of the world and Porter (1926), the North American forms. A summary of the thirty-two world species given by van der Vecht (1961*b*), divided them into the *coromandelicum* group, *madraspatanum* group, and *spirifex* group. Of these, the first has pygostyles in the male, simple mandibles in the female, and is restricted to the Old World. The second named group is cosmopolitan, includes the Nearctic species, lacks pygostyles, and has the female mandibles bidentate. The last named group is Neotropical as well as Old World, includes the generic type, lacks pygostyles, and has simple or bidentate mandibles in the female.

Biology.—These wasps make mud nests in sheltered places and store them with spiders. Each nest usually contains a number of tubular cells.

Distribution.—The genus is cosmopolitan.

KEY TO THE NEARCTIC SPECIES OF SCELIPHRON

1. Abdominal segments III–VII with yellow bands . . . . . *lucae* (Saussure)
   Abdominal segments III–VII all black 2
2. Hind tibia yellow on basal one-half; male clypeal lobes broad (United States, Mexico) *caementarium* (Drury)
   Hind tibia all black; male clypeal lobes small, narrow (Mexico, Texas) . . *assimile* (Dahlbom)

Sceliphron assimile (Dahlbom)

(Figs. 8, 61)

Pelopoeus assimilis Dahlbom, 1843, Hymen. Europaea, 1:23. Lectotype ♂ (on same pin with lectoparatype ♀), Cuba (LUND). Present designation.

Sceliphron caementarium nicaraguanum Kohl, 1918, Ann. K. K. Naturhist. Hofmus. Wien, 32:118. Syntypes, Nicaragua, probably at VIENNA.

The females of this species are separable from *S. caementarium* only by the completely black hind legs. In *caementarium* the basal one-half of the hind tibia and most of the tarsus are yellow. Male *assimile* sometimes have a yellow streak on the inner basal one-half of the hind tibia, and the basal segments of the tarsus may be yellow as well. However, in male *assimile* the two clypeal lobes are narrower and smaller than in *caementarium*. The genitalia also offer distinctive differences (compare figures 61 and 62). Bohart studied the types at Lund, Sweden.

Distribution.—*S. assimile* occurs in Cuba, Mexico (Hidalgo, Michoacan, San Luis Potosi, Sinaloa, Tamaulipas, Vera Cruz), Guatemala, Costa Rica, Nicaragua, and Panama. In the U. S. National Museum are specimens from the following Texas localities: Mission, Brownsville, and Fort Ringgold (K. V. Krombein, Correspondence) (fig. 8).

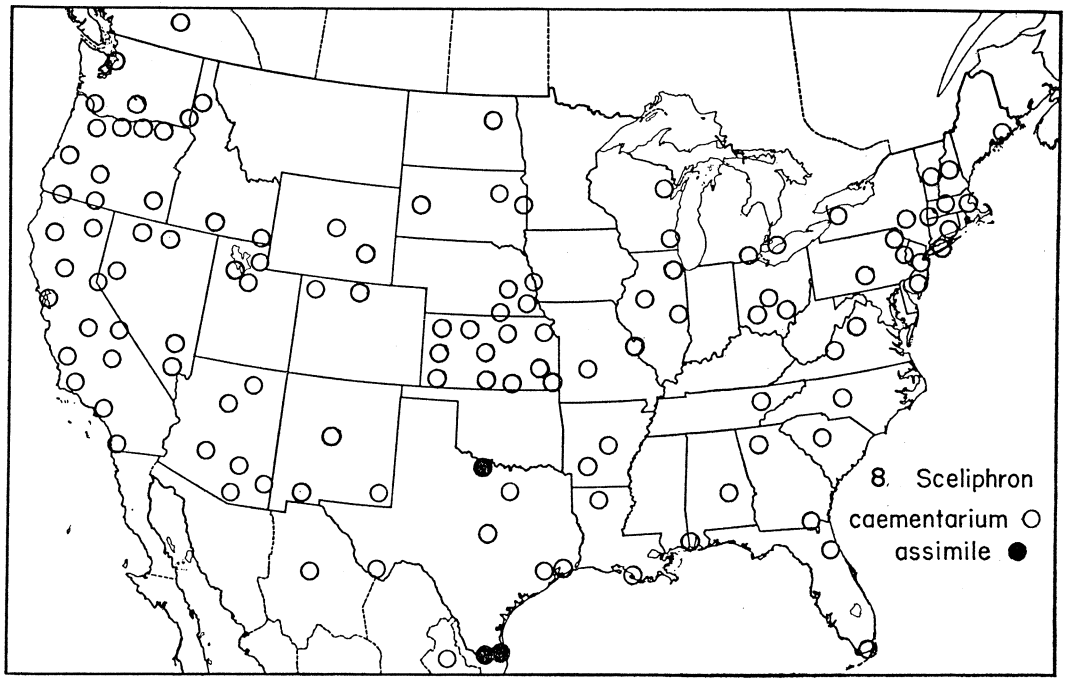


Fig. 8. Known distribution of *Sceliphron caementarium* (Drury) (white circles) and *S. assimile* (Dahlbom) (black circles) in Canada, the United States, and northern Mexico.

Sceliphron caementarium (Drury)

(Figs. 8, 42, 50, 62, 106)

Sphex caementaria Drury, 1773, Illus. Nat. Hist. 2:index for vol. 1, description in vol. 1 (1770), p. 105, pl. 44, figs. 6, 8. Type presumed lost or destroyed. "Antigua, St. Christopher's, and Jamaica."

Sphex flavomaculata De Geer, 1773, Mem. Hist. Insect., 3:588. Holotype ♀, Pennsylvania (STOCKHOLM), *teste* Krombein, 1949.

Sphex lunata Fabricius, 1775, Systema Ent., p. 347. Lectotype ♀, Island of Antigua (COPENHAGEN). Designated by van der Vecht, 1961*a*.

Sphex flavipes Fabricius, 1781, Species Insect., p. 444. Lectotype ♀, America (COPENHAGEN). Designated by van der Vecht, 1961*a*.

Sphex flavipunctata Christ, 1791. Naturges. Klass. Nomen. Insekt., p. 301, pl. 30, fig. 1. New name for *Sphex caementaria* Drury, 1773.

Sphex affinis Fabricius, 1793, Ent. System., 2:203. Syntype ♀ ♀, "Americae Insulis" (COPENHAGEN).

Pelopoeus architectus Lepeletier, 1845, Hist. Nat. Insect. Hymén., 3:313. Holotype ♀, New Orleans, La. (TURIN).

?Pelopoeus servillei Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:313. Locality unknown, types supposedly in Turin.

Pelopoeus solieri Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:313. Holotype ♀, Guadaloupe (TURIN).

Pelopoeus canadensis Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:233. Holotype ♂, Canada (BMNH).

Pelopoeus nigriventris Costa, 1864, Ann. Mus. Zool. Napoli, 2:60. Holotype (sex unknown), North America (NAPLES), *teste* Krombein, 1949.

Pelopoeus tahitensis Saussure, 1867, Reise der Öst. Freg. Novara, Zool., 2:27. Syntypes ♂, ♀, Otahili, Tahiti (GENEVA).

S. caementarium is an extremely variable insect with respect to the yellow markings. Specimens from the northern limits of its range, Canada and the northern United States, show a great reduction in the amount of yellow: the pedicel, pronotum, scutellum, postscutellum, propodeum, mesopleura below the tegulae, and tergite II are entirely black or have only traces of yellow. In addition, the front and middle femora usually are nearly all black except at the extreme tip. Southward the yellow markings increase in size. In extreme examples the propodeum is nearly all yellow, there is a yellow spot anterior to the metathoracic spiracle, tergite II is all yellow, the areas mentioned previously as black or with traces of yellow are extensively so, and the front and middle femora may be three-fourths yellow. This clinal variation probably is explained by climatic factors.

On the basis of characters seemingly independent of those listed above, the species is divisible into two separate populations. Most of the individuals east of the Rockies have dark amber wings and long, narrow, black petioles. West of the Rockies the wings are a clear amber and the petiole is usually yellow. Specimens from California sometimes have a rather thick short petiole. The variation found in *caementarium* has led to the description of many "species" as attested by the extensive synonymical bibliography. Bohart has seen the types of *canadensis, architectus* and *solieri. S. servillei* was described from a female, but in the collection at Turin only a male could be found that might have been studied by Lepeletier. Van der Vecht (1961*a*) is the authority for the synonymy of *lunata, affinis,*

and *flavipes*. Krombein (1949) is the authority for the synonymy of *flavomaculata, nigriventris* and *tahitensis*.

Biology.—The life history of this wasp is well known and is similar to that reported for the genus. Shafer (1949) has devoted an entire book to the subject. Other references include the works of Rau and Rau (1918), Rau (1928*b*), Peckham and Peckham (1898), and Morley (1900). Rau and Rau (1916) recorded this wasp congregating on twigs of elderberry at night. Muma and Jeffers (1945) summarized data on spider prey.

Distribution.—The range includes all of the United States and southern Canada, Mexico, Central America, and the West Indies (fig. 8). It is recorded from South America as well, but these records may be in error as we have seen no specimens from there.

Krombein (1949) recorded the introduction of this species into Hawaii, the Marshall Islands, and the Marianas, presumably during World War II. *S. caementarium* appeared in Tahiti many years ago, and Williams (1947) stated that it has been introduced into the Marquesas Islands, Fiji, Samoa, and the Society Islands also.

Sceliphron lucae (Saussure)

Pelopoeus lucae Saussure, 1867, Reise der öst. Freg. Novara, Zool., 2:30. Holotype ♂, "Promentorium St. Lucae, California inferior" (GENEVA).

This species is easily recognized by the broad yellow bands on the abdomen. The male genitalia are nearly identical with those of typical *caementarium*. Bohart examined Saussure's type.

Distribution.—The species is known only from the southern part of Baja California.

Tribe SPHECINI

Tarsal claw with two or more teeth toward base of inner margin; ventral terminal bladelike setae of fifth hind tarsomere broad, separated by less than twice a setal breadth; second and third submarginal cells each receiving a recurrent vein (may be interstitial) (figs. 40, 41), rarely with both recurrents interstitial; third maxillary palpomere not swollen asymmetrically.

KEY TO GENERA OF WORLD SPHECINI

1. Width of second submarginal cell equal to or greater than height (subtribe Sphecina) . . 2
   Width of second submarginal cell less than height (in one South American species of *Prionyx* of the *pumilio* group the second submarginal cell irregular or lacking) (subtribe Prionyxina) 4
2. Length of anterior veinlet of third submarginal cell greater than length of basoposterior veinlet (fig. 41) . . . . . *Isodontia* Patton
   Length of anterior veinlet of third submarginal cell equal to or less than length of basoposterior veinlet (frontispiece) 3
3. Stigmatal groove present . . . . . *Sphex* Linnaeus
   Stigmatal groove absent . . . . . *Fernaldina* Bohart and Menke
4. Tarsal claw with two teeth along inner margin;[1] female clypeus with a median truncation bounded laterally by a notch or sinuation; male antenna without fossulae (Northern Hemisphere) . . . . . *Palmodes* Kohl
   Tarsal claw with two to five teeth along inner margin; but if only two then one of the following characters present: metapleuron depressed, channellike, for reception of hind femur, female clypeus entire or with a median emargination or U-shaped notch, male antenna with fossulae . . . . . *Prionyx* Vander Linden

[1] Males of two species of South American *Prionyx* of the *pumilio* group will key out here. They can be identified by genitalia.

Subtribe SPHECINA

Forewing with second submarginal cell as broad as or broader than high; tarsal claw with two teeth toward base of inner margin; sternites IV–V in male without velvety pubescence.

Genus *Sphex* Linnaeus

Sphex Linnaeus, 1758, Systema Nat., 10th ed., 1:569. Type: *Sphex flavipennis* Fabricius, 1793. Designated by Internatl. Comm. Zool. Nomencl., Opin. 180, 1946. Opin. and Decl. Internatl. Comm. Zool. Nomencl. 2:569–585.

Ammobia Billberg, 1820, Enum. Insect., p. 105. Type: *Sphex argentata* Fabricius, 1787. Designated by Rohwer, 1911.

Proterosphex Fernald, 1905, Ent. News, 16:165. Type: *Sphex maxillosa* Fabricius, 1793 (= *Sphex leuconota* Brullé, 1832). Preoccupied by *Sphex maxillosa* Poiret, 1787.

Male antenna with fossulae; female mandible with teeth at or before middle, free margin of female clypeus arcurate, sometimes with small median lobe or emargination; anterior veinlet of third submarginal cell shorter than posterobasal veinlet; propodeum with stigmatal groove; petiole subequal in length to hind coxa; pygostyles present; female with a psammophore; claw teeth blunt and angled toward apex.

In 1758 Linnaeus described *Sphex,* including twenty-five species. Their diverse nature was soon recognized and this led by 1805 to the removal of all of Linnaeus' original species for the formation of new genera. In the meantime Linnaeus, Fabricius, and others described additional forms under the genus *Sphex,* most of which were not congeneric with the various originally included species. These later species belong to the category now generally accepted as *Sphex.* Fernald (1905) pointed out that the name *Sphex* had been used for a long time for a group of insects not represented by any of the original twenty-five species. Therefore, he arbitrarily and logically designated *sabulosa* as the type of *Sphex,* an action in accord with the Rules of the International Commission on Zoological Nomenclature. Fernald's action, however, was not subsequently supported by world-wide entomological usage because Kirby in describing *Ammophila* (1798) had included *sabulosa,* and this generic name had become generally accepted for the group of wasps to which *sabulosa* belonged. In Opinion 32 the International Commission on Zoological Nomenclature (1911) concurred with Fernald by officially designating *sabulosa* as the type of *Sphex.* But in 1946, after reëvaluation, the Commission made a new ruling, Opinion 180, in which a non-Linnaean species, *Sphex flavipennis* Fabricius, was designated as the type of *Sphex.* This ruling satisfied most workers because of its agreement with the popular usage of *Sphex.* Today a minority of opinion still favors the use of *Sphex* in place of *Ammophila,* and on the basis of a technicality it has been claimed that Opinion 180 is invalid (Muesebeck *et al.,* 1951).

The synonymy of the type species of *Proterosphex* has been explained by van der Vecht, 1959. A motion is before the International Commission on Zoological Nomenclature to suppress Poiret's name according to van der Vecht (1961*a,* page 10).

Kohl's papers (1890, 1895) represent a world revision. Useful faunal works are those of Fernald (1906) for the Nearctic region; Roth (1925), North Africa; Arnold (1928), Ethiopian region; Yasumatsu (1938), Oriental region; Honore (1944), Egypt; Willink (1951), southern South America; and van de Vecht and Krombein (1955), Indonesia.

Biology.—These wasps are ground nesters and usually are gregarious, some colonies being maintained over a period of many years. The burrow may contain one or more cells, and a type of progressive provisioning occurs. The egg is laid on the first prey and several more prey are then added. Prey consists of Tettigoniidae in the Nearctic forms, although Rau (1933) cited *Gryllus* as prey of *S. cubensis* (Fernald) (probably refers to *melanopus* Dahlbom). In the same paper Rau reported *S. ichneumoneus* in Panama using *Gryllacris* sp. (Gryllacrididae) in addition to the usual conocephaline Tettigoniidae. Rau stated that *ichneumoneus* made a single-celled nest and *melanopus* a two-celled nest. Williams (1919), reporting on Old World species, said that *Sphex aurulentus* Fabricius (= *sericeus* Fabricius) used *Gryllacris brevispina* Stål as prey. Nests had one or two cells. Williams noted that in *Sphex muticus* Kohl (probably *subtruncatus* Dahlbom) provisioning took several days. So far as known, *Sphex* dig the nest prior to obtaining prey, which then are carried to the nest on the wing. Some species construct more than one burrow at a time but provision only one of these. This was discussed in a paper by Piel (1935) on the habits of *Sphex umbrosus* Christ (= *argentatus* Fabricius), in China. He theorized that the several burrows would serve to confuse the parasitic flies (*Metopia*) which hovered about. Piel found that the cells were usually provisioned with four katydids. The prey belonged to four subfamilies: Copiphorinae (*Homorocoryphus*), Listroscelinae (*Hexacentrus*), Conocephalinae (*Conocephalus*), and Phaneropterinae (*Phaneroptera*).

Distribution.—The large genus *Sphex* is cosmopolitan and numbers over sixty species.

KEY TO THE NEARCTIC SPECIES OF SPHEX

1. Antenna with eleven flagellomeres, abdomen with seven visible tergites (males) 2
   Antenna with ten flagellomeres, abdomen with six visible tergites (females) 11
2. Erect hair on clypeus and pronotal lobe black 3
   Erect hair on clypeus and pronotal lobe silvery, grey, or golden 5
3. Wings dark brown to black; flagellum with fossula on V only . . . *pensylvanicus* Linnaeus
   Wings partly infused with reddish colors; flagellum with fossulae on IV or on both V and VI 4
4. Tibiae bright orange; flagellomeres V and VI with small, oval, orange fossulae; last visible sternite produced and narrowly rounded posteriorly . . . . *ashmeadi* (Fernald)
   Tibiae dark; flagellomere IV only with a long oval fossula; last visible sternite not produced, distal margin somewhat wavy . . . . . *tepanecus* Saussure
5. Tibiae mostly dark; flagellomeres V and VI only with fossulae 6
   Tibiae bright orange; flagellomeres III or III and IV with fossulae as well as V and VI . 8
6. Last visible sternite broadly obtuse distally, depressed, cuplike medially; abdomen usually all red; free edge of clypeus bent under to give an appearance of thickness; fossulae slender, oval, three-fourths as long as segments concerned . . . . *habenus* Say
   Last visible sternite produced nearly into a right angle or narrower, not cuplike; abdomen all dark or at least last four segments; free edge of clypeus not bent under . 7
7. Clypeus with median truncation somewhat emarginate and about as broad as antennal socket area; fossulae narrowly oval; penultimate sternite without a median subbasal spine . . . . . *texanus* Cresson

   Clypeus with median truncation poorly defined, broader than antennal socket area; fossulae broadly oval to rectangular; penultimate sternite with a median subbasal spine *dorsalis* Lepeletier
8. Abdomen dark, femora dark except distally 9

Abdomen all red or at least red toward base; femora usually with distal one-half or more red, often all red 10

9. Last tergite broadly truncate to slightly emarginate; fossulae rather slender, extending along basal two-thirds of flagellomeres IV–VI; appressed facial pubescence golden *flavitarsis* (Fernald)

Last tergite broadly rounded, a median longitudinal ridge evident toward tip; fossulae very broad, extending along nine-tenths of flagellomeres III and IV; appressed facial pubescence silvery to straw colored . . . . . *nudus* Fernald

10. Abdomen all reddish, including petiole; fossulae slender, oval, usually not extending along more than basal three-fourths of flagellomeres IV–VI . . . *jamaicensis* (Drury)

Abdomen with segments III and following mostly or all black; fossulae broad (in Nearctic specimens), extending along nine-tenths of flagellar segments IV–VI *ichneumoneus* (Linnaeus)

11. Mesopleuron without a bright spot of silvery or golden pubescence behind pronotal lobe . 12

Mesopleuron with a bright spot of silvery or golden pubescence behind pronotal lobe . 15

12. Abdomen partly or wholly red; outstanding hair on clypeus and pronotal lobe black *ashmeadi* (Fernald)

Abdomen all dark 13

13. Tibiae bright orange red; outstanding hair on clypeus and pronotal lobe tawny *nudus* Fernald

Tibiae black; outstanding hair on clypeus and pronotal lobe black 14

14. Wings dark brown . . . . . *pensylvanicus* Linnaeus

Wings reddish . . . . . *tepanecus* Saussure

15. Fore femur with much fine erect hair on lower one-half of outer surface 16

Fore femur with scattered bristly hair on lower one-half of outer surface, concentrated mostly along ventral line 17

16. Legs black, abdomen usually black; large species . . . . . *habenus* Say

Legs mostly red, abdomen red basally and apically . . . . . *dorsalis* Lepeletier

17. Dorsum of propodeum as seen from above and behind with much golden appressed pubescence; femora mostly or all red 18

Dorsum of propodeum as seen from above and behind without golden appressed pubescence; femora more than one-half black or all dark 19

18. Abdomen with last three segments black, petiole (in Nearctic specimens) black *ichneumoneus* (Linnaeus)

Abdomen all red including petiole . . . . . *jamaicensis* (Drury)

19. Legs practically all black; least interocular distance about three-fourths of that measured at posterior ocelli . . . . . *texanus* Cresson

Legs mostly red as far up as femoral apex; least interocular distance nearly equal to that measured at posterior ocelli . . . . . *flavitarsis* (Fernald)

Sphex ashmeadi (Fernald)

(Figs. 9, 86, 88)

Chlorion ashmeadi Fernald, 1906, Proc. United States Natl. Mus., 31:389. Lectotype ♂, "Ariz." (USNM). Present designation.

Male.—Average length 23 mm; head and thorax black, wings dark, partly bluish, dull red toward base; mandible mostly, tegula, femoral apex, tibiae, tarsi, gaster orange-red; erect hair of head and thorax dark, face with extensive appressed silvery pubescence; flagellum as in figure 88; sternite VIII produced, the projection narrowly rounded posteriorly; genitalia as in figure 86.

Female.—Length about 25 mm; scape, legs beyond trochanters, and entire abdomen red, wings yellowish red.

Distribution.—This species is known from California, Nevada, southern Utah, Arizona, New Mexico, Texas, and northern Mexico (fig. 9). Fernald (1906) recorded it from Colorado.

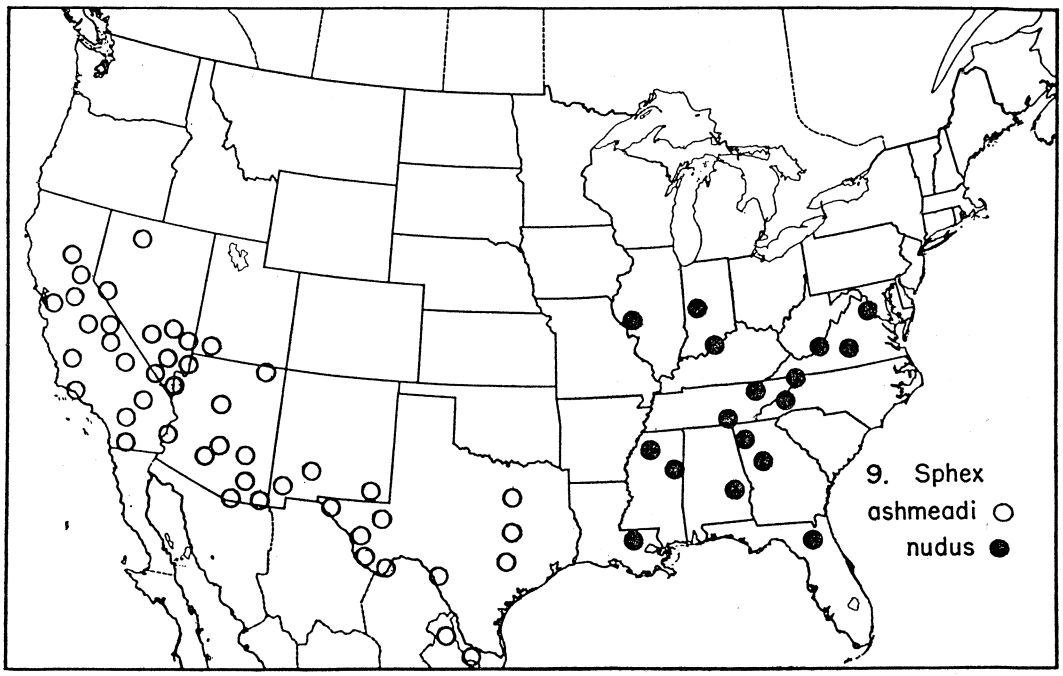


Fig. 9. Known distribution of *Sphex ashmeadi* (Fernald) (white circles) and *S. nudus* Fernald (black circles) in the United States and northern Mexico.

Sphex flavitarsis (Fernald)

(Figs. 10, 72, 79)

Sphex flavipes Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:263. Holotype ♀, "Georgia" (BMNH). Preoccupied by *Sphex flavipes* Fabricius, 1781.

Chlorion flavitarsis Fernald, 1906, Proc. United States Natl. Mus., 31:379. New name for *flavipes* Smith.

Male.—Average length 23 mm; body black, wings evenly light brown; tegula, femoral apex, tibiae, tarsi orange red (fore femur extensively orange red); erect hair of head and thorax golden; face, lobe and apex of pronotum, tegula, scutal furrows, postscutellum, propodeum above hind coxa, episternal suture behind pronotal lobe, and fore coxa with appressed whitish to golden pubescence; flagellum about as in figure 91; sternite VIII with a short, broadly rounded, median projection; genitalia as in figures 72 and 79.

Female.—Average length 27 mm; essentially like male; fore femur with scattered bristly hair on lower one-half of outer surface.

Murray (1951) placed *flavitarsis* as a subspecies of *opacus* Dahlbom. The two are distinct on the basis of male genitalia, however, and *opacus* is South American.

Distribution.—We have seen specimens of *flavitarsis* from Florida, Georgia, North Carolina, Virginia, Mississippi, eastern Texas, and northern Durango, Mexico (fig. 10).

Sphex habenus Say

(Figs. 11, 71, 77)

Sphex habena Say, 1832, New species of North American insects chiefly of Louisiana, p. 14. Type lost.

Sphex lauta Cresson, 1872, Trans. Amer. Ent. Soc., 4:212. Holotype ♀, Dallas, Texas (ANSP).

Sphex lauta var. *illustris* Cresson, 1872, Trans. Amer. Ent. Soc., 4:210. Holotype ♀, Texas (ANSP).

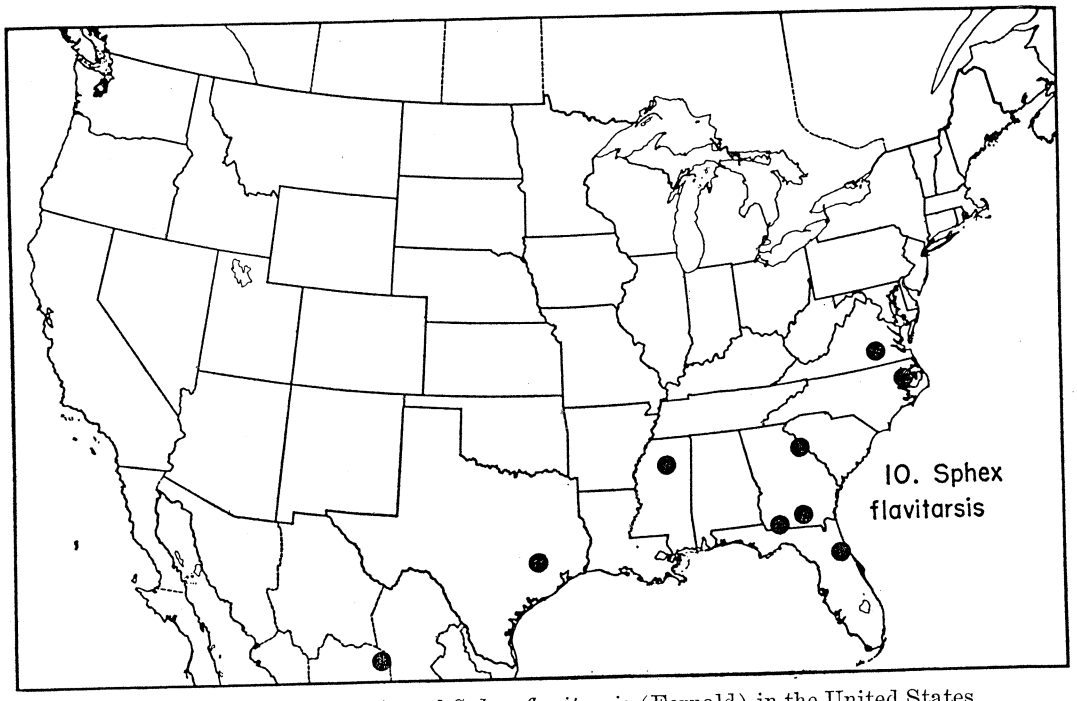


Fig. 10. Known distribution of *Sphex flavitarsis* (Fernald) in the United States and northern Mexico.

Sphex princeps Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:200. Holotype ♀, no data (VIENNA).

Sphex chrysophorus Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:201. Holotype ♀, Mexico (BUDAPEST).

Sphex lanciger Kohl, 1895, Ann. K. K. Naturhist. Hofmus. Wien, 10:55. Holotype ♂, New Orleans (BERLIN).

Male.—Average length 29 mm; head, thorax, petiole, and legs black; wings nearly clear; gaster red; erect hair of head and thorax golden; face with extensive appressed silvery pubescence; postocular area, lobe and apex of pronotum, scutum laterally, tegula, postscutellum, propodeal enclosure, and area above hind coxa with appressed golden pubescence; mesopleura from base of mid coxa to episternal suture, and metapleura along stigmatal groove with a band of appressed golden pubescence; mesosternum with appressed golden pubescence; flagellum as in figure 89, sternite VII with a broad V-shaped notch posteriorly, sides of plate elevated and bearing numerous stout setae; sternite VIII broadly rounded, slightly acuminate posteriorly, plate roundly depressed mesally; genitalia as in figures 71 and 77.

Female.—Average length 25 mm; abdomen black or rarely red; wings slightly yellowish brown; facial pubescence golden; mesopleura with a spot of silvery gold appressed pubescence behind pronotal lobe and above mid coxa; mesosternum without appressed golden pubescence; fore femur with much fine erect hair on lower one-half of outer surface.

We have studied the types of *lauta* and *illustris*. Bohart has examined *princeps*. Kohl's figure of the male sternites of *lanciger* positively identify the species as a synonym of *habenus*. *S. chrysophorus* is probably a specimen with a reddish abdomen, an infrequent color form in *habenus* females.

Biology.—Strandtmann (1953) recorded nymphal Tettigoniidae as prey.

Distribution.—*S. habenus* occurs in the southeastern United States (North Carolina, South Carolina, Georgia, Alabama, Arkansas, and Texas) and ranges south into Mexico (fig. 11).

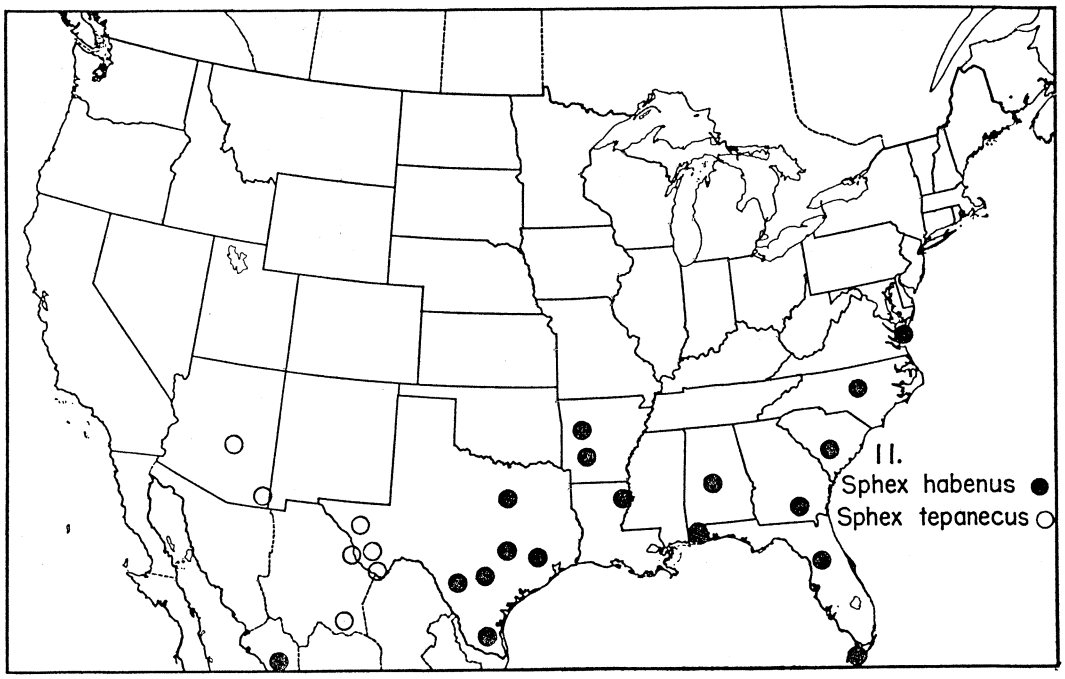


Fig. 11. Known distribution of *Sphex habenus* Say (black circles) and *S. tepanecus* Saussure (white circles) in the United States and northern Mexico.

Sphex ichneumoneus (Linnaeus)

(Frontispiece; figs. 12, 43, 46, 52, 83, 92, 108, 113)

Apis ichneumonea Linnaeus, 1758, Systema Nat., 10th ed., p. 578. Lectotype ♀, "habitat in America" (type locality here restricted to Surinam, the area in which Rolander collected the material on which Linnaeus based his description) (STOCKHOLM). Present designation.

Nomada surinamensis Retzius, 1783, Genera et Species Insectorum, p. 62. New name for *Apis ichneumonea* Linneaus, 1758.

Sphex dimidiatus Lepeletier, 1845. Hist. Nat. Insect, Hymen., 3:352. Holotype ♂ (labeled ♀ by Lepeletier), "Am. Sept." (TURIN). Preoccupied by *Sphex dimidiatus* De Geer, 1773.

Male.—Length about 19 mm; head, thorax, femora partly, and gastral segments III–VII black (III partly red basally); mandible basally, scape ventrally, tegula, tibia, and gastral segments I and II red; erect hair of head, thorax, and sternites V–VIII golden; face, postocular area, lobe and ridge of pronotum, and tegula with appressed golden pile; similar pubescence in lateral furrows of scutum, spots on scutellum, mesopleural spot behind pronotal lobe, propodeum, and spot above hind coxa; flagellomeres IV–VI with fossulae (fig. 92); sternite VIII acutely produced; genitalia as in figure 83.

Female.—Average length 23 mm; markings and pubescence about as in male but femora usually all red and trochanters sometimes a little or all red; golden pile more abundant, especially along stigmatal groove and on propodeal enclosure; fore femur with scattered bristly hair on lower one-half of outer surface, mostly concentrated along ventral line.

Through the kindness of Dr. Eric Kjellander of the Riksmuseet, Stockholm, we have been able to examine two Linnaean female syntypes, one of which is hereby labeled and designated as lectotype. These obviously belong with other material sent to us by Dr. J. van der Vecht, Rijksmuseum, Leiden, from Surinam. They are characterized by the narrow fossulae on flagellomeres IV through VI in the male and by the mostly red petiole and trochanters in both sexes. The wing is

fairly dark brown and the pleural gold pubescent markings are stronger than in Nearctic specimens. *S. ichneumoneus* appears to be quite variable over its range. Breadth of the fossulae of the male flagellum, color of the petiole, extent of red markings on the legs, and degree of infumation of the wings are the most obvious variables. Material from the Nearctic region normally has the petiole black and the fossulae broad. The wings tend to be much clearer in western than in eastern specimens, as discussed under distribution. Various combinations of wing color, petiole color, and breadth of fossulae occur in Central and South America. Since male genitalia seem to be alike and no other constant structural differences have been noted, we are inclined to view the polymorphism as an intergrading and sometimes local phenomenon not lending itself to separation into subspecies without much more study.

Biology.—The gregarious nature of this species is well known. Fernald (1945) cited one colony that remained in a single location for at least twenty-five years. We observed a colony of at least one hundred individuals nesting in the hard sandy soil of a gentle slope in the San Rafael Mts. of Santa Barbara Co., California. Menke noted a colony nesting in the sandy soil of a meadow at 3,800 feet elevation in Tuolumne Co., California. Prey consisted of female *Conocephalus fasciatus* (De Geer). Prey records from east of the 100th meridian are (Rau and Rau, 1918): *Conocephalus attenuatus* (Scudder), *C. triops* (Linnaeus), *Orchelimum vulgare* Harris, *O. calcaratum* Rehn and Hebard, *O. delicatum* Bruner, *O. gracile* (Harris), and the decticine *Atlanticus dorsalis* (Burmeister). Fernald (1945) cited *Neoconocephalus ensiger* (Harris) as prey in Florida. Abbott (1931) and Frisch (1937) gave detailed accounts of the biology of this wasp. The burrow ends in a pocket from which radiate two to six short tunnels ending in single cells. Two to six katydids are placed in each cell.

Distribution.—The species is widespread from southern Canada to Brazil, Peru, and Ecuador. The range of this large, handsome wasp in the United States is especially interesting when plotted on the basis of the more "clear-winged" versus the more "dark-winged" individuals. The band "dividing" these approximates the 100th meridian, which seems to be significant in so many other wasps as well as other insects. This band stretches irregularly from north to south, and it probably varies in location from year to year depending upon climate. Its approximate extent is indicated in figure 12.

Paige, 1961, made a study of this situation and attempted to delimit a reasonable dividing band on the basis of available information concerning wasp data, faunal zones, vegetation, and climate. Material furnished by the University of Nebraska was particularly significant. Paige decided that climate, especially precipitation and humidity, was the greatest determinant, because of its influence on vegetation and faunal zones. Figure 12 illustrates the observed distribution. The paler-winged form was found to be largely limited by the eastern boundary of the western Dry-Subhumid Belt. Here in the western Steppe, there is no accretion of ground water, except in rainy years, and thus the subsoil is virtually permanently dry. In the eastern Prairie of the Moist-Subhumid Belt, in contrast, there is a precipitation surplus and a moist subsoil. Here the dark-winged form is dominant and ranges to the eastern coast. Of further interest is the fact that

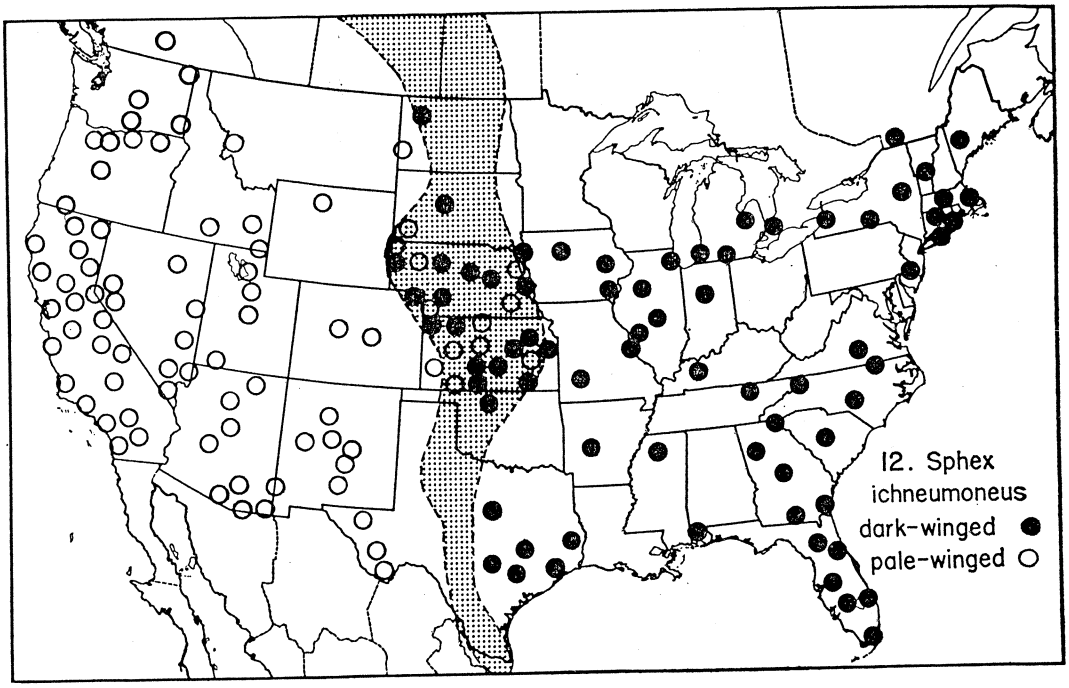


Fig. 12. Known Nearctic distribution of *Sphex ichneumoneus* (Linnaeus), dark-winged forms (black circles), pale-winged forms (white circles). Dotted overlay indicates zone of overlap based on observed specimens and on bioclimatic considerations.

the line between the dry and moist subhumid climates also separates the aluminum- and iron-accumulating soils to the east, which contain the more soluble materials subject to leaching, and the lime-accumulating soils to the west wherein the soil water is lost by evaporation or transpiration and soluble materials tend to concentrate near the ground surface. The overlapping ranges of wing types and the existence of some intermediate forms can be explained by the fluctuation of rainfall over periods of wet and dry years in the area along the dividing zone whose approximate center is an isoline drawn north to south through points of about twenty inches of annual rainfall in the central United States.

A possible explanation for the differences in wing color is that the sun's rays pass through the relatively clear wings of the arid-region form without excessive heat absorption and consequent water loss. In the humid-region form there may be a selective advantage in the absorption of energy-producing heat by the dark wings because water loss is less important. If this is true, it would account for the fact that a majority of desert-inhabiting wasps have clear wings whereas those of moist areas have much darker wings on the average.

Sphex jamaicensis (Drury)

(Figs. 13, 73, 84, 91)

Vespa jamaicensis Drury, 1773, Illus. Nat. Hist. 2:index for vol. 1, description in vol. 1 (1770), p. 104, pl. 44, fig. 4, "Jamaica." Type presumed lost.

Sphex jamaica Christ, 1791, Naturges. Klass. Nomen. Insekt., p. 292, pl. 29, fig. 1. Emendation of *Vespa jamaicensis* Drury, 1773.

? *Sphex auriflua* Perty, 1833, Delect. Anim. Articul. Brasil, p. 142, pl. 27, fig. 19. Syntypes ♂, ♀, "ad flumin Rio Negro," Brazil (MUNICH?).

Sphex aurulenta Guérin-Méneville, 1835, plate 70, fig. 2, of Icon. Reg. Animal, vol. 2, Planches Animaux Invert. *Lapsus* for *Sphex lanierii* Guérin-Méneville, 1844.

Sphex lanierii Guérin-Méneville, 1844, Icon. Reg. Animal, 3:433. Lectotype ♂, Cuba (GENOA). Present designation.

Sphex ornata Lepeletier, 1845, Hist. Nat. Insect., Hymen., 3:344. Syntype ♂, ♀, Cuba (TURIN?).

Sphex fulviventris Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:431. Lectotype ♂, Cuba (LEIDEN). Present designation.

Male.—Average length 19 mm; head and thorax black, scape, tegula, femur, tibia and tarsus of fore leg, all but coxae of mid and hind legs, petiole, and gaster orange red; wings brown, nearly clear in cellular area, darker at tip; erect hair of head and thorax golden; face, pronotal ridge and lobe, scutal furrows and central longitudinal stripe, postscutellum, propodeal enclosure and propodeum above hind coxa, episternal suture behind pronotal lobe, pleura above mid coxa, and stripe anterior to stigmatal groove with appressed golden pubescence; flagellum as in figure 91; sternite VIII acutely produced; genitalia as in figures 73 and 84.

Female.—Average length 24 mm; wings evenly dark brown; fore femur with scattered bristly hair on lower one-half of outer surface.

We have not studied sufficient South American *Sphex* to determine if *jamaicensis* occurs there. Therefore we have only tentatively placed *aurifluus* Perty in the synonymy. Dr. F. Kuhlhorn, Munich, has been unable to locate Perty's type. Guérin-Méneville's use of the name *aurulenta* for figure 2 on plate 70 in the "Iconographie" (1835) appears to be an error since in the description of *lanierii* (1844) he refers to the same figure. Bohart was unable to locate the syntypes of *ornata* but they may be at Turin. However, Lepeletier's description of *ornata* leaves little doubt that it is the same as *jamaicensis*. The name *fulviventris* usually is attributed to Guérin-Méneville (1831, 1838). However, van der Vecht (1957*a*) pointed out that there is no description in any of Guérin-Méneville's works for the species. Kohl (1890) must be considered as the author of the name. Van der Vecht (1957*a*) states that there is a male and a female labeled "Cuba" in Guérin-Méneville's handwriting in the Leiden collection. We are selecting the male as lectotype. Van der Vecht (1954, 1957*a*) suggested that *lanierii* is synonymous with *clavipes* Kohl [= *cubensis* (Fernald)]. However, *Sphex cubensis* has clublike hind femora and Guérin-Méneville's figure of *lanierii* (mislabeled *aurulenta*) definitely does not show this feature and neither do the syntypes seen by Bohart at Genoa.

Biology.—Krombein and Evans (1954) reported nesting colonies of twenty to forty individuals in Florida.

Distribution.—The species was described from South America and Cuba (fig. 13). In the United States the species is confined to Florida. We have also seen specimens from various islands in the West Indies.

Sphex nudus Fernald

(Figs. 9, 75, 81, 93)

Sphex nudus Fernald, 1903, Psyche, 10:201. Lectotype ♂, "Tenn.," Tennessee (USNM). Present designation.

Sphex bridwelli Fernald, 1903, Psyche, 10:202. Lectotype ♀, Indian Head, Maryland (USNM). Present designation.

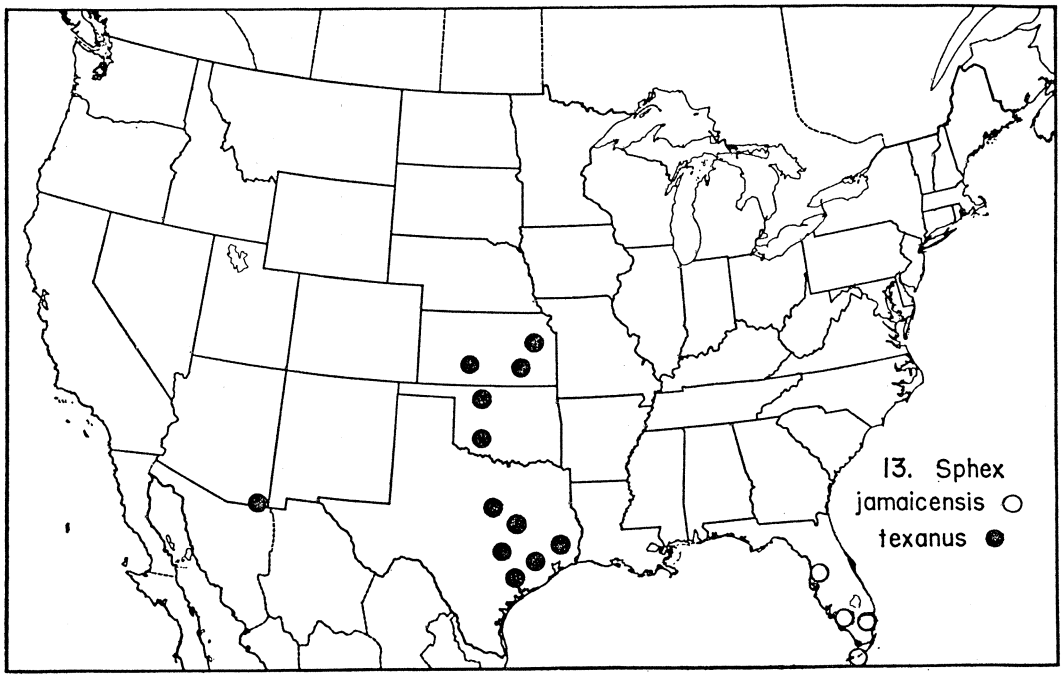


Fig. 13. Known distribution of *Sphex jamaicensis* (Drury) (white circles) and *S. texanus* Cresson (black circles) in the United States.

Male.—Average length 19 mm; body black; apex of femora, tibiae, and tarsi reddish; wings clear, dark towards tip; erect hair of body white; clypeus, and propodeum above hind coxa with silver appressed pubescence; flagellum as in figure 93; sternite VIII with a small median projection; genitalia as in figures 75 and 81.

Female.—Average length 22 mm; wings evenly dark brown; face with dark coppery appressed pubescence; propodeum without appressed silvery pubescence.

The bright orange tibiae, broad fossulae in the male, and silvery to straw-colored appressed facial pubescence are distinctive.

Biology.—Rau and Rau (1918) recorded *Camptonotus carolinensis* Gerstäcker as prey.

Distribution.—The range covers the eastern part of the country south of the Great Lakes and east of the Mississippi River (fig. 9).

Sphex dorsalis Lepeletier

(Figs. 14, 76, 82, 90)

Sphex dorsalis Lepeletier, 1845, Hist. Nat. Insect. Hymén., 3:347. Holotype ♂, Cayenne (TURIN).

Sphex singularis Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:261. Holotype ♂, Honduras (BMNH).

Sphex chlorargyrica Costa, 1862, Ann. Mus. Zool. Napoli, 1:66. Holotype ♂, "Bras.," Brazil (NAPLES).

Sphex micans Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:419. Lectotype ♀, Parana, Argentina (HALLE). Designated by Menke, 1963. Preoccupied by *Sphex micans* Eversmann, 1849.

Sphex dubitata Cresson, 1872, Trans. Am. Ent. Soc., 4:213. Holotype ♀, Texas (ANSP).

Sphex spiniger Kohl, 1890, Ann. K. K. Naturhist. Hofmus., 5:428. Syntype ♂ ♂, Mexico, Brazil (VIENNA, BUDAPEST). Synonymy *teste* Fernald, 1931.

Male.—Average length 19 mm; body black; wings clear; erect hair of head and thorax whitish; face with yellowish silvery appressed pubescence; lobe and apex of pronotum, tegula, scutal furrows, postscutellum, propodeum above hind coxae, mesopleura behind pronotal lobe, band on stigmatal groove of metapleura, fore coxa, and mesosternum with appressed silver pubescence; flagellum as in figure 90; sternite VIII acutely produced posteriorly, plate bearing a spinous process basally; genitalia as in figures 76 and 82.

Female.—Average length 19 mm; femora, tibiae, tarsi, gastral segments I–III, VI red; propodeal enclosure with appressed silver pubescence; fore femur with abundant hair on lower one-half of outer surface.

This species has been generally known as *singularis* Smith, but Bohart studied the type of *dorsalis* and verified the synonymy. Bohart has seen the types of *singularis, chlorargyrica,* and *dubitata.* Fernald (1931) is the authority for the synonymy of *spiniger.* Menke examined the syntypes of *micans.*

Males exhibit some color variation, and in Central American specimens the legs and abdomen are frequently partly red.

Biology.—Krombein and Evans (1954) described the nest as three-celled, with prey of *Conocephalus fasciatus* (De Geer). Three of the tettigoniids were found in each of two of the cells.

Distribution.—This species occurs in Mexico, Central America, and South America, as well as in the southeastern United States from Florida to New Mexico (fig. 14). We have seen additional material from California from which state it has not been previously known. These specimens, collected between August 9 and October 6, bear the following data: 2 males, 1 female, Sacramento, on *Melilotus alba* (L. Bruner, NEBR); 1 male, Davis (UCD); 1 male, 1 female, Turlock (R. Snelling, UCD).

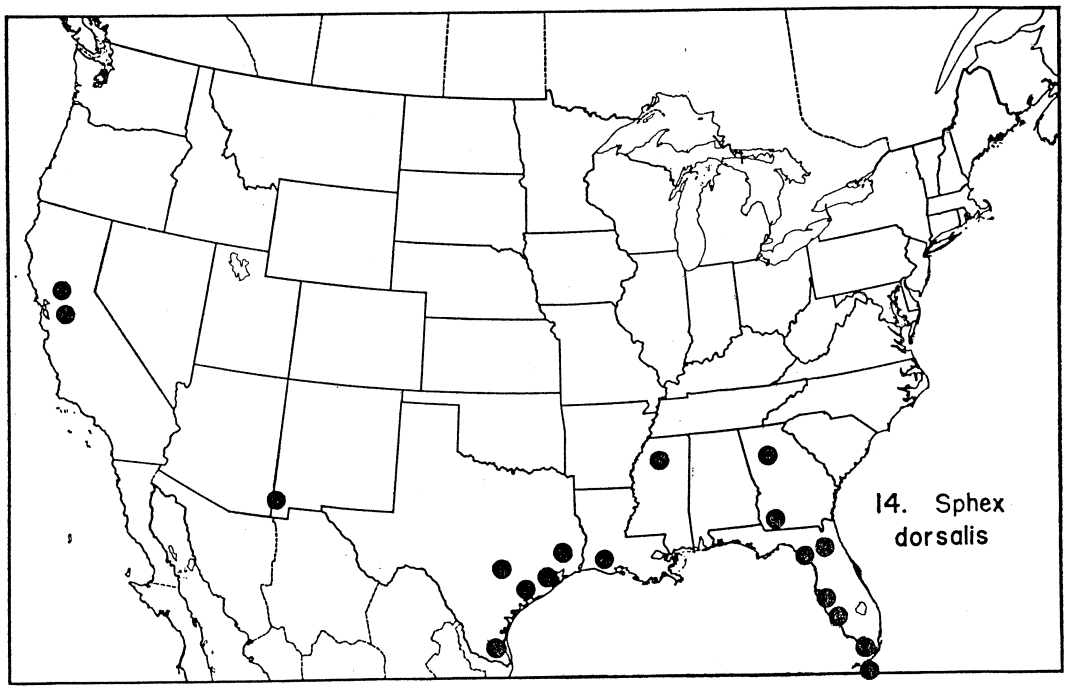


Fig. 14. Known distribution of *Sphex dorsalis* Lepeletier in the United States.

Sphex pensylvanicus Linnaeus

(Figs. 15, 85, 87)

Sphex pensylvanica Linnaeus, 1763, Centuria Insect Rar., p. 30. Holotype ♀, Pennsylvania (BMNH).

Male.—Average length 22 mm; body all black; wings black with violaceous tint; erect hairs of head and thorax black; face with some appressed tarnished silver pubescence; flagellum as in figure 87; sternite VIII triangular, apex truncate; genitalia as in figure 85.

Female.—Average length 28 mm; facial pubescence all dark.

The type, a well-preserved female in the Banksian collection at the British Museum, was examined by Bohart.

Biology.—Reinhard (1929) described a colony nesting in the floor of a greenhouse. Prey consisted of *Microcentrum laurifolium* (Linnaeus) and *Scudderia furcata* Brunner (Tettigoniidae). Rau (1944) observed this wasp nesting in the floor of a tool house. The burrows contained a single cell in which were placed up to five *Phaneroptera furcata* Brunner (Tettigoniidae). Krombein (1955) reported a dozen wasps nesting together on a perpendicular bluff. Prey consisted of the tettigoniid *Microcentrum retinerve* (Burmeister). Frisch (1938) described the burrow as containing up to ten cells. Two to six *Microcentrum rhombifolium* (Saussure) were placed in each cell.

Distribution.—*Sphex pensylvanicus* occurs throughout most of the United States north to the forty-third parallel (fig. 15).

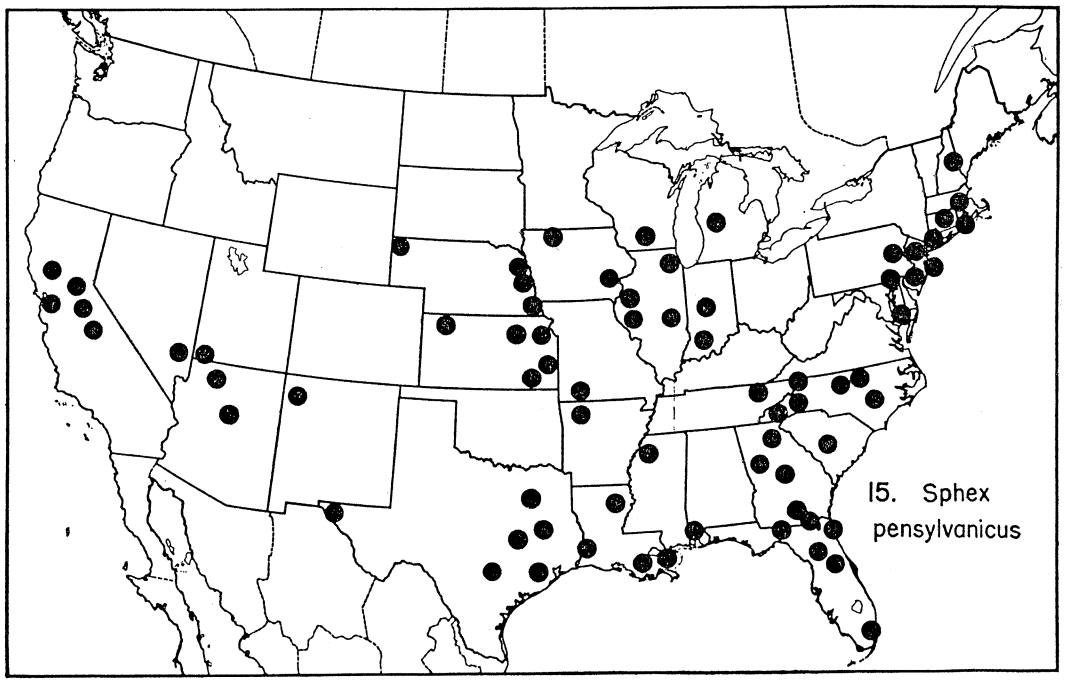


Fig. 15. Known distribution of *Sphex pensylvanicus* Linnaeus in the United States.

Sphex tepanecus Saussure

(Figs. 11, 74, 80)

Sphex tepanecus Saussure, 1867, Reise der Öst. Freg. Novara, Zool., 2:41. Holotype ♂, "Mextill." (Mextitlan) (GENEVA).

Sphex mexicana Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:416. Holotype ♂, Mexico (HALLE). Preoccupied by *Sphex apicalis mexicana* Saussure, 1867.

Male.—Average length 30 mm; body black, gastral segments I–III red (III black posteriorly), closing face of mid and hind femora reddish or all legs black; wings orange in cellular area, darker at tip; erect hair of head and thorax black; face with appressed silver pubescence; flagellum with segment IV only with a long oval fossula; sternite VIII truncate, sinuate; genitalia as in figures 74 and 80.

Female.—Average length 31 mm; body completely black; face without silver pubescence.

Bohart has studied the type of *tepanecus*. Kohl (1890) and Menke (1963*b*) synonymized *mexicana* after studying Taschenberg's type.

Biology.—Gillaspy (1962) reported an eight-celled nest provisioned with Tettigoniidae. The cells ranged in depth from 31 to 60 centimeters.

Distribution.—We have seen specimens from Arizona and Texas (fig. 11). The insect ranges southward into Mexico.

Sphex texanus Cresson

(Figs. 13, 70, 78, 89)

Sphex texana Cresson, 1872, Trans. Amer. Ent. Soc., 4:212. Holotype ♀, Texas (ANSP).

Male.—Average length 22 mm; body black; gastral segment I reddish posteriorly; wings clear; erect hair of head and thorax white; face, lobe and apex of pronotum, scutal furrows, propodeum above hind coxa, mesopleura behind pronotal lobe with appressed silvery pubescence; metapleura with appressed silvery pubescence along stigmatal groove; flagellum as in figure 89; sternite VII with a rounded median projection; genitalia as in figures 70 and 78.

Female.—Average length 21 mm; wing tips brown, gastral segments I–III red (III black posteriorly); postscutellum with appressed silvery pubescence.

Distribution.—We have seen specimens from Kansas, Oklahoma, Texas, and Arizona (fig. 13).

Genus **Fernaldina** Bohart and Menke, new genus

Type: *Sphex lucae* Saussure, 1867

Propodeum without a stigmatal groove; anterior veinlet of third submarginal cell as long as posterobasal veinlet; pygostyles absent; claw teeth sharp and perpendicular to claw axis (fig. 109); male antenna with weakly developed fossulae; free margin of female clypeus arcuate with a median notch; female mandible with teeth at or before middle; petiole subequal in length to hind coxa.

Fernaldina occupies a position intermediate between *Sphex* and *Isodontia*. The lack of a stigmatal groove and pygostyles separates this genus from *Sphex*. The wing venation as well as the head and claw characteristics differentiate *Fernaldina* from *Isodontia*. Only one species is known.

Biology.—Nesting habits are unknown.

Distribution.—*Fernaldina* occurs throughout the western United States and ranges along the southern coastal area to the southeastern United States. It also occurs in northern Mexico.

Fernaldina lucae (Saussure)

(Figs. 16, 109)

Sphex lucae Saussure, 1867, Reise der Öst. Freg. Novara, Zool., 2:41. Holotype ♀, Cape San Lucas, Baja California, Mexico (GENEVA).
Sphex belfragei Cresson, 1872, Trans. Amer. Ent. Soc., 4:212. Holotype ♀, Texas (ANSP).

Male.—Average length 15 mm; body dark (basal gastral tergites sometimes red), wings dark violaceous; erect hair pale on propodeal enclosure, dark otherwise; face with extensive appressed silvery pubescence; flagellomeres II–VIII with weak fossulae; genitalia similar to those of *Sphex ashmeadi* (fig. 86) but gonostyle more simple.

Female.—Average length 22 mm; gaster usually all red, rarely all black except last tergite; wings paler in cellular area where sometimes infused with reddish, or violaceous; face with dark appressed pubescence.

Bohart has studied the types of *lucae* and *belfragei*. This species exhibits color variation in different parts of its range. Female specimens from the western half of the United States have paler wings than specimens from the southeastern United States. In addition, all females we have seen from the southeast (South Carolina, Florida) have gastral tergites IV through VI black. In some males from these areas the basal tergites are reddish. However, we have seen males with this color pattern from Texas, and males with the typical all-black gaster occur in both areas. When more material is available it may be possible to erect a subspecies for the southeastern form.

Biology.—Linsley (1962) has described aggregations of both sexes of this species sleeping on *Melilotus alba*.

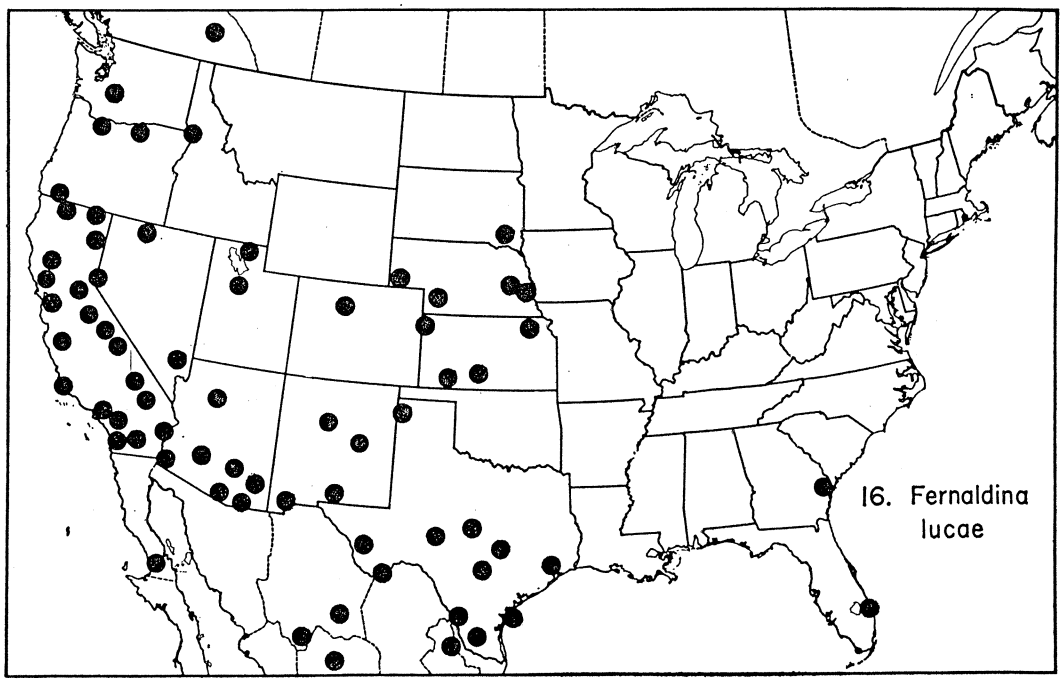


Fig. 16. Known distribution of *Fernaldina lucae* (Saussure) in Canada, the United States, and northern Mexico.

Distribution.—*F. lucae* occurs throughout the western half of the United States and in the southeast (fig. 16). It ranges southward into Mexico as far as the state of Morelos.

Genus *Isodontia* Patton

Isodontia Patton, 1880, Proc. Boston Soc. Nat. Hist., 20:380. Type: *Sphex philadelphica* Lepeletier, 1845. Original designation.

Leontosphex Arnold, 1944, Sphecidae of Madagascar, p. 90–91. Type: *Sphex leoninus* Saussure, 1891. Monobasic.

Propodeum without stigmatal groove; anterior veinlet of third submarginal longer than posterobasal veinlet; claw teeth blunt and angled toward apex (fig. 110); free margin of female clypeus broadly concave or convex, with a median notch or lobe (fig. 51); female without psammophore; female mandible with two to three distal teeth (figs. 44, 45); petiole one and one-half to two times length of hind coxa; male gastral sternites usually with cilia.

The characters used by Arnold for *Leontosphex* agree with those of *Isodontia.* Although the genitalia of the type species *leonina* are unusual, there appears to be no justification for retaining *Leontosphex* as a subgenus. On the basis of mandibular teeth and the presence or absence of pygostyles we have divided *Isodontia* into two subgenera: mandible with two distal teeth, and pygostyles present, *Isodontia s.s.;* mandible with three distal teeth, and no pygostyles, *Murrayella. Leontosphex* is synonymous with the first category. Kohl (1890) treated the world fauna, and Fernald (1906) the Nearctic species. Willink (1951) provided keys to some South American species. Arnold (1928) reviewed the South African species.

Biology.—These are commonly called grass-carrier wasps because of their habit of flying with bits of grass, with which they line their nests. So far as is known, Nearctic *Isodontia* nest in hollow stems of plants, abandoned bee burrows, or bee holes in wood. There is one interesting record of *Isodontia* nesting in pitcher-plants in Florida (Hubbard, 1896). The Nearctic species generally provision with oecanthine Gryllidae, although conocephaline Tettigoniidae may be used also. Willink (1951) in reviewing the biology of *Isodontia,* reported the Old World species *I. splendidula* (Costa) and *paludose* (Rossi) using phaneropterine Tettigoniidae and oecanthine Gryllidae. He cited one South American species, *I. paranensis* (Berland), using phasgonurine Tettigoniidae. A detailed account of the nesting habits of a Chinese species, *I.* (*Murrayella*) *nigellus* (Smith), was given by Piel (1933). This wasp used cut bamboo lined with rice straw and usually provisioned with conocephaline Tettigoniidae (*Conocephalus*). Exceptional prey were *Phaneroptera* and *Copiphora* or a near relative. Berland (1959) reported on the habits of *I.* (*Murrayella*) *paludosa* (Rossi) in France. He observed it making a solitary cell in a stone wall, lining it with vegetable fibers, and provisioning with the tettigoniid *Platycleis tessellata* (Charpentier).

Richards (1937) reported the observations of several workers on *I. costipennis* (Spinola) [=*fuscipennis* (Fabricius)] in South America. In one case the wasp made a cigar-shaped nest in a curled leaf. Other nests were described as "long cylindrical bags woven of hairs from Apocynaceae or Ascelpidaceae." Tettigoniidae were used as prey.

Distribution.—The genus is world-wide and contains over twenty species.

KEY TO THE SPECIES OF ISODONTIA IN AMERICA NORTH OF MEXICO

1. Antenna with eleven flagellomeres, abdomen with seven visible tergites (males) . . . 2
   Antenna with ten flagellomeres, abdomen with six visible tergites (females) 8
2. Mandible tridentate, mostly red; thick bands of cilia across sternites IV–VII (subgenus *Murrayella*) 3
   Mandible bidentate (subgenus *Isodontia*) 5
3. Hind tibia dark; scutum with much erect pale grey hair . . . . . *mexicana* (Saussure)
   Hind tibiae reddish, at least partly 4
4. Wings uniformly dark brown; sternal cilia nearly black; erect hair of frons nearly black *auripes* (Fernald)
   Wings yellowish to amber; sternal cilia yellowish; erect hair of frons grey to reddish gold *elegans* (Smith)
5. Fossulae present on flagellomeres IV–VI or VII 6
   Antennae without fossulae 7
6. Fore and mid tibiae and tarsi, petiole, and base of flagellum reddish; wings uniformly dark brown; appressed pubescence coppery . . . . . *exornata* Fernald
   Fore and mid tibiae and tarsi, petiole, and flagellum dark; wings clear except along anterior margin; appressed pubescence silvery gold . . . . . *fuscipennis* (Fabricius)
7. Thick bands of cilia across sternites IV–VII; sternite VIII with long, dense, black, erect hair; outstanding pubescence of frons mostly or all dark . . *philadelphica* (Lepeletier)
   No bands of sternal cilia; sternite VIII with weak, pale hair; outstanding pubescence of frons mostly pale grey . . . . . *apicalis* (Smith)
8. Mandible distinctly tridentate, the innermost tooth separated from the second one by a well-defined groove (subgenus *Murrayella*) 9
   Mandible bidentate, innermost tooth sometimes very weakly double (subgenus *Isodontia*) 11
9. Hind tibia dark, scutum with much erect pale grey hair . . . . . *mexicana* (Saussure)
   Hind tibia reddish 10
10. Wings infused with reddish, veins usually red; scutum and face with much erect, yellowish to golden pubescence . . . . . *elegans* (Smith)
    Wings dark, violaceous, veins brown to black; scutum and face with much erect, dark reddish-brown pubescence . . . . . *auripes* (Fernald)
11. Postscutellum and posterior margin of metapleuron with silvery to coppery appressed pubescence 12
    Postscutellum and posterior margin of metapleuron without silvery or coppery appressed pubescence 13
12. Fore and mid tibiae and tarsi, petiole, and basal flagellomeres reddish; wings uniformly dark brown . . . . . *exornata* Fernald
    Fore and mid tibiae and tarsi, petiole, and flagellum black; wings clear except along anterior margin . . . . . *fuscipennis* (Fabricius)
13. Erect scutal pubescence mostly dark . . . . . *philadelphica* (Lepeletier)
    Erect scutal pubescence mostly pale grey . . . . . *apicalis* (Smith)

Subgenus *Isodontia* Patton

Female mandible with two teeth (fig. 44); pygostyles present in male.

The Nearctic species of this subgenus belong to two distinct species groups. *I. apicalis* and *philadelphica* males are without fossulae and have specifically distinct genitalia. *I. exornata* and *fuscipennis* males have fossulae and the genitalia of the two species seem to be identical.

Distribution.—Found in both hemispheres.

ISODONTIA PHILADELPHICA GROUP

Isodontia (Isodontia) apicalis (Smith)

(Figs. 17, 67)

Sphex apicalis Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:262. Holotype ♂, St. John's Bluff, Florida (BMNH).

Isodontia macrocephala cinerea Fernald, 1903, Canadian Ent., 35:271. Lectotype ♀, Enterprise, Florida (USNM). Present designation.

Chlorion harrisi Fernald, 1906, Proc. United States Natl. Mus., 31:359. New name for *Sphex apicalis* Smith, 1856, p. 262.

Male.—Average length 18 mm; black, fore femur red basally; wings irregularly brown-stained, especially along veins and toward anterior margin; erect hair of head and thorax mostly pale, face with appressed silvery pubescence, bands of sternal cilia weakly developed and pale, sternite VIII with weak pale hair; flagellomere I shorter than IV or V; flagellomeres IV–VIII extensively spiculate; apex of sternite VIII with a broad V-shaped notch; genitalia as in figure 67.

Female.—Average length 20 mm; erect clypeal hair mostly dark.

Bohart has studied the type of *apicalis* Smith. In 1856 Smith used the name *apicalis* twice, on page 253 for a species from Sumatra (subsequently renamed *chrysorrhoeus* by Kohl, 1890, as first reviser) and on page 262 for an American species. Kohl's new name for Smith's first *apicalis* eliminates the homonymy and therefore his second name is available. *Sphex apicalis* Harris, 1835, is a *nomen nudum* and has no standing in the synonymy. Kohl (1890) placed *Pronoeus apicalis* Guérin-Méneville, 1850, in *Sphex*, thus establishing *Sphex apicalis* Smith (p. 262) as a secondary homonym. However, Guérin-Méneville's species belongs in *Chlorion* and the removal of his name from *Sphex* leaves *apicalis* Smith (p. 262)

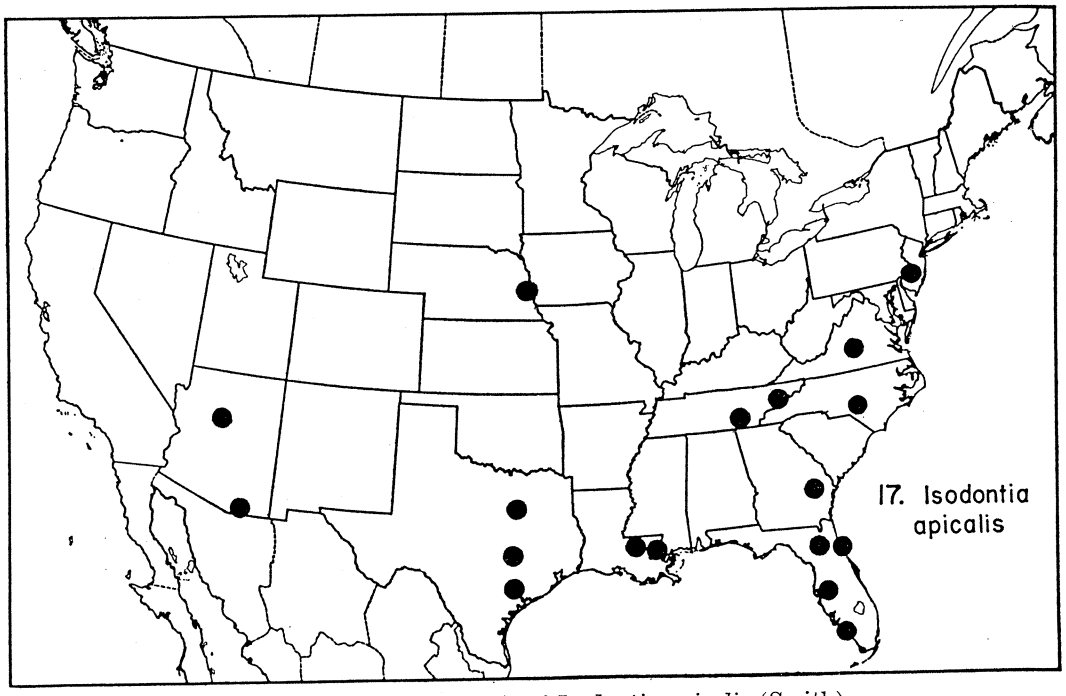


Fig. 17. Known distribution of *Isodontia apicalis* (Smith).

still available. Fernald's *harrisi* refers to this species rather than to the common North American species to which it has usually been applied (*I. mexicana*) since he stated it was a new name for *apicalis* Smith.

Isodontia azteca (Saussure), 1867, described from Mexico, resembles this species closely. However, the genitalia and last sternite display specific differences (compare figs. 67, 68).

Distribution.—*I. apicalis* occurs in the eastern United States (New Jersey, Virginia, South Carolina, Georgia, Florida), and ranges westward through Tennessee and Louisiana to Texas (fig. 17). Outlying localities are found in eastern Nebraska and in Arizona.

Isodontia (*Isodontia*) *philadelphica* (Lepeletier)

(Figs. 18, 44, 69)

Sphex philadelphica Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:340. Holotype ♀, Philadelphia, Pa. (TURIN).

Sphex macrocephalus Fox, 1890, Ent. News, 1:137. Holotype ♀, Philadelphia, Pa. (USNM).

Sphex (*Isodontia*) *azteca* of authors, not Saussure.

Male.—Average length 18 mm; black, fore femur red basally, wings dark violaceous; erect hair of head and thorax mostly black; face with appressed silvery pubescence; thick bands of cilia across sternites IV–VII, sternite VIII with dense black erect hair; flagellomere I shorter than IV or V, flagellomeres V–VII extensively spiculate; apex of sternite VIII with a narrow V-shaped notch; genitalia as in figure 69.

Female.—Average length 23 mm.

Lepeletier's species has been questionably regarded as being the same as *harrisi* (Fernald), e.g., *mexicana* (Saussure), but examination of the type by Bohart has established the identity of this species as that generally known as *azteca* (Saussure) (Murray, 1951). True *I. azteca,* however, is a Mexican species. Cameron's *robusta,* described from Mexico, probably is synonymous with *azteca.* Bohart has studied the type of *macrocephalus.*

Biology.—Menke observed several females nesting in a log in Santa Barbara Co., California.

Distribution.—This species occurs from coast to coast in the United States but does not appear to be a common insect (fig. 18). Our records cover most of the area south of the Great Lakes, from New York to eastern Kansas, thence westward to Texas, Arizona, and California, where it is found mainly along the coast north to the Oregon border.

Isodontia fuscipennis Group

Isodontia (*Isodontia*) *fuscipennis* (Fabricius)

?*Sphex petiolatus* Drury, 1773, Illus. Nat. Hist. 2: index, description p. 75, pl. 39, fig. 7. "Jamaica." Type presumed lost.

Sphex vaga Christ, 1791, Naturges. Klass. Nomen. Insekt., p. 305. New name for *Sphex petiolatus* Drury, 1773. Preoccupied by *Sphex vaga* Scopoli, 1763.

Pepsis fuscipennis Fabricius, 1804, Systema Piez., p. 210. Lectotype ♀, "Amer. Merid." (COPENHAGEN). Designated by van der Vecht, 1961.

Sphex costipennis Spinola, 1853, Mem. Accad. Sci. Torino, 13:54. Holotype ♀, Pará, Brazil (TURIN?) or (PARIS?).

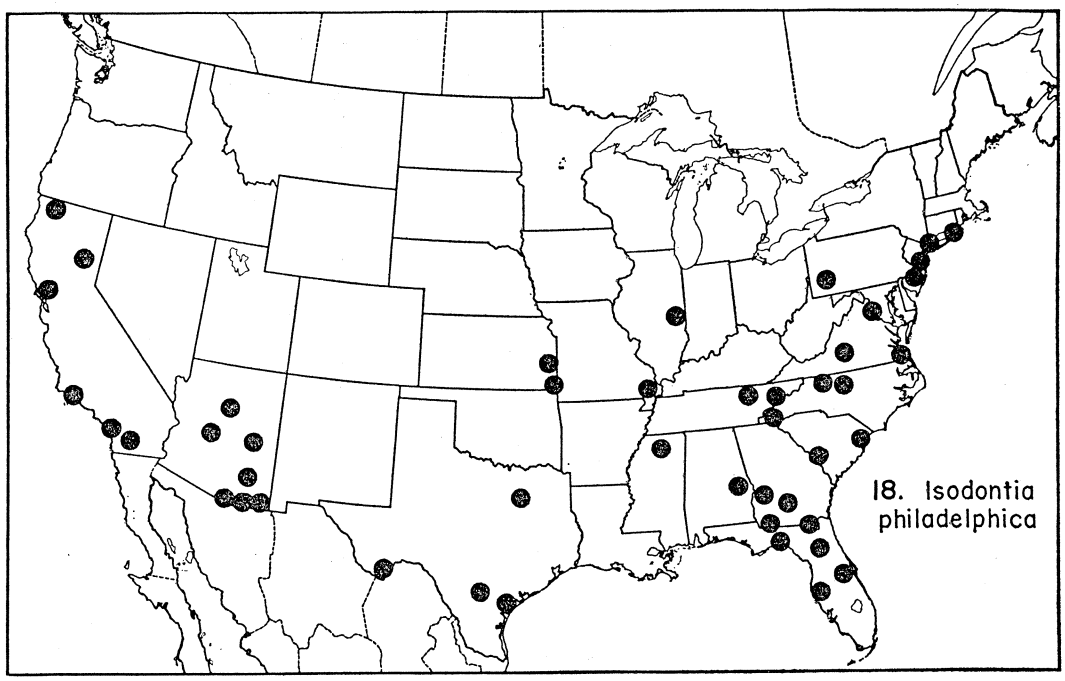


Fig. 18. Known distribution of *Isodontia philadelphica* (Lepeletier).

?*Sphex chrysobapta* Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:257. Holotype ♀, Brazil (BMNH).

?*Sphex petiolata* Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:259. Holotype ♂, Pará, Brazil (BMNH). Preoccupied by *Sphex petiolatus* Drury, 1773.

Male.—Average length 16 mm; black, tibiae and tarsi with some reddish tints behind, tegula and posterior margins of gastral tergites lighter; wings infused with brown along anterior margins; erect hair of head and thorax white; face, pronotal ridge, pronotal lobe, mesopleural spot, scutellum laterally, postscutellum, a lateral stripe and posterior spot on propodeum with silvery appressed pubescence; sternal cilia reddish brown; flagellomere I longer than IV or V, fossulae on IV–VI or IV–VII frequently reddish, no obvious spiculation; apex of sternite VIII broadly emarginate; genitalia similar to those of *exornata.*

Female.—Average length 17 mm; essentially like male.

Bohart has seen the type of *fuscipennis.* In the material we have studied the number of fossulae on the antennae vary from two to four or a partial fifth. In all specimens the genitalia appear identical, and although the number of fossulae is usually a specific character, this does not seem to be the case in *fuscipennis.* All males from Mexico that we have seen have three fossulae. In Central and South America males have three or four. Several specimens from South America have only two fossulae. An intensive study of this situation based on long series may eventually prove *fuscipennis* to be a complex of closely related species, and therefore the above synonymy may have to be modified. *Sphex petiolatus* Drury described from Jamaica may represent this species or it could be a member of the genus *Podium.*

I. fuscipennis is closely related to *exornata,* and the two seem to have identical genitalia. The fossulae of the latter are narrower, however, and the color differences mentioned in the key seem constant.

The gaster of *fuscipennis* may be extensively reddish brown in some specimens.

Biology.—According to Richards (1937), South American *fuscipennis* has been observed nesting in bamboo. Prey consisted of pseudophylline Tettigoniidae (*Pleminia*).

Distribution.—We have not seen *fuscipennis* from the United States, but it occurs as far north as Ciudad Mante, Tamaulipas, Mexico, and probably could occur in Texas. The species ranges south as far as Argentina.

Isodontia (*Isodontia*) *exornata* Fernald

(Figs. 19, 66)

Isodontia exornata Fernald, 1903, Canadian Ent., 35:270. Lectotype ♀, "Ga." (USNM). Present designation.

Male.—Average length 15 mm; black, marked with dark orange red on basal three-fourths of antenna, mandible, legs beyond middle or distal two-thirds of femur, tegula, and petiole; wings dark violaceous; erect hair of head and thorax reddish; face, pronotal ridge, pronotal lobe, mesopleural spot, scutellum laterally, postscutellum, a lateral stripe and posterior spot on propodeum with bright coppery appressed pubescence; no sternal ciliate bands; flagellomere I longer than IV or V; distant narrow fossulae on flagellomeres IV–VI, no obvious spiculation on flagellomeres; apex of sternite VIII with a deep median emargination; genitalia as in figure 66.

Female.—Average length 19 mm; essentially like male.

This species is closely related to *I. fuscipennis* (Fabricius) but the key characters readily separate them. We have seen females of what appear to be *exornata* from Mexico, but the antennae are dark, the wings and body lighter, and the appressed pubescence is not so coppery. These may represent a distinct subspecies.

Distribution.—*I. exornata* occurs in the southeastern United States (Georgia, Florida, Alabama) and ranges west to Texas (fig. 19). Murray (1951) reported it also in North Carolina.

Subgenus **Murrayella** Bohart and Menke, new subgenus

Type: *Sphex elegans* Smith, 1856

Female mandible with three teeth; pygostyles absent in male.

The Nearctic species of this subgenus have apparently identical genitalia. The subgenus is named in honor of W. D. Murray in recognition of his studies on American *Podalonia* and *Ammophila.*

Distribution.—This group occurs in both the Old and the New World.

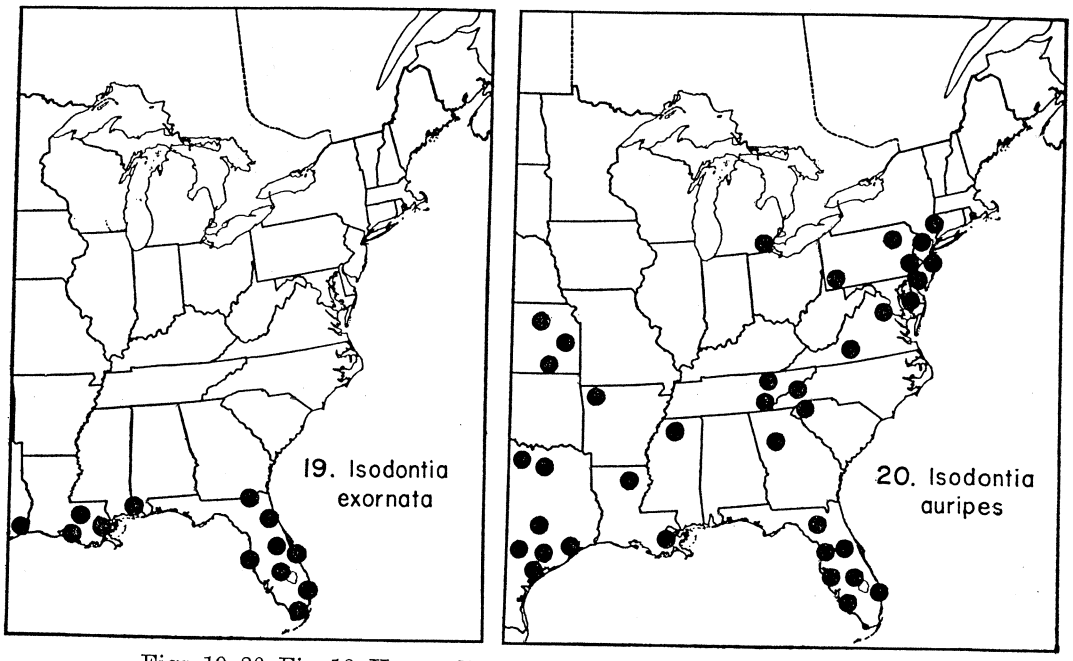
Isodontia (*Murrayella*) *auripes* (Fernald)

(Fig. 20)

Sphex tibialis Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:339. Holotype ♀, "Philadelphie" (TURIN). Preoccupied by *Sphex tibialis* Fabricius 1781.

Chlorion auripes Fernald, 1906, Proc. United States Natl. Mus., 31:356. New name for *Sphex tibialis* Lepeletier, 1845.

Male.—Average length 18 mm; black; apex of hind femur, tibiae, and tarsi reddish brown; wings dark violaceous; erect hair of head and thorax off-white to brownish or black; face, pronotal ridge, and metapleuron above hind coxa with appressed silver pubescence; sternites



Figs. 19–20. Fig. 19. Known distribution of *Isodontia exornata* Fernald.
Fig. 20. Known distribution of *I. auripes* (Fernald).

IV–VII with transverse bands of brown cilia; flagellomere I slightly longer than II; flagellomeres IV–VI spiculate; apex of sternite VIII emarginate; genitalia about as in figure 65.

Female.—Average length 19 mm; fore and mid tibiae and tarsi reddish brown or brown.

Bohart has studied the type of *tibialis.*

Biology.—Rau (1928*b*) observed *auripes* nesting in the burrows of *Melitoma taurea* (Say) and *Anthophora abrupta* Say (Anthophoridae) in a bluff. Rau also recorded nests in carpenter bee burrows and sumac stems. Prey consisted of Gryllidae (*Oecanthus quadripunctatus* Beutenmuller, *O. latipennis* Riley) and conocephaline Tettigoniidae (*Conocephalus memorale* Scudder, *Orchelimum vulgare* Harris).

Distribution.—This species occurs in the eastern United States, south of the Great Lakes and east of the 100th meridian (fig. 20).

Isodontia (*Murrayella*) *elegans* (Smith)

(Figs. 21, 41, 45, 51, 65, 110)

Sphex elegans Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:262. Holotype ♀, California (BMNH).

?*Chlorion bruneri* Fernald, 1943, Ann. Ent. Soc. Amer., 36:238. Holotype ♀, Cuba (USNM).

Male.—Average length 15 mm; head, thorax, petiole, femora except apical one-fifth black; tegula, tibiae and tarsi, except last tarsomere and claws, reddish brown; last tarsomere blackish; gaster reddish brown with extensive black on IV–VI; wings yellowish, clear in cellular area, apex darker, veins reddish brown; face, pronotal ridge, scutellum laterally, postscutellum, metapleura above hind coxa with appressed silvery pubescence; erect hair of body off-white; sternites IV–VII with thick transverse bands of reddish cilia; flagellomere I slightly longer than II; sternite VIII emarginate; genitalia as in figure 65.

Female.—Average length 17 mm; tarsi all reddish brown; appressed pubescence and erect hairs silvery gold or golden; wings yellow, tip brownish; gaster reddish brown.

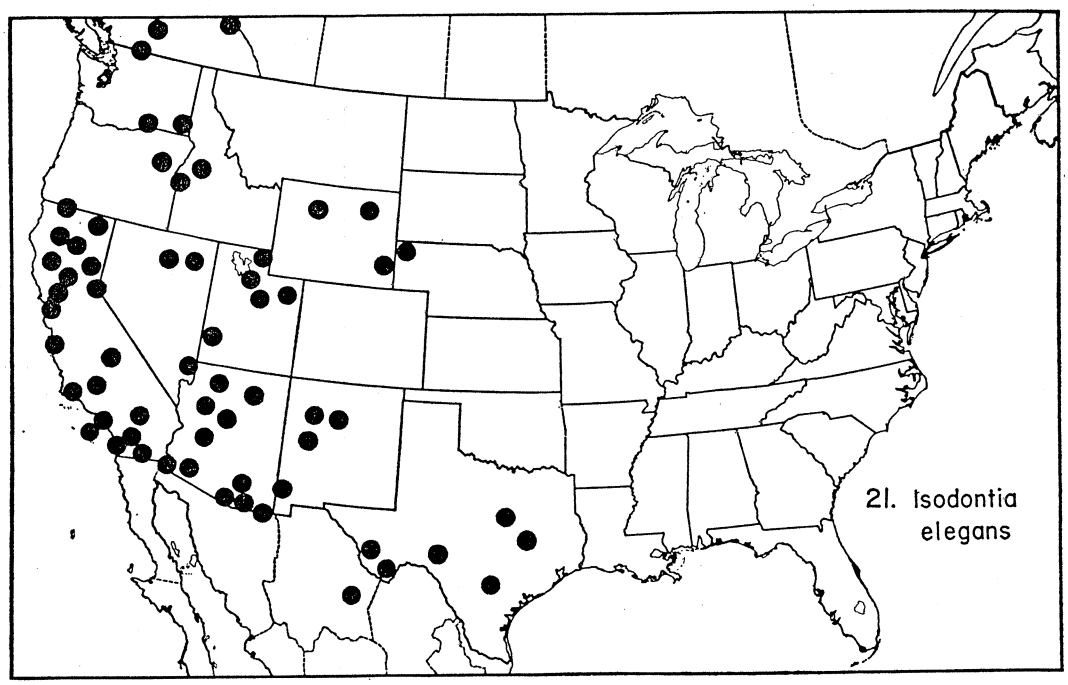


Fig. 21. Known distribution of *Isodontia elegans* (Smith).

Bohart has studied the type. This species has a sizeable color range with the gaster varying from nearly all reddish brown to black. We have seen the type of *bruneri* and tentatively place it here until males are available.

Biology.—Davidson (1899) observed *elegans* nesting in stems of white sage and provisioning with tree crickets (*Oecanthus*). Fernald (1906) recorded this species nesting in burrows of *Anthophora occidentalis* Cresson found in the vertical face of a bluff. Prey consisted of Gryllidae (*Oecanthus* sp.) and "grasshopper" nymphs. We have observed *elegans* nesting in cut bamboo stalks at Davis, California. The nests are provisioned with *Oecanthus* species.

Distribution.—The range includes the western states and northern Mexico (fig. 21). Except for a few specimens in eastern Texas, we have not seen any material from west of the 100th meridian.

Isodontia (*Murrayella*) *mexicana* (Saussure)

(Fig. 22)

Sphex apicalis Harris, 1835, *in*: Hitchcock, Rpt. Geol. Mineral. Bot. Zool. Massachusetts, p. 588. *Nomen nudum.*

Sphex apicalis Saussure, 1867, Reise der öst. Freg. Novara, Zool., 2:38. Syntypes, ♀ ♀, ♂ ♂, Illinois, Tennessee, Kansas (GENEVA). Preoccupied by *Sphex apicalis* Smith, 1856, p. 262.

Sphex apicalis mexicana Saussure, 1867, Reise der öst. Freg. Novara, Zool., 2:38. Holotype ♂, Orizaba, Mexico (GENEVA).

Male.—Average length 16 mm; black, thorax with bluish tint; posterior tibiae sometimes with reddish tints; wings clear in cellular area, suffused with brown along anterior margin, veins black brown; erect hair of body white, that of face partly brown; face, pronotal ridge, metapleuron above hind coxa with appressed silver pubescence; sternites V–VII with transverse bands of dark brown cilia; flagellomere I longer than II; apex of sternite VIII emarginate; genitalia about as in figure 65.

Female.—Average length 17 mm.

Bohart has studied the type of *mexicana.* Because of mistaken synonymy by Fernald (1906), this species has generally been known as *harrisi* (Fernald). Fernald confused *apicalis* Smith, 1856, page 262, with this species; and apparently unaware that homonymy no longer existed owing to Kohl's (1890) renaming of *apicalis* Smith, 1856, page 253, proposed the name *harrisi. I. harrisi* then becomes an unnecessary new name for *Isodontia* (*Isodontia*) *apicalis* Smith.

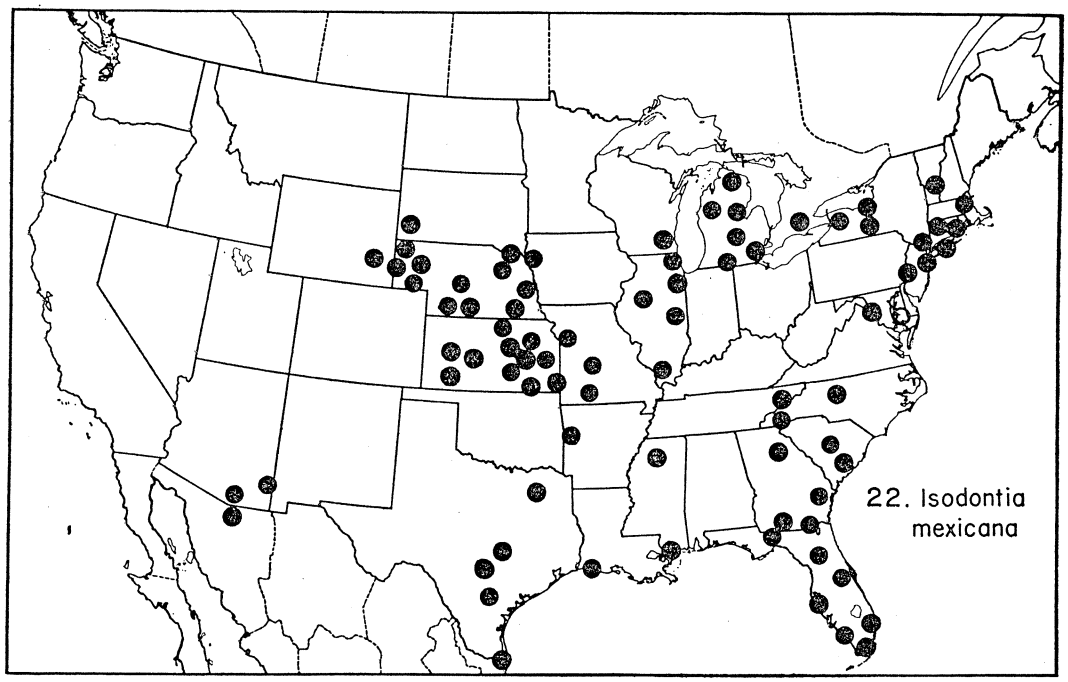


Fig. 22. Known distribution of *Isodontia mexicana* (Saussure) in the United States and northern Mexico.

This species is close to *elegans* but the rather consistently black body and appendages, wing color, lack of postscutellar silver appressed pubescence, and the reduction of it on the metapleuron are diagnostic for *mexicana.*

Biology.—Fernald (1906) recorded Gryllidae (*Oecanthus* sp.) as prey. The interesting account of Hubbard (1896) probably pertains to this species. He observed females nesting inside pitcher-plants (*Sarracenia variolaria*) in Florida. The wasp stuffed the pitcher with a floating mat of grass and plant fibers. Englehardt (1928) reported nests in the dead rolled leaves of yucca plants in Texas. Tettigoniids (*Rehnia spinosa* Caudell) were used as prey. Grasshopper nymphs, spiders, and crickets were also reported as prey by H. B. Parks in an annotation to Englehardt's paper, but the validity of the spider record is doubtful.

Distribution.—I. mexicana occurs throughout the United States east of the Rockies and ranges south through Texas into Mexico and Central America (fig. 22). In the west it is known only from southern Arizona and Sonora, Mexico. It was introduced into Hawaii (Oahu) some time after 1940, and recently into France (S. Kelner-Pillault, correspondence).

Subtribe PRIONYXINA

Second submarginal cell of forewing higher than broad (fig. 40); claws with two to five teeth toward base of inner margin (figs. 111, 114, 115); sternites IV and V in male with velvety pubescence; propodeum without stigmatal groove; pygostyles absent in male.

Genus *Palmodes* Kohl

Palmodes Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:112. Type: *Sphex occitanica* Lepeletier and Serville, 1828. Designated by Fernald, 1906.

Claws with two teeth (fig. 111); female clypeus with a median truncation bounded laterally by a notch or broad emargination (fig. 53); male genitalia with spatulate digitus (fig. 57,*d*), Northern Hemisphere.

Kohl (1890) treated the world species as a subgenus of *Sphex*. Bohard and Menke (1961) reviewed the North American species. Roth (1963) has completed a revision of the Palaearctic species.

Biology.—Nearctic *Palmodes* are solitary nesters and dig the burrow before seeking prey (Krombein, 1953). Prey consists of decticine Tettigoniidae (Bohart and Menke, 1961) and they are dragged to the nest along the ground (Krombein, 1955*b*). Most authors state that the nest is always dug first, but La Rivers (1945) was in partial disagreement. However, he indicated that this is the most common procedure. The Old World species *occitanicus* (Lepeletier) was reported by Kohl (1890) to provision with ephippigerine Tettigoniidae (*Ephippiger*), and to dig the nest after obtaining and paralyzing the katydid. *Tettigonia viridissima* (Linnaeus) was recorded as prey by Berland and Bernard (1947). Another Old World species, *argyrius* (Brullé) was observed by Berland (1958) to use phasgonurine Tettigoniidae (*Pholidoptera*) as prey and to nest in the crevices of a stone wall. The nest was lined with vegetable fibers and resembled that of *Isodontia paludosa* (Rossi). Unlike other *Palmodes, P. argyrius* has a poorly developed psammophore, as do all *Isodontia*. This condition is apparently correlated with its nesting habits.

Distribution.—The genus appears restricted to North African and the Mediterranean region in the Old World, and to North America in the New World. About twenty species have been described.

KEY TO THE NEARCTIC SPECIES OF PALMODES

1. Antennae thirteen-segmented; seven tergites visible (males) 2
   Antennae twelve-segmented; six tergites visible (females) 11
2. Clypeus without appressed silvery pubescence, hairs brown or black 3
   Clypeus covered with appressed silvery pubescence 7
3. Median apical margin of clypeus strongly produced, narrowly bilobed; body all black *stygicus* Bohart and Menke
   Median apical margin of clypeus not strongly produced, broadly and slightly emarginate 4
4. Flagellomere IX about twice as long as broad in dorsal (noncarinate) view; body 13 mm or less in length, all black 5
   Flagellomere IX more than twice as long as broad in dorsal (noncarinate) view; body usually 15 mm or more in length; abdomen red to black, some smaller forms with red-marked abdomen as short as 14 mm 6

5. Hindwing rather evenly brown stained and violaceous; inner angle of cuspis sharply protruding . . . . . *pacificus* Bohart and Menke
   Hindwing nearly clear in cellular area; inner angle of cuspis moderately protruding *insularis* Bohart and Menke

6. Petiole with abundant hair on distal one-half above; scutum with long, dense hair anteriorly; abdomen black; row of teeth toward apex of aedeagus nearly straight in flat, dissected mount . . . . . *carbo* Bohart and Menke
   Petiole nearly bare on distal one-half above; scutum with shorter, sparser hair anteriorly; abdomen red to black (usually partly red in Californian specimens); row of teeth toward apex of aedeagus sinuate in flat, dissected mount . . . . *dimidiatus* (De Geer)

7. Tegular pubescence dark or fulvous, not very pale; body length 17–24 mm; cross-striae of propodeal enclosure coarse 8
   Tegular pubescence partly silvery or very pale (sometimes scanty and best viewed from above and in front); body length usually less than 15 mm; cross-striae of propodeal enclosure fine 9

8. Anal lobe of hind wing nearly clear; clypeus medially with two prominent, glabrous, polished lobes; abdomen black . . . . . *laeviventris* (Cresson)
   Anal lobe of hind wing plainly brown stained; clypeus medially with very weakly developed lobes; abdomen with basal segments red . . . . . *praestans* (Kohl)

9. Scutellum mostly shiny, not indented nor shagreened medially; scutum with posterior one-third mostly shiny with well-separated punctures; abdomen black *lissus* Bohart and Menke
   Scutellum rather dull, shagreened and often indented; scutum with posterior one-third covered with close, swirling microridges 10

10. Scutum heavily shagreened in front, minute longitudinal and transverse ridges giving a "frosted" appearance; abdomen black . . . . . *californicus* Bohart and Menke
    Scutum somewhat polished in front, the punctures well separated; abdomen black or reddish basally . . . . . *hesperus* Bohart and Menke

11. Flat or concave margin of median clypeal lobe shorter than flagellar segment II and shorter than antennal socket expanse; scutum rather shiny posteriorly and often extensively smooth 12
    Flat or concave margin of median clypeal lobe equal to or greater than length of flagellar segment II or antennal socket expanse; scutum rather dull posteriorly except in one species 15

12. Clypeus deeply notched submedially; large black wasps about 23 mm long *stygicus* Bohart and Menke
    Clypeus broadly and shallowly emarginate submedially; body usually less than 20 mm long 13

13. Scutellum flattened, ungrooved, with scattered punctures but highly polished; abdomen black . . . . . *lissus* Bohart and Menke
    Scutellum distinctly raised, largely or all shagreened, usually grooved medially 14

14. Abdomen all red; face and clypeus with all pubescence dark *californicus* Bohart and Menke
    Abdomen with last three or more segments black; face and clypeus usually with some silvery or pale golden appressed pubescence, particularly in specimens from the Great Basin fauna . . . . . *hesperus* Bohart and Menke

15. Hindwing partly clear in cellular area or suffused with orange 16
    Hindwing rather evenly brown, violaceous 17

16. Wings extensively orange; abdomen red . . . . . *praestans* (Kohl)
    Wings partly clear in cellular area, otherwise brown stained . . *insularis* Bohart and Menke

17. Clypeal margin with a deep, acute, submedian notch; body all black . . *laeviventris* (Cresson)
    Clypeal margin with a shallow and obtuse submedian notch 18

18. Terminal sternite rather sharply ridged along median line opposite bristled area; body usually 14 mm or less in length; abdomen black . . . . . *pacificus* Bohart and Menke
    Terminal sternite narrowly but not very sharply rounded along median line; body usually 18–23 mm in length 19
19. Abdomen partly or all red (rare exceptions); ventral surface of sternite VI with six to eight stout bristles on either side of median ridge . . . . . *dimidiatus* (De Geer)
    Abdomen black; ventral surface of sternite VI usually with ten or more stout bristles on either side of median ridge . . . . . *carbo* Bohart and Menke

Palmodes californicus Bohart and Menke

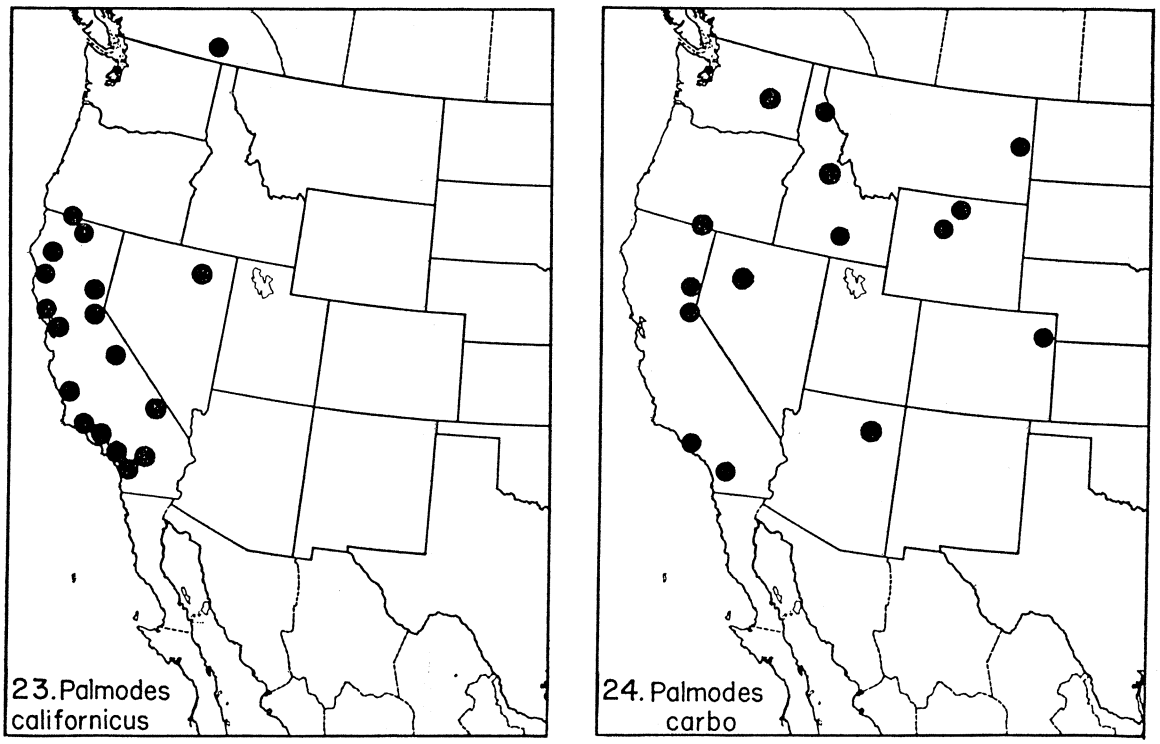
(Figs. 23, 57, 111)

Palmodes californicus Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:182. Holotype ♂, Tanbark Flat, Los Angeles Co., California (CAS).

Male.—Average length 14 mm; body black; wings dark brown, lighter toward base of median cell; face and tegula with appressed silvery pubescence; dorsum of thorax finely and closely punctate and shagreened, dull, scutum in front with dense longitudinal and cross shagreening; propodeal enclosure finely cross striate; genitalia as in figure 57.

Female.—Average length 15 mm; gaster all red; body without silvery pubescence; dorsum of thorax subshining with small shiny areas on scutum and scutellum; clypeal truncation relatively narrow (Bohart and Menke, 1961, fig. 3).

P. californicus is very similar to *hesperus* and occasionally occurs with that species. The male of *californicus* has the anterior part of the scutum shagreened and dull, and the gaster of the female seems to be always completely red. Furthermore, the clypeus of *californicus* females is always dark-haired and has a more sharply impressed lip than in *hesperus*.



Figs. 23–24. Fig. 23. Known distribution of *Palmodes californicus* Bohart and Menke.
Fig. 24. Known distribution of *Palmodes carbo* Bohart and Menke.

Biology.—Bohart and Menke (1961) recorded decticine Tettigoniidae (*Platylyra californica* Scudder, *Neduba morsei* Caudell) as prey.

Distribution.—*P. californicus* is restricted to the western states (fig. 23).

Palmodes carbo Bohart and Menke, new name

(Fig. 24)

Sphex morio Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:321. Lectotype ♀, Spences Bridge, British Columbia (VIENNA). Designated by Bohart and Menke, 1961. Preoccupied by *Sphex morio* Fabricius, 1775.

Male.—Average length 18 mm; body black; wings uniformly brown; dorsum of thorax moderately and rather closely punctuate, integument with faint shagreening, subshining; propodeal enclosure finely cross striate; petiole quite hairy on distal one-half above; genitalia illustrated by Bohart and Menke (1961, fig. 17).

Female.—Average length 24 mm; dorsum of thorax finely and closely punctate but with scattered large punctures, intervening spaces shiny; propodeal enclosure coarsely cross striate; sternite VI usually with ten or more stout bristles on either side of median ridge.

Unfortunately, the authors (1961) were not aware of the homonymy of Kohl's name with *S. morio* Fabricius, a pompilid. We have renamed Kohl's species *carbo,* meaning coal, referring to the black color of the species. The more hairy and robust body of *carbo* indicates that it is distinct from *dimidiatus.* In the female the black abdomen of *carbo* will almost invariably distinguish it from its close relative. Black males of the two species are difficult to separate.

Distribution.—*P. carbo* is primarily a Great Basin species (fig. 24).

Palmodes dimidiatus (De Geer)

(Fig. 25)

Sphex dimidiatus De Geer, 1773, Mem. Hist. Insect., 3:587. Holotype ♂, Pennsylvania (STOCKHOLM).

Sphex rufiventris Cresson, 1872, Trans. Amer. Ent. Soc., 4:211. Holotype ♀, "Tex." (ANSP).

Sphex abdominalis Cresson, 1872, Trans. Amer. Ent. Soc., 4:211. Holotype ♂, Texas (USNM). Preoccupied by *Sphex abdominalis* Drury, 1773.

Chlorion rufiventris opuntiae Rohwer, 1911, Proc. United States Natl. Mus., 40:257. Holotype ♀, Texas (USNM).

Sphex daggyi Murray, 1951, *in* Muesebeck *et al.,* United States Department Agric. Monogr. no. 2, p. 974. New name for *abdominalis* Cresson.

Male.—Average length 15 mm; head and thorax black; gaster all black or segments I and II and sometimes base of III red; wings uniformly dark brown; body without silvery appressed pubescence; dorsum of thorax moderately and closely punctate, dull; propodeal enclosure finely cross striate; petiole nearly bare on distal one-half above; genitalia illustrated by Bohart and Menke (1961, fig. 15).

Female.—Average length 20 mm; gaster all red or with segments IV–VII black, rarely all black (Nebraska specimens); sternite VI with six to eight stout bristles on either side of median ridge; broad clypeal truncation illustrated by Bohart and Menke (1961, fig. 7).

The authors have studied De Geer's type. Schulz (1912) pointed out the priority of De Geer's name over *abdominalis* Cresson, but subsequent authors neglected his note. We have studied the types of *rufiventris, abdominalis,* and *opuntiae.*

This species is rather variable in color. In the eastern United States both sexes have the gaster red and black, but in other parts of its range the gaster is usually all red in the female. In the southwest and Mexico, males sometimes have an

all-black gaster, whereas some Arizona males have an all-red gaster. We have seen a series from northwestern Nebraska in which both sexes are entirely black. The all-black males of *dimidiatus* are difficult to separate from *carbo* males, but the genitalia show slight differences and *carbo* is usually more robust and more densely hairy.

Biology.—Williams (1913) cited the tettigoniid *Stipator* as prey. Krombein (1953) observed *dimidiatus* using *Atlanticus pachymerus* (Burmeister) as prey, and the same author (1955*b*) reported the nest to contain a single cell.

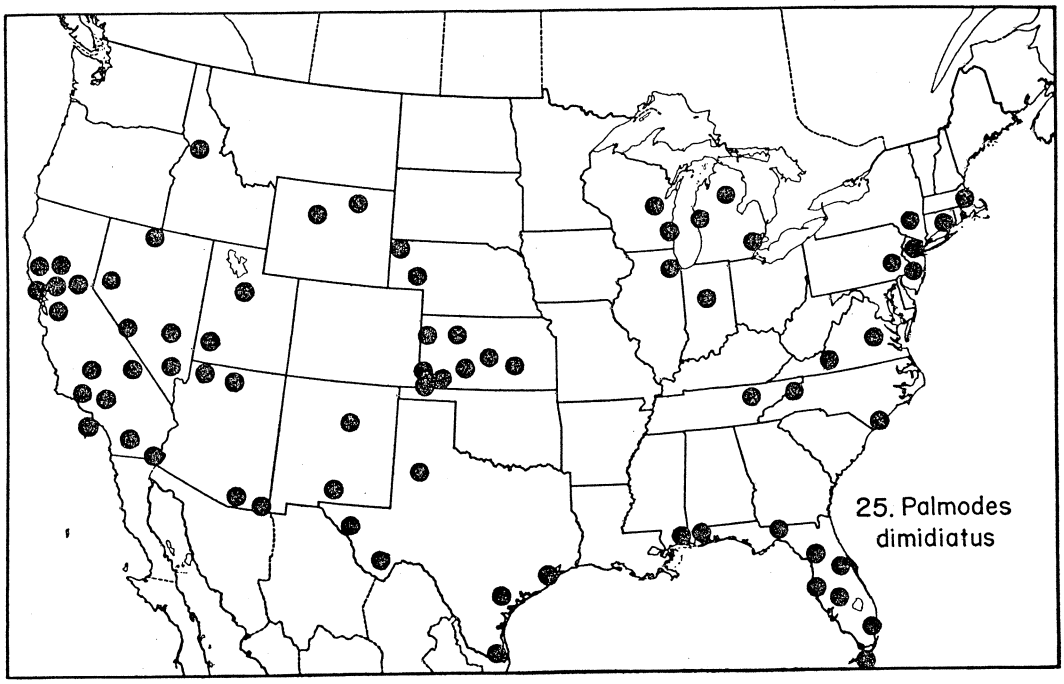


Fig. 25. Known distribution of *Palmodes dimidiatus* (De Geer) in the United States and northern Mexico.

Distribution.—*P. dimidiatus* occurs from coast to coast in the United States and ranges south into northern Mexico (fig. 25).

Palmodes hesperus Bohart and Menke

(Fig. 26)

Palmodes hesperus Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:184. Holotype ♂, Golconda, Humboldt Co., Nevada (CAS).

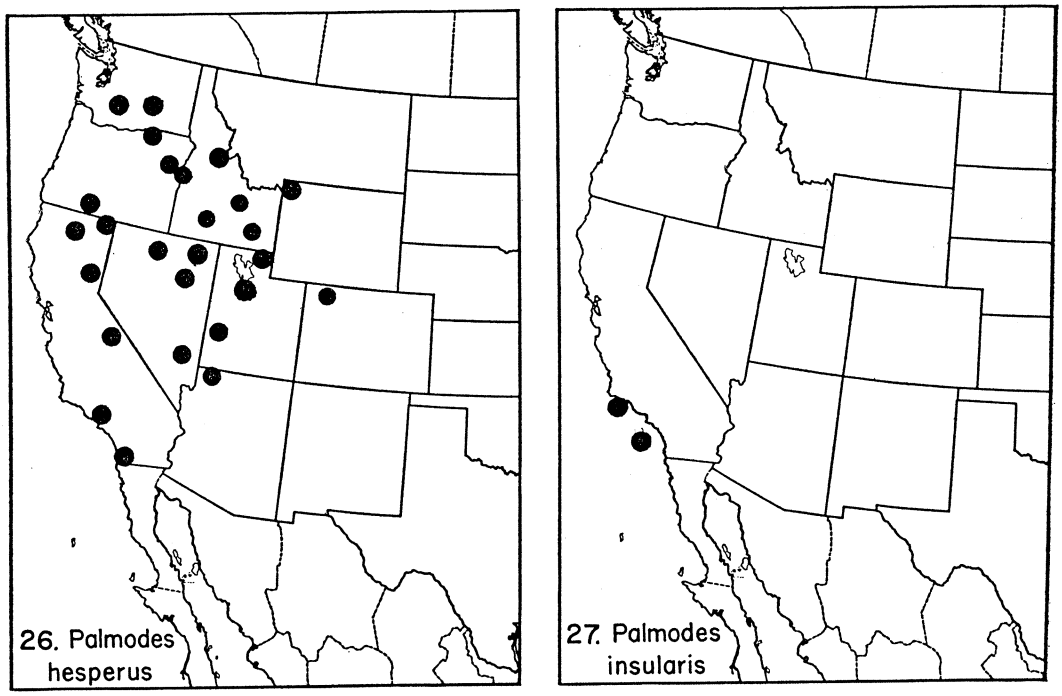
Male.—Average length 11 mm; body black; wings evenly brown; face and tegula with silvery appressed pubescence; dorsum of thorax finely and rather closely punctate and shagreened except toward front of scutum where punctures well separated, shagreening faint, and integument somewhat shiny; propodeal enclosure very finely, transversely striate; genitalia similar to those of *lissus*.

Female.—Average length 17 mm; gastral segments II through III or IV usually red, sometimes all black; facial pubescence often tarnished, silvery pubescence sometimes reduced or absent; dorsum of thorax subshining with small shiny areas on scutum; clypeus illustrated by Bohart and Menke (1961, fig. 6).

Great Basin females usually have silver faces but some from southern California and northern Nevada are dark and resemble *californicus* females. The shagreening of the anterior part of the scutum in the dark-faced females is diagnostic, however. *P. californicus* has an all-red gaster, whereas *hesperus* females are red-and-black or all black. Some males of *hesperus* have a partly red gaster.

Biology.—Bohart and Menke (1961) recorded nymphs of *Anabrus simplex* Haldemann as prey.

Distribution.—*P. hesperus* is primarily a Great Basin species (fig. 26).



Figs. 26–27. Fig. 26. Known distribution of *Palmodes hesperus* Bohart and Menke.
Fig. 27. Known distribution of *Palmodes insularis* Bohart and Menke.

Palmodes insularis Bohart and Menke

(Fig. 27)

Palmodes insularis Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:186. Holotype ♂, San Clemente Island, Los Angeles Co., California, (CAS).

Male.—Average length 14 mm; body black; wings only faintly stained in cellular area, a little more so beyond, median cell practically clear; body without silvery appressed pubescence; dorsum of thorax finely and closely punctate and shagreened, dull; propodeal enclosure finely but distinctly cross striate; scutellum nearly flat, not indented; genitalia with inner angle of cuspis obtuse.

Female.—Average length 15 mm; wing slightly darker than in male; scutum more finely punctate than in male, subshining.

This species is close to *P. pacificus,* but the lighter wings of *insularis,* nonindented scutellum, genitalia, and restricted habitat differentiate the two.

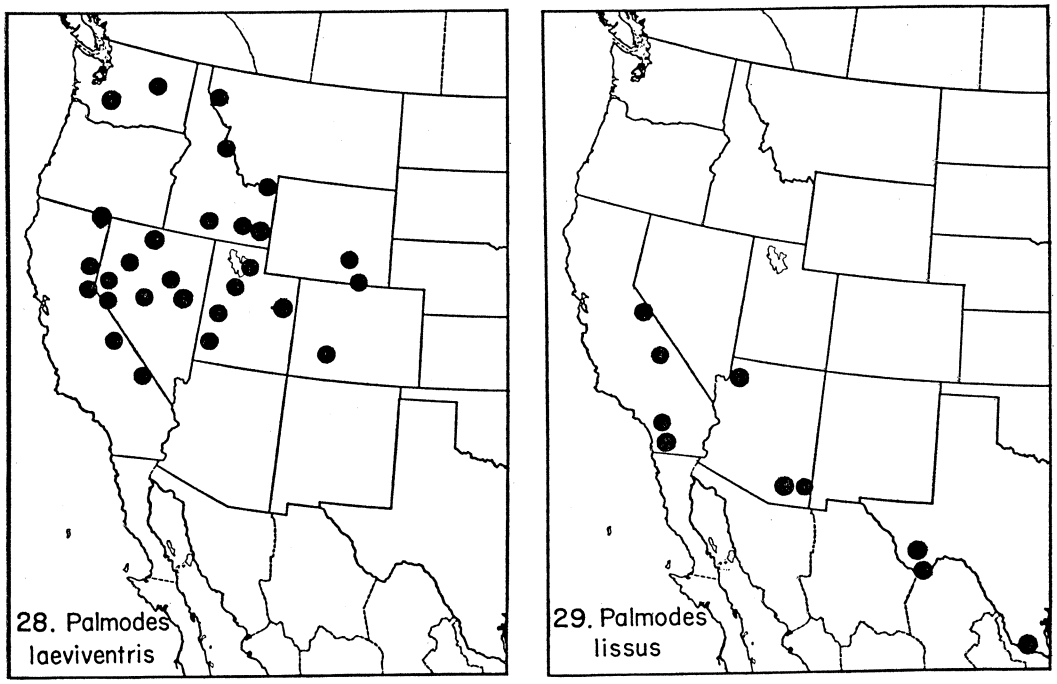
Distribution.—Known only from the Channel Islands off the coast of southern California (fig. 27).

Palmodes laeviventris (Cresson)

(Fig. 28)

Sphex laeviventris Cresson, 1865, Proc. Ent. Soc. Philadelphia, 4:463. Lectotype ♀, "Colorado Territory" (ANSP). Designated by Bohart and Menke, 1961.

Male.—Average length 22 mm; body black; wings evenly brown; face with appressed silvery pubescence; dorsum of thorax moderately and closely punctate, punctures elongate laterally, intervening spaces shining; propodeal enclosure coarsely cross striate; clypeus somewhat produced and bilobed apically as illustrated by Bohart and Menke (1961, fig. 10).



Figs. 28–29. Fig. 28. Known distribution of *Palmodes laeviventris* (Cresson).
Fig. 29. Known distribution of *Palmodes lissus* Bohart and Menke.

Female.—Average length 26 mm; face without silvery pubescence; dorsum of thorax finely and closely punctate but with scattered large punctures, intervening spaces shiny; propodeal enclosure finely cross striate; clypeus narrowly and deeply incised on either side of median truncation as illustrated by Bohart and Menke (1961, fig. 4).

The authors have studied the lectotype of this large species. The clypeus is distinctive in both sexes.

Biology.—La Rivers (1945) recorded this species using the Mormon Cricket, *Anabrus simplex* Haldemann, as prey. He observed that although most females dug the burrow first and then sought prey, some did the reverse. Usually two crickets were placed in the single cell and an egg laid on each, although as many as four crickets were used. The prey were dragged along the ground to the nest. Williams (1913) recorded *Stipator* as prey.

Distribution.—*P. laeviventris* is a Great Basin species (fig. 28).

Palmodes lissus Bohart and Menke

(Fig. 29)

Palmodes lissus Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:187. Holotype ♂, Surprise Canyon, Inyo Co., California (CAS).

Male.—Average length 13 mm; body black; wings light brown in cellular area, darker towards tip; face and tegula with appressed silvery pubescence; dorsum of thorax finely and rather closely punctate, subshining; scutum shiny in front where there are both coarse and fine punctures; propodeal enclosure finely granulate with faint indication of cross striae; genitalia illustrated by Bohart and Menke (1961, fig. 12).

Female.—Average length 17 mm; wings uniformly brown; body without silver pubescence; clypeus illustrated by Bohart and Menke (1961, fig. 5).

Palmodes lissus is related to *hesperus* and *californicus,* which have the clypeus similar in shape. The all-black body in both sexes of *lissus,* together with the polished scutellum (flattened in the female), and the partially clear wings of the male serve to distinguish this species.

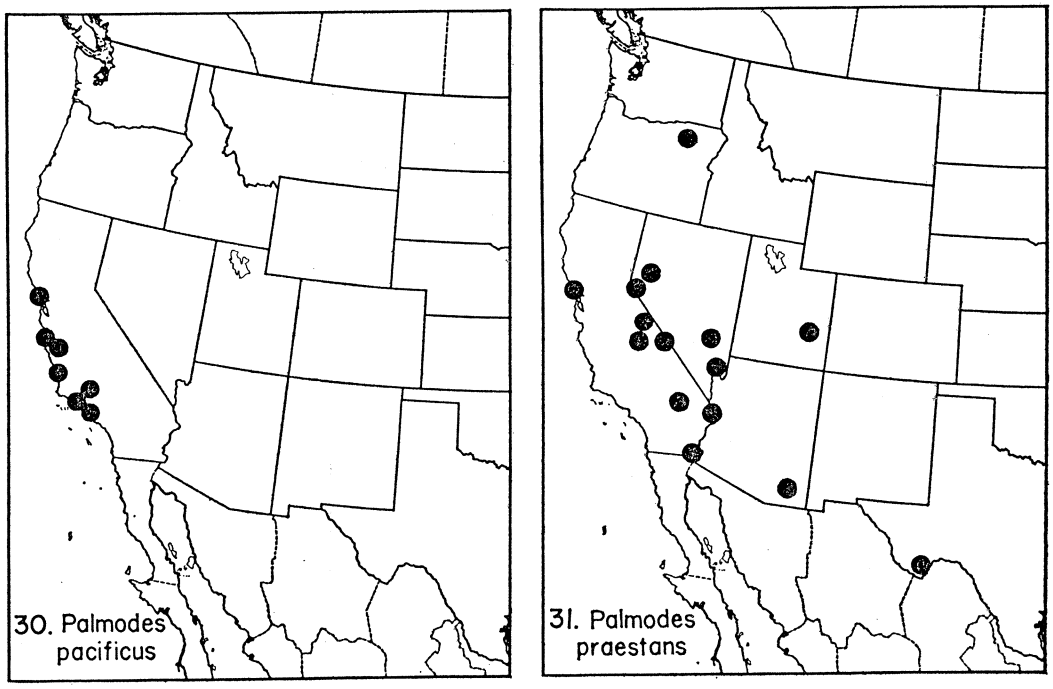
Distribution.—P. lissus appears to be restricted to the desert regions of the southwestern United States.

Palmodes pacificus Bohart and Menke

(Frontispiece; fig. 30)

Palmodes pacificus Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:188. Holotype ♂, 3 mi. west Cachuma Lake, Santa Barbara Co., California (CAS).

Male.—Average length 13 mm; body black; wings dark brown, with violaceous tints; body without silvery appressed pubescence; dorsum of thorax finely and closely punctate, shagreened,



Figs. 30–31. Fig. 30. Known distribution of *Palmodes pacificus* Bohart and Menke.
Fig. 31. Known distribution of *Palmodes praestans* (Kohl).

dull; propodeal enclosure finely but distinctly cross striate; scutellum slightly indented; genitalia with inner angle of cuspis a right angle as illustrated by Bohart and Menke (1961, fig. 14).

Female.—Average length 14 mm; clypeus illustrated by Bohart and Menke (1961, fig. 8).

The close relationship with *insularis* is discussed under that species.

Distribution.—This species is restricted to the coastal areas of California (fig. 30).

Palmodes praestans (Kohl)

(Fig. 31)

Sphex praestans Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:323. Holotype ♀, California. Type at Hamburg Museum, Germany, was destroyed.

Male.—Average length 18 mm; body black, gastral segments I–III and sometimes tergites IV–VI orange red; wings uniformly dark brown; face with appressed silvery pubescence; dorsum of thorax closely shagreened and dull; propodeal enclosure coarsely cross striate; genitalia with definitive teeth relatively few, large and irregular.

Female.—Average length 24 mm; gaster red; wings yellowish; dorsum of thorax finely and closely punctate, integument shiny; propodeal enclosure with moderate cross striae.

The silvery clypeus and frons of the male separate it from *dimidiatus*. The orange wings of the female are likewise distinctive.

Biology.—Caudell (1919) identified the prey used by a female of *praestans* as a male *Capnobates fuliginosus* Thomas.

Distribution.—*P. praestans* is restricted to the western states (fig. 31).

Palmodes stygicus Bohart and Menke

(Figs. 32, 53)

Palmodes stygicus Bohart and Menke, 1961, Proc. Ent. Soc. Washington, 63:191. Holotype ♂, Delta, Utah (CAS).

Male.—Average length 19 mm; body black; wings uniformly dark brown; head and thorax without appressed silvery pubescence; clypeus quadrilobate as illustrated by Bohart and Menke (1961, fig. 11); dorsum of thorax finely and closely punctate and shagreened, dull; propodeal enclosure coarsely cross striate; genitalia illustrated by Bohart and Menke (1961, fig. 16).

Female.—Average length 22 mm; dorsum of thorax somewhat shiny, punctation of scutum rather close but without much shagreening; clypeal shape as in figure 53.

This species resembles *laeviventris,* but the deep and broader notches of the female clypeus and the prominent lobes of the male clypeus in *stygicus* are diagnostic.

Distribution.—Primarily a Great Basin species (fig. 32).

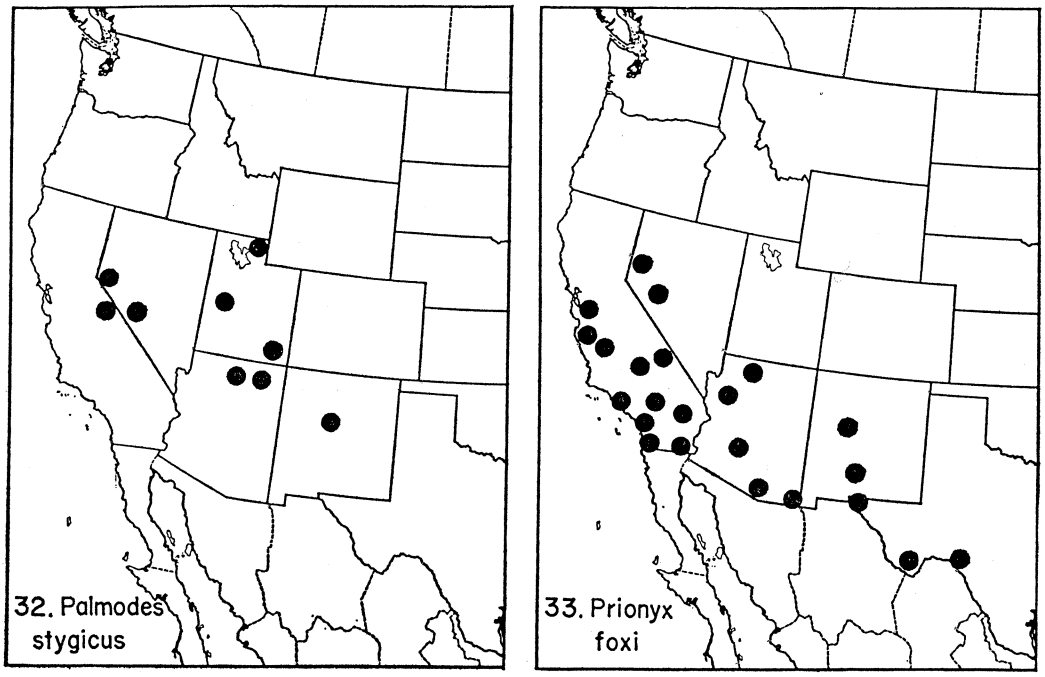
Genus *Prionyx* Vander Linden

Prionyx Vander Linden, 1827, Nouv. Mem. Acad. Roy. Sci. Bruxelles, 4:362. *Ammophila kirbii*[2] Vander Linden, 1827. Monobasic.

Priononyx Dahlbom, 1843, Hymen. Europaea, 1:28. Type: *Sphex thomae* Fabricius, 1775. Monobasic.

Enodia Dahlbom, 1843, Hymen. Europaea, 1:28. Type: *Sphex albisectus* Lepeletier and Serville, 1828 (= *Ammophila kirbyi* Vander Linden, 1827). Designated by Kohl, 1885. Preoccupied by *Enodia* Hübner, 1818.

[2] Kohl (1890) and Dalla Torre (1897) emended the spelling of *kirbii* to *kirbyi*. Vander Linden undoubtedly named *kirbyi* in honor of his contemporary, W. K. Kirby.



Figs. 32–33. Fig. 32. Known distribution of *Palmodes stygicus* Bohart and Menke.
Fig. 33. Known distribution of *Prionyx foxi* Bohart and Menke in the United States.

Harpactopus Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:264. Type: *Harpactopus crudelis* Smith, 1856. Designated by Patton, 1880.

Parasphex Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:267. Type: *Sphex albisectus* Lepeletier and Serville, 1828 (= *Ammophila kirbyi* Vander Linden, 1827). Designated by Kohl, 1885.

Gastrosphaeria Costa, 1858, Fauna Regn. Napoli, Imenott. Aculeati, Sphecidea, p. 10. Type: *Gastrosphaeria anthracina* Costa, 1858 (= *Sphex subfuscatus* Dahlbom, 1845). Monobasic.

Pseudosphex Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:420. Type: *Pseudosphex pumilio* Taschenberg, 1869. Monobasic, preoccupied by *Pseudosphex* Hübner, 1818.

Calosphex Kohl, 1890, Ann. K. K. Naturh. Hofmus. Wien, 5:113. Type: *Sphex niveatus* Dufour, 1853. Designated by Pate, 1937.

Neosphex Reed, 1894, Ann. Univ., Chile, 85:627. Type: *Neosphex albospiniferus* Reed, 1894 (= *Pseudosphex pumilio* Taschenberg, 1869). Monobasic.

Claws with two to five teeth (figs. 114, 115); female clypeus entire or notched medially (fig. 54); male genitalia with narrow, uniformly linear digitus (fig. 56), profile of distal lobes of aedeagus usually diagnostic for species as illustrated by Parker (1960, figs. 9–15).

After studying material from various parts of the world, the authors have come to the conclusion that the generic entities in the above synonymy represent one plastic genus, *Prionyx*. Several of these (e.g., *Calosphex, Neosphex, Prionony x, Harpactopus*) could be used as subgenera of *Prionyx* if considered from a limited faunal area, but on a world-wide basis intermediates occur that destroy the sharp distinctions between each taxon. *Harpactopus,* for example, appears to be distinct if only the African fauna is considered, but in Asia and Australia there are species which are intermediate between *Harpactopus* and *Prionyx s.s.* Consequently, we have divided *Prionyx* into species groups with the realization that

a future intensive study of the genus on a world basis may indicate the feasibility of using subgenera.

Biology.—These wasps utilize Acrididae as provisions and the burrow may be dug before or after prey is obtained depending on the species group. The grasshoppers are usually dragged along the ground to the nest, but in the *pumilio* group the female flies with the prey. The burrows may be uni- or multicellular depending on the species group.

Distribution.—The genus is world-wide although each species group is usually restricted to a certain area of the globe. Over fifty species are known.

Prionyx pumilio Group
(= *Neosphex* of authors)

Claws with two well-formed teeth; metapleuron not channeled; female clypeus entire; male flagellum without fossulae; South America.

Two species are known, but one, *P. spinolae* (Smith), generally has been placed in the *thomae* group. Males of the *pumilio* group offer no good external characters for separation from the genus *Palmodes,* but the digitus is strictly of the *Prionyx* type.

Biology.—Claude-Joseph (1928) observed *Prionyx chilensis* (Spinola) [= *spinolae* (Smith)] nesting in colonies. The nest was dug prior to obtaining prey and contained several cells. The acridid prey was carried to the nest on the wing. According to Claude-Joseph's account of the biology, the *pumilio* group displays the most highly evolved nesting habits in *Prionyx.* However, there is some doubt as to the correctness of his observations. From Claude-Joseph's description of the wasp, it appears possible that he may have confused two different species of *Prionyx,* one of which may not belong to the *pumilio* group.

Distribution.—This group is known from Chile, Argentina, and Peru.

Prionyx niveatus Group
(= *Calosphex* of authors)

Claws with two well-formed teeth; metapleuron with a definite channel to receive hind femur; female clypeus entire; male flagellum without fossulae.

This group is very close to the *kirbyi* group but the two claw teeth are diagnostic. Kohl (1890) listed four species.

Biology.—Berland (1956) stated that *P. nigropectinatus* (Taschenberg) uses the acridid *Schistocerca peregrina* Olivier as prey.

Distribution.—The group is restricted to the Mediterranean region and North Africa.

Prionyx kirbyi Group
(= *Prionyx* of authors)

Claws with three well-formed teeth and sometimes a weak fourth one basally; metapleuron with a definite channel to receive hind femur; female clypeus entire or with a median V-shaped notch; male flagellum without fossulae.

Kohl (1890) listed ten species of *Prionyx.*

Biology.—According to Kohl (1890), *Prionyx kirbyi* (Vander Linden) digs a

single-celled nest and provisions it with oedipodine Acrididae (*Oedipoda*). The nest is dug before prey is obtained, and the prey is carried in short hopping flights along the ground. Berland and Bernard (1947) recorded the following acridid prey for *P. kirbyi: Euchorthippus pulvinatus* Fischer de Waldheim, *Omocestus ventralis* Zetterstedts, *Calliptamus italicus* (Linnaeus), *Chorthippus biguttulus* (Linnaeus), and *Dociostaurus genei* (Ocskay).

Distribution.—This group is restricted to the Old World.

Prionyx foxi Group
(= *Prononyx* of authors, in part)

Claws with five well-formed inner teeth (fig. 115); metapleuron with a definite channel to receive hind femur; female clypeus entire; male flagellum without fossulae; one North American species.

This monotypic group is allied to the *kirbyi* group and the *niveatus* group, but the five claw teeth are diagnostic.

Distribution.—This group is restricted to the southwestern United States and northwestern Mexico.

Prionyx foxi Bohart and Menke, new name
(Figs. 33, 98, 115)

Sphex ferrugineus Fox, 1892, Ent. News, 3:170. Holotype ♀, southern California (USNM). Preoccupied by *Sphex ferruginea* Lepeletier, 1845.

Male.—Average length 12 mm; head and thorax black; wings clear in cellular area, darker beyond; tegula and gaster orange; erect hair of body white; face, pronotum, scutal furrows, propodeal enclosure mesally, propodeum laterally, mosepleura, hind coxa, and trochanter with appressed silvery pubescence; scutum smooth, shining, with scattered punctures; scutellum shiny; sternite VII entire; genitalia with aedeagal profile sawlike as illustrated by Parker (1960, fig. 9).

Female.—Average length 17 mm; head and thorax orange; flagellomeres except base of I black; propodeal enclosure black laterally; face, pronotum, scutum, scutellum, postscutellum, propodeum, and mesopleura with appressed gold-white pubescence.

The absence of fossulae on the male flagellum and the reddish head and thorax of the female distinguish this species from other Nearctic *Prionyx*. Some males are extensively red.

Distribution.—This insect occurs in the drier regions of California, Utah, Nevada, Arizona, Texas, and northern Mexico (fig. 33).

Prionyx globosus Group
(= *Harpactopus* of authors, in part)

Claws with two well-formed teeth; metapleuron slightly depressed, channel-like; female clypeus entire; male flagellum with spiculate fossulae.

The single species we place here, *Prionyx globosus* (Smith), is most closely allied to the *crudelis* group, but the female clypeal character and the shallow channel on the thoracic pleura isolate this species.

Biology.—Chandler (1928) gave a rather detailed account of *Prionyx globosus*. Acrididae served as prey and the egg was laid near the base of the hind leg. The nest was dug after obtaining prey and consisted of one cell.

Distribution.—This group is found in Australia.

Prionyx crudelis Group
(= *Harpactopus* of authors, in part)

Claws with two well-formed teeth; metapleuron not channeled; female clypeus with a U-shaped median notch, rarely entire; male flagellum with fossulae.

Kohl (1890) reviewed the species.

Biology.—Evans (1958) discussed the biology of *P. subfuscatus* (Dahlbom). The nest is dug after the female obtains prey, which is dragged along the ground. Berland and Bernard (1947) recorded Acrididae as prey: *Calliptamus italicus* (Linnaeus), *Oedipoda coerulescens* (Linnaeus), and *Dociostaurus maroccanus* Thunberg. Piel (1935) reported *Chorthippus, Calliptamus, Trilophidia, Celes,* and *Locusta* as prey in China.

Distribution.—This group is distributed throughout most of the Old World. Kohl (1890) recorded twelve species.

Prionyx thomae Group
(= *Prononyx* of authors, in part)

Claws with four to five well-formed teeth (fig. 114); metapleuron not channeled; female clypeus with a U- or V-shaped median notch (fig. 54); male flagellum with fossulae.

This group is closely related to the *crudelis* group and the *globosus* group, but the four to five claw teeth are diagnostic. Willink (1951) revised some of the South American species. Bohart (1958) and Parker (1961) treated the Nearctic species. Parker's illustrations are particularly useful, and references are made to them in the descriptions which follow.

Biology.—Evans (1958) has extensively reviewed the habits of this group. Prey generally are obtained before the female builds the single-celled nest, and consist of Acrididae of the subfamilies Acridinae, Oedipodinae, and Cyrtacanthacridinae. The prey are dragged over the ground to the nesting site. After completion of the nest, the grasshopper is usually grasped by an antenna, which conveniently fits in the clypeal notch of the female wasp, and is pulled into the nest. Evans, quoting Liebermann (1931), pointed out a questionable exception to this pattern of nesting behavior. Liebermann observed the South American *striatulus* (Brèthes) digging the nest prior to obtaining prey.

Distribution.—This group occurs only in the New World and numbers about fifteen species.

KEY TO THE NEARCTIC SPECIES OF THE PRIONYX THOMAE GROUP

1. Flagellum eleven-segmented, gaster with seven visible tergites (males) 2
   Flagellum ten-segmented, gaster with six visible tergites and a terminal sting (females) 7
2. Body all black; erect hairs of body black 3
   Gaster partly to all red; erect hairs of body white 4
3. Flagellomere VI with a broad fossula extending length of segment; scutum dull, individual punctures obscured by shagreening; scutellum dull . . . . *atratus* (Lepeletier)
   Flagellomere VI with a narrow fossula not attaining distal end of segment; scutum partly polished, many individual punctures distinct; summit of scutellum shiny *subatratus* (Bohart)

4. Sternite VI with a broad U-shaped median emargination; flagellomeres I and II together longer than IV, fossulae narrow 5
   Sternite VI entire; flagellomeres I and II together shorter than IV; fossulae broad . . 6
5. Flagellomeres III–VI with fossulae . . . . . *parkeri* Bohart and Menke
   Flagellomeres III–V with fossulae . . . . . *canadensis* (Provancher)
6. Wings clear in cellular area, lightly brown stained at tip; scutellum low *thomae* (Fabricius)
   Wings evenly dark brown violaceous; scutellum humped . . . . . *fervens* (Linnaeus)
7. Body all black; erect hair of body black 8
   Gaster partly or all red; erect hair of body white 9
8. Clypeus with silvery to golden appressed pubescence; scutum completely shagreened, dull; scutellum not especially raised nor shiny . . . . . *atratus* (Lepeletier)
   Clypeus black; scutum somewhat smooth and distinctly punctured toward middle; scutellum humped, shiny . . . . . *subatratus* (Bohart)
9. Wings clear in cellular area, darker beyond; length less than 20 mm 10
   Wings evenly dark brown violaceous; scutum with strong, longitudinally converging striae; length more than 20 mm . . . . . *fervens* (Linnaeus)
10. Maxillary palpus more than twice as long as labial palpus (which may appear to be missing) . . . . . *thomae* (Fabricius)
    Maxillary and labial palpi about equal in length, conspicuous 11
11. Prothoracic lobe generally one-half or more covered with silvery pubescence; scutellum and postscutellum usually with abundant silvery appressed pubescence *parkeri* Bohart and Menke
    Silvery pubescence of pronotal lobe restricted to posterior margin, never more than one-half covered; scutellum and postscutellum essentially glabrous . *canadensis* (Provancher)

Prionyx atratus (Lepeletier)

(Fig. 34)

Sphex labrosa Harris, 1835, *in* Hitchcock, Rpt. Geol. Min. Bot. Zool. Mass., p. 588. *Nomen nudum.*
Sphex atrata Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:355. Lectotype ♀, "sans Patrie" (TURIN). Present designation.
Priononyx brunnipes Cresson, 1872, Trans. Amer. Ent. Soc., 4:213. Holotype ♂, Texas (USNM).

Male.—Average length 12 mm; head, thorax, and gaster black; wings dark; erect hair of head and thorax black; face with some appressed silvery pubescence; flagellum with fossulae about as in figure 102 (see Parker, 1960, fig. 4); scutum dull, individual punctures obscured by shagreening; scutellum slightly raised but dull; sternite VII entire; genitalia illustrated in Parker, 1960, figure 14.

Female.—Average length 15 mm; face with extensive appressed silvery pubescence.

There are two female syntypes in Turin labeled *atrata* but without locality data. We are designating one as lectotype. The other all-black Nearctic species, *subatratus,* has different flagellar fossulae and a more strongly raised scutellum.

Biology.—Evans (1958) listed the prey recorded for this species (Acridinae, Oedipodinae, Cyrtacanthacridinae). Rau and Rau (1916) and Rau (1938) observed males and females of *atratus* in gregarious slumber on plants.

Distribution.—This species is the most abundant black *Prionyx* in the United States and northern Mexico. To the north it ranges into southern Canada (fig. 34).

Prionyx parkeri Bohart and Menke, new species

(Figs. 35, 54, 96, 102)

Priononyx pubidorsum of authors, not Costa.
Priononyx bifoveolata of authors, not Taschenberg.

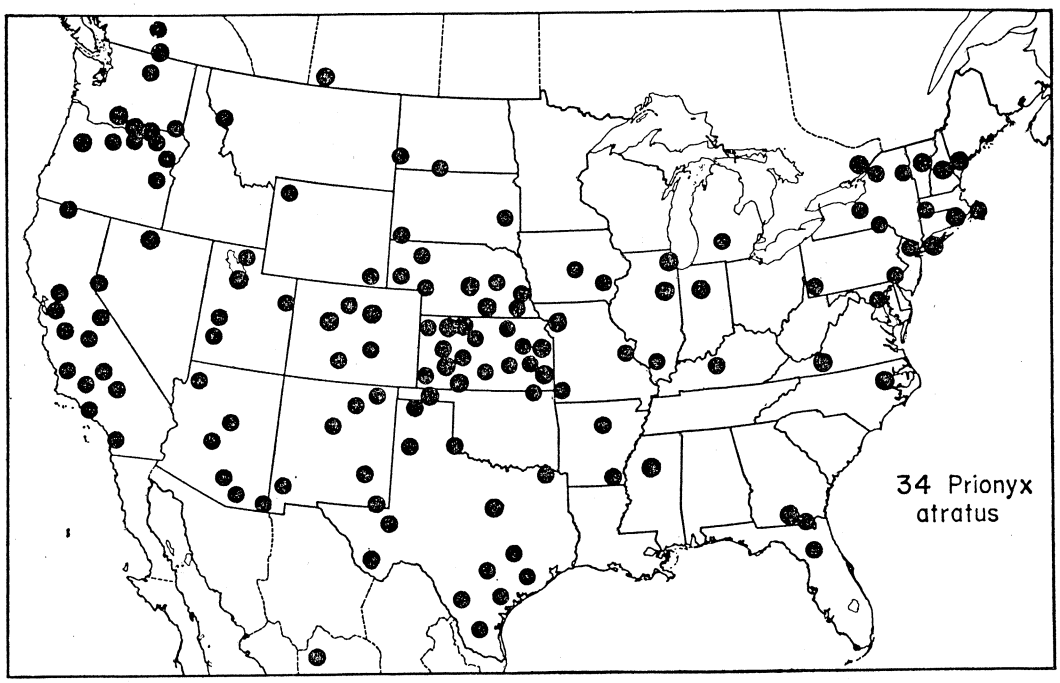


Fig. 34. Known distribution of *Prionyx atratus* (Lepeletier) in Canada, the United States, and northern Mexico.

Male.—Length 10.5 mm; head and thorax black, gaster red, tergites I and II black on basal two-thirds, tergites IV–VII and sternite VII black; wings clear in cellular area, darker beyond; erect hair of head and thorax white; face, pronotal lobe and vertex, scutal furrows, scutellum, postscutellum, pleura above mid and hind coxae with weakly developed silver appressed pubescence; flagellum as in figure 102; labial palpus subequal to maxillary palpus; sternite VII with a broad U-shaped emargination; genitalia illustrated in Parker, 1960, figure 11.

Female.—Average length 18 mm; gaster all red, or tergites V and VI black; clypeus (fig. 54) with smooth dimpled area preceding notch much larger than median ocellus; prothoracic lobe nearly always with posterior one-half or more silvery; scutellum and postscutellum usually with conspicuous silvery pubescence; labial palpus about as long as maxillary palpus (compare figs. 96, 97, and see Parker, 1960, figs. 7, 8).

Types.—Holotype ♂: Mill Potrero (north side Mt. Pinos) Kern Co., California, July 6, 1959 (F. D. Parker, UCD); 65 ♂ and 51 ♀ paratypes collected by R. C. Bechtel, R. M. Bohart, R. W. Bushing, D. Q. Cavagnaro, J. C. Downey, A. A. Grigarick, W. G. Iltis, M. E. Irwin, P. M. Marsh, A. S. Menke, D. R. Miller, C. G. Moore, W. D. McClellan, L. R. Nault, P. E. Paige, F. D. Parker, E. I. Schlinger, R. W. Spore, V. L. Vesterby and R. K. Washino (UCD), from April 18 through October 23, in 1950–1961, at the following localities. CALIFORNIA: Mill Potrero, Kern Co.; 3 mi. W. Cachuma Lake, Santa Ynez Mts., Santa Barbara Co.; Davis, Yolo Co.

Kohl (1890) and Fernald (1906) considered this species to be Taschenberg's *bifoveolata,* described from Brazil. Later, Fernald (1931) synonymized *bifoveolata* under Costa's earlier name *pubidorsum,* after examination of the types of both species. However, Bohart has seen Costa's type and verified that it is synonymous with *thomae* (Fabricius). Although we have not seen the type of *bifoveolata* it is very doubtful that Taschenberg's species is conspecific with *parkeri.* We have not seen any examples of *parkeri* from South America in the many collec-

tions we have examined, and apparently the only material that Kohl and Fernald saw from South America was the type of *bifoveolata* collected at "Nov. Friburgo," Brazil. The common South American species *Prionyx striatulus* (Brethes) is very similar to *parkeri* except that the seventh sternite is entire in *striatulus,* and therefore, it is very probable that Brethes' species is synonymous with Taschenberg's *bifoveolatus*. The director of the museum in Halle recently tried to locate the type of *bifoveolata,* but it could not be found even though Kohl and Fernald studied it there.

Prionyx canadensis is very close to *parkeri* but the male antenna is diagnostic (compare figs. 100, 102). For many years, the females of *parkeri* and *thomae*

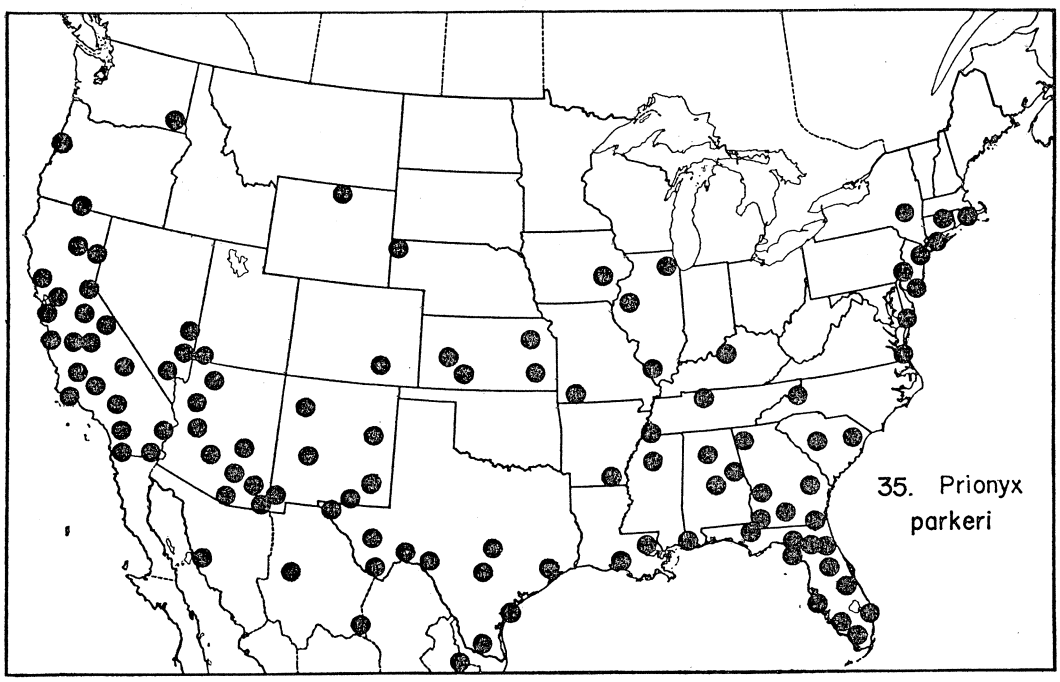


Fig. 35. Known distribution of *Prionyx parkeri* Bohart and Menke in the United States and northern Mexico.

were considered to be indistinguishable. Then, Bohart (1958) separated the two on the basis of the larger dimpled area preceding the clypeal notch in the former. Finally Parker (1960) discovered that the very short labial palpus of *thomae* offered an easy means of distinction.

Specimens of *parkeri* from the eastern United States, especially Florida, have darker wings, and frequently the tergites are mostly dark. In addition, these specimens may have the appressed thoracic pubescence greatly reduced. In such specimens, the male antenna and genitalia must be relied upon to distinguish the species from *canadensis.*

Biology.—Evans (1958) listed the known prey as *Melanoplus scudderi* Uhler, *M. femurrubrum propinquus* Scudder, *Trimeroptropis citrina* Scudder, and *Sciretetica marmorata picta* (Scudder). Sleeping aggregations of males of this wasp (identified as *pubidorsum*) have been detailed by Linsley (1962).

Distribution.—This species is found throughout the United States and southward to the Isthmus of Tehuantepec (fig. 35).

Prionyx canadensis (Provancher)

(Figs. 36, 100, 114)

Prononyx canadensis Provancher, 1889, Addit. Corr. Faune Ent. Canada, Hymen., p. 258. Holotype ♂, Ottawa, Quebec, Canada (QUEBEC).

Sphex excisus Kohl, 1890, Ann. K. K. Naturhist. Hofmus. Wien, 5:362. Lectotype ♂, Vancouver Island (VIENNA). Present designation.

Male.—Average length 12 mm; head and thorax black, gaster black with reddish tints at sides of tergites I and II; wings clear in cellular area, darker beyond; erect hair of head and thorax white; face with extensive silvery appressed pubescence; prothoracic lobe not more than one-half covered with silvery pubescence, scutal furrows and pleura above mid and hind coxae with weakly developed appressed silvery pubescence; flagellum as in figure 97; labial palpus subequal to maxillary palpus; sternite VII with a broad U-shaped emargination; genitalia as in Parker, 1960, figure 12.

Female.—Average length 13 mm; gaster all red.

Parker (1960) pointed out the validity of Provancher's species. Bohart has studied the type of *excisus* Kohl. There is a close relationship to *parkeri,* but the male genitalia and antennae are diagnostic. Females are difficult to separate, but *canadensis* females have more weakly developed appressed pubescence on the thorax (see discussion under *parkeri*).

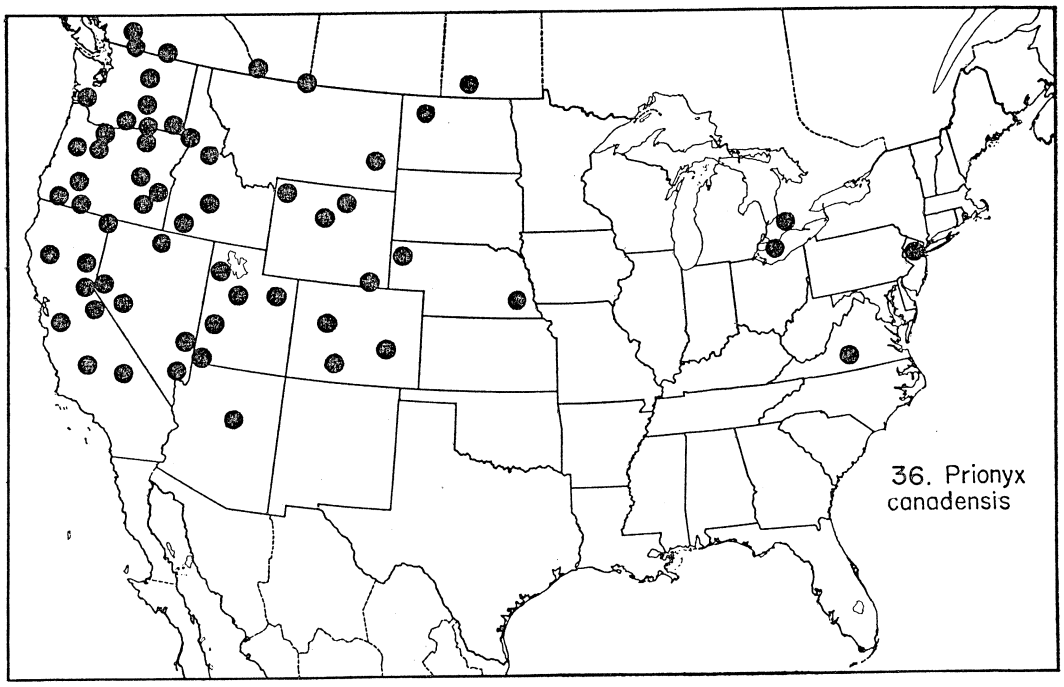


Fig. 36. Known distribution of *Prionyx canadensis* (Provancher).

Distribution.—*P. canadensis* is largely a Great Basin and Canadian species (fig. 36). We have seen two males from the eastern United States, one from Glencarlyn, Virginia (MCZ), and one from Bergen County, New Jersey (NEBR).

Prionyx fervens (Linnaeus)

(Fig. 37)

Sphex fervens Linnaeus, 1758, Systema Nat., 10th ed., p. 569. Holotype ♀, "Indies" (West Indies-Surinam?) (UPPSALA).

Pepsis johannis Fabricius, 1804. Systema Piez., p. 208. Holotype ♀, "Amer. Meridionalis Insulis" (COPENHAGEN).

Sphex doumerci Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:357. Holotype ♀, "Brésil" (TURIN).

Priononyx striata Smith, 1856, Cat. Hymen. Insects Brit. Mus., 4:266. Holotype ♀, Brazil (BMNH).

Sphex laerma Cameron, 1897, Ann. Mag. Nat. Hist., (6) 19:370. Holotype ♀, "Rio Papagaio in Guerrero," Mexico (BMNH).

Male.—Average length 21 mm; head and thorax black; gaster red; wings dark with violaceous tints; erect hair of head and thorax white; face with appressed silvery pubescence; flagellum about as in figure 102; labial palpus about one-half length of maxillary palpus; scutum with strong diagonal rugae converging posteriorly at midline; scutellum with two prominent humps, subshining; sternite VII broadly, shallowly emarginate; genitalia as in Parker, 1960, figure 15.

Female.—Average length 24 mm; labial palpus nearly as long as maxillary palpus; mesopleura with a suggestion of a tubercle anteroventrally.

Schulz (1912) pointed out the proper assignment of Linnaeus' name, and van der Vecht (1959) elaborated on the synonymy. Bohart has studied the types of *johannis, doumerci,* and *striata.* Fernald (1931) saw the type of *laerma* and is the authority for the synonymy. *Prionyx fervens* is our largest species of *Prionyx* and the most coarsely sculptured.

Biology.—Evans (1958) reported provisioning with *Xyleus* (Oedipodinae, Acrididae). The nest was dug after prey was obtained. Evans also quoted Conil as observing this species digging the nest first and then obtaining prey, which consisted of *Schistocerca cancellata* (Serville) (Cyrtacanthacridinae).

Distribution.—P. fervens occurs along the United States–Mexico boundary from the southern tip of Texas to southeastern California (fig. 37). The range includes Central and South America.

Prionyx subatratus (Bohart)

(Figs. 38, 56, 99, 101)

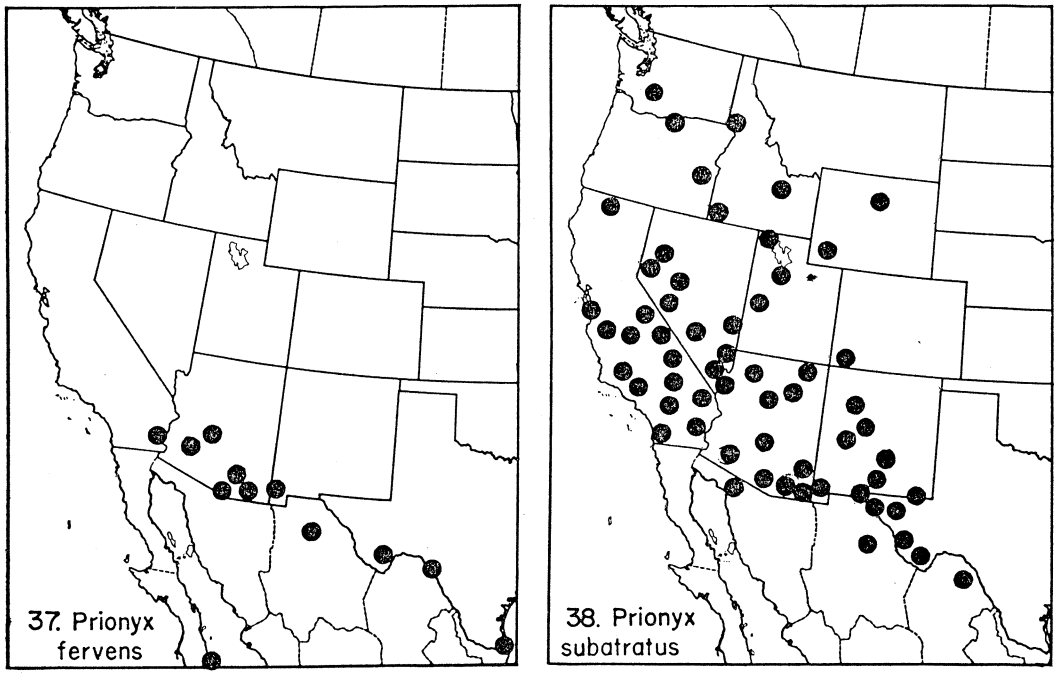
Priononyx subatrata Bohart, 1958, Bull. Brooklyn Ent. Soc., 53:90. Holotype ♂, Deep Springs, Inyo Co., California (CAS).

Male.—Average length 17 mm; head, thorax, and gaster black; wings dark; erect hair of head and thorax black; face without silver appressed pubescence; flagellum as in figure 101; scutum partly polished, many individual punctures distinct; scutellum strongly raised, vertex shiny; sternite VII entire; genitalia as in Parker, 1960, figure 13.

Female.—Average length 19 mm; clypeal pubescence all dark.

This species is close to *atratus,* but the shiny raised scutellum, the male antenna, and lack of silvery facial pubescence in the female are diagnostic.

Distribution.—This species is found in the Rocky Mountain states westward to the Pacific Ocean, and southward into Coahuila, Chihuahua, and Sonora (fig. 38).



Figs. 37–38. Fig. 37. Known distribution of *Prionyx fervens* (Linnaeus) in the United States and northern Mexico. Fig. 38. Known distribution of *P. subatratus* (Bohart) in the United States and northern Mexico.

Prionyx thomae (Fabricius)

(Figs. 39, 40, 97, 103)

Sphex thomae Fabricius, 1775, Systema Ent., p. 346. Lectotype ♂, "Insula St. Thomae Americes" (KIEL). Designated by van der Vecht, 1961.

Pepsis crucis Fabricius, 1804, Systema Piez., p. 209. Lectotype ♀, "Ins. Amer." (COPENHAGEN). Present designation.

Enodia pubidorsum Costa, 1862, Ann. Mus. Zool. Napoli, 1:69. Holotype ♂, "Rio Gian.," Rio de Janeiro, Brazil (NAPLES). New synonymy.

Sphex platensis Brèthes, 1908, Anal. Mus. Nac. Buenos Aires, 17:146. Syntypes, 2 ♂♂, 2 ♀♀, La Plata, Jujuy, Mendoza, Argentina; Nov. Friburg, Brazil (MNBA). Synonymy *teste* Willink (1948).

Male.—Average length 12 mm; head and thorax black, gaster red, tergites rarely with darker markings; wing clear in cellular area, darker beyond; erect hair of head and thorax white; flagellum as in figure 103; sternite VII entire; genitalia as in Parker, 1960, figure 10.

Female.—Average length 13 mm; pronotal lobe and vertex, scutal furrows, mesopleura behind pronotal lobe, and pleura above mid and hind coxae with appressed silvery pubescence; labial palpus generally not visible in museum specimens, much shorter than maxillary palpus (fig. 97).

Bohart has studied the types of the first three names in the synonymy. *P. thomae* is very similar to *parkeri,* but the antenna, sternite VII in the male, and the short labial palpus in the female separate the two (compare figs. 96, 97, and 102, 103). Flagellomeres I and II in *thomae* males are about as long as broad, and taken together are not so long as III. In *parkeri,* I and II are about twice as long as broad, and together are longer than III.

We have seen two males of *thomae* from six miles southwest of Murrell's Inlet,

Georgetown County, South Carolina (MCZ). In these specimens the fossulae are narrower than normal and the gaster is black except posteriorly on each tergite.

Biology.—Evans (1958) summarized the prey records for this species. Acridinae, Oedipodinae, and Cyrtacanthacridinae are used. Williams (1913) noted males clustering on grass at night. R. C. Bechtel (in conversation) reported males congregating on weeds near Fairbanks Spring, Nevada, on a cloudy day.

Distribution.—P. thomae is found throughout the western half of the United States and ranges south to Argentina (fig. 39). Apparently, it occurs also in the

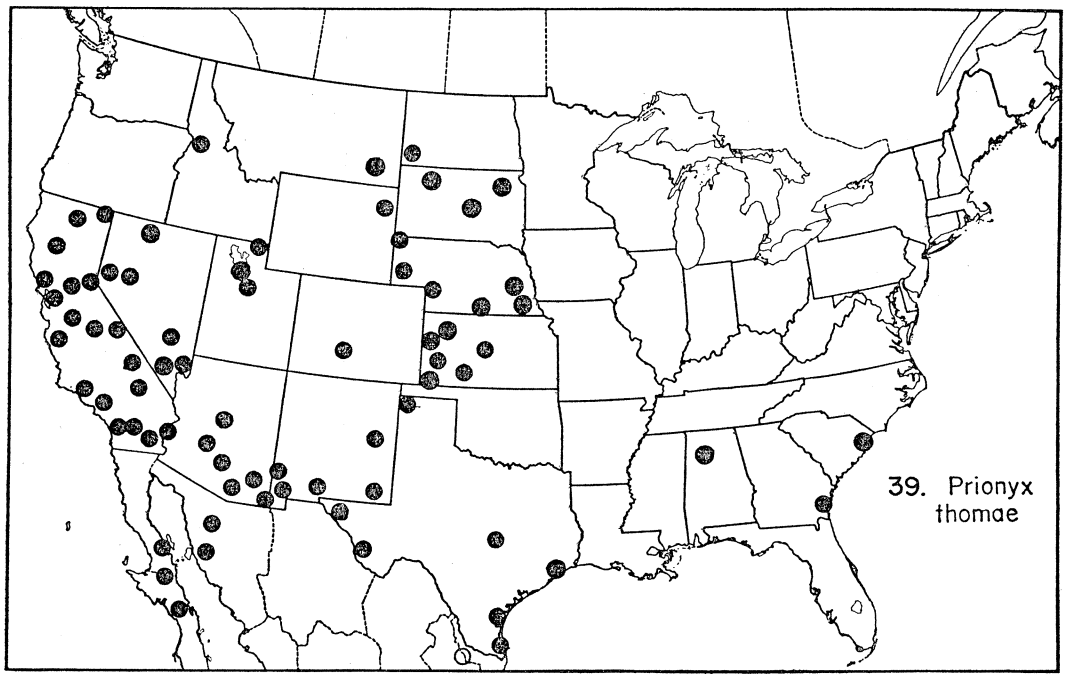


Fig. 39. Known distribution of *Prionyx thomae* (Fabricius) in the United States and northern Mexico.

southeastern section of this country, though uncommonly. We have seen specimens from Georgetown County, South Carolina (MCZ), and from Auburn, Alabama (MCZ). It has been introduced into Hawaii (Oahu and Kauai) within the last ten years.

Tribe Ammophilini

Claws simple or with one or two basal teeth on inner margin; ventral terminal setae of fifth hind tarsomere narrow, separated by more than twice a setal breadth; second submarginal cell usually receiving both recurrent veins; third maxillary palpomere not broadened asymmetrically; propodeum without stigmatal groove.

This tribe is in need of a thorough world-wide study before generic limits can be ascertained, and therefore this discussion is only an attempt to synthesize the work done within the tribe up to the present time. Kohl (1907) recognized one genus, *Ammophila,* and divided it into ten species groups, some of which he used in the subgeneric sense: *Psammophila* Dahlbom (=*Podalonia* Spinola), *Parapsammophila* Taschenberg, *Eremochares* Gribodo, *Coloptera* Lepeletier, *Miscus* Jurine, and

Ammophila s.s. This classification is still retained for the most part by the majority of contemporary European workers (Roth, 1928, 1929; Alfieri, 1946; Beaumont, 1958, 1960; and Leclercq, 1955, 1961). Roth (1928) proposed additional subgroups within Kohl's *Ammophila s.s.* Subsequent authors have proposed subgeneric names for some of Kohl's and Roth's species groups. Gussakovsky (1928) described *Argyrammophila* for the *A. producticollis* group of Roth (1928). Beaumont (1960) used the name *Hoplammophila* for the *A. armata* group of Kohl. Leclercq (1961) proposed the name *Apycnemia* for the *A. fallax* group of Kohl, and finally Tsuneki (1962*a,b*) described *Micadophila* for *A. aemulans* Kohl, a member of the *armata* group.

Some of the subgeneric entities listed above are clearly distinct genera. *Podalonia* has long been recognized in this country (Fernald, 1927; Murray, 1940) as a genus, and Leclercq (1955) removed it from *Ammophila.* The presence of one or two claw teeth and the swollen first abdominal tergite (second petiole segment) in *Parapsammophila, Eremochares,* and *Hoplammophila* make these entities distinct enough for separation from *Ammophila,* but we have not seen sufficient material to determine whether each should be considered a separate genus. Beaumont (1956) suggested that *Parapsammophila* and *Eremochares* might be united.

Coloptera, Miscus, Argyrammophila, and *Apycnemia* all seem to be groups which fall within the strict interpretation of *Ammophila. Apycnemia* includes two species which possess a small basal tooth on the claw and also have a short episternal suture. We have examined specimens of the type of *Apycnemia* (*Ammophila fallax* Kohl), and it is a close relative of two North American species, *Ammophila placida* Smith and *A. pictipennis* Walsh. Both of these also possess the minute claw tooth but have an episternal suture which extends almost to the sternal region of the mesothorax. However, in occasional specimens it is poorly defined below the pronotal lobe. The short episternal suture in *fallax* may be unusual in the Old World fauna but it is common in many Nearctic species. The presence of a small basal claw tooth in *Ammophila* is peculiar and rare, but should not be construed as a subgeneric character by itself. Several close relatives of *placida* and *pictipennis* lack claw teeth. It should be mentioned that the European *Podalonia affinis* (Kirby) also possesses a basal tooth on the claw but in all other respects is an ordinary *Podalonia.*

In summary, we recognize four genera: *Ammophila, Podalonia, Eremochares,* and *Parapsammophila.* We tentatively place *Hoplammophila* with *Parapsammophila,* but with the realization that this arrangement may prove impractical.

Biology.—As a general rule these wasps use lepidopterous larvae as prey. However, *Eremochares* provisions its nest with grasshoppers, and some species of *Ammophila* may use larvae of Tenthredinidae. The only reference to *Parapsammophila* biology appears to be that of Iwata (1938), in which he discusses observations of *P. aemulans* (Kohl). According to Beaumont (1960), *aemulans* belongs in *Hoplammophila;* and if this category eventually proves to be distinct from *Parapsammophila* our dendrogram (fig. 1) will need modification.

Distribution.—Except for *Eremochares* and *Parapsammophila,* which are restricted to the Old World, the tribe is world-wide in distribution.

KEY TO GENERA OF WORLD AMMOPHILINI[3]

1. Claws without teeth along inner margin[4] 2
   Claws with one or two basal teeth along inner margin; female clypeal length equal to at least one-half of least interocular distance 3
2. Petiole appearing two-segmented because of slender, elongate first tergite . *Ammophila* Kirby
   Petiole one-segmented, first tergite bell-shaped . . . . . *Podalonia* Spinola
3. Female clypeal length about equal to least interocular distance; male flagellomere I longer than least interocular distance (Old World) . . . . . *Eremochares* Gribodo
   Female clypeal length not much, if any, greater than one-half of least interocular distance; male flagellomere I shorter than least interocular distance (Old World) *Parapsammophila* Taschenberg

Genus *Parapsammophila* Taschenberg

Parapsammophila Taschenberg, 1869, Zeitschr. Ges. Naturwiss. Halle, 34:469. Type: *Parapsammophila miles* Taschenberg 1869 (=*Ammophila cyanipennis* Lepeletier, 1845). Designated by Pate, 1937.

Ceratosphex Rohwer, 1921, Philippine Jour. Sci., 19:671. Type: *Sphex bakeri* Rohwer, 1921. Original designation.

Hoplammophila Beaumont, 1960, Opusc. Zool., 52:1. Type: *Ammophila armata* (Illiger). Original designation.

Micadophila Tsuneki, 1962. The Life Study (Fukui), 6:28. Type: *Ammophila aemulans* Kohl. Original designation.

The head characters used in the key seem more reliable than the number of claw teeth character used by Kohl (1907) in separating this taxon from *Eremochares*. *Eremochares* has a single basal tooth on the claw whereas *Parapsammophila* supposedly has two. Examination of several species in *Parapsammophila* has revealed that the basal "tooth" is formed by a swelling at the point where the claw setae originate. It is true that in some species the swelling is produced into a blunt "tooth" (which does not resemble the second tooth), but the inconsistency of this feature makes it an unreliable generic character. Our inclusion of *Hoplammophila* here is perhaps too conservative, but this action seems best considering the state of our knowledge. *Hoplammophila* should at least be treated as a subgenus of *Parapsammophila*. Beaumont (1958, p. 291) inferred that males of *Hoplammophila* possess pygostyles. However, Beaumont in recent correspondence with Menke pointed out that this statement was in error.

Biology.—Iwata (1938) observed *Parapsammophila* (*Hoplammophila*) *aemulans* (Kohl) nesting in an old burrow which opened at a height of one meter in the trunk of a hardwood tree. The nest contained a single large cutworm larva with the wasp egg attached mediolaterally. The cell was plugged with debris below, and was plugged above with rotten wood and pebbles a short distance inside the mouth of the burrow.

Distribution.—The genus is restricted to the Old World.

[3] The *Eremochares-Parapsammophila* couplet characters are based on the few species that we have been able to examine.

[4] Several species of *Ammophilia* and one Palaearctic *Podalonia* possess one minute basal booth on the inner margin of the claw. However, the slender "two-segmented" petiole will identify all *Ammophila*, and in *Podalonia* the clypeal length of the female is considerably less than one-half the least interocular distance.

Genus *Eremochares* Gribodo

Eremochares Gribodo, 1882, Ann. Mus. Civ. Stor. Nat. Genova, 18:265. Type: *Eremochares doriae* Gribodo, 1882 (= *Ammophila dives* Brullé, 1832). Monobasic.

We have separated this genus from *Parapsammophila* primarily on the basis of the narrow face. The only species assignable to *Eremochares* that we have seen is the type of the genus, *dives* (Brullé). Several of the species usually assigned to *Eremochares*, such as *lutea* Taschenberg and *algira* Kohl, appear to belong in *Parapsammophila*. As far as can be determined there is always a single basal tooth on the claw of *Eremochares*.

Biology.—Our information on biology comes from Smirnov (1915) and Beaumont (1951). The genus is remarkable among the Ammophilini in that it provisions with Orthoptera. According to Roth's translation of the Russian, *E. dives* Brullé places its paralyzed grasshopper across the entrance of an open burrow, uncovers a nearly hidden entrance to another burrow, inspects the burrow, and then deposits the prey in the second burrow. The entrance of the latter is closed with damp sand extracted previously in the burrowing process. Beaumont observed female *Eremochares* using as prey acridid nymphs of the genera *Chorthippus, Sphingonotus* and *Acrotylus*.

Distribution.—Apparently this genus is composed of a few species restricted to the Mediterranean and Transcaspian regions.

Genus *Podalonia* Spinola

Psammophila Dahlbom, 1842, Dispos. Method. Spec. Scand. Hymen., 1:8. Type: *Ammophila affinis* Kirby, 1798. Designated by Fernald, 1927. Preoccupied by *Psammophila* Brown, 1827.
Podalonia Spinola, 1853, Mem. Accad. Sci. Torino, 8:53. Type: *Ammophila bocandei* Spinola, 1853. Monobasic.

The exact status of *Podalonia* is unknown since the type, *bocandei,* from "Guinée" (= Guinea, Africa) has gone unrecognized since its description. There are no teeth on the tarsal claw in Nearctic forms, but at least one exotic species, *P. affinis* (Kirby), has a single subbasal tooth. Fernald (1927) and Murray (1940) revised our nineteen known species.

Biology.—These wasps search for prey before digging a nest. Hicks (1931*a*, 1931*b*) observed *Podalonia luctuosa* (Smith) digging for cutworms (Noctuidae). After locating and digging up the caterpillar, the wasp stung it and dragged it to a suitable nesting site where it was hung on a handy support, such as a plant stem. The burrow ended in a single cell. Evans (1959*b*) considered the nesting habits of this genus more primitive than those of *Ammophila,* which digs its burrow before searching for prey. Hicks (1931*b*) suggested that *Podalonia* may overwinter in special burrows in the soil. On one occasion he found four wasps resting in a burrow on an overcast day. Menke has seen large clusters of *Podalonia* under bark of dead trees under similar conditions.

Distribution.—The genus is widespread but is not known to occur in South America.

Genus *Ammophila* Kirby

Ammophila Kirby, 1798, Trans. Linn. Soc. London, 4:199. Type: *Sphex sabulosa* Linnaeus, 1758. Designated by Internatl. Comm. Zool. Nomencl., Opin. 180, 1946, Opin. and Decl. Internatl. Comm. Zool. Nomencl., 2:569–585.

Miscus Jurine, 1807, Nouv. Meth. Class. Hymen., p. 130. Type: *Ammophila campestris* Latreille, 1809. Designated by Shuckard, 1837.

Coloptera Lepeletier, 1845, Hist. Nat. Insect., Hymén., 3:387. Type: *Colopera barbara* Lepeletier, 1845. Monobasic.

Argyrammophila Gussakovskij, 1928, Bull. Inst. Zool. Appl. Phytopath. Leningrad, 4:7. Type: *Ammophila induta* Kohl, original designation.

Apycnemia Leclercq, 1961, Rev. Espanola Ent., 37:211. Type: *Ammophila fallax* Kohl. Original designation.

Sphex of authors, *nec* Linnaeus (see nomenclatural discussion under genus *Sphex*).

We are restricting *Ammophila* to those wasps with simple claws and a two-segmented petiole. However, the second segment of the petiole is actually the tergite of the second true abdominal segment (first visible abdominal segment). Although in the vast majority of species the claws are simple, there are a few which possess a minute basal tooth on the claw. All the species we have seen with a tooth on the claw appear closely related. Leclercq (1961) described the subgenus *Apycnemia* for this group. *Miscus* and *Coloptera* are based on peculiarities of wing venation and we do not recognize them as subgenera. *Ammophila* probably should be broken into subgenera and species groups, but this cannot be accomplished satisfactorily unless a world-wide study is made.

Menke is preparing a revision of the Nearctic *Ammophila* and recognizes approximately sixty-five species. Useful papers on the North American species are those of Fernald (1934), Murray (1938), and Menke (1963*a*). Significant papers on the Old World species are by Kohl (1907), Arnold (1920, 1928), Roth (1928), and Alfieri (1946).

Biology.—In contrast to *Podalonia, Ammophila* usually digs the nest before searching for prey, although Roth (1928) says the reverse is true for the Palaearctic species *haimatosoma* Kohl. The nests are simple, ending in one cell. Caterpillars of various families of Lepidoptera are used as prey, and at least one European species, *A. campestris* Latreille, has been reported using eruciform hymenopterous larvae of the Tenthredinidae. There is a great deal of variation in details of the nesting behavior. Evans (1959*b*), in his fine paper on the biology of this genus, reported that a type of progressive provisioning may occur. Baerends (1941*a*) stated that the Old World species *A. campestris* (probably refers to *pubescens* Curtis) cared for two or three nests at once and used progressive provisioning. Some species provision their nests with a single caterpillar while others may use up to ten. There has been considerable controversy over "reason" versus "instinct" in the use of a "tool" by females of *Ammophila* in tamping down the soil after closing the nest. Evans discussed this at length, concluding, "It seems far more probable that the pounding behavior of *Ammophila* is nothing more that a particular combination of instinctive behavioral elements."

Baerend's (1941*b*) work on the biology and ethology of *Ammophila campestris* (actually *A. pubescens* Curtis) should be mentioned. This is an exhaustive bio-

logical study of a single species and should serve as a model for future studies of this type.

Ammophila commonly cluster on plants in the late afternoon and remain during the night. Menke has observed individuals occupying the same spot on a twig on successive nights. It is difficult to understand why certain plants are always selected in areas where many may be present. Evans and Linsley (1960) and Linsley (1962) described in detail the sleeping habits of these wasps.

Distribution.—The genus occurs in all the world faunal regions.

SUMMARY

The subfamily Sphecinae is divided into three tribes, five subtribes, and seventeen genera. The eleven Nearctic genera include forty-six species excluding those of the Ammophilini, which are not treated.

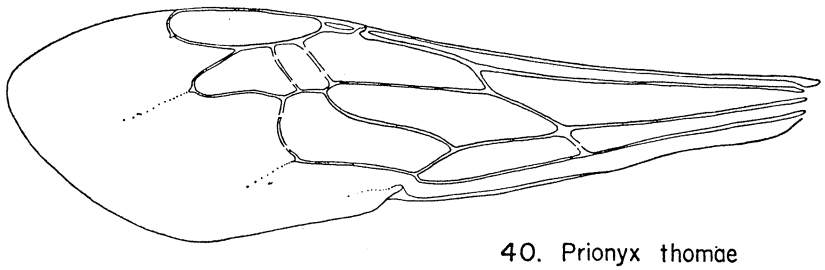
The sphecine wasps are all solitary and predaceous, provisioning their nests with Orthoptera, spiders, and caterpillars. Colonial tendencies and progressive provisioning in some species indicate an approach to a social state. Geographic color variation is frequent, with differences showing up especially on either side of the 100th meridian in the United States. Evolution seems to have proceeded in several directions from a black wasp with short mouthparts, a short petiole, and one-toothed claws toward species with yellow markings, long mouthparts and petiole, and simple or complex claws. Habits have evolved also, from a cavity-nesting or ground-nesting to specialized mud-nesting.

The types of most of the species concerned were examined by one or both authors, and many lectotypes are designated. Important references on each genus are cited as well as the numbers of species involved, their distribution and biology.

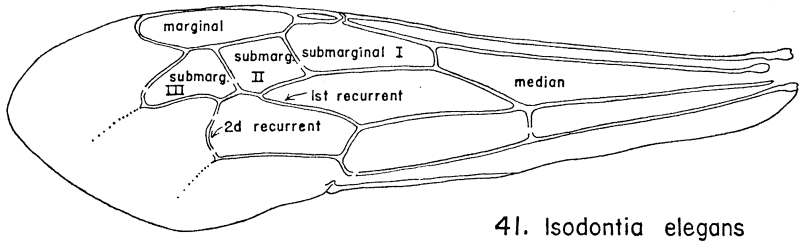
In the systematics the tribe Podiini of authors is incorporated in the tribe Sceliphronini; *Chlorion* and *Stangeella* are placed in Sceliphronini, also; *Dynatus, Podium,* and *Trigonopsis* are considered genera; and *Podium krombeini* new species and *Chalybion zimmermanni peninsularum* new subspecies are described.

In the tribe Sphecini two subtribes are used: Sphecina (*Sphex, Isodontia, Fernaldina*), and Prionyxina (*Palmodes, Prionyx*). New generic and specific names are: *Fernaldina* new genus, *Murrayella* new subgenus, *Palmodes carbo* new name for *morio* Kohl, *Prionyx parkeri* new species, and *Prionyx foxi* new name for *ferrugineus* Fox. The genus *Prionyx* is divided into seven species groups.

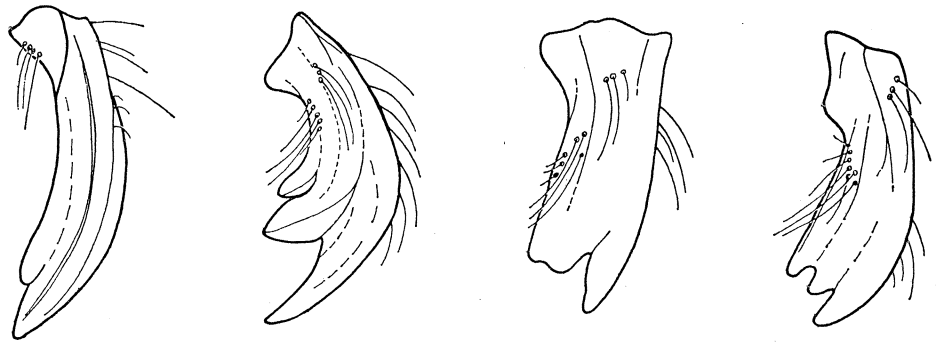
In the tribe Ammophilini a tentative generic scheme is proposed recognizing four genera: *Parapsammophila, Eremochares, Podalonia,* and *Ammophila.*



40. Prionyx thomae



41. Isodontia elegans

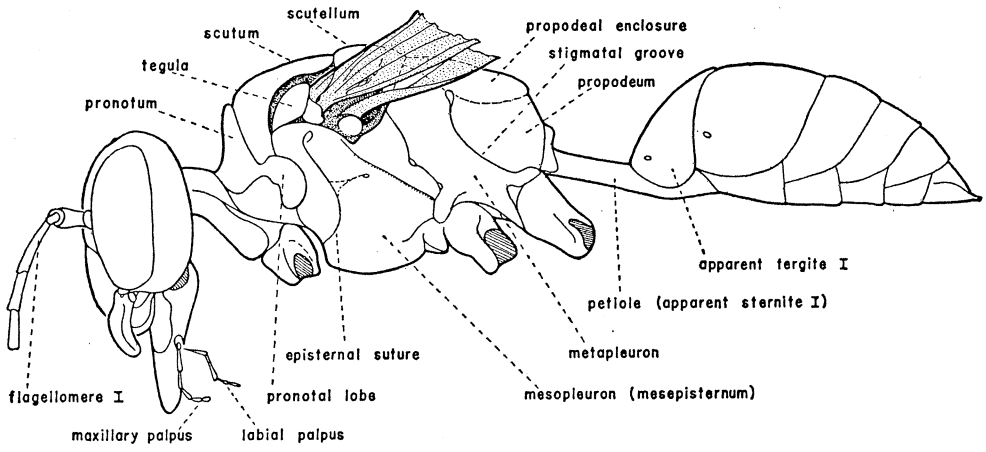


42. Sceliphron caementarium

43. Sphex ichneumoneus

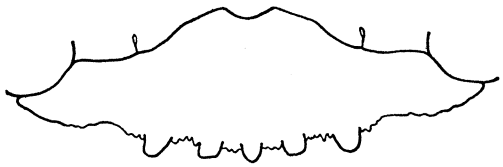
44. Isodontia philadelphica

45. Isodontia elegans

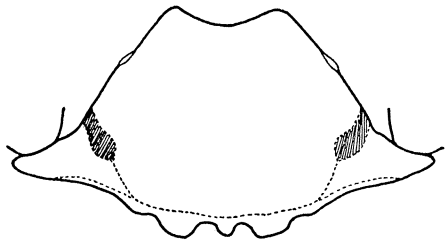


46. Sphex ichneumoneus

Figs. 40–46. Fig. 40. Forewing of *Prionyx thomae* (Fabricius), ♀. Fig. 41. Forewing of *Isodontia elegans* (Smith), ♀, names of principal cells indicated. Figs. 42–45. Profile of mandible, ♀, of *Sceliphron caementarium* (Drury), *Sphex ichneumoneus* (Linnaeus), *Isodontia philadelphica* (Lepeletier), and *Isodontia elegans* (Smith), respectively. Fig. 46. Profile outline of *Sphex ichneumoneus* (Linnaeus), ♀, with parts labeled.

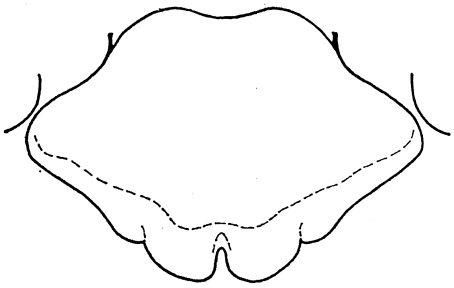


47. Chlorion aerarium

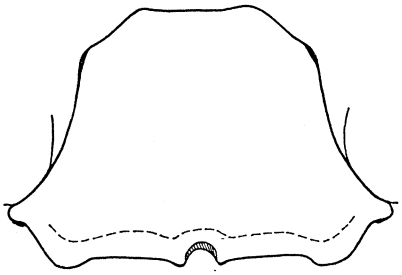


48. Chalybion californicum

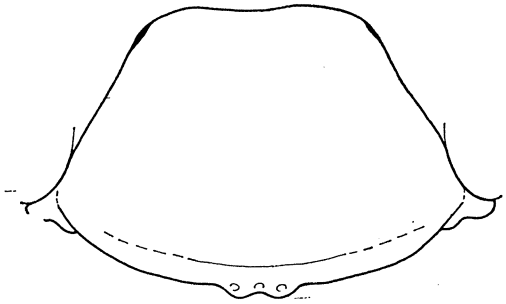
49. Podium krombeini



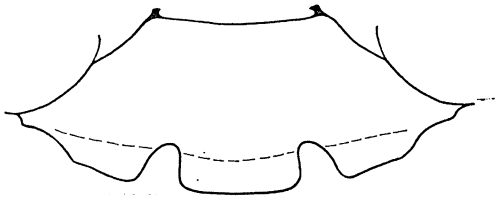
50. Sceliphron caementarium



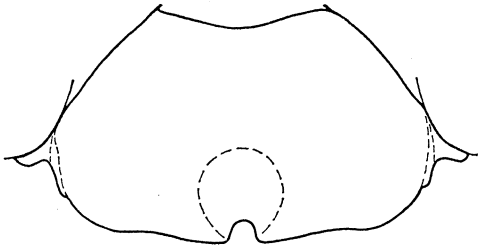
51. Isodontia elegans



52. Sphex ichneumoneus

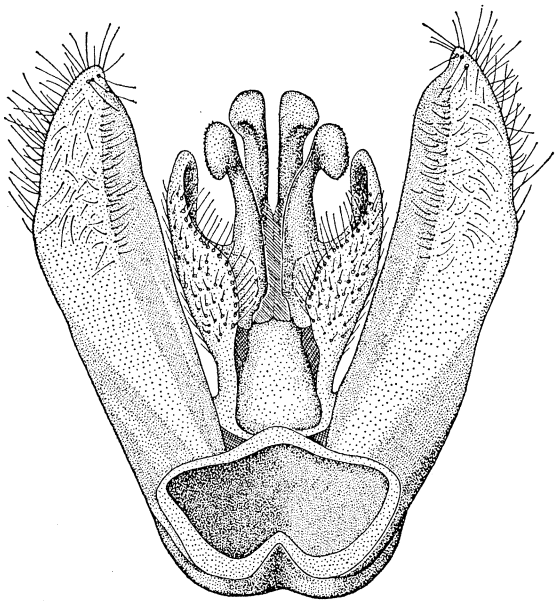


53. Palmodes stygicus

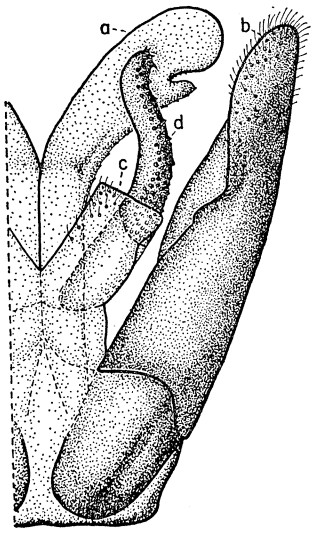


54. Prionyx parkeri

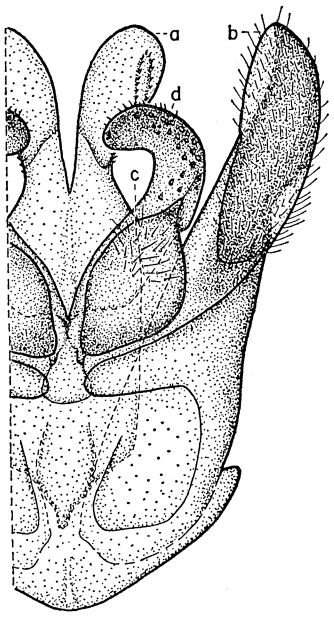
Figs. 47–54. Clypeus, ♀, of *Chlorion aerarium* Patton, *Chalybion californicum* (Saussure), *Podium krombeini* Bohart and Menke, *Sceliphron caementarium* (Drury), *Isodontia elegans* (Smith), *Sphex ichneumoneus* (Linnaeus), *Palmodes stygicus* Bohart and Menke, and *Prionyx parkeri* Bohart and Menke, respectively.



55. Chlorion aerarium

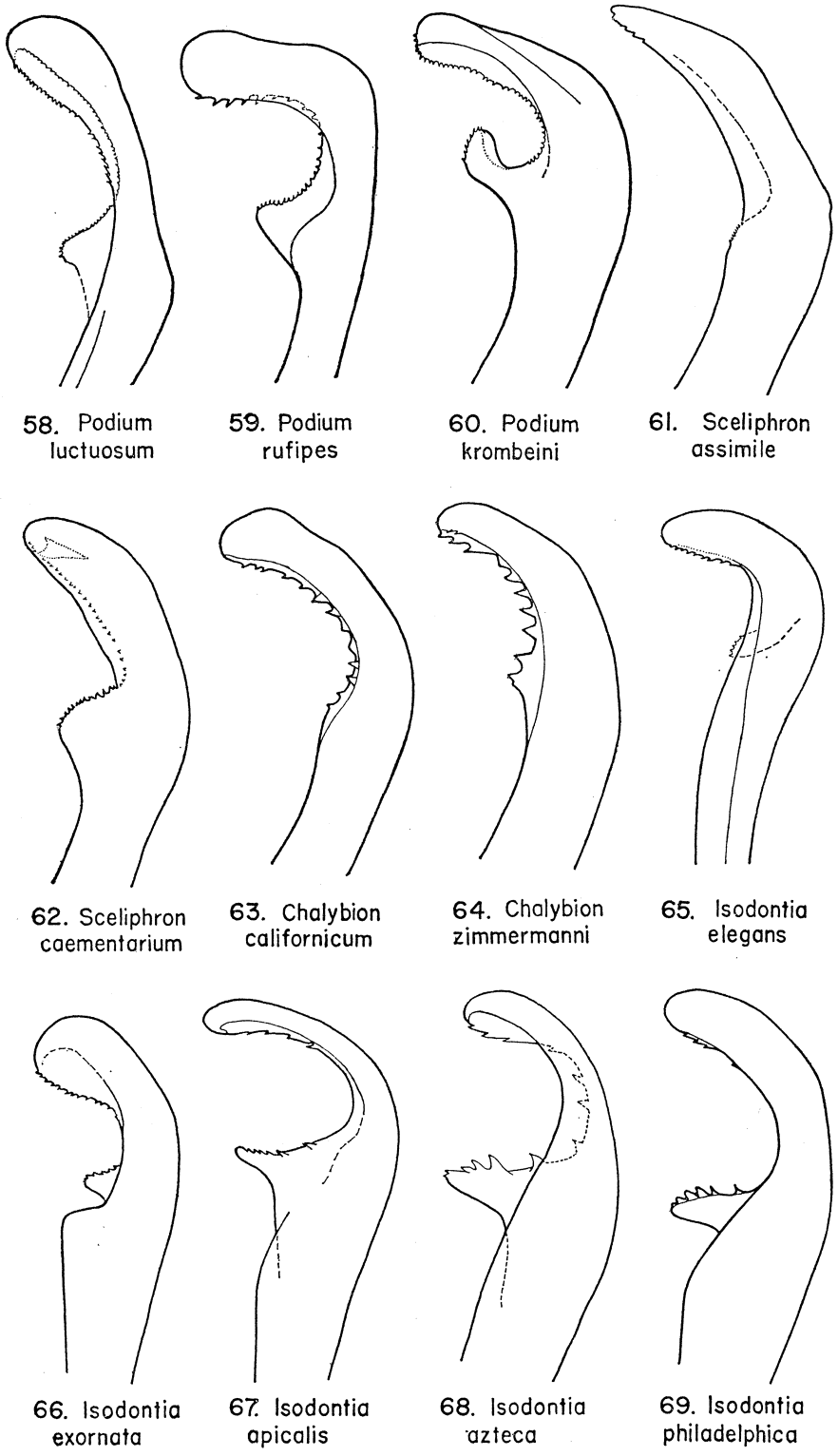


56. Prionyx subatratus

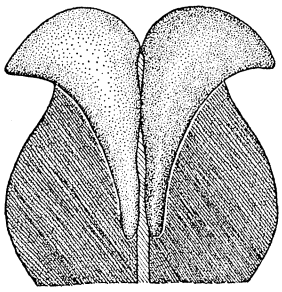


57. Palmodes californicus

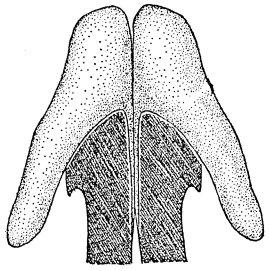
Figs. 55–57. Fig. 55. Genitalia of *Chlorion aerarium* Patton, ♂, ventral view. Figs. 56–57. Genitalia of *Prionyx subatratus* (Bohart) and *Palmodes californicus* Bohart and Menke, ♂, ventral view of flattened mount, left side: *a*, aedeagus; *b*, gonostyle; *c*, cuspis; *d*, digitus.



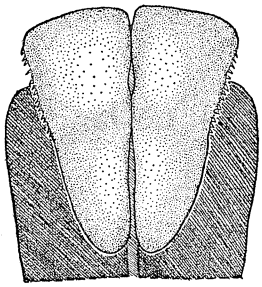
Figs. 58–69. Profile of lobe of aedeagus of *Podium luctuosum* Smith, *P. rufipes* Fabricius; *P. krombeini* Bohart and Menke, *Sceliphron assimile* (Dahlbom), *S. caementarium* (Drury), *Chalybion californicum* (Saussure), *C. zimmermanni* Dahlbom, *Isodontia elegans* (Smith), *Isodontia exornata* Fernald, *I. apicalis* (Smith), *I. azteca* (Saussure), and *I. philadelphica* (Lepeletier), respectively.



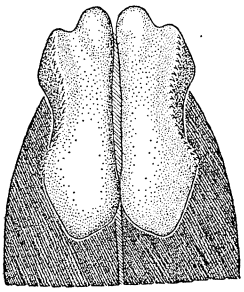
70. Sphex texanus



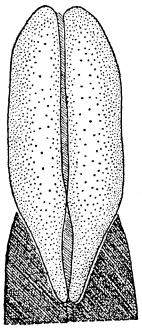
71. Sphex habenus

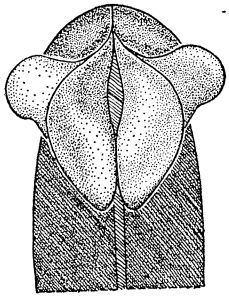


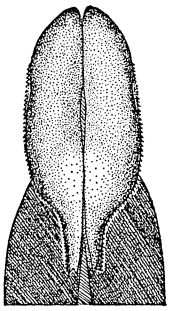
72. Sphex flavitarsis



73. Sphex jamaicensis





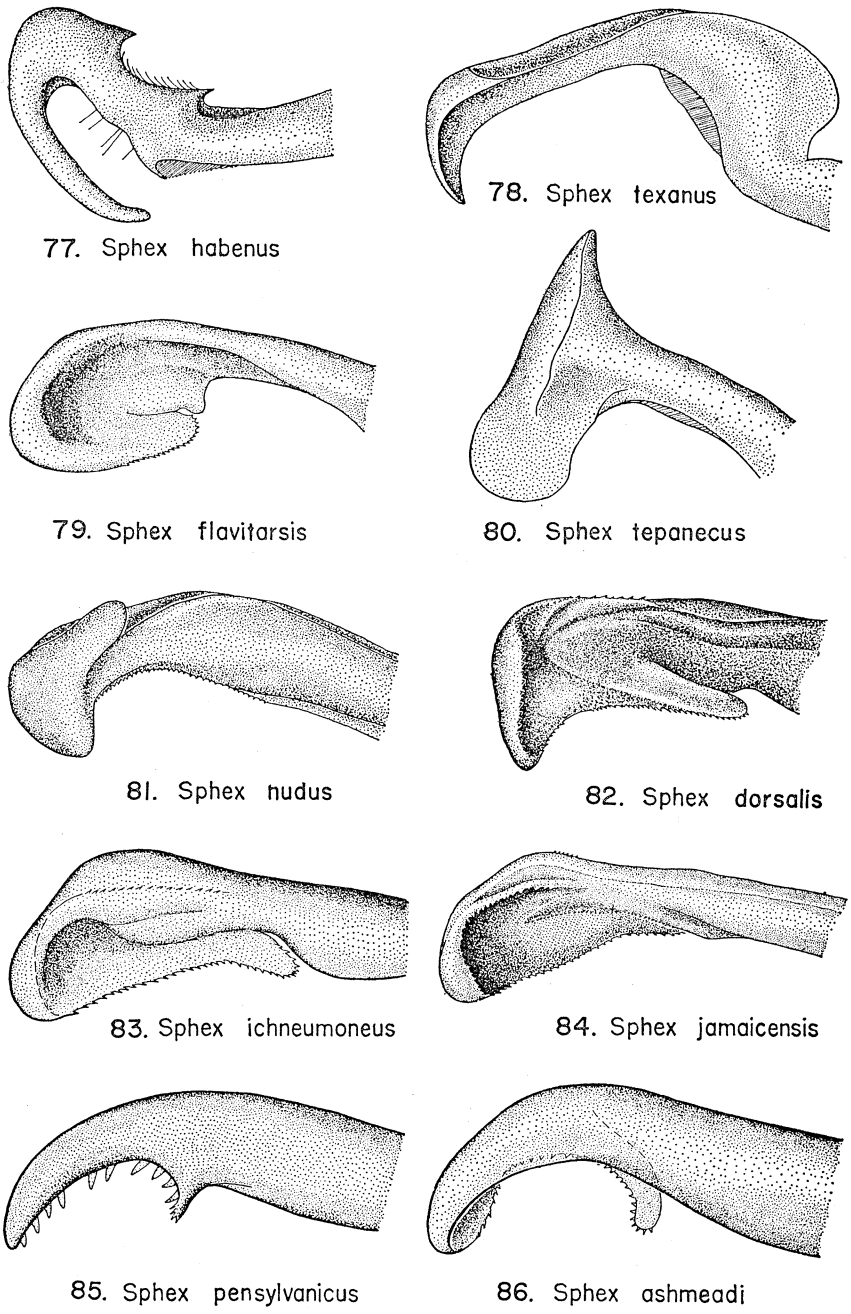


75. Sphex nudus

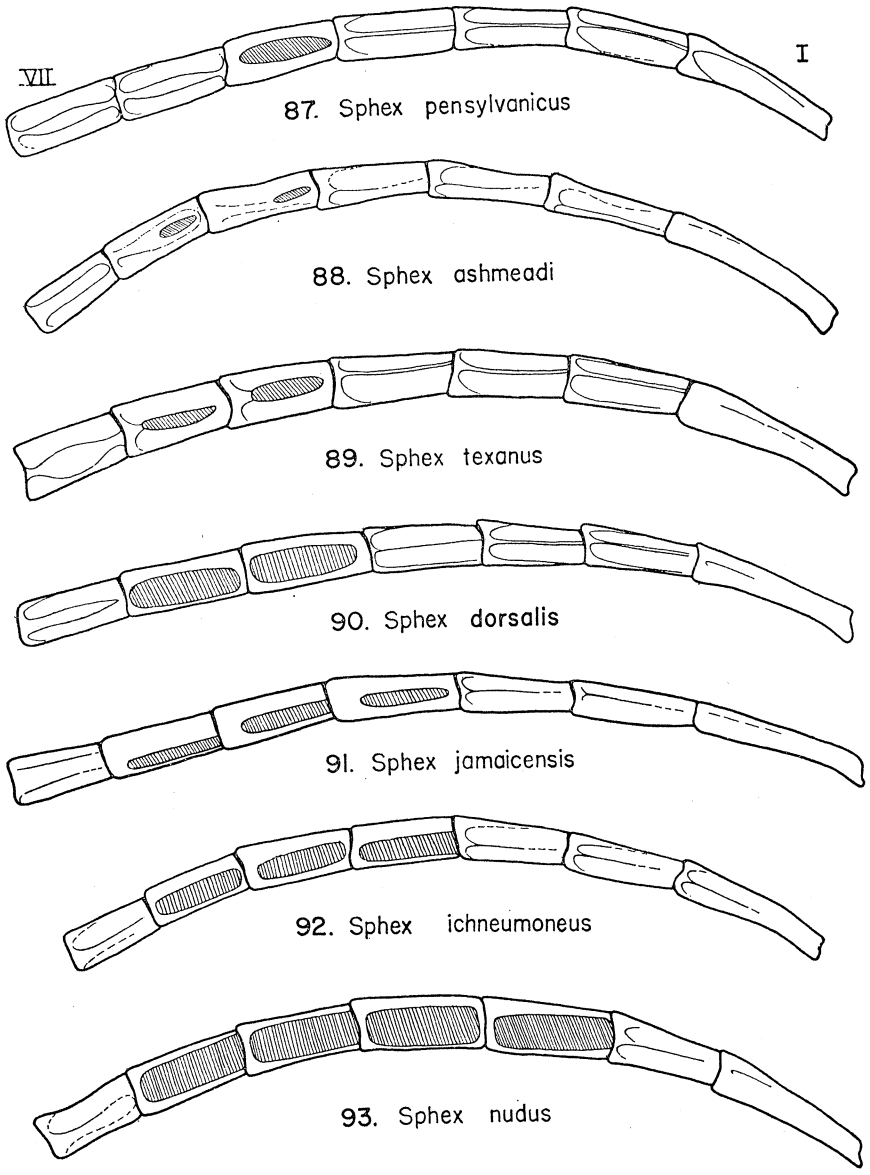
74. Sphex tepanecus

76. Sphex dorsalis

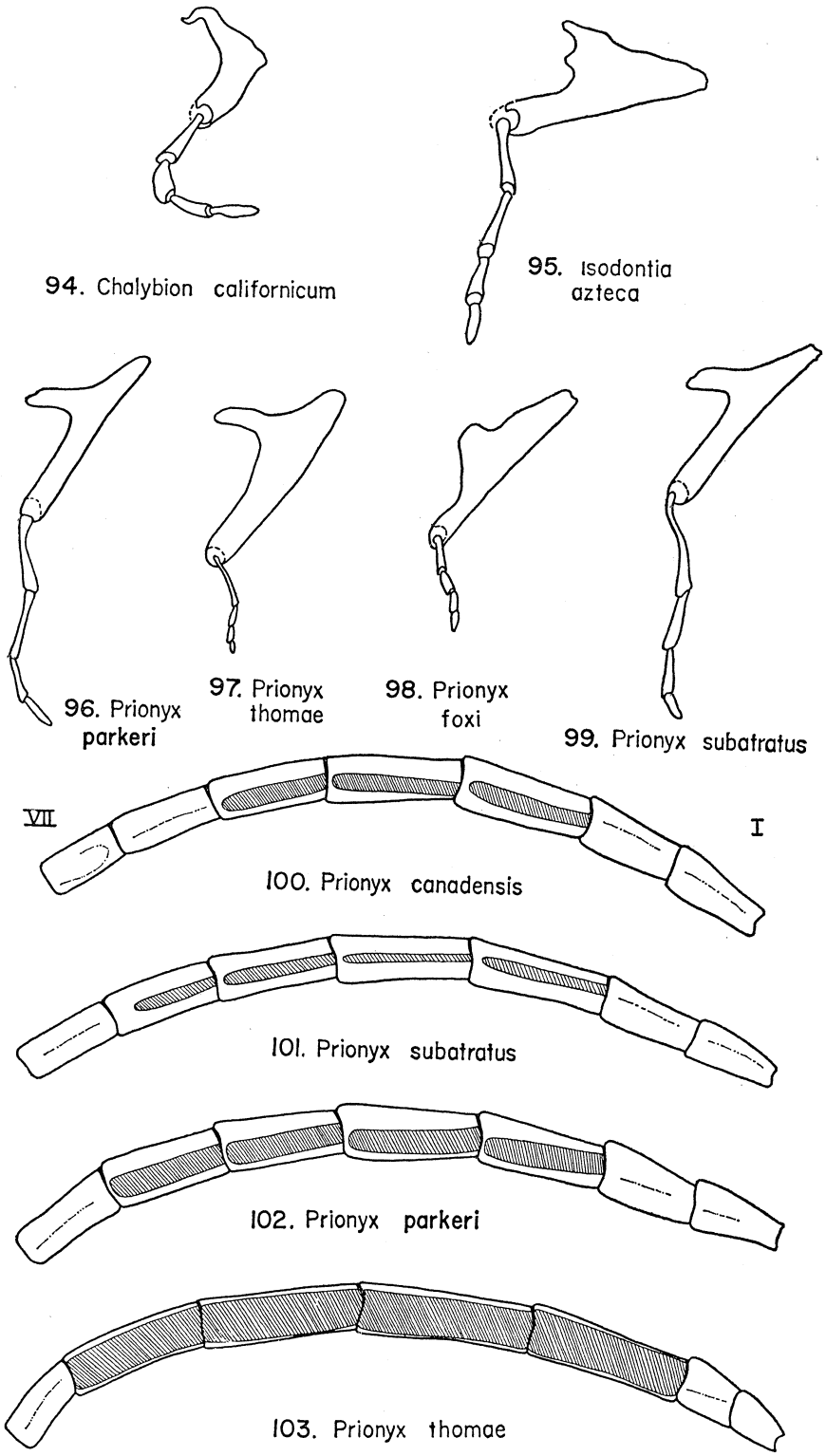
Figs. 70–76. Aedeagus, end-on view, of *Sphex texanus* Cresson, *S. habenus* Say, *S. flavitarsis* (Fernald), *S. jamaicensis* (Drury), *S. tepanecus* Saussure, *S. nudus* Fernald, and *S. dorsalis* Lepeletier, respectively.



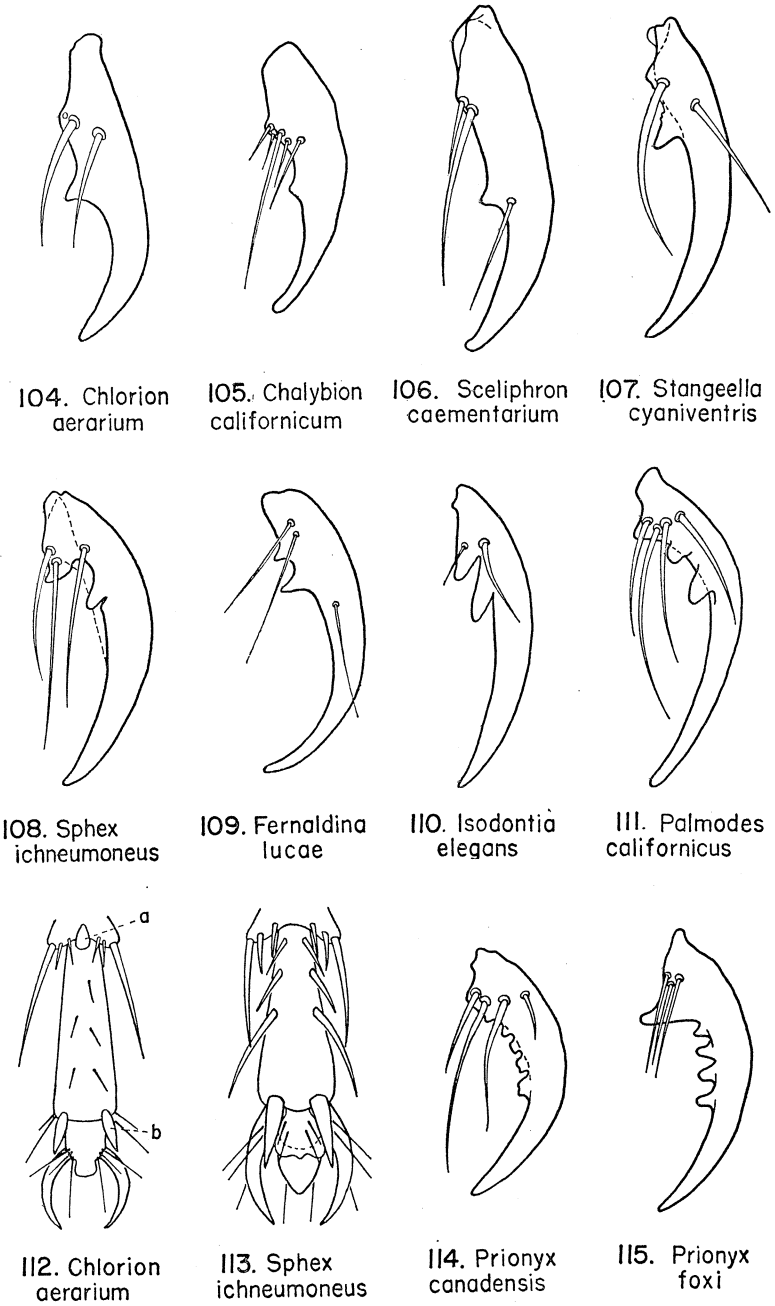
Figs. 77–86. Aedeagus, profile of apex, of *Sphex habenus* Say, *S. texanus* Cresson, *S. flavitarsis* (Fernald), *S. tepanecus* Saussure, *S. nudus* Fernald, *S. dorsalis* Lepeletier, *S. ichneumoneus* (Linnaeus), *S. jamaicensis* (Drury), *S. pensylvanicus* Linnaeus, and *S. ashmeadi* (Fernald), respectively.



Figs. 87–93. Flagellomeres I–VII, ♂, inner ventral view, of *Sphex pensylvanicus* Linnaeus, *S. ashmeadi* (Fernald), *S. texanus* Cresson, *S. dorsalis* Lepeletier, *S. jamaicensis* (Drury), *S. ichneumoneus* Linnaeus, and *S. nudus* Fernald, respectively. Obliquely lined areas represent fossulae.



Figs. 94–103. Figs. 94–99. Galea and labial palpus, ♀, of *Chalybion californicum* (Saussure), *Isodontia azteca* (Saussure), *Prionyx parkeri* Bohart and Menke, *Prionyx thomae* (Fabricius), respectively. Figs. 100–103. Flagellomeres I–VII, ♂, inner ventral view, of *Prionyx canadensis* (Provancher), *P. subatratus* (Bohart), *P. parkeri* Bohart and Menke, and *P. thomae* (Fabricius), respectively. Obliquely lined areas represent fossulae.



Figs. 104–115. Figs. 104–111. Profile of mid tarsal claw, ♀, of *Chlorion aerarium* Patton, *Chalybion californicum* (Saussure), *Sceliphron caementarium* Drury, *Stangeella cyaniventris* (Guérin-Méneville), *Sphex ichneumoneus* (Linnaeus), *Fernaldina lucae* (Saussure), *Isodontia elegans* (Smith), and *Palmodes californicus* Bohart and Menke, respectively. Figs. 112–113. Apex of hind tarsus, ♀, ventral view, of *Chlorion aerarium* Patton and *Sphex ichneumoneus* (Linnaeus), respectively: *a*, lamellate oval intersegmental pad; *b*, bladelike seta. Figs. 114–115. Profile of mid tarsal claw, ♀, of *Prionyx canadensis* (Provancher) and *P. foxi* Bohart and Menke, respectively.

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