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A REVISION OF THE GENERA *PHILOPHUGA*
MOTSCHOULSKY AND *TECNOPHILUS*
CHAUDOIR WITH NOTES ON THE NORTH AMERICAN
CALLIDINA (COLEOPTERA: CARABIDAE)

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A taxonomic revision of the species of the North American genera Philophuga Motschoulsky and Tecnophilus Chaudoir is presented. Four species and four subspecies of Philophuga are recognized. The taxa Philophuga horni Chaudoir and Philophuga amoena LeConte are grouped with P. viridis Dejean to form a polytypic species, and P. viridis klamathea new subspecies is described. Infernophilus new genus, is erected to contain the species castaneus Horn, formerly included in Philophuga. The following names are synonymized for the first time: P. lauta Casey (= P. viridis viridis Dejean), P. canora Casey (= P. viridis amoena LeConte), P. obscura Casey (= P. viridis amoena LeConte), P. cobaltina Casey (= P. viridis horni Chaudoir), P. uteana Casey (= P. viridis horni Chaudoir). The name Tecnophilus pilatei Chaudoir is removed from synonymy to the name of a species. Two subspecies of a second species of Tecnophilus are recognized; T. c. croceicollis Menetries and T. c. peigani new subspecies.

Geographical variation among the populations of Philophuga viridis Dejean and Tecnophilus croceicollis Menetries is analyzed.

The structure of the female stylus is described for the Callidina and the variation pattern of this sclerite is used to erect a classification of the North American species of this group.

The method of oviposition and the habitats of the adults are described, as well as the larvae of Philophuga viridicollis and Tecnophilus croceicollis.

My interest in this group of carabids began with the discovery of specimens of *Tecnophilus croceicollis* Menetries in southern Alberta. Examination of specimens of *T. croceicollis* from other localities indicated that considerable geographic variation was exhibited by specimens belonging to this species, and also suggested to me that the genus *Tecnophilus* contained more than the one recognized species. I decided to include the genus *Philophuga* in this study because of the similarities in both morphological characteristics and distribution patterns shown by members of the genera *Philophuga* and *Tecnophilus*. I undertook a cursory study of the subtribe Callidina to elucidate the relationship between these two genera, and their relationships to the genus *Callida*.

The complexity of the tribe Lebiini has led many authors to divide it into subtribes. The concept of the supra-generic grouping, the Callidina, was first introduced by Chaudoir (1872). Chaudoir's *Callidides* was a heterogeneous assemblage of lebiine genera which included some genera not belonging here, and excluded others, such as *Philophuga*, previously described by Motschoulsky 1859, which are certainly callidines. When Chaudoir (1877) later described *Tecnophilus*, a callidine genus in even the strictest sense, he placed it in his unspecified grouping *Mimodromiides*.

Horn's (1882) synopsis of the tribe Lebiini was the next, and last comprehensive work on the North American Callidina. Although Horn did not recognize any formal subtribal groupings, he did indicate that a close relationship existed between *Callida*, *Philophuga* and *Plochionus*. Without reference to the genitalic structures, Horn described *castanea* as a member of *Philophuga*. He also suggested that a relationship may exist between *Tecnophilus* Chaudoir and *Euproctus* Solier (= *Euproctinus* Leng and Mutchler) and that these two genera are rather separate from *Callida*.

Since Horn's time, the only work on a large group of North American lebiines has been Madge's (1967) revision of *Lebia* Latreille.

Casey (1913 and 1924) described six species of *Philophuga*, five of which are here regarded as conspecific with previously described species.

Jeannel (1942 and 1949) treated the lebiine faunas of France and Madagascar respectively. He recognized the formal grouping Callidinae but did not present any truly diagnostic characters.

Recently, two major works by Jedlička (1963) and Habu (1967) have appeared, dealing with the Asian Lebiini. Habu presents the best subtribal classification yet proposed, based largely on the structure of the legs, mandibles and female ovipositor. Habu's definition of the Callidina is followed in part in this study.

MATERIALS, METHODS, AND TAXONOMIC CHARACTERS

Materials

I have examined over 1200 specimens of adults and larvae of the genera *Philophuga* and *Tecnophilus* in the course of this study. Most of these specimens were obtained on loan from various museums in Canada and the United States. Many specimens of *Tecnophilus* were collected by myself on a number of field trips to southeastern Alberta, and on an extended trip through southwestern United States. Larvae were reared in the laboratory from eggs laid by captive adults.

Following the description and discussion for each species and subspecies, a list of the localities from which specimens have been examined is presented. The localities are listed alphabetically, in the following order: country, province or state, county and specific locality. Following this, the collector's name and the museum in which the specimen is stored are listed in parentheses.

Abbreviations for museums from which specimens were seen, are as follows: AMNH - American Museum of Natural History; Car. M. - Carnegie Museum; CAS - California Academy of Sciences; CNC - Canadian National Collection, Ottawa; CNHM - Chicago Natural History Museum; CU - Cornell University; DAL - Canada Department of Agriculture Research Station, Lethbridge, Alberta; INHS - Illinois Natural History Survey; IUM - University

of Idaho; KUM - University of Kansas; MUB - University of Montana, Bozeman; MCZ - Museum of Comparative Zoology; OUM - Oregon State University; SJSC - San Jose State College, California; UASM - University of Alberta, Strickland Museum; USNM - United States National Museum; and WUM - University of Washington, Seattle.

Methods

General

Observation and comparison were the methods used (Ball 1966). Observations were made of both morphological and biological features of both preserved and living specimens of the subtribe Callidina. Using these observations, comparisons were made between different population samples in order to ascertain similarities and differences. Most observed characteristics were compared independently and were weighed subjectively depending upon the circumstances. That is, in one situation a given character may have been regarded as possessing no discriminatory value, while in another situation it may have been judged important. However, in dealing with variation in one species, *Tecnophilus croceicollis*, several characters were compared simultaneously and the weights for each of these characters were calculated according to their individual statistical discriminatory value, regardless of other considerations.

Criteria for Species, Subspecies and Genera

The multi-dimensional definition of the species (Mayr 1963) has been used as the underlying basis for the taxonomy in this study. The taxa assigned to the species category are less arbitrary than taxa assigned to lower or higher categories, hence the species category forms the basis around which a classification is built. Because it is difficult to make the necessary tests on a population to prove the principal criterion for recognizing a species, that is, genetical isolation from other such groups, this information must be obtained indirectly.

In this study, evidence interpreted as indicating specific identity, is provided by: forms which overlap geographically but do not intergrade in their diagnostic characters in the area of overlap; and allopatric forms in which geographically intermediate specimens do not show intermediate states in their diagnostic characters. For example, the two species *Tecnophilus croceicollis* Menetries and *T. pilatei* Chaudoir are primarily allopatric, and their members can be consistently distinguished from one another on the basis of several characters. However, in the vicinity of Brownsville, Texas, the ranges of these two species overlap, yet the diagnostic characters still hold and permit complete segregation of members of each of these species. I assume that maintenance of these differences is the result of reproductive isolation between these two groups.

I have recognized subspecies only in cases of concordant non-clinal variation in two or more characters. I have not recognized populations along, or at the end of clines as being subspecifically distinct. Rather an attempt has been made to point out such clines and to describe them when they have been recognized (Mayr, Linsley, and Usinger 1953). In one

species, *Tecnophilus croceicollis* Menetries, clinal variation occurs in many characteristics; however, two subspecies of this species have been recognized. The new subspecies, *T. c. peigani*, was recognized because a number of characters, many of which varied clinally, showed a sharp change through a relatively short distance to produce two forms which were remarkably different in general appearance, and could be readily distinguished from one another.

A genus has been defined as “a systematic category [= taxon] including one species or a group of species of presumably common phylogenetic origin, which is separated from other similar units by a decided gap” (Mayr, Linsley, and Usinger 1953). However, the gap necessary to distinguish between groups of species belonging to different genera cannot be objectively defined. Rather, this must be decided by the taxonomist on the basis of his knowledge and experience in the group. Consistency in deciding the nature and size of the gap (degree of morphological difference) required to separate related genera is imperative in producing a uniform and workable classification.

In this study, I have recognized the previously described genera, *Callida*, *Philophuga* and *Tecnophilus*, and have used the degree of morphological difference between these three genera as a guideline by which to recognize other genera within this subtribe. The species *Philophuga castanea* Horn differs from the other species included in the genus *Philophuga* by at least as much as these species differ from the species included in the genera *Callida* and *Tecnophilus*. For this reason, I removed *castanea* from *Philophuga* and proposed the new genus *Infernophilus* to contain it. Recognition of *Infernophilus* is consistent with the maintenance of *Callida*, *Philophuga* and *Tecnophilus* as distinct genera.

Morphological Methods

To examine characters of the wings and of the genitalia, the specimens were first relaxed by placing them in boiling water for five to ten minutes. After this time, the specimens were sufficiently pliant to allow the elytra to be lifted so that the hind wings could be examined. This was adequate to determine the relative size of the wings. However, in cases where it was necessary to study the pigmentation of the wings, the hind wing was removed by breaking it off near the base. The wing was unfolded and first studied in water, then flattened out and glued to a card which was pinned beneath the specimen.

Male and female genitalia were removed from the relaxed specimens by breaking the supporting membranes around the genitalia with a hooked insect pin. The genitalia were removed with a pair of fine forceps. After dissection, the genitalia were placed in cold 10% KOH and allowed to stand overnight to clear the sclerites. The male genitalia were then examined with a binocular microscope. It was necessary to mount the female genitalia on slides and examine them with a compound microscope at higher magnification.

Preservation of Larvae

To prevent distortion and discoloration of specimens, larvae were killed by dropping them directly into gently boiling water. They were quickly removed and preserved in 70% ethanol. This method of killing extends the larvae to their maximum length and preserves color and hence facilitates later study.

Rearing Methods

Adult specimens of *Tecnophilus* were reared in the laboratory to obtain eggs and larvae. After collection, five or six specimens were placed in each jar, where mating readily occurred. After mating, the females were removed and isolated in small jars which contained soil a half inch deep and several twigs that permitted the insects to climb. Pieces of mealworm were added for food, and water was sprinkled into the jar weekly.

If adequate food and moisture were provided, the females began to oviposit within a week after mating. The eggs were removed as they appeared, and were placed on a moistened blotter in a petri dish where they were left until hatching occurred. Newly emerged larvae were isolated in small vials and were fed pieces of various soft-bodied insect larvae. High humidity was maintained by placing a piece of moistened blotting paper in the neck of the vial. Mortality was high, but a number of larvae were reared to the second and third instars.

Measurements and Ratios

Measurements were made of representative specimens of all species and subspecies dealt with in this study. Although they did not provide diagnostic characters for any species, measurements and the ratios derived from them were valuable in the analysis of intra-specific variation. A micrometer eyepiece in a Wild M5 stereoscopic microscope at a magnification of X 50 was used for these measurements.

The total length (TL) of adult specimens was obtained by the addition of three measurements: the length of the head from the anterior margin of the clypeus to the mid-point of the occipital groove (LH); the length of the pronotum along the mid-line (LP); and the length of the left elytron from the apex of the scutellum to the apex of the elytron (LE). Total length (LH + LP + LE) obtained in this way was not affected by contraction or curvature of the specimen. Other measurements taken of adult specimens and their abbreviations are: Width of pronotum (WP) - width across widest point of pronotum; maximum width of head (WH₁) - width of head across eyes; width of head between eyes (WH₂) - minimum width of frons between eyes. Measurements taken of larval specimens are: Width of head (WH) - width across widest part of head capsule; width of pronotum (WP) - width across widest part of pronotum; total length (TL) - one measurement of length from the anterior margin of the nasale to the posterior margin of abdominal segment 10. All ratios used in the text are derived from the above measurements, and are expressed in terms of the above abbreviations.

Analysis of Variation

Specimens from populations that differ slightly and possibly discordantly in a number of characters, may be assigned to the correct population by means of the discriminant function. In the study of such groups, the traditional methods of taxonomy, observation and comparison, do not work well for the mind is incapable of making the numerous summated judgments required.

The discriminant function used in this study has been developed by Fisher (1936) and outlined by Stanley (McGill University unpublished MS). The method has been used or discussed by Goulden (1952) and Bigelow and Reimer (1954).

Interpretation of the discriminant function is similar to that used for the hybrid index (Freitag 1965). Using this method, a specimen which deviates from the other members of its population in only one or a small percentage of its total characters, is still assigned to its correct population because of its greater overall similarity to members of that population. This reduces the possibility of mis-identification due to the over-weighting of one character.

Illustrations

Illustrations are presented to augment descriptions. These were prepared with the aid of an ocular grid in a stereoscopic microscope.

The male genitalia have been illustrated for many species even though they usually present few useful characters. Stippling has been used to indicate the folding pattern of the endophallus but as this folding pattern varies with small changes in inversion, it should not be considered as important in identification.

The slender sub-apical spines on the stylus of the female ovipositor have been included in illustrations of the styli. Both dorsal and ventral spines have been shown as though they occurred in the same plane, as this is the way they appear when the stylus is cleared in potassium hydroxide and mounted on a microscope slide.

Distribution maps are presented for all species and subspecies. Also maps summarizing data on intra-specific variation in the species *Philophuga viridis* and *Tecnophilus croceicollis* are included.

Taxonomic Characters

Taxonomic Characters of Adults

Color. - Within the Callidina, color is useful in the identification and classification of species, and to a limited extent, genera. Non-metallic colors are described by the terms yellow, testaceous (brownish-yellow), rufous (reddish), brown, piceous and black. The color black often has a metallic sheen associated with it. Metallic colors are usually blue or green. To describe variation in certain species, intermediate colors are designated in terms such as blue-green (green predominant) or greenish-blue.

External morphology. - Punctuation and vestiture of the body, while extremely useful for the recognition of species and subspecies with *Philophuga* and *Tecnophilus*, are difficult characters to interpret and quantify. As the setae composing the dorsal vestiture of the body are situated in usually distinct punctures, the punctuation of the body often gives an indication of the vestiture. However, in specimens from certain populations, the body is deeply punctate, but the punctures do not bear setae, or bear very inconspicuous setae. Care must be taken to avoid confusing these specimens with normally setose specimens that have been rubbed. The depth and density of the punctures in the elytral striae and on the elytral intervals are important for identification.

To describe the depth of punctuation of the body and the depth of the impression of the elytral striae, the terms lightly, moderately and coarsely have been used. These terms are strictly comparative, and have been avoided as much as possible in keys. However, they have been used in descriptions in a comparative sense. Similarly, the terms sparse, moderate and dense have been used to describe vestiture.

The shape of the head shows both intra- and inter-specific variation. Differences in the convexity of the eyes and the constriction of the neck present characteristic forms for certain species. For all species, values for the ratio of the width of the head across the eyes to the minimum width of the head between the eyes has been presented in an attempt to quantify differences in eye convexity. This ratio is not diagnostic of any species but it provides an index of the head shape.

The post-ocular pinch is an impression just behind the posterior dorsal margin of the eye. This pinch is evident but small in most of the Callidina. However, in some of the neotropical species of *Callida* and in some species of *Cymindis* this pinch is very strongly developed.

The mouthparts were not found to provide any characters useful for species recognition. They are of value at the generic level, but even here their importance has been overestimated in past works.

The shape of the pronotum is of appreciable diagnostic value. In *Philophuga*, differences in pronotal shapes between related species are often slight and may be within the range of normal intra-specific variation. In *Tecnophilus* the shape of the pronotum is much more characteristic of a species, and is usually rather constant within a population sample. The pronotum has been illustrated for most species and subspecies.

The wings present several characters which are considered very important in *Philophuga*. Wing reduction occurs in this genus and has been used to distinguish between several subspecies of *viridis*. Also, the degree to which the membranous areas of the wings are pigmented is useful in the recognition of certain species. The wing venation was not found to offer any characters of diagnostic value at either the specific or generic levels.

Habu (1967) made extensive use of the structure of the legs in his classification of the Japanese Lebiini. In the present study, only two characteristics of the legs have been used: the structure of tarsal article 4; and the structure of the tarsal claws. Two forms of tarsal article 4 are found among the Nearctic Callidina, the bilobed form and the emarginate form. These are illustrated in figs. 28 and 29 respectively. The tarsal claws of members of the genus *Tecnophilus* are simple, while members of the other North American callidine genera possess pectinate claws.

Characteristic arrangements of setae on the ventral surface of the abdomen provide useful characters for the recognition of two genera. The usual arrangement of setae is: visible sterna 2 to 5 each with a pair of medial setae, sternum 6 with one to three pairs of anal setae. However, members of the genus *Plochionus* bear, in addition to the above-mentioned setae, a distinctive arrangement of setae on the lateral margins of sterna 4, 5 and 6 (fig. 26). Members of the genus *Infernophilus* lack the lateral setae, but sternum 6 possesses a pair of dense brushes of setae (these brushes are much denser in the male than in the female, fig. 27).

Male genitalia. - The structure of the male genitalia is rather consistent within the species of *Philophuga* and *Tecnophilus*. The aedoeagus (intromittent organ, see Torre-Bueno 1962) is slightly arcuate, with a prominent rounded apex. The basal piece, the portion of the aedoeagus surrounding the basal orifice, varies slightly, but is of minor taxonomic importance. The endophallus is usually unarmed and possess only poorly defined spiculate fields. However, the genitalia of *Infernophilus* shows a number of peculiarities.

Female ovipositor. - The structure of the apical article of the stylus is of great importance in determining subtribal affinities. Basically, the stylus is rectangular in shape, lightly sclerotized and with a setose apical margin. In *Tecnophilus pilatei* Chaudoir (fig. 55), and *Callida decora* Fabricius (fig. 50), the outer apical corner of the stylus is greatly produced. In *Infernophilus* (fig. 57) the apex of the stylus is broadly rounded and in *Plochionus* (figs. 45, 46) the apex is sharply pointed with a tassel-like arrangement of setae. Small slender spines are scattered over the surface of the stylus but were found to be of little taxonomic value.

Taxonomic Characters of Larvae

As larvae representing only a few of the species of the *Callidina* have been seen, the variation and distribution of the taxonomically important characters within the subtribe are unknown.

Color. - Color is of considerable value in recognizing the larvae of certain genera. The terminology used to describe color is presented under taxonomic characters of adults.

External morphology. - Most of the characters and terminology used are taken from Van Emden (1942).

The subtribal character of the presence of a soft membranous pulvillus between the tarsal claws is difficult to observe in some specimens; hence this structure must be sought for with care.

The dorsal surface of the maxilla of *Plochionus* possesses short dense setae (fig. 8). This surface is glabrous or covered with very short stout sensilla in the larvae of the other callidine genera.

The shapes of the pronota of *Philophuga* (fig. 9) and *Tecnophilus* (fig. 10) have been used to separate the larvae of these two genera. The number of articles in the cerci of 2nd and 3rd instar larvae also separates these two genera, but because this character could not be used to separate the larvae of all instars, it was not used in the key to genera.

TAXONOMY - THE SUBTRIBE CALLIDINA

This subtribe may be defined as follows:

Adult. - Lebiini with the following characteristics: labrum transverse, with six setae along anterior margin; mandible widened toward base, usually with scrobe; labial palpus with penultimate article bisetose, apical article securiform or at least tumid (less in female than in male) and truncate apically; ligula bi- or plurisetose apically, paraglossae not or but slightly extending beyond ligula; mentum usually with a tooth; fore tarsus of male with various number of articles bearing ventral adhesive scales, such scales frequently present on some articles of middle tarsus; tarsal article 4 bilobed, emarginate or simple; prothorax not lobed behind; male genitalia with smaller paramere bilobed apically; female stylus with setose apex.

Larva. - Head approximately quadrate; epicranial suture wanting, lateral sutures meeting medially at cervical margin; adnasale prominent, covering base of mandibles; nasale broad and prominent, entire or variously emarginate apically; antenna shorter than mandible, arti-

cle 3 about twice length of article 1, and bearing a short sensory papilla distally; mandible bisetose externally, with reduced or obsolete retinaculum, penicillus present; maxilla without an inner lobe, palpiger evident; labium with a pair of prominent apical setae; leg with two equal claws, claws simple or toothed basally; pulvillus present, conspicuous or not; tergites margined anteriorly; abdominal segment 10 with a pair of protrusible vesicles, each bearing a semicircular row of crochets; cerci of four or five articles.

This definition of the Callidina is based upon the limited lebiine fauna of the United States. In this region, the genera *Callida* Latreille and Dejean, *Cylindronotum* Putzeys, *Lecalida* Casey, *Onota* Chaudoir, *Philophuga* Motschoulsky, *Plochionus* Wiedemann, *Tecnophilus* Chaudoir, and *Infernophilus* new genus may be assigned to the Callidina.

As defined here, this subtribe is more restricted than conceived by either Chaudoir (1872) or Habu (1967). Habu regarded the shape of the mandibles, the form of the tarsi and the structure of the female ovipositor as the principal subtribal characters. The structure of the tarsus does not unite the Nearctic genera of the Callidina. *Callida* possesses dilated tarsi (fig. 28) which Habu regards as characteristic of this subtribe. However, the closely related genus *Philophuga*, has only the stout form of tarsus (fig. 29) and members of the genus *Tecnophilus* possess almost slender tarsi. Both stout and dilated tarsi are found in the genus *Plochionus*.

Habu recognizes three forms of female ovipositor among the Japanese Callidina. These are as follows: (a) hemisternites transverse, apical segment of stylus long and pubescent apically (figs. 44-57); (b) hemisternites transverse, apical segment of stylus without terminal setae; (c) hemisternites not transverse, apical segment of stylus without pubescence but with slender spines near apical angle (fig. 43). In the Nearctic fauna, no genus occurs which possesses type "b" ovipositor, so I have not been able to determine the relationship between this form of ovipositor and type "a" ovipositor. Members of *Euproctinus* Leng and Mutchler possess type "c" ovipositor (fig. 43). As this genus differs from the North American callidines on the basis of the female ovipositor and larval characteristics, I exclude it from the Callidina. Because *Euproctinus* cannot be assigned to any of the presently recognized subtribes, a new subtribe may have to be proposed to receive it.

The unique brush-like stylus forms an excellent subtribal character for the Callidina, for while the structure shows considerable variation among the genera, the basic form remains recognizable. No other character examined has shown as great a diagnostic value within this group at the subtribal level.

LARVAE

The larvae of few species of the tribe Lebiini have been described. This may be the result of at least two factors which make it difficult to obtain the requisite specimens: adults of many species are rarely collected; and the species of at least one genus, *Lebia* Latreille, have a complex developmental cycle (Lindroth 1954, Madge 1967).

Key to the Larvae of the North American Subtribes of Lebiini (*modified from van Emden 1942*)

1. Retinaculum of mandible vestigial or absent; or if well developed, the cervical groove and keel are present; antenna with article 1 longer than article 3 2
- 1'. Retinaculum well developed, projecting by more than a third of width of mandible just apicad of retinaculum; head without cervical groove or keel; antenna with article 1 shorter than article 3; tarsal claws toothed or simple Dromiina
- 2(1). Tarsus without a pulvillus; tarsal claws with or without a basal tooth, but if tooth present, head with a cervical groove 3
- 2'. Tarsus with a soft unpaired but more or less bilobed pulvillus between claws; retinaculum vestigial or absent; head without cervical groove; epicranial suture very short or almost absent 5
- 3(2). Retinaculum distinct; cervical groove and keel present except if antennal article 1 is longer than article 3; maxillary stipes rather slender, almost or fully three times as long as wide Coptoderina
- 3'. Retinaculum small, vestigial or absent; cervical groove absent; antennal article 1 shorter than 3; maxillary stipes robust, at most twice as long as wide 4
- 4(3). Ligula and its two setae well developed; epicranial suture present though short in some species; cercus of 5-7 articles (but of four articles in at least some first instar specimens) Cymindina
- 4'. Ligula and its two setae minute or absent; epicranial suture absent; cercus with at most four articles Lebiina
- 5(2). Anterior margin of abdominal tergites with margined border Callidina
- 5'. Anterior margin of abdominal tergites without margined border *Euproctinus* Leng and Mutchler

The Callidina, Cymindina and Lebiina show a number of common features that distinguish these groups from the Dromiina and Coptoderina. However, I do not intend to propose a classification based on characteristics of lebiine larvae. Rather, the known larvae were examined to determine if their characteristics substantiated the generic separations proposed in the Callidina on the basis of characters of adults. Where larvae were available, their characters supported the adult classification.

Key to the known Larvae of the Nearctic Genera of the Subtribe Callidina

1. Anal vesicles of abdominal segment 10 bearing crochets 2
- 1'. Anal vesicles of abdominal segment 10 without crochets *Onota* Chaudoir
- 2(1). Maxilla with dorsal pubescence in addition to the usual fixed setae (fig. 8); nasale narrow, without a deep medial incision (fig. 7) *Plochionus* Weid. p. 25
- 2'. Maxilla glabrous except for usual fixed setae and short stout sensillae; nasale broad, with a deep medial emargination (figs. 11-14) 3
- 3(2). Pronotum quadrate (fig. 9) *Philophuga* Mots. p. 25
- 3'. Pronotum conical, widest basally and narrowing anteriorly (fig. 10) *Tecnophilus* Chaud. p. 26

Plochionus Wiedemann 1823

Larvae of only *P. timidus* Haldeman 1843 have been seen. The following description is based on five specimens from Kirkwood, Missouri (29/VI/1892, USNM).

Description. - Values for ratios and measurements are: TL, 2nd instar 5.9-7.4 mm; 3rd instar 8.9-10.4 mm; WH/LH, 2nd instar 1.30-1.36, 3rd instar 1.24-1.28; WP/WH, 2nd instar 1.20-1.24, 3rd instar 1.25.

Color whitish, head and anterior portion of pronotum yellow; nota two and three, legs, and abdominal tergites testaceous, without metallic lustre; sternites and pleurites testaceous-yellow.

Head broad, more or less quadrate, but somewhat rounded laterally; nasale convex with a prominent relatively narrow tri- or quadridentate medial tooth (fig.7); medial suture present but very short, divided into paired sinuate lateral sutures a short distance anterior to cervical margin, cervical border narrow.

Antenna shorter than mandible, with four articles; article 1 broad, about one half length of article 3; article 4 narrow, broadly rounded apically; article 3 with a minute subapical sensillum; subapical setae on articles 3 and 4 only.

Mandible relatively short, slightly and unevenly arcuate, with two external setae; retinaculum minute, rounded and blunt apically; internal apical half of mandible expanded and plate-like; penicillus present at base.

Maxilla (fig. 8) hairy above, with internal dorsal row of short stiff setae; ventral surface glabrous except for usual long setae; internal lobe absent; palpiger well developed, terminal article of palpus conical and pointed apically; median lobe with two articles, distal article very small.

Labium with medial pair of setae subapical and dorsal, ventral pair of setae also present; palpi of two articles, glabrous, apical article elongate, conical.

Prothorax transversely rectangular, broader and longer than head; lateral margin narrow and faint.

Legs with tarsal claws toothed at base and equal; pulvilli present but inconspicuous.

Anterior margins of tergites and nota strongly margined; tergites entire; ventral sclerites consisting of a ventrite and three pairs of lateral postventrites, all lightly sclerotized and poorly delimited.

Abdominal segment 10 with a pair of protrusible anal tubes, each bearing a semicircular row of crochets; cerci elongate, slender, with five articles in 2nd and 3rd instar larvae (1st instar larvae not seen).

Discussion. - The larva of *Plochionus* stands apart from the known larvae of the other North American callidine genera on the basis of its setose maxillae, and toothed tarsal claws. Consequently, the position of this genus among the North American Callidina is unclear, and probably cannot be settled until the Neotropical genera are better known.

Philophuga Motschoulsky 1859

In this genus, the larvae of *P. viridicollis* LeConte and *P. viridis amoena* LeConte are known. As only first instar larvae of *viridis*, and second and third instar larvae of *viridicollis* were available, I was not able to find characters that would distinguish between the two

species with any degree of certainty. Because of this, a key is not provided, and only the larva of *viridicollis* is described below.

Philophuga viridicollis LeConte 1848

A third instar larva, two pupae, an associated adult and a number of exuviae of *viridicollis* were seen (Rocky Ford, Colorado, Aug. 17, 1915, Hamilton Coll., USNM). Van Emden (1942) included this material under *Callida*, as *C. purpurea* Say.

Description. - Values for ratios and measurements of 12 larvae and exuviae are: TL, 3rd instar 9.1 mm; WH/LH, 3rd instar 1.18-1.22 (\bar{X} = 1.20), 2nd instar 1.15-1.20 (\bar{X} = 1.18); WP/WH, 3rd instar 1.18.

Color whitish; head testaceous; body sclerites brown to piceous with a metallic green or violaceous sheen.

Head (fig. 11) broad, almost quadrate with hind angles broadly rounded; frontal piece broad; sinuate lateral sutures meeting medially at cervical margin, median suture absent; nasale very broad, deeply incised medially, lateral portions tridentate; cervical margin narrow; ocelli six, strongly pigmented.

Antenna slightly shorter than mandible, of four articles; article 4 narrow, subequal in length to article 3, article 1 short; article 3 with a small subapical sensillum; subapical setae on articles 3 and 4 only.

Mandible slender and arcuate, with two lateral setae; retinaculum small and inconspicuous; basal penicillus present.

Maxilla with an internal dorsal row of stout setae plus usual long fixed setae, otherwise glabrous above; inner lobe absent; palpi with well developed palpiger, terminal article narrow and pointed.

Labium broad, bisetose apically, also with a pair of subapical ventral setae; palpi of two articles, glabrous.

Prothorax transversely rectangular (fig. 9), wider than head; lateral margin strong and complete.

Legs with equal simple claws; pulvilli present.

Tergites entire, with strong anterior borders; lateral margins of meso- and metanota angular; ventral sclerites consisting of a ventrite and three pairs of lateral postventrites.

Cerci with five articles in second and third instars, only subapical setae present; abdominal segment 10 with a pair of eversible anal tubes, each bearing a semicircular row of crochets.

Discussion. - Van Emden (1942), who saw some larval specimens of *Callida*, keyed *Callida* and *Philophuga* to the same couplet, stressing their similarities especially in the shape of the nasale, number of articles in the cerci, and the shape of the tarsal claws. Larval characteristics apparently confirm the close relationship suggested for these two genera by adult characteristics.

Tecnophilus Chaudoir 1877

The larvae of both subspecies of *Tecnophilus croceicollis* Mén. are known. They were obtained by rearing from adults collected at the following localities: junction of the Lost and Milk Rivers, Alberta (*T. c. peigani* n. ssp.); Cuddeback Lake and Alviso, California (*T. c. croceicollis* Mén.).

Description. - Values for ratios and measurements are presented in table 1. The first instar larva of *T. croceicollis* Men. is illustrated in fig. 6.

TABLE 1. Variation in dimensions and ratios among the larvae of *Tecnophilus croceicollis* Ménériés.

Locality	No. of specimens	Instar	Width/length of head		Width pronotum/width of head		Width of head (mm)	
			Range	Mean	Range	Mean	Range	Mean
Newark, Calif.	15	1	0.93-1.04	(0.97)	1.07-1.20	(1.14)	0.52-0.54	(0.52)
	6	2	0.97-1.03	(0.98)	1.14-1.31	(1.22)	0.62-0.70	(0.68)
	1	3	1.00		1.17		0.96	
Cuddeback Lake, Calif.	6	1	0.93-1.04	(0.98)	1.16-1.20	(1.17)	0.48-0.50	(0.50)
	2	3	0.94-0.98	(0.96)	1.16-1.18	(1.17)	0.90-0.96	(0.94)
Jct. Lost & Milk Rivers, Alberta	13	1	0.96-1.04	(0.97)	1.13-1.29	(1.19)	0.48-0.54	(0.51)
	2	2	0.91-0.93	(0.92)	1.24-1.38	(1.31)	0.78-0.84	(0.81)
	1	3	0.96		1.25		0.88	

Color whitish; head capsule and in many specimens prosternum and anterior half of pronotum yellow; remaining sclerites and appendages piceous, with at least a faint metallic green cast.

Head rectangular (figs. 12-14); frontal piece broad, medial suture wanting, sinuate lateral sutures meeting medially just anterior to cervical margin; nasale broad, deeply cleft medially, lateral pieces shallowly bifid; posterior constriction of head varied; cervical margin narrow; ocelli six, strongly pigmented.

Antenna shorter than mandible, with four articles; article 1 short, broad, about one half length of article 3; article 4 narrow, widening apically where broadly rounded; subapical setae on articles 3 and 4 only; small sensillum on article 3.

Mandible slender, with two lateral setae; retinaculum small, but evident; basal penicillus present.

Maxilla with internal dorsal row of short, stiff setae and scattered long external setae, otherwise glabrous; palpiger distinct; palpus with three articles, article 3 short, narrow; inner lobe absent; outer lobe with two articles, article 2 very short and narrow, basal article with a single preapical seta.

Labium bisetose apically, also with a pair of ventral setae; palpi with two articles, terminal

article short and narrow, pointed apically.

Prothorax somewhat conical (fig. 10), widest basally and narrowing anteriorly to about width of base of head; variously margined laterally.

Legs with equal simple claws; pulvilli present but reduced.

Tergites and nota margined anteriorly; ventral sclerites consisting of a ventrite and three pairs of postventrites.

Cerci of four articles in all instars; abdominal segment 10 with a pair of eversible vesicles, each bearing a semicircular row of crochets.

Discussion. - I was unable to find characters to distinguish between the larvae of *T. c. croceicollis* and *T. c. peigani*. Table 1 summarizes variation in measured characteristics and ratios among larvae from three localities.

The larvae of *Tecnophilus* are similar to those of *Philophuga*, but they can be distinguished from one another by the character presented in the key. Also, larvae of all instars of *Tecnophilus* have cerci of only four articles. In *Philophuga*, on the other hand, the first instar larvae have cerci of four articles while later instars have cerci of five articles. These differences do not contradict the separation of *Tecnophilus* and *Philophuga* at the generic level.

ADULTS

Characteristics common to all members of the subtribe Callidina, are presented in the taxonomy section. Below is a key to the adults of the North American genera of the subtribe Callidina. Following the key, the genera *Philophuga*, *Infernophilus* and *Tecnophilus* are discussed in detail. I have not had the opportunity to examine the other genera in detail, as the majority of their members are neotropical. Hence any remarks about the latter group are tentative.

Key to the Adults of the North American Genera of the Subtribe Callidina

(modified from Ball 1963)

1. Mandible broadly expanded, without scrobe *Onota* Chaudoir
- 1'. Mandible with scrobe 2
- 2(1).Mentum without a tooth; width of pronotum less than maximum width of head
 *Cylindronotum* Putzeys
- 2'. Mentum with a tooth; width of pronotum greater than width of head 3
- 3(2).Lateral margin of abdominal sternum 4 with one seta, sternum 5 with two setae, and sternum 6 with one seta (fig. 16); hind femur broad. *Plochionus* Wiedemann
- 3'. Lateral margin of abdominal sterna 4, 5 and 6 without such arrangement of long setae; hind femur slender 4
- 4(3).Tarsus with fourth article bilobed (fig. 28) 5
- 4'. Tarsus with fourth article at most emarginate (fig. 29). 6
- 5(4).Elytra metallic green or blue; pronotum elongate and slender, lateral grooves narrow .
 *Callida* Latreille and Dejean

- 5'. Entire body rufo-piceous, without metallic color; pronotum with lateral grooves broad
 *Lecalida* Casey
- 6(4). Tarsal claws pectinate 7
- 6'. Tarsal claws simple *Tecnophilus* Chaudoir, p. 38
- 7(6). Color dark with metallic blue or green sheen; abdominal sternum 6 with at most four
 pairs of anal setae. *Philophuga* Motschoulsky, p. 24
- 7'. Color brown, non-metallic; abdominal sternum 6 with at least six pairs of moderate to
 long setae in female, distinct anal brushes present on male (fig. 27).
 *Infernophilus* new genus, p. 37

Philophuga Motschoulsky 1859

Philophuga Motschoulsky 1859 - 140.

Philopheuga Bates 1883 - 202.

Glycia LeConte 1851, not Chaudoir 1842.

Type species - *Philophuga cyanea* Motschoulsky 1850 (= *P. viridis* Dejean), here designated.

The diagnostic features of this genus are presented in the key. Other characteristics, common to all species of *Philophuga*, are given in the following description.

Description - Beetles 5.5-10.0 mm in length. Color various, but at least elytra and abdominal sterna dark with a metallic blue or green sheen; antennae black with articles 1 to 3 and base of 4 pale, at least on ventral surface.

Head with eyes prominent, convex; at least a faint post-ocular pinch present. Genae variously narrowed behind, neck evident. Labrum slightly emarginate medially; clypeus with a single seta on each side. Frons with indistinctly defined, rugose frontal furrows; punctate, at least laterally and posteriorly. Antennal articles 1 to 3 and base of 4 glabrous or very sparsely and finely hairy; remaining articles pubescent. Maxillary palpus with fusiform terminal article. Labial palpus with penultimate article bisetose; terminal article securiform (narrower in female). Ligula bisetose. Mentum with a prominent margined tooth.

Pronotum varied in shape; sides usually evidently sinuate behind; disc transversely rugose, best developed laterally; posterior lateral setae present or absent.

Tarsal articles glabrous or sparsely hairy above, moderately setose beneath; article 4 emarginate; claws pectinate; male with articles 1 to 4 of front and middle tarsi bearing two rows of scales beneath.

Elytra completely margined basally and apically. Hind wings full or reduced.

Abdominal sterna 3 to 5 with a pair of medial setae; sternum 6 with one to four pair of anal setae (male with usually one less pair of setae than female); sterna 4 to 6 without long lateral setae.

Male genitalia on right side in repose, left paramere large; aedoeagus tube-like, with apical orifice opening slightly to left of midline of aedoeagus; endophallus unarmed.

Female styli of typical callidine form.

Discussion. - Some members of this genus are superficially very similar to certain of the species included in the genus *Callida* (for example *Philophuga viridis amoena* LeConte and *Callida purpurea* Say; and *Philophuga brachinoides* Bates and *Callida decora* Fab.), and can often be recognized only on the basis of the character presented in the key. Even in the

structure of tarsal article 4, *C. purpurea* very closely approaches the condition found in members of *Philophuga*. Perhaps when the species of *Callida* are studied in more detail, it will be found necessary to include *Philophuga* in *Callida*, as a subgenus (a parallel situation occurs in the two subgenera of *Plochionus* Weidemann which are separated by differences in the structure of tarsal article 4). However, in this study the status of *Philophuga* as a distinct genus is maintained

Distribution.- The species of *Philophuga* occur in the semi-arid and arid regions of western North America.

Key to the Species of *Philophuga* Motschoulsky

1. Pronotum rufous, contrasting with black head. *brachinoides* Bates, p. 30
- 1'. Pronotum and head concolorous, black with a metallic blue or green sheen. 2
- 2(1). Hind wings constantly full, membranous areas distinctly pigmented (fig. 23); hind angle of pronotum with a setiferous puncture 3
- 2'. Hind wings reduced, without reflexed apex, or if full, membranous areas not or only lightly pigmented; hind angle of pronotum with or without a setiferous puncture *viridis* Dejean, p. 34
- 3(2). Head and pronotum with metallic green lustre, contrasting with blue elytra, or elytra also green; elytral striae shallowly impressed; intervals flat, finely punctate. *viridicollis* LeConte, p. 31
- 3'. Head and pronotum with metallic blue or blue-green lustre, similar in color to elytra and not contrasting; elytral striae deeply impressed; intervals convex, finely to moderately coarsely punctate. *caerulea* Casey, p. 33

Philophuga brachinoides Bates 1883

Philopheuga rachinoides Bates 1883 - 202. *Type locality* - Cerro de Plumas, Veracruz (Selander and Vaurie 1962), Mexico. Blackwelder 1944 - 62 (*Philophuga*).

Description. - Values for ratios and measurements for five specimens are: TL 6.8-7.8 mm (7.2); LE/LP 2.70-2.86 (2.75); WP/LP 1.18-1.28 (1.24); WH₁/WH₂ 1.41-1.48 (1.45).

Color of prothorax, mesothorax, femora and antennal articles 1 to 3 and base of 4 rufous; remainder of body piceous to black with a metallic blue lustre.

Microsculpture obsolete on frons and disc of pronotum; strong on elytra, isodiametric medially, slightly stretched laterally.

Eyes prominent; post-ocular pinch faint. Genae strongly constricted behind, forming relatively narrow neck. Labrum broadly but shallowly emarginate. Clypeus micropunctate. Frons smooth and shiny medially, deeply but sparsely punctate posteriorly and laterally; frontal furrows short, deep, confluent punctate.

Prothorax (fig. 33) rounded laterally, sinuate before prominent though obtuse hind angles; front angles rounded, not or only slightly protruding; hind angle on each side bearing a setiferous puncture; disc glabrous, transversely rugose. Prosternum with very short fine setae. Metasternum with scattered moderately long fine setae.

Elytral striae clearly impressed medially on disc, effaced apically and in some specimens also laterally; discal striae finely punctate, punctures coarser basally and laterally; intervals

slightly convex, each bearing an irregular row of fine punctures. Wings full, densely pigmented.

Abdominal sternum 2 with a small medial patch of setae; remaining sterna with very short sparse setae; abdominal sternum 6 with two pairs of anal setae in male, and three pairs in female.

Aedoeagus elongate, slender. Female stylus as in fig. 54.

Discussion. - This species very closely resembles *Callida decora* Fab. in color. It is the only species of *Philophuga* with pale legs and thorax.

Distribution. - I have seen only five specimens of this species from the following locality (fig. 60).

MEXICO, Oaxaca, Rte. 190, 21.7 miles SE Nochixtlan, 7200'. March 24, 1966 (Ball and Whitehead, UASM).

Philophuga viridicollis LeConte 1848

Cymindis viridicollis LeConte 1848 - 188. *Lectotype* - (here selected) female, labelled as follows: green disc, *Glycia viridicollis* Lec., Type 5821 MCZ, *Philophuga viridicollis* (Lec.). *Philophuga subcordata* Chaudoir 1877 - 246. Holotype not seen. *Type locality* - "Mexique". *Philophuga purpurea* Chaudoir 1877 - 245, not Say 1823.

Description. - Values for ratios and measurements of 40 specimens are: TL 7.1-9.6 mm; LE/LP 2.77-3.13 (2.98); WP/LP 1.07-1.29 (1.19); WH₁/WH₂ 1.42-1.54 (1.47).

Color of head, pronotum and ventral parts of thorax and abdomen shiny metallic green or blue-green; elytra duller, blue or rarely in some specimens green; legs, epipleura and lateral portions of abdominal sterna piceous to black; antennae with articles 1 to 3 and base of 4 pale, at least on ventral side, outer articles black; palpi dark, with apex of terminal articles pale.

Microsculpture more or less effaced on head; lightly impressed and transverse on pronotum; finely granular on elytra, rarely slightly stretched.

Head with basal constriction gradual, neck evident; eyes prominent, convex. Labrum slightly emarginate. Clypeus smooth and shiny, irregularly and finely punctate; frons shiny, often with faint transverse rugae, sparsely but deeply punctate posteriorly and laterally; frontal furrows broad, poorly delimited, confluent punctate and longitudinally rugose; genae behind and below eyes with short sparse setae; labial palpus with terminal article very broadly dilated in male, less so in female.

Pronotum (fig. 31) narrow, broadest in apical third, rounded laterally with a faint sinuation before hind angle; hind angle obtuse and somewhat rounded, bearing a setiferous puncture; front angle rounded, slightly protruding; base clearly margined, at least laterally; prosternum and proepisternum sparsely punctate; prosternal punctures bearing very short fine setae. Metasternum punctate laterally, sparsely setose medially.

Elytra elongate, subparallel; striae fine, often only very faintly impressed apically, moderately punctate, punctures deeper and denser in basal half; intervals flat, with an irregular row of faint punctulae in each. Wings fully developed, strongly pigmented.

Abdominal sterna with fine setiferous punctures medially; abdominal sternum 6 with two pairs of anal setae in female and three pairs in male.

Male genitalia (fig. 15) with aedoeagus slightly arcuate dorsally; basal piece flattened, bent

somewhat to right. Female stylus as in fig. 51.

Variation. - No marked pattern of variation was noticed for this species. These characters were observed to vary within a single population sample: shape of the pronotum, microsculpture of frons and pronotum, and the depth of the elytral striae. The color of the head and the pronotum varies from metallic green to blue-green, but remains sufficiently green to contrast conspicuously with the blue elytra. This color contrast is lost in the few specimens that possess greenish elytra. Color, however, is the most reliable character for separating *viridicollis* from the markedly similar *caerulea*.

Discussion. - I have seen two specimens of *viridicollis* from the following California localities: San Francisco (Hopping, CAS); Needles (CAS). As no specimens of this species have been seen from Arizona and western New Mexico, these specimens may have been accidentally mislabelled. The two species *viridicollis* and *caerulea* appear to be almost completely allopatric (see discussion under *caerulea*).

Notes on synonymy. - Say's (1823) original description of *Callida purpurea* and *C. viridipennis* (both originally assigned to *Cymindis*) stated that article 4 of the tarsus was bilobed for these two species, thereby confirming their position in *Callida*. However, Chaudoir (1877) applied the name *purpurea* Say to specimens of *Philophuga viridicollis* LeConte, and relegated the name *viridicollis* LeConte to synonymy. Horn (1882), after receiving identified specimens of *Philophuga* from Chaudoir, noticed this confusion and corrected it by placing *purpurea* Say in the genus *Callida*, and reinstating *viridicollis* in *Philophuga*. In the same paper, Horn suggested that *subcordata* Chaudoir was probably a synonym of *viridicollis* LeConte. Leng (1920) followed Horn's suggested synonymy, and although the type of *subcordata* Chaudoir has not been seen in this study, this synonymy is followed here.

Specimens of the species *viridicollis* LeConte and *caerulea* Casey have been confused with one another. LeConte's collection contains specimens of both of these species under the name *viridicollis*.

Distribution. - The species *viridicollis* is found in the southern Great Plains, from Kansas and eastern Colorado south into eastern New Mexico, Texas (excluding the Edwards Plateau), northeastern Mexico and possibly California – but see above (fig. 58). I have examined over 260 specimens of this species from the following localities:

United States - ALABAMA: one specimen labelled "Ala." (WUM). COLORADO: Otero Co., Rocky Ford (Hamilton, USNM). KANSAS: Ellsworth Co., (Martin, KUM); Kiowa Co., (Woodruff, KUM); Reno Co., (Hopping, CAS); Sumner Co., (USNM). NEW MEXICO: Lincoln Co., Ramon (Ball, UASM); Roosevelt Co., Portales (IUM), Water Canyon (Shaw, CU). OKLAHOMA: Oklahoma Co., Oklahoma City (Grant, CAS), Stillwater (Whitaker, MCZ). TEXAS: Atascosa Co., Pleasanton (White, CNHM); Bee Co., Beeville (Tucker, USNM); Bexar Co., San Antonio (CAS, CUM, USNM); Blanco Co., Cypress Mill (USNM); Brewster Co., Alpine (CAS, USNM), Big Bend Nat'l Park (Becker & Howden, CNC), Horse Canyon (Becker & Howden, CNC), Marathon (Malkin, CNHM); Brooks Co., Falfurrias (Beer, Martin, CAS, KUM); Cameron Co., Brownsville (Glick, USNM), Bruni (Martin, CAS), Childress Co., Childress (Mitchell, USNM); Comal Co., New Braunfels (CAS, MCZ, USNM); Culberson Co., Van Horn (Barr, IUM); Denton Co., Denton (Bishop, USNM); Duval Co., San Diego (USNM); Frio Co., Pearsall (Tucker, USNM); Hardeman Co., Quanah (Morrill, USNM); Hemphill Co., Canadian (Mann, USNM); Hidalgo Co., Edinburg (CUM, USNM); Jeff Davis Co., Davis Mts. (CAS), Ft. Davis (Ball, CAS, UASM); Karnes Co., Kenedy (Marlatt, USNM); Kerr Co., Kerrville (Becker & Howden, CNC); Kleberg Co., Kingsville (Reed, CUM); LaSalle Co., Cotulla (USNM); Lubbock Co., (Manis, IUM); Nueces Co., Corpus Christi (CNHM, USNM); Presidio Co., Marfa (Scullen, Wickham, MCZ, OUM, USNM); Randall Co., Canyon (Stephenson, KUM); Terrell Co., Dryden (Ball, UASM), Sanderson (Martin, Mason, CAS, CNC); Travis Co., Austin (Darlington, Martin, Pinkus, CAS, MCZ, USNM); Uvalde Co., Sabinal (Pratt, USNM), Uvalde

(CAS, CNC, USNM); Val Verde Co., Comstock (Barr, IUM), Del Rio (CAS, CNC, USNM), Devils River (Schwarz, USNM); Victoria Co., Victoria (USNM); Ward Co., Monahans (Larson, UASM); Webb Co., Laredo (Martin, Werner, CAS, UASM).

Philophuga caerulea Casey 1913

Philophuga caerulea Casey 1913 - 174. *Holotype* - female labelled as follows: Ariz., Casey bequest 1925, Type USNM 47668, *caerulea* Casey.

Calleida viridis Chevrolat 1825 - 155 (not Dejean 1831). *Type locality* - Las Vigas, Veracruz, Mexico.

Description. - Values for ratios and measurements for ten specimens from Arizona are: TL 7.46-9.02 mm (8.36 mm); LE/LP 2.73-3.07 (2.94); WP/LP 1.12-1.26 (1.18); WH₁/WH₂ 1.44-1.57 (1.49).

Color of dorsal surface uniformly metallic blue or greenish-blue; head and pronotum more shining than elytra but of about the same hue; epipleura rufo-piceous; legs piceous to black; antennal articles 1 to 3 and base of 4 pale, at least on ventral side, outer articles black; palpi dark with apices of terminal articles paler.

Microsculpture obsolete on frons and disc of pronotum; on elytra isodiametric and finely granular medially, slightly stretched laterally.

Head as in *viridicollis*; short sparse setae present on genae behind and below eyes.

Pronotum (fig. 32) varied in shape with seta present near each hind angle. More constricted basally than in specimens of *viridicollis*, with a longer more evident lateral sinuation; posterior lateral impressions slightly broader; lateral reflexion narrower.

Elytral striae clearly impressed, moderately punctate; intervals slightly convex, distinctly punctate, punctures stronger than in *viridicollis*. Hind wings fully developed; distinctly pigmented (fig. 23).

Male genitalia as in fig. 16. Female stylus similar to that of *viridicollis*.

Variation. - Size was the only character observed to vary geographically. Specimens from the southeastern portion of the range of *caerulea* tend to be noticeably smaller than specimens from other populations. The mean length for a sample of five specimens from Las Vigas, Veracruz, was 6.92 mm (range 6.74-7.22 mm), while the mean of a sample of ten specimens from Arizona was 8.36 mm (range 7.46-9.02 mm). Too few specimens from intermediate localities were available to determine if this variation was clinal.

Discussion. - *Philophuga caerulea* strongly resembles *viridicollis*, and differs little from this species aside from the characters presented in the key. In the United States, these two species are allopatric and are readily separated from one another. However, in Mexico the distributions are too incompletely known to determine if this geographical separation is maintained. A specimen from Monterrey, and two specimens from Monclova, Mexico, resemble *viridicollis* in color, but *caerulea* in the convexity of the elytral intervals and the depth of the striae. Perhaps when more specimens are available from Mexico, it will be necessary to treat these two species as well marked subspecies.

Distribution. - I have examined 92 specimens of this species from the following localities (fig. 58):

Mexico - AQUASCALIENTES: Aquascalientes (Hendrichs); CHIHUAHUA: Chihuahua (Wickham, MCZ); COAHUILA: Monclova (Schwarz, USNM); JALISCO: Guadalajara (MCZ, UASM); MEXICO: Lerma (Ball, UASM); Presa

del Angulo (Hendrichs); Toluca (Bowditch, MCZ); Valle de Bravo (Hendrichs); NUEVO LEON: Monterrey; PUEBLA: Tlachichuca (Ball, UASM); TAMAULIPAS: "Mesa Gonzales" (= Gonzales) (CAS); VERACRUZ: Las Vigas (Hoege, MCZ, USNM); ZACATECAS: Sombrerete (Evans, UASM).

United States - ARIZONA: Cochise Co., Huachuca Mts. (CAS, USNM); Tombstone (UASM); Gila Co., Pinal Mts. (USNM); Santa Cruz Co., Nogales (CAS, CNHM); Patagonia (CNHM, MCZ); Sonoita (CAS, KUM); Sta. Rita Mts. (CAS, MCZ, UASM).

Philophuga viridis Dejean 1831

Cymindis viridis Dejean 1831 - 325. *Type locality* - California. Holotype not seen. Motschoulsky 1859 - 144 (*Philophuga*); Horn 1882 - 144 (*Philophuga*); Leng 1920 - 67. Hatch 1953 - 157 (not Chevrolat 1835 - 155).

This is the most varied species of *Philophuga*, containing four well defined subspecies. Characteristics common to all subspecies of *viridis* are presented in the following description.

Description. - Values for ratios and measurements are presented separately under each of the following four subspecies.

Color varied, ranging from dull black with a faint metallic blue sheen to bright metallic blue or green; palpi, legs and outer antennal articles piceous to black; antennal articles 1 to 3 and base of 4 pale, at least on ventral surface.

Microsculpture varied; effaced on frons and disc of pronotum in many specimens; isodiametric or slightly transverse on elytra, faintly impressed to granular.

Dorsal surface of body glabrous or setose; frons and disc of pronotum punctate.

Pronotum varied in shape; with or without a seta near each hind angle.

Elytra relatively short, oval, with greatest width in apical half. Hind wings varied in development, with reflexed apex or reduced to a small scale; when fully developed, membranous areas only lightly pigmented.

Male genitalia with aedeagus short, slightly arcuate; basal piece curved (fig. 17).

Female stylus as in figs. 52 and 53.

Geographical variation and subspecies. - The species *Philophuga viridis* Dejean ranges widely in the semi-arid and cold desert regions of western North America, from the prairies of southern Canada west to Washington and Oregon, and south to northern New Mexico, Arizona, and California. Over this range, color, vestiture, wing development, and the presence of the posterior-lateral prothoracic setae vary. Data on variation in these characters is summarized in a pie diagram map (fig. 1) and in table 2. Four subspecies are recognized, based on variation in these characters.

On the eastern side of the Rocky Mountains, and in British Columbia, Washington, and northern Oregon, populations possessing the following characteristics occur: the posterior-lateral setae of the prothorax are absent; the wings are fully developed; the dorsal surface of the body is glabrous; and the color is a dark blue-black. Associated with the absence of the posterior-lateral setae, the pronotum tends to be less sinuate laterally, with more obtuse hind angles than in specimens that possess the setae. The name *viridis amoena* LeConte applies to specimens with these characteristics.

To the west of the Rocky Mountains, a population centering around the Great Basin occurs. This subspecies, *v. horni* Chaudoir, differs from the neighboring *v. amoena* by possessing a posterior-lateral seta on each hind angle of the pronotum, and by being bright metallic green or blue in color. The hind angles of the pronotum are more distinct than in *v.*

amoena and the lateral margins are more sinuate posteriorly.

TABLE 2. List of localities from which specimens of *Philophuga viridis* Dejean were used to compile pie-diagram map (fig. 1).

Map symbol	Locality	No. of specimens
A	Southern British Columbia	4
B	Southern Alberta	24
C	Southern Saskatchewan	3
D	Southern Manitoba	15
E	Valley Co., Montana	1
F	Lake Co., Montana	1
G	Lewis & Clark, and Missoula Cos., Montana	11
H	Musselshell Co., Montana	1
I	Gallatin Co., Montana	6
J	Bighorn Co., and Yellowstone National Park, Wyoming	6
K	Carbon and Laramie Cos., Wyoming	4
L	Delta and Garfield Cos., Colorado	2
M	Boulder, Jefferson, and Larimer Cos., Colorado	5
N	Chaffee, El Paso, Park and Teller Cos., Colorado	8
O	La Plata Co., Colorado	2
P	Sapello, San Miguel Co., New Mexico	1
Q	Coconino Co., Arizona	7
R	Washington Co., Utah	1
S	Soldier Summit, Utah Co., Utah	1
T	Touele Co., Utah	12
U	Esmeralda Co., Nevada	2
V	White Pine Co., Nevada	1
W	Washoe Co., Nevada	13
X	Humbolt Co., Nevada	1
Y	Ada, Canyon, Owyhee, and Payette Cos., Idaho	8
Z	Blaine, Cassia, Lincoln, Twin Falls Cos., Idaho	13
a	Bannock and Lake Cos., Idaho	2
b	Clark and Lemhi Cos., Idaho	2
c	Adams and Nez Perce Cos., Idaho	4
d	Grant Co., Washington	3
e	Seattle, Washington	2
f	Wasco Co., Oregon	3
g	Baker Co., Oregon	16

TABLE 2. (cont.).

Map symbol	Locality	No. of specimens
h	Harney, Lake, and Malheur Cos., Oregon	10
i	Klamath Co., Oregon	5
j	Jackson Co., Oregon	3
k	Yreka, California	1
l	Lassen, and Modoc Cos., California	8
m	San Francisco, California	<u>96</u>
	TOTAL	308

Although *amoena* and *horni* are consistent in their characters over the major portion of their respective ranges, two areas of intergradation occur; along the Rocky Mountains, and in the northwestern states. In the Rocky Mountains intergradation is most pronounced around low passes. I have seen two typical specimens of *amoena* from Pocatello and Salmon, Idaho. A specimen from Dubois was colored like *horni* but lacked the posterior-lateral prothoracic setae. All other specimens seen from Idaho were typical *horni*. Some specimens from the eastern side of the continental divide in southwestern Montana and northwestern Wyoming show *horni* characteristics. One of the six specimens seen from Gallatin Co., Montana, possessed posterior-lateral pronotal setae. One specimen of the six seen from Yellowstone National Park had the coloration of *horni*.

A similar situation in which the mountains do not form a complete barrier to genetic interchange, occurs in western Colorado and eastern Utah. On the eastern slopes of the Rocky Mountains in Colorado, some specimens of *amoena* show a brighter metallic blue or green coloration, most obvious along the frontal grooves of the head and the lateral margins of the prothorax. Specimens from localities to the south and west in Colorado show a higher incidence of bright coloration until all specimens seen from Utah, Arizona and New Mexico show the *horni* coloration. The posterior-lateral prothoracic setae tend to be absent from populations of *horni* colored beetles in eastern Utah, western Colorado and in New Mexico. Some specimens of *horni* from as far west as Salt Lake City, Utah, lack these setae even though the pronotum has the characteristic shape for *horni*. In this region, the bright coloration of *horni* seems to pass through or around the southern Rocky Mountains and occurs with limited frequencies in populations on the eastern slopes of the mountains. The *amoena* characteristic, the absence of the posterior-lateral pronotal setae, tends to occur in populations of *horni* as far west as Toule Co., Utah.

The situation in the northwestern states is similar. The subspecies *amoena* is found in the north and western portions of Washington and Oregon. One of the four specimens I have seen from southern British Columbia is typical *horni* while the remaining specimens are *amoena*. Even more surprising are two specimens of *horni* labelled Seattle, Washington (O.B.J.), while all other Washington specimens may be assigned to *amoena*. On the validity of O.B. Johnson's labels, Hatch (1950, p. 21) stated "But if he (O.B. Johnson) believed that

a given species occurred in the vicinity of Seattle, he would not hesitate, according to Professor Kincaid, to put a Seattle label on any specimen that came to hand regardless of its exact point of origin." However, a specimen with *horni* characteristics from southern British Columbia does not permit me to discount the possibility that *horni* does occur in the Seattle region. Hybrid specimens have been seen from Baker and Wasco Counties, Oregon.

The separation of *amoena* and *horni* may be primarily ecological. Specimens of *amoena* are found on short-grass prairie in southern Alberta, and seem to occur in regions where grassland is prevalent. The subspecies *horni* seems to be found in regions of desert scrub vegetation.

The third subspecies, *v. klamathea* new subspecies, is known from only a small area in south-central Oregon and northern California. In coloration and the shape of the pronotum (the posterior-lateral setae are present), this subspecies resembles *horni*. However, it is readily distinguished from the latter by the presence of sparse vestiture on the dorsal surface of the body and by the reduced hind wings which are represented by no more than small scales. On the basis of these two characters, *klamathea* is quite distinct from *horni*. Nevertheless some introgression does occur. One macropterous specimen was collected along with four micropterous beetles in a series from Klamath Co., Oregon. All specimens from the neighboring Lake Co. to the east are macropterous but some specimens show traces of fine vestiture on the elytral intervals and on the genae below the eyes (such specimens have been scored as being glabrous in pie-graph map (fig. 1). The subspecies *klamathea* does not show any signs of intergrading with *amoena* to the north.

The fourth subspecies, *v. viridis* Dejean, appears to be isolated in the vicinity of San Francisco Bay and Sonoma Co., California. Its characteristics are: hind wings reduced to a small scale; vestiture present on dorsum; color black to dull blue-black, rarely bright blue or green; posterior-lateral setae of pronotum absent from most specimens (94%); however, the lateral margin of the thorax is sinuate and the hind angles are distinct though obtuse. The basal border of the elytra tends to be more sinuate internally in micropterous than in macropterous specimens. Also, this situation is usually stronger in *viridis s. str.* than in *klamathea*. These two subspecies also differ in some characteristics of the elytral striae and microsculpture. These differences are described below.

The geographically isolated position of *v. viridis* in conjunction with the differences mentioned above, suggest that *viridis* and *klamathea* may actually be specifically distinct. However, some instability in the diagnostic characters of color and the presence of the posterior-lateral pronotal setae cause me to consider these populations to be conspecific, at least until better evidence to the contrary is discovered.

Key to the Subspecies of *Philophuga viridis* Dejean

1. Hind wing reduced, much shorter and narrower than a single elytron 2
- 1'. Hind wing full, with reflexed apex 3
- 2(1). Hind angle of pronotum lacking setiferous puncture in most specimens (fig. 37); elytral striae finely impressed, outer striae often obsolete and represented by a row of fine punctures *v. viridis* Dejean, p. 38
- 2'. Hind angle of pronotum with a setiferous puncture (fig. 36); elytral striae clearly im-

- pressed, outer striae distinct almost to apex. *v. klamathea* new subspecies, p. 40
 3(2). Hind angle of pronotum with a setiferous puncture (fig. 35). . . *v. horni* Chaudoir, p. 41
 3'. Hind angle of pronotum without a setiferous puncture (fig. 34)
 *v. amoena* LeConte, p. 42

Philophuga viridis viridis Dejean 1831

Cymindis viridis Dejean 1831 - 325. *Type locality* - California. Type specimen not seen (not Chevrolat 1835 - 155).

Callida cyanea Motschoulsky 1850 - 36. *Type locality* - San Francisco, California. Type specimen not seen.

Philophuga lauta Casey 1913 - 175. *Holotype* - male, labelled as follows: Cal., Casey bequest 1925, Type USNM 47670, *lautae* Csy. New Synonymy.

Description. - Values for ratios and measurements of fifty-two specimens are: TL 5.7-7.5 mm (6.8 mm); LE/LP 2.39-2.80 (2.59); WP/LP 1.10-1.29 (1.21); WH₁/WH₂ 1.41-1.54 (1.46).

Color dark, ranging from dull black to metallic blue or green; palpi and legs dark piceous to black; abdomen piceous to black.

Microsculpture varied; isodiametric to slightly transverse on frons, obsolete in many specimens; on disc of pronotum lightly impressed, transverse; isodiametric, faintly impressed to granular on elytra.

Body setose dorsally; evident setae present on frons behind and below eyes, on disc of pronotum and on at least odd numbered elytral intervals.

Head broad, genae broadly rounded laterally; postocular pinch faint; frons with setiferous punctures best developed posteriorly and laterally, also micropunctate.

Pronotum varied (fig. 37); lateral margins rounded, each with a long sinuate posterior constriction; sides subparallel or slightly converging behind; front angles rounded, slightly protruding; hind angles prominent but obtuse; most specimens without posterior lateral setae (setae present in 6% of specimens examined); lateral margin narrow, widening toward hind angles; disc with sparse setiferous punctures, deeper and denser posteriorly and laterally.

Elytra relatively short, oval, with greatest width in apical half; shoulders broadly rounded, basal margin with strong anterior convexity; striae lightly impressed, finely punctate, outer striae often incomplete before apex, stria 8 represented by a row of punctures in many specimens; intervals flat to slightly convex, with an irregular row of small punctures in each. Hind wings reduced, represented by a small scale.

Abdominal sterna sparsely and finely setose; sternum 6 bearing one pair of anal setae in the male or two pairs in the female.

Male genitalia (fig. 17) with aedoeagus short, apex short; basal piece strongly curved.

Female stylus as in fig. 52.

Distribution. - Localities from which specimens of this subspecies have been collected are indicated in fig. 59. I have examined 96 specimens of this subspecies from the following localities:

CALIFORNIA: Alameda Co., Grizzly Peak (Van Dyke, CAS); San Francisco Co., Lake Merced (Van Dyke, CAS), San Francisco (Blaisdell, Van Dyke, CAS, MCZ, USNM); Sonoma Co., Eldridge (CAS, USNM).

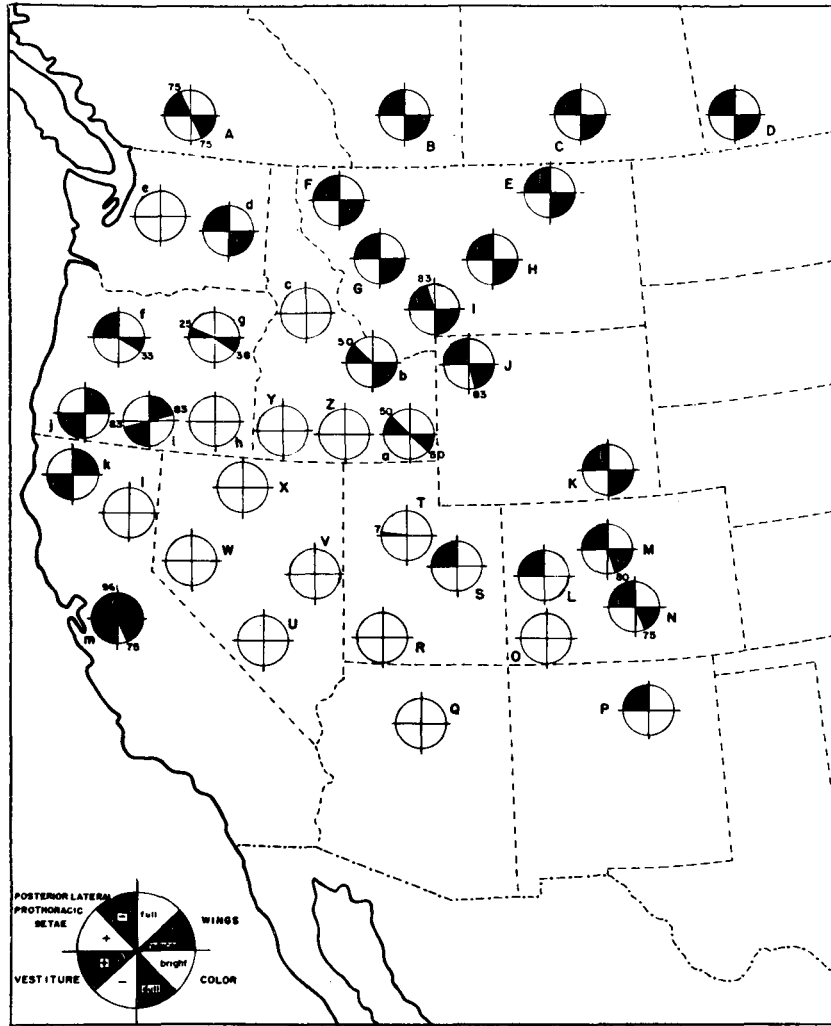


Fig. 1. Pie-diagram map illustrating geographic variation in four characteristics: wing development; color; vestiture; and presence of posterior-lateral prothoracic setae, of selected population samples of *Philophuga viridis* Dejean. A number external to a quadrant, indicates the percentage of specimens of that sample that show the black phase of the character. Localities represented by each pie-diagram are listed in Table 2.

Philophuga viridis klamathea new subspecies

Holotype - male, Klamath Falls, Oregon (Van Dyke, CAS).

Allotype - female, Medford, Oregon (USNM).

Paratypes are from the following localities:

CALIFORNIA: "Cal." (MCZ, WUM); Siskiyou Co., Yreka (USNM); OREGON: "Or." (USNM); Jackson Co., Ashland (Stephen, OUM), Coolestine (Bishop, OUM), Medford (USNM); Klamath Co., (CNHM).

The diagnostic characteristics of this subspecies are presented in the key and in the discussion of variation under *Philophuga viridis*.

Description. - Values for ratios and measurements of ten specimens are: TL 6.56-8.00 mm (7.03 mm); WP/LP 1.16-1.29 (1.22); WH₁/WH₂ 1.37-1.50 (1.45).

Color bright metallic blue or green. Antennal articles 1 to 3 and base of 4 pale, outer articles black.

Microsculpture highly effaced on head and pronotum, these areas shiny; irregularly isodiametric or faintly stretched on elytra, lightly impressed and shiny in many specimens.

Body setose dorsally. Setae evident on head behind and below eyes; on disc of pronotum most conspicuous along posterior-lateral margins; on disc of elytra forming an irregular row in at least odd numbered intervals. Ventral portions of body also with short evident setae.

Shape of head similar to *v. horni*; eyes convex, neck evidently constricted.

Pronotum as in fig. 36, but in some specimens somewhat narrower with sides more strongly constricted behind; differing from *v. viridis* by narrowness with greater lateral sinuation; posterior-lateral angles each bearing a setiferous puncture.

Elytra oval, narrowed basally; basal margin strongly sinuate; striae clearly impressed on disc, outer striae evident almost to apex, strongly punctate; intervals varied, flat to convex, deeply punctate.

Male genitalia similar in shape to that of *v. viridis*. Female stylus as in fig. 53.

Variation. - The following characteristics were observed to vary; shape of pronotum; density of vestiture; microsculpture, and depth of impression of elytral striae. As few specimens of this subspecies were available, I was unable to determine the pattern of variation in any of these characters. Variation was most evident among specimens from localities near the periphery of the range of *klamathea*, indicating that hybridization with *horni* may in part at least be responsible for this variation.

Relationships. - This subspecies is intermediate between *viridis s. str.* and *horni* in the diagnostic characters presented in fig. 1. However, on the basis of its peculiar combination of characteristics, and the apparently isolated geographical position it occupies, I chose to recognize this form as a subspecies.

Etymology. - This name is the latinized form of part of the name of the type locality - Klamath Falls, Oregon.

Disposition of type material. -The holotype has been deposited in the California Academy of Sciences. The allotype is in the United States National Museum. Paratypes have been deposited in the Chicago Natural History Museum (4 specimens), Museum of Comparative Zoology (1), Oregon State University (2), United States National Museum (2) and the University of Washington (3).

Distribution. - *Philophuga viridis klamathea* is known only from southwestern Oregon and

northern California (fig. 59).

Philophuga viridis horni Chaudoir 1877, new combination

Philophuga horni Chaudoir 1877 - 245. *Type locality* - Nevada.

Philophuga uteana Casey 1924 - 92. *Holotype* - male, labelled as follows: Stockton, Utah, IV/7/04, Tom Spalding, Casey bequest 1925, Type USNM 47673, *uteana* Csy. New Synonymy.

Philophuga cobaltina Casey 1924 - 91. *Holotype* - male, labelled as follows: Trout Creek Juab Co., Utah, VII/4/22. Tom Spalding, Casey bequest 1925, Type USNM 47672, *cobaltina* Csy. New Synonymy.

Description. - Values for ratios and measurements of ten specimens are: TL, 7.02-8.24 mm (7.58 mm); LE/LP, 2.77-2.93 (2.83); WP/LP, 1.21-1.27 (1.24); WH₁/WH₂, 1.38-1.50 (1.45).

Color shiny metallic blue or green. Antennal articles 1 to 3 and base of 4 pale, outer articles black.

Microsculpture absent or highly effaced on head and pronotum; strong on elytra, isodiametric medially showing tendency to become stretched and arranged in transverse rows laterally.

Body glabrous dorsally; even head below eyes without setae.

Head with eyes large, strongly convex; genae constricted posteriorly forming evident neck.

Pronotum as in fig. 35; lateral margin with long sinuation towards hind angle; hind angles prominent though somewhat obtuse, each bearing a setiferous puncture.

Elytra with greatest width in apical half but not strongly narrowed basally; basal border only slightly sinuate; elytral striae clearly impressed, moderately to coarsely punctate; intervals slightly to strongly convex, finely to coarsely punctate. Hind wings fully developed.

Male with three, female with two pair of anal setae on abdominal sternum 6.

Male genitalia similar to that of *v. viridis*. Female stylus as in *v. klamatheae*.

Distribution. - This subspecies occurs throughout the Great Basin province, and extends a little outside of this region especially in the north (fig. 59). I have seen more than 90 specimens from the following localities:

United States - ARIZONA: Coconino Co., Flagstaff (USNM), Pinal Mts. (CU), Williams (Wickham USNM). CALIFORNIA: Lassen Co., Bridgeport (Wickham, USNM), Hallelujah Junction (Westcott, UASM), Susanville (Martin, CAS), Modoc Co., Davis Creek (Fox, CAS), Hackmore (Van Dyke, CAS). COLORADO: La Plata Co., Pagosa Springs (Bowditch, MCZ); IDAHO: Ada Co., Nampa (Barr, IUM), Regina (Barr, IUM); Adams Co., Martin (Houk, WUM), Mesa (IUM); Bear Lake Co., Bear Lake (AMNH); Blaine Co., Carey (Hewitt, IUM), Crystal Ice Cave (Westcott, IUM), Magic Reservoir (Barr, IUM); Canyon Co., Caldwell (Barr, IUM), Parma (WUM); Cassia Co., Elba-Basin Pass (Stecker, SJSC), Malta (Henry, IUM), Rupert (Shull, IUM); Clark Co., Dubois (Penrose, UASM); Lincoln Co., Richfield (Barr, IUM); Nez Perce Co., Lewiston (Shull, IUM, USNM); Owyhee Co., Bruneau (Fillmore, IUM), Jordan Valley (Henry, IUM), Reynolds (Hewitt, IUM); Payette Co., Payette (Shull, IUM); Twin Falls Co., Hollister (Fox, IUSNM), Twin Falls (Homan, IUM). NEVADA: Esmeralda Co., Lida (O'Brien, UASM); Humboldt Co., Winnemucca (Barr, IUM); Washoe Co., Reno (Wickham, CAS, MCZ, USNM), Steamboat Springs (Van Dyke, CAS), Verdi (Blaisdell, CAS); White Pine Co., Ely (Van Dyke, CAS). OREGON: Baker Co., Baker (Van Dyke, CAS, WUM), Durkee (WUM), Pleasant Valley (Fender, WUM), Sparta (Van Dyke, CAS), Wallowa Mts. (Van Dyke, CAS), Harney Co., Frenchglen (Malkin, WUM), Tencent Lake (Malkin, CNHM, WUM); Lake Co., Hart Mtn. Antelope Refuge (Nelson, OUM); Malheur Co., Harper (OUM), Rome (CAS, OUM). NEW MEXICO: San Miguel Co., Sapello (Ball, UASM); UTAH: Towelee Co., Stanisbury I. (USNM), Stockton (Spalding, CAS, MCZ); American Fork (H & S, USNM); Washington Co., St. George (AMNH). WASHINGTON: King Co., Seattle (O.B.J., WUM).

Philophuga viridis amoena LeConte 1848, new combination

Cymindis amoena LeConte 1848 - 188. *Lectotype* - (here selected) female, labelled as follows: green disc, *amoena* LeC., Type 5822 MCZ, *P. amoena* (LeC.).

Philophuga canora Casey 1913 - 174. *Holotype* - female, labelled as follows: Tex., Casey bequest 1925, Type USNM 47669, *canora* Csy. New Synonymy.

Philophuga puella Casey 1913 - 176. *Holotype* - male, labelled as follows: Boulder Co., Colo., Casey bequest 1925, Type USNM 47671, *puella* Csy. New Synonymy.

Philophuga obscura Casey 1924 - 91. *Holotype* - female, labelled as follows: N.Y., Casey bequest 1925, Type USNM 47674, *obscura* Casy. New Synonymy.

Description. - Values for ratios and measurements of ten specimens are: TL 7.20-8.32 mm (7.52 mm); LE/LP, 2.68-2.90 (2.80); WP/LP, 1.18-1.24 (1.21); WH₁/WH₂, 1.28-1.46 (1.40).

Color black (elytra piceous in some specimens) with a dull metallic blue sheen on disc of pronotum and elytra; very rarely with faint blue-green sheen, usually restricted to frontal furrows and lateral margins of pronotum. Antennae with articles 1 to 3 and base of 4 pale, at least ventrally.

Body glabrous dorsally; glabrous even laterally behind and below eye.

Head broad; eyes flattened, somewhat reduced; neck broad. Antennae with outer articles relatively short and stout.

Pronotum (fig. 34) convex; sides slightly rounded and only shallowly sinuate posteriorly; hind angles broadly rounded and lacking setiferous puncture on each side; front angles rounded, not or only slightly protruding; lateral margin narrowly and uniformly reflexed.

Elytra relatively convex, elongate oval, with greatest width in apical third; shoulders broad, basal border slightly sinuate interiorly; striae finely impressed, finely to moderately punctate; intervals faintly convex basally, flat apically, sparsely and finely punctate.

Abdominal sternum 6 with one pair of anal setae in male, and two pairs in female.

Male genitalia as in *v. viridis*.

Female stylus as in the other subspecies of *viridis*.

Variation. - Hybridization between *v. amoena* and *v. horni* has been discussed above. Some variation has been observed in the eastern portion of the range of *amoena*. Here, hybridization with *horni* would not occur.

Only a single female specimen has been seen from Kansas. It differs from the more typical western and northern specimens of *amoena* by a greenish-blue cast dorsally, and by a strongly rounded pronotum with a strong lateral reflexion, narrow anteriorly and broadening behind. The single female specimens seen from Nebraska has a normally proportioned pronotum, but the elytral striae are rather coarsely punctate, and the elytral intervals are convex and coarse punctate.

Distribution. - This species occurs primarily on the Great Plains east of the Rocky Mountains, and along the northern periphery of the Great Basin (fig. 59).

Canada - ALBERTA: Lethbridge (Larson, UASM); Lost River nr. Onefour (Larson, UASM); Medicine Hat (Carr, Pepper, CAS, CNC, CU, UASM); Milk River (Pepper, CNC); Ralston (Ball, UASM); Taber (White, DAL). BRITISH COLUMBIA: Mts. between Hope and Okanagan (Bowditch, MCZ); "Van." (= Vancouver?) (MCZ). MANITOBA: Aweme (Criddle, White, AMNH, CAS, CNC, CU, DAL, USNM); Brandon (AMNH, USNM); SASKATCHEWAN: Cypress Hills (Ball & Lindroth, UASM); Roche Percee (Criddle, CNC); Saskatoon (McMillan, CNC).

United States - COLORADO: Boulder Co., Nederland (Stainer, CNC); Chaffee Co., Buena Vista (Wickham, USNM); Delta Co., Paonia (Van Dyke, CAS); El Paso Co., Colorado Springs (Soltau, Wickham, MCZ, USNM); Garfield Co.,

Glenwood Springs (AMNH); Jefferson Co., Denver (Soltau, USNM); Mesa Co., Grand Junction (Titus, USNM); Park Co., Trout Creek Pass (Beamer, KUM), Wilkerson Pass (White, KUM); Teller Co., Florissant (Bowditch, MCZ). IDAHO: Bannock Co., Pocatello (Bruner, USNM); Lemhi Co., Salmon (Wakeland, IUM); KANSAS: "Ks." (MCZ); MONTANA: Gallatin Co., (MUB); Lake Co., (MUB); Lewis and Clark Co., Helena (many collectors, CAS, MCZ, USNM); Missoula Co., Missoula (MUB); Musselshell Co., (MUB); Valley Co., Hinsdale (MUB); NEBRASKA: "Neb." (MCZ); OREGON: Wasco Co., Maupin (Van Dyke, CAS), Warm Springs Indian Reserve (WUM); WASHINGTON: Grant Co., Dry Falls (Burnes, WUM), Grand Coulee (MCZ), Soap Lake (Hatch, WUM); WYOMING: Bighorn Co., Bighorn Mts. (Edwards, SJSC); Carbon Co., Rawlins (AMNH); Laramie Co., Cheyenne (Soltau, USNM); Yellowstone National Park (Hatch, Van Dyke, CAS, WUM).

Infernophilus new genus

Type species. - *Philophuga castanea* Horn 1882, here designated.

The species *I. castaneus* Horn was described originally as a member of the genus *Philophuga*, but it differs in several important details from the other species included in that genus. Further, this species cannot be included in any other known callidine genus. For these reasons, the genus *Infernophilus* is established to include *castaneus*.

The most striking external features of this genus are indicated in the preceding key. Another remarkable feature is the orientation of the male genitalia. In repose, the aedoeagus is on its left instead of on its right side; the latter is the usual position among the members of the Lebiini. Associated with this, the parameres are reversed. They are of the typical form for the Callidina, but the large paramere is on the right rather than on the left side of the aedoeagus. Also, the apical orifice opens dorso-laterally to the right. I know of no other North American callidine, or even lebiine, that shows a similar condition. As no intermediate stages are known between the normal and the reversed position of the genitalia, it seems plausible that the initial 180° rotation arose in a single step. Other modifications such as the reversal of the parameres and the shift of the apical orifice may have been secondary.

Etymology. - The name is derived from the Latin noun *infernus* - m., hell; and the Greek *philia* - fondness. The name refers to the hot desert region in which this insect is found.

Infernophilus castaneus Horn 1882

Philophuga castanea Horn 1882 - 144. *Type locality* - Kern Co., California. Leng 1920 - 67. Csiki 1932 - 1462.

Description. - Values for ratios and measurements for fourteen specimens are: TL 7.9-9.1 mm (8.6 mm); LE/LP 2.62-2.84 (2.74); WP/LP 1.07-1.25 (1.17); WH₁/WH₂ 1.46-1.56 (1.52).

Color brown; elytra and abdomen darker brown to piceous.

Microsculpture on frons isodiametric, but effaced on most specimens; obsolete on disc of pronotum; isodiametric on elytra, but partly effaced and shiny. Body sparsely setose above.

Head with eyes prominent, convex. Genae broad behind eyes, with faint postocular pinch; narrowing posteriorly to form an evident neck. Labrum slightly emarginate. Clypeus with a single seta on each side; sparsely punctulate medially. Frons with poorly defined rugose frontal furrows; sparsely punctate medially with deeper setiferous punctures posteriorly and laterally. Antennae with articles 1 to 3 and base of 4 sparsely hairy; remaining articles pubescent. Maxillary palpus with terminal article cylindrical. Labial palpus with penultimate article bisetose; terminal article securiform (narrower in female). Ligula bisetose. Mentum

with a prominent margined tooth.

Pronotum (fig. 30) varied in shape; lateral situation long, lateral margins subparallel toward base; hind angles obtuse, with setiferous puncture present; base slightly sinuate laterally; frontal angles broadly rounded, slightly protruding; posterior lateral impressions indistinctly limited and continuous with broad lateral grooves; lateral margins uniformly reflexed; disc transversely rugose laterally.

Tarsal articles sparsely hairy above, densely setose beneath; article 4 emarginate; basal article of middle and hind tarsi with faint median dorsal groove; claws pectinate; male with articles 1 to 3 of front tarsi and articles 1 and 2 of middle tarsus bearing two rows of scales beneath.

Elytra completely bordered both apically and basally; striae clearly impressed and well defined to apex, lightly punctate; intervals broadly convex, bearing small irregular setiferous punctures; odd-numbered intervals and apex of even numbered intervals with an irregular row of larger setiferous punctures. Hind wings fully developed.

Abdominal sternum 6 of male with a paired brush of setae along hind margin (fig. 27); in female brush reduced and in some specimens it is represented by as few as six pairs of moderate to long setae.

Male genitalia (figs. 21-22) with reversed parameres; endophallus with a field of short spines.

Stylus of ovipositor (fig. 57) short, broad; broadly rounded apically, sparsely setose.

Distribution. - I have examined fifteen specimens of this species from the following localities (fig. 61).

CALIFORNIA: Kern Co. (AMNH); Mono Co., Bridgeport (O'Brien, UASM, Coleville (O'Brien, CAS, DAO, UASM); San Diego Co., (USNM), NEVADA: (AMNH, USNM).

Biology. - Several specimens in a series taken at Coleville, California (July 6-10, 1966) were slightly teneral.

Tecnophilus Chaudoir 1877

Tecnophilus Chaudoir 1877 - 240. *Type species* - *Calleida croceicollis* Ménétriés 1843, here designated.

Philotecnus LeConte 1851 - 175, not Mannerheim 1837 - 42. *Type species* - *Philotecnus nigricollis* LeConte 1851 (= *T. croceicollis* Ménétriés), here designated.

This is a small genus closely related to *Philophuga*. Aside from the characters presented in the key to Callidina, the adults can be recognized on the basis of the cordate pronotum and the usually dense vestiture of the body.

Characteristics common to all species of *Tecnophilus* are given in the following description.

Description. - Beetles 5.7 to 8.0 mm in length. Color various, but elytra always metallic blue or green. Basal three articles of antenna similarly colored to outer articles.

Body variously punctate and setose dorsally; ventral portions of body moderately to densely setose.

Eyes prominent, of various convexity; hairy or glabrous. Labrum truncate apically with slight medial elevation. Frontal furrows shallow, broad, deeply punctate. Frons punctate.

Antennal articles 1 to 3 and base of 4 hairy; outer articles pubescent. Maxillary palpus with fusiform terminal article. Labial palpus with terminal article securiform; penultimate article bisetose. Ligula bisetose. Mentum with a prominent margined tooth.

Pronotum cordate, with strong posterior-lateral sinuations; lateral setae present; hind angles lacking setiferous punctures.

Tarsal articles slender; article 4 at most emarginate; hairy dorsally; tarsal claws simple (in some specimens may be minutely serrulate); articles 1 to 3 of front tarsi, and 2 and 3 of middle tarsi of male bearing two rows of scales beneath.

Elytra parallel sided or oval; completely margined both basally and apically; striae evident and punctate; intervals variously punctate. Hind wings fully developed.

Abdominal sterna 3, 4 and 5 with a pair of medial setae; sternum 6 with at most three pairs of anal setae; sterna 4 to 6 without long lateral setae.

Male genitalia on right side in repose. Left paramere large; right paramere smaller, bilobed apically. Aedoeagus simple, tube-like, with apical orifice opening somewhat laterally to the left; endophallus unarmed.

Female stylus with densely setose apex.

Discussion. - Chaudoir (1877) separated *Tecnophilus* from his Callidides on the basis of the structure of the ligula and paraglossae, and placed the genus in his Mimodromiides. However, Horn (1881) carefully studied the ligula and paraglossae of the Lebiini and concluded that they were of little value in defining groups of higher rank than the genus, and even here he suggested that they be used with caution. *Tecnophilus* is certainly a callidine in the sense used here.

Many of the peculiar features of *Tecnophilus*, such as the simple tarsal claws, slender tarsi, cordate pronotum and setose body, may be regarded as adaptations to a terrestrial mode of life.

Distribution. - The members of this genus are found in alkaline or saline situations in western North America.

Key to the Species of *Tecnophilus* Chaudoir

1. Apex of femur infuscated and contrasting with the otherwise rufous legs
 *pilatei* Chaudoir, p. 45
- 1'. Femur concolorous, rufous to black; or if femur rufous and infuscated apically, tarsi
 also infuscated *croceicollis* Ménétriés, p. 46

Tecnophilus pilatei Chaudoir 1877

Tecnophilus pilatei Chaudoir 1877 - 239. *Type locality* - Texas. Horn 1882 - 137. Leng 1920 - 67. Csiki 1932 - 1462.

Specimens of this species can be readily recognized by possession of the infuscated apices of otherwise rufous femora. Also, the elytral striae are much more coarsely punctate than in *croceicollis*.

Description. - Values for ratios and measurements of ten specimens are: LE 4.44-4.76 mm (4.56 mm); WP/LP 1.06-1.15 (1.10); WH₁/WH₂ 1.61-1.70 (1.65).

Color of head and thorax rufous; abdomen piceous medially, paler laterally; elytra metal-

lic blue or green, often with rufinistic background; antennae and palpi pale; legs pale except for conspicuous infuscated apical spot on femur.

Microsculpture obsolete on head; lightly impressed, transversely stretched on disc of pronotum; isodiametric but shallowly impressed on elytra.

Body densely pubescent, both dorsally and ventrally.

Head narrow, with temporal region strongly constricted; eyes very convex and protruding, glabrous.

Pronotum (fig. 38) narrow; sides slightly rounded laterally, relatively shallowly sinuate behind; front angles rounded, not protruding; hind angles obtuse, broadly rounded; lateral reflexion narrow.

Tarsal article 4 deeply emarginate, almost bilobed but not bearing dense setiferous pads beneath.

Elytra elongate, parallel sided; striae moderately impressed medially on disc, becoming obsolete laterally; striae with very coarse often confluent punctures, deepest in basal half but also evident apically; intervals flat; basal margin strongly sinuate internally; apex obliquely truncate and slightly sinuate.

Abdominal sternum 6 of male with two pairs of anal setae, with three pairs in female.

Male genitalia as in fig. 18; aedoeagus slightly arcuate, apex elongate.

Female stylus (fig. 55) with external apical angle greatly produced.

Relationships. - Specimens of the species *pilatei* superficially resemble Texas specimens of the species *croceicollis*. However, the strikingly different styli of the female ovipositor and the elongated apex of the male genitalia, associated with the external characteristics mentioned above, consistently separate specimens of these two species. The species *pilatei* is isolated from the *croceicollis* complex.

Distribution. - I have seen specimens of this species only from localities along the Gulf Coast of Texas (fig. 62). I examined 140 specimens from the following localities:

TEXAS: Aransas Co., Goose Island State Park (Larson, UASM), Brazori Co., Freeport (Evans, UASM); Cameron Co., Brownsville (UASM, USNM), Port Isabel (Ball, UASM), Cedar Lane (Shaw, KUM); Nueces Co., Corpus Christi (Hubbard & Schwarz, USNM).

Tecnophilus croceicollis Ménétériés 1843

Calleida croceicollis Menetries 1843 - 54. *Type locality* - California.

The most diagnostic characteristic of this highly variable species is presented in the preceding key to the species of the genus *Tecnophilus*.

Description. - Values for ratios and measurements of selected population samples are presented in tables 6 to 10.

Color highly varied; head and pronotum black to rufous with head always same color or darker than disc of pronotum; appendages black to rufous, femur uniformly colored, or if rufous and infuscated apically, tarsus and clypeus also infuscated; elytra black to piceous with metallic green, blue or purple sheen.

Vestiture varied, but even in least setose specimens setae present on head behind and below eyes, along lateral margins of pronotum and on at least odd numbered elytral intervals; dorsal vestiture of most specimens quite conspicuous.

Microsculpture obsolete on frons; on pronotum consisting of partially effaced transverse meshes; on elytra isodiametric but shallowly impressed and shiny on many specimens.

Head with neck variously constricted; eyes of various size and convexity (figs. 24 and 25).

Pronotum varied; more rounded laterally and more constricted behind than in *pilatei* (figs. 39-42).

Elytra with basal border shallowly sinuate; apex truncate or slightly sinuate; striae finely to moderately punctate, never as coarsely punctate as in *pilatei*.

Aedoeagus of male genitalia (figs. 19 and 20) short, arcuate, with short apex.

Female stylus (fig. 56) with apex truncate, not produced.

Geographical variation and subspecies. - The complex geographical variation displayed by this species makes it very difficult to organize the available population samples into well defined subspecies. Clinal variation occurs in several characteristics, and the general pattern of variation is discordant. Geographically terminal populations are comprised of individuals easily distinguished by distinctive combinations of characters, but specimens from intermediate areas are often difficult to associate with the terminal groups. However, as is shown below, it is possible to distinguish two groups of subspecific rank.

The pattern of variation of each character is described below, and this section is concluded with a summary of this information.

Color. - Over much of the range of *croceicollis*, the basic color pattern is as follows: elytra metallic blue or green; head, pronotum, and legs rufous; abdominal sterna piceous. However, considerable variation in color of each of these body parts occurs.

Data on variation in the color of the elytra among selected population samples of the species *croceicollis* are presented in table 3. Briefly, the color of the elytra varies in the following way: populations from the vicinity of San Francisco Bay, and from the Central Valley of California, possess dark blue or purple elytra; populations from southern California, Arizona, Nevada, and southern Utah generally have blue elytra, with a very small percentage of the specimens possessing greenish-blue or green elytra. The incidence of green elytra increases southwardly along the Gulf of California, and eastwardly through New Mexico, until green or blue-green is the predominant color in Texas populations. All specimens seen from Wyoming and Alberta show dark blue elytra. West of the Rocky Mountains in Idaho and northern Utah, the color of the elytra is highly varied.

Data on variation in the color of the head and pronotum are presented in tables 4 and 5. In specimens that show infuscation of the head and pronotum, the head is always the same color or darker than the disc of the pronotum. All specimens that have been seen from Mexico, and the United States from southeastern California east to Texas, and north to central Colorado, Utah, and Nevada, possess rufous heads and pronota. Specimens from the eastern side of the Rocky Mountains from northern Colorado to southern Alberta, possess black heads and pronota. I have not seen any specimens from Colorado that were intermediate between the black color of northern specimens, and the rufous color of specimens from southern localities. This suggests that no hybridization occurs between specimens belonging to these two different color classes in this region. However, west of the Rocky Mountains in Idaho and northern Utah, specimens of *croceicollis* are highly varied in color, with the color ranging from entirely black to rufous with only a light infuscation of the tarsi and the cly-

peus. This variability in color probably results from hybridization between the black members of the northern population, and rufous colored specimens which occupy the Great Basin. Similar variation in color occurs among populations in the Central Valley of California. Many specimens occurring around San Francisco Bay are black in color. Specimens from further inland tend to be paler, and specimens from the southern end of the San Joaquin Valley are almost as pale as specimens from the Mojave Desert. This evidence suggests that there is gene flow from the Mojave Desert, into the San Joaquin Valley.

TABLE 3. Geographical variation in color of elytra of *Tecnophilus croceicollis* Ménétriés.

Locality	Number of specimens	Purple	Blue	Blue-green	Green
Alberta	52	9	38	9	-
Wyoming	7	-	7	-	-
Idaho	5	1	1	2	1
San Francisco Bay, California	39	34	4	1	-
Central Valley, California	29	9	13	7	-
Cuddeback Lake, California	65	-	15	38	12
Arizona	32	-	13	18	-
Texas	38	-	1	12	25
Sinaloa, Mexico	8	-	-	-	8

TABLE 4. Geographical variation in color of head of *Tecnophilus croceicollis* Ménétriés.

Locality	Number of specimens	Black	Piceous	Rufous
Alberta	52	52	-	-
Wyoming	7	7	-	-
Idaho	5	2	3	-
San Francisco Bay, California	39	30	8	1
Central Valley, California	41	4	28	9
Cuddeback Lake, California	65	-	-	65
Arizona	32	-	-	32
Texas	38	-	-	38
Sinaloa, Mexico	8	-	-	8

TABLE 5. Geographical variation in color of pronotum of *Tecnophilus croceicollis* Ménétrés.

Locality	Number of specimens	Black	Piceous	Rufous
Alberta	52	52	-	-
Wyoming	7	7	-	-
Idaho	5	1	1	3
San Francisco Bay, California	39	9	16	14
Central Valley, California	41	1	4	36
Cuddeback Lake, California	65	-	-	65
Arizona	32	-	-	32
Texas	38	-	-	38
Sinaloa, Mexico	8	-	-	8

Vestiture. - Specimens from southeastern Alberta, and from southeastern California and the neighboring portion of Arizona, possess very short sparse setae. Over the remainder of the range of *croceicollis*, specimens are moderately setose, or in southern New Mexico and along the Rio Grande in Texas, specimens are very densely setose.

Measurements and ratios. - Five measurements were taken of specimens of *Tecnophilus croceicollis*. Various combinations of these measurements were made up to produce four ratios to map out the general shape of the insects and to quantify observed differences in habitus between members belonging to different populations of this species. Values for measurements and ratios of four population samples of the species *croceicollis* are presented in tables 6 to 10. Data are given for only four population samples, as these four are the only homogeneous samples available of sufficient size to yield statistically significant results. The analysis of variation which follows is based on these four samples.

Below, the pattern of variation shown by each of these characters is discussed separately.

Length of elytra (table 6). - This measurement is taken as giving an index of the size of the beetle. The largest specimens seen were from coastal localities (Brownsville, Texas, \bar{X} = 4.38 mm; Newark, California, \bar{X} = 4.21 mm). Specimens from intermediate inland localities were smaller (Cuddeback Lake, California, \bar{X} = 4.03) and the smallest specimens seen were from northern inland localities (Lost River Ranch, Alberta, \bar{X} = 3.73 mm).

Width of pronotum/length of pronotum (table 7). - The population sample with the highest mean value for this ratio is from Newark, California (\bar{X} = 1.22). The sample from Cuddeback Lake, California has the lowest mean value for this ratio (\bar{X} = 1.14). Population samples from Brownsville, Texas and Lost River Ranch, Alberta possess intermediate mean values, and do not differ significantly between themselves.

TABLE 6. Geographical variation in length of elytra (mm) among selected population samples of *Tecnophilus croceicollis* Ménétrés.

Locality	N	Range	Mean	S.E.	S.D.	C.V.%
Newark, Cal.	40	3.83 - 4.57	4.21	0.03	0.20	4.75
Cuddeback Lake, Cal.	64	3.64 - 4.48	4.03	0.03	0.22	5.71
Brownsville, Texas	20	3.92 - 4.77	4.38	0.06	0.25	5.71
S.E. Alberta	38	3.30 - 4.28	3.73	0.04	0.23	6.17

TABLE 7. Geographical variation in the ratio width of pronotum/length of pronotum among selected population samples of *Tecnophilus croceicollis* Ménétrés.

Locality	N	Range	Mean	S.E.	S.D.	C.V.%
Newark, Cal.	40	1.16 - 1.32	1.22	0.01	0.04	3.28
Cuddeback Lake, Cal.	64	1.06 - 1.25	1.14	0.01	0.04	3.51
Brownsville, Texas	20	1.15 - 1.23	1.18	0.01	0.02	1.69
S.E. Alberta	38	1.13 - 1.25	1.19	0.01	0.03	2.52

Length of elytra/length of pronotum (table 8). - The pattern of variation shown by this character is similar to the pattern of variation shown by the length of the elytra. The samples with the largest mean values are from coastal localities while samples from inland and northern localities possess smaller mean values for this ratio.

Width of pronotum/maximum width of head (table 9). - The pattern of variation in this character is similar to the pattern of variation shown by the character width of pronotum/length of pronotum. The sample from Newark, California possesses the greatest mean value for this ratio ($\bar{X} = 1.18$) while the sample from Cuddeback Lake, California has the smallest mean value ($\bar{X} = 1.10$). The means for the samples from southeastern Alberta and from Brownsville, Texas are identical in value to one another ($\bar{X} = 1.14$) and are intermediate between the mean values for the two California population samples.

Maximum width of head/minimum width of frons between eyes (table 10). - The sample with the largest mean value for this ratio is from Brownsville, Texas ($\bar{X} = 1.63$). This is followed in descending order by the samples from Cuddeback Lake, California ($\bar{X} = 1.54$), Newark, California ($\bar{X} = 1.45$), and southeastern Alberta ($\bar{X} = 1.41$). The value for this ratio becomes smaller for samples from east to west and from south to north.

The above five characters show several different patterns of variation. Because it is difficult to justify the weighting of any one of these characters above the other four in any given comparison of population samples, all characters were used simultaneously to develop discriminant functions to compare population samples with one another. For each comparison of a pair of population samples, a weight was calculated for each character used. The calculation was such that the value of the weight depended upon the discriminatory value of

the character in that comparison (see Stanley MS for details on calculation). That is, if a character can separate members of two populations consistently, that character has a higher weighting coefficient than a character that gives inconsistent separations.

For the sake of brevity in the following discussion the population samples used in the comparisons are designated alphabetically, as follows:

- A = Brownsville, Texas
- B = Cuddeback Lake, California
- C = Newark, California
- D = Lost River Ranch, Alberta

Not all possible combinations of population comparisons were made. The Brownsville, Texas population sample was not compared with the population sample from Newark, California because both of these populations were independently compared with the geographically intermediate population sample from Cuddeback Lake, California. Thus, the A versus C comparison was made indirectly. Similarly, an indirect comparison between Newark, California (C) and Lost River Ranch, Alberta (D) was made. The populations of *croceicollis* in the central valley of California appear to be effectively isolated to the north and east by the Klamath Mountains and Sierra Nevadas respectively. This means that any genetical connection between these two populations would have to be indirect, through southern California. For this reason, the population sample from Cuddeback Lake was also taken as being intermediate between these two populations.

TABLE 8. Geographical variation in the ratio of length of elytra/length of pronotum among selected population samples of *Tecnophilus croceicollis* Ménétriés.

Locality	N	Range	Mean	S.E.	S.D.	C.V.%
Newark, Cal.	40	2.76 - 3.06	2.92	0.01	0.08	2.74
Cuddeback Lake, Cal.	64	2.65 - 3.11	2.84	0.01	0.08	2.82
Brownsville, Texas	20	2.84 - 3.09	2.95	0.02	0.08	2.71
S.E. Alberta	38	2.59 - 2.82	2.71	0.01	0.06	2.21

TABLE 9. Geographical variation in the ratio of width of pronotum/maximum width of head among selected population samples of *Tecnophilus croceicollis* Ménétriés.

Locality	N	Range	Mean	S.E.	S.D.	C.V.%
Newark, Cal.	40	1.09 - 1.24	1.18	0.01	0.03	2.54
Cuddeback Lake, Cal.	64	1.03 - 1.16	1.10	0.01	0.04	3.64
Brownsville, Texas	20	1.08 - 1.20	1.14	0.01	0.03	2.63
S.E. Alberta	38	1.07 - 1.18	1.14	0.01	0.03	2.63

TABLE 10. Geographical variation in the ratio of maximum width of head/minimum width of head between eyes among selected population samples of *Tecnophilus croceicollis* Ménétríés.

Locality	N	Range	Mean	S.E.	S.D.	C.V.%
Newark, Cal.	40	1.40 - 1.53	1.45	0.01	0.03	2.07
Cuddeback Lake, Cal.	64	1.49 - 1.63	1.54	0.01	0.03	1.95
Brownsville, Texas	20	1.57 - 1.67	1.63	0.01	0.03	1.84
S.E. Alberta	38	1.31 - 1.48	1.41	0.01	0.03	2.13

Comparisons between pairs of populations were made in the following way. A \bar{Z}_i value (the sum of the mean character values multiplied by their individual weighting coefficients) was calculated for each of the two population samples compared. An axis was plotted on a map joining the localities from which these population samples were obtained. Using the weighting coefficient calculated for the original comparison, \bar{Z}_i values were calculated for samples from geographically intermediate localities that lay along the axis and these \bar{Z}_i values were plotted on a map. Where the \bar{Z}_i value obtained from geographically intermediate population samples was equal to or approached the mid-point value, a transverse line was drawn across the axis. This transverse line theoretically divided members of the two populations and their associated specimens from one another. If the position in which this transverse line occurred was concordant with a change in the state of one or more other characters such as color, the populations separated by this line were considered to be subspecifically distinct.

A summary of the population comparisons that have been made is presented below. Table 11 gives the weighting coefficients and the calculated \bar{Z}_i values of the population samples used for each set of comparisons.

TABLE 11. Summary of calculated weighting coefficients (W^*) and \bar{Z}_i values obtained for each comparison of a pair of population samples of *Tecnophilus croceicollis* Ménétríés.

Comparison		W^*					\bar{Z}_I	\bar{Z}_{II}	Mid-point Z_i value	% overlap	
I vs II		W_1	W_2	W_3	W_4	W_5				Ob- served	Calcu- lated
A	B	0.715	0.105	0.845	-0.135	-0.489	1.721	1.613	1.667	25	44
A	D	-	-0.053	3.643	1.165	-	9.102	8.090	8.596	0	30
B	C	-0.489	-0.029	0.715	0.707	0.038	0.673	0.568	0.621	9.8	44
B	D	-3.281	-0.223	2.023	1.396	3.768	6.611	6.209	6.410	0	22

W_1 to W_5 are weighting coefficients for characters X_1 to X_5 respectively, where character $X_1 = WP/LP$; $X_2 = LE$ mm; $X_3 = WH_1/WH_2$; $X_4 = SE/LP$; and $X_5 = WP/WH_1$.

Population samples have been designated alphabetically as follows: A = Brownsville, Texas; B = Cuddeback Lake, California; C = Newark, California; and D = Lost River Ranch, Alberta.

Brownsville, Texas versus Cuddeback Lake, California (Comparison A-B). - Calculated \bar{Z}_i values for population samples from Brownsville, Texas, Cuddeback Lake, California and for specimens from intermediate localities are presented in table 12, and are plotted on a map in fig. 2. The line transverse to the A-B axis separates populations with \bar{Z}_i values above the mid-point value. This line is not concordant with that of any other character observed to vary between the two populations.

TABLE 12. \bar{Z}_i values calculated for selected population samples of *Tecnophilus croceicollis* Ménétriés from the discriminant function developed for the Brownsville, Texas (A) vs Cuddeback Lake, California (B) populations comparison (mid-point \bar{Z}_i value is 1.667).

<u>Comparison A vs B</u>				
Map symbol	Locality	Number of specimens	Range	\bar{Z}_i
TEXAS				
A	Brownsville	20	1.667 - 1.799	1.721
b	Mission	1	1.698	1.698
c	Pecos	2	1.782 - 1.800	1.791
d	Fabens	5	1.726 - 1.786	1.743
NEW MEXICO				
e	Alamogordo	1	1.759	1.759
f	Lordsburg	7	1.716 - 1.886	1.782
g	Fort Wingate	1	1.606	1.606
h	San Juan Valley	2	1.655 - 1.736	1.695
	Coolidge (?)	5	1.605 - 1.668	1.630
ARIZONA				
i	San Bernardino	2	1.718 - 1.725	1.722
j	Tuscon	1	1.669	1.669
k	Globe	1	1.752	1.752
l	Winslow	5	1.592 - 1.664	1.631
m	Tempe	1	1.678	1.678
n	Palomas	1	1.617	1.617
o	Welton	5	1.605 - 1.696	1.659
CALIFORNIA				
B	Cuddeback Lake	64	1.541 - 1.701	1.613

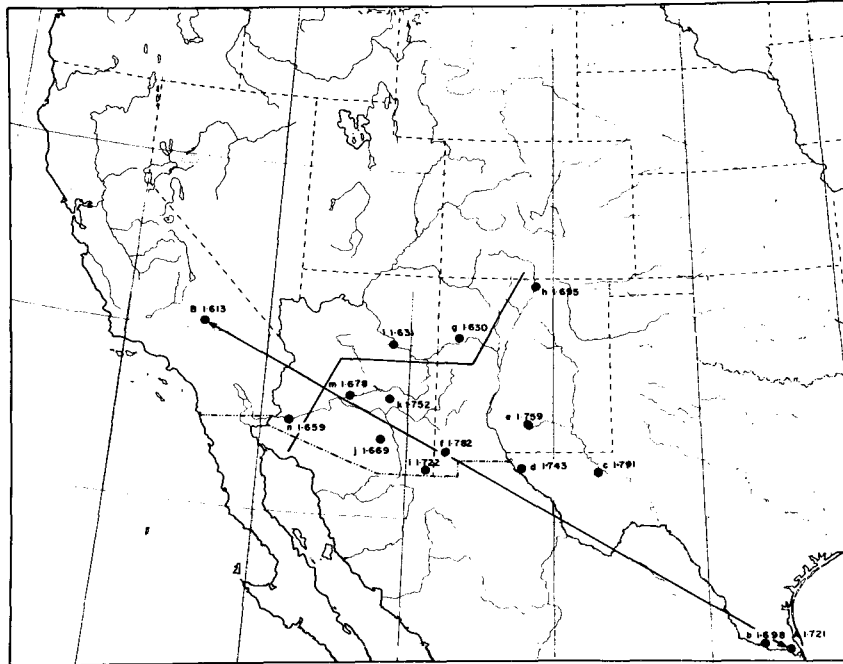


Fig. 2. Plotted mean Z_i values of selected population samples of *Tecnoiphilus croceicollis* Ménétériés used in the comparison of populations from Brownsville, Texas (A) to Cuddeback Lake, California (B). The mid-point Z_i value equals 1.667. Association of letters and locality names are made in Table 13.

Brownsville, Texas versus Lost River Ranch, Alberta (Comparison A-D). - Calculated \bar{Z}_i values for the two population samples compared and for specimens from intermediate localities are presented in table 13 and are plotted on a map in fig. 3. The transverse line representing the position in which mid-point values are expected to occur extends across northern Colorado. This line is concordant with a change in color and a change in eye shape.

Cuddeback Lake, California versus Newark, California (Comparison B-C). - Calculated \bar{Z}_i values are presented in table 14 and fig. 4, in the same way as above. The discriminant function gives poor separation of specimens from the two populations used in the original comparison. It provides even poorer separation of specimens from intermediate localities. Specimens with intermediate \bar{Z}_i values are found in the northern portions of the San Joaquin Valley and this change is not concordant with a change in the state of any other character. Like color, \bar{Z}_i values vary clinally.

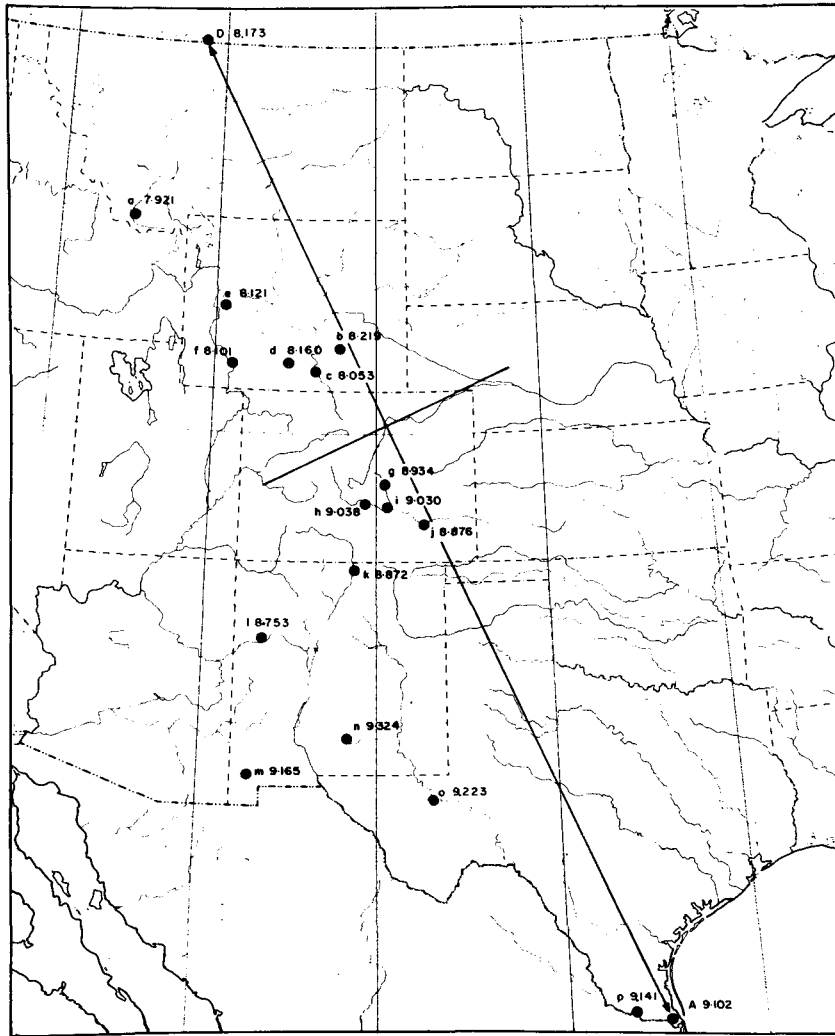


Fig. 3. Plotted mean Z_i values of selected population samples of *Tecnophilus croceicollis* Ménériés used in the comparison of populations from Brownsville, Texas (A) to Lost River Ranch, Alberta (D). The mid-point Z_i value equals 8.596. Association of letters and locality names are made in Table 14.

TABLE 13. \bar{Z}_i values calculated for selected population samples of *Tecnophilus croceicollis* Ménériés from the discriminant function developed for the Brownsville, Texas (A) vs Lost River Ranch, Alberta (D) populations comparison (mid-point \bar{Z}_i value is 8.596).

Map symbol	Locality	Number of specimens	Range	\bar{Z}_i
	ALBERTA			
D	Lost River Ranch	38	7.783 - 8.379	8.173
	MONTANA			
a	Dillon	1	7.921	7.921
	WYOMING			
b	Medicine Bow	1	8.249	8.249
c	Saratoga	2	7.974 - 8.133	8.053
d	Creston	2	8.110 - 8.210	8.160
e	Pinedale	1	8.121	8.121
f	Green River	1	8.101	8.101
	COLORADO			
g	Colorado Springs	2	8.769 - 9.099	8.934
h	Florence	1	9.038	9.038
i	Pueblo	1	9.030	9.030
j	La Junta	1	8.876	8.876
	NEW MEXICO			
k	San Juan Valley	2	8.618 - 9.124	8.872
l	Ft. Wingate	1	8.465	8.465
m	Lordsburg	7	9.031 - 9.457	9.165
n	Alamogordo	1	9.324	9.324
	TEXAS			
o	Reeves Co., Pecos	2	9.150 - 9.296	9.223
p	Mission	1	9.141	9.141
A	Brownsville	20	8.967 - 9.291	9.102

Cuddeback Lake, California versus Lost River Ranch, Alberta (Comparison B-D). - Calculated \bar{Z}_i values are presented in table 15 and fig. 5 in the manner outlined above. In this case, the transverse line representing the approximate location of specimens possessing mid-point \bar{Z}_i values, is in northern Utah. \bar{Z}_i values for specimens collected from localities in close proximity to this line, tend to intergrade into each other. Color and vestiture also change through this region.

Summary. - Because of lack of concordance in the variation patterns among the characters studied, the population samples A, B and C are considered to be consubspecific. However, several characteristics differentiating population samples A and D change in the same area. Also, several characteristics differentiating population samples B and D change in the same area. I conclude therefore, that population sample D and specimens associated with it are subspecifically distinct from samples A, B and C and their associated specimens.

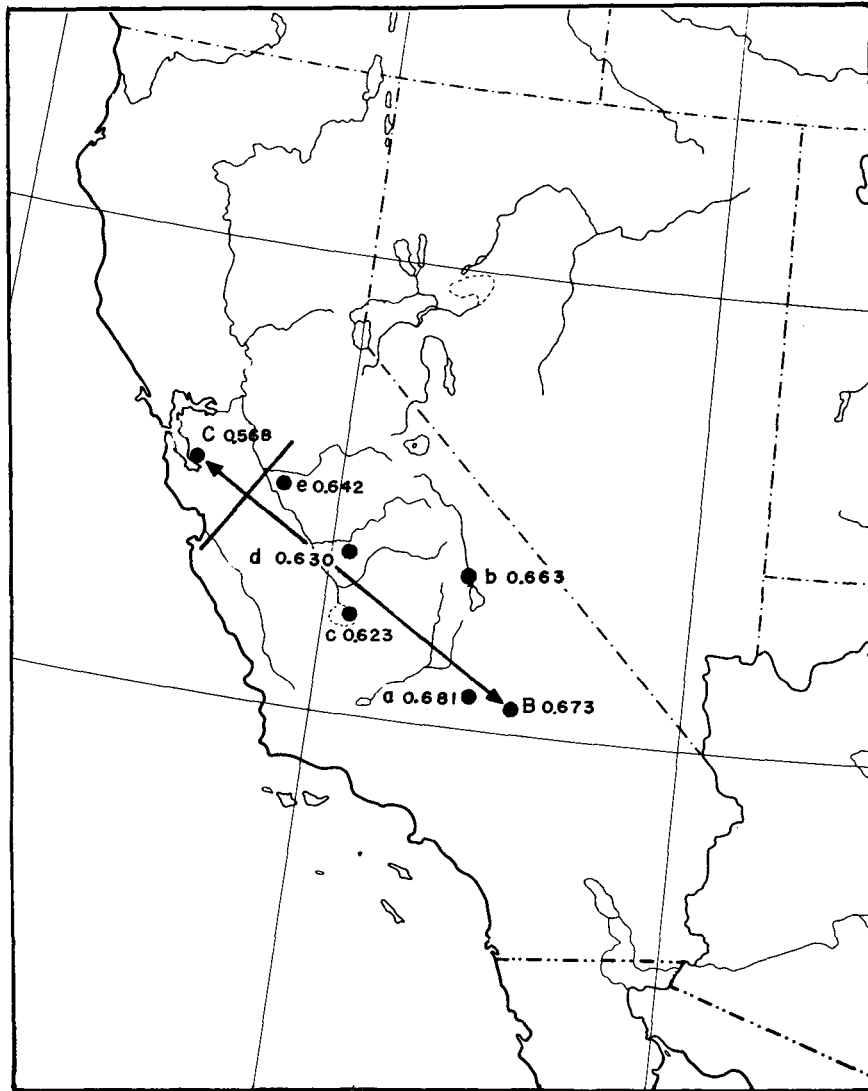


Fig. 4. Plotted mean Z_i values of selected population samples of *Tecnoophilus croceicollis* Ménériés used in the comparison of populations from Cuddeback Lake, California (B) to Newark, California (C). The mid-point Z_i value equals 0.621. Association of letters and locality names are made in Table 15.

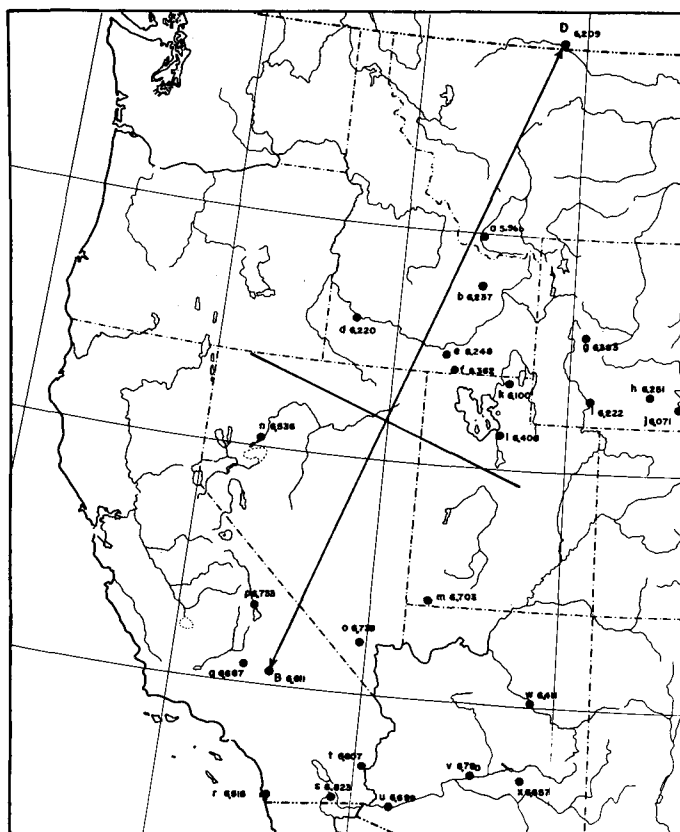


Fig. 5. Plotted mean Z_i values of selected population samples of *Tecnoophilus croceicollis* Ménétriés used in the comparison of populations from Cuddeback Lake, California (B) to Lost River Ranch, Alberta (D). The mid-point Z_i value equals 6.410. Association of letters and locality names are made in Table 15.

TABLE 14. \bar{Z}_i values calculated for selected population samples of *Tecnoophilus croceicollis* Ménétriés from the discriminant function developed for the Cuddeback Lake, California (B) vs Newark, California (C) populations comparison (mid-point \bar{Z}_i value is 0.621) (fig. 4).

Map symbol	Locality	Comparison B vs C		
		Number of specimens	Range	\bar{Z}_i
B	Cuddeback Lake	64	0.622 - 0.773	0.673
a	Koehn Lake	7	0.645 - 0.780	0.681
b	Lone Pine	3	0.632 - 0.690	0.663
c	Kings Co.	4	0.594 - 0.649	0.623
d	Fresno Co.	4	0.605 - 0.656	0.630
e	Merced Co.	3	0.624 - 0.653	0.642
C	Newark	40	0.492 - 0.648	0.568

TABLE 15. \bar{Z}_i values calculated for selected population samples of *Tecnophilus croceicollis* Ménériés from the discriminant function developed for the Cuddeback Lake, California (B) vs. Lost River Ranch, Alberta (D) populations comparison (mid-point \bar{Z}_i value is 6.410).

Map symbol	Locality	Number of specimens	Range	\bar{Z}_i
	ALBERTA			
D	Lost River Ranch	38	5.926 - 6.308	6.209
	MONTANA			
a	Dillon, Beaverhead Co.	1	5.966	5.966
	IDAHO			
b	Howe	1	6.237	6.237
c	Viola	1	5.710	5.710
d	Grandview	1	6.220	6.220
e	Malta	1	6.248	6.248
f	Strevell	1	6.362	6.362
	WYOMING			
g	Pinedale	1	6.383	6.383
h	Creston	2	6.235 - 6.267	6.251
i	Green River	1	6.222	6.222
j	Saratoga	2	6.052 - 6.099	6.071
	UTAH			
k	Logan	1	6.100	6.100
l	Salt Lake City	6	6.267 - 6.488	6.408
m	St. George	5	6.510 - 6.866	6.703
	NEVADA			
n	Humbolt Lake	2	6.403 - 6.669	6.536
o	Las Vegas	2	6.651 - 6.827	6.739
	CALIFORNIA			
p	Lone Pine	3	6.567 - 7.056	6.733
q	Koehn Lake	7	6.499 - 6.804	6.687
B	Cuddeback Lake	64	6.421 - 6.871	6.611
r	San Diego	2	6.494 - 6.536	6.515
s	El Centro	3	6.690 - 6.906	6.823
t	Palo Verde	4	6.411 - 6.719	6.607
	ARIZONA			
u	Welton	5	6.489 - 6.982	6.699
v	Tempe	3	6.724 - 6.866	6.790
w	Winslow	5	6.410 - 6.537	6.411
x	Globe	1	6.657	6.657

Key to the Subspecies of *Tecnophilus croceicollis* Menetries

1. Specimens from California *c. croceicollis* Menetries
 1'. Specimens from localities other than California 2
 2(1). Color of head, pronotum and legs rufous; eyes large and convex (fig. 25).
 *c. croceicollis* Men., p.60
 2'. Color not as above; if head, pronotum and legs basically rufous in color, at least tarsi,
 clypeus and frons between eyes somewhat infuscated: eyes small and flat (fig. 24)
 *c. peigani* new subspecies, p. 61

OR

- 2a(1). Specimens from west of Rocky Mountains 3
 2a'. Specimens from east of Rocky Mountains 4
 3(2). $(-3.281)WP/LP + (-0.223)LE + (2.023)WH_1/WH_2 + (1.396)LE/LP + (3.768)WP/WH$
 > 6.410 *c. croceicollis* Men.
 3'. ${}^{''}+{}^{''}+{}^{''}+{}^{''} < 6.410$ *c. peigani* n. ssp.
 4(2). $(0)WP/LP + (-0.053)LE + (3.643)WH_1/WH_2 + (1.165)LE/LP + (0)WP/WH > 8.596$.
 *c. croceicollis* Men.
 4'. ${}^{''}+{}^{''}+{}^{''}+{}^{''} < 8.596$ *c. peigani* n. ssp.

Tecnophilus croceicollis croceicollis Ménétériés 1843

Calleida croceicollis Ménétériés 1843 - 54. *Type locality* - California.

Callida chloridipennis Motschoulsky 1850 - 39. (from Horn 1882)

Philotecnus nigricollis LeConte 1851 - 176. *Type locality* - San Jose, California.

Philotecnus ruficollis LeConte 1851 - 176. *Type locality* - San Diego, California.

Tecnophilus glabripennis Chaudoir 1877 - 242. *Type locality* - Nevada.

Specimens of this subspecies may best be recognized on the basis of the combination of characters presented in the key to subspecies of *croceicollis*.

Description. - Values for ratios and measurements of selected population samples of this subspecies are presented in tables 6 to 10.

Color varied in specimens from the Central Valley of California; head, pronotum and legs basically rufous with at least some infuscation and in some specimens these parts are black; elytra dark blue or purple. Specimens from remainder of range with head, pronotum and legs uniformly rufous; elytra blue to green.

Microsculpture lightly impressed or obsolete on head and disc of pronotum; varied on elytra from granular to lightly impressed and shiny.

Head with eyes large and convex (fig. 25). Antenna relatively long and slender.

Pronotum varied in shape (figs. 39 to 41); not so cordate as in *peigani*.

Elytra varied in shape, short and oval in some specimens to more elongate and parallel sided; striae evidently impressed and distinctly punctate; intervals flat to convex, variably punctate.

Male genitalia as in fig. 19. Similar to that of *T. pilatei* but with a shorter apex.

Female stylus (fig. 56) truncate apically, not produced.

Discussion. - The high degree of variation shown by this subspecies has led past authors to describe a number of species, or to regard *croceicollis* as a single highly variable species.

Notes on synonymy. - The name *pilatei* Chaudoir is not a synonym for *croceicollis* Menetries as is shown above.

Mexico - DURANGO: Durango (Emburg, CAS); SINALOA: El Camaron (Ball, UASM).

United States - ARIZONA: Cochise Co., San Bernardino Ranch (Snow, UASM); Gila Co., Globe (USNM); Navajo Co., Winslow (USNM); Pima Co., Tucson (MCZ); Yuma Co., Palomas (CU), Wellton (CU), CALIFORNIA: Alameda Co., Bay Farm Island (Barr, Dahl, CAS, IUM, MCZ), Newark (Tyson, UASM); Butte Co., Oroville (Kelfer, CAS); Contra Costa Co., Antioch (Rose, CAS), Brentwood (Van Dyke, CAS), Vine Hill (Blaisdell, CAS); Fresno Co., Mendota (MCZ); Imperial Co., El Centro (Hanson, Van Dyke, CAS, CU, WUM); Palo Verde (Barr, IUM); Inyo Co., Lone Pine (Van Dyke, CAS) Panamint Valley (USNM), (Nunenmacher, CNHM); Kern Co., Koehn Lake (Erwin, UASM); Kings Co., (CNHM); Lassen Co., (Nunenmacher, CNHM); Merced Co., Los Banos (O'Brien, Van Dyke, CAS, UASM); Orange Co., Seal Beach (Gilligly, CAS); Riverside Co., Coachella (Van Dyke, CAS); San Bernardino Co., Barstow (Hayward, MCZ), Cuddeback Lake (Larson & Sharp, UASM); Needles (Kusche, CAS); Santa Clara Co., Aviso (Erwin, Larson & Sharp, UASM); San Diego Co., San Diego (CAS); San Joaquin Co., Weston (Van Dyke, CAS); San Mateo Co., San Mateo (Nunenmacher, Van Dyke, CAS, CNHM); Solano Co., Benica (Car. M); Sonoma Co., Glen Ellen (Kusche, CAS, CNC); Stanislaus Co., Patterson (Ross, CAS); Yolo Co., Davis (Erwin, Hatch, Car. M., UASM, WUM); Yuba Co., Marysville (Van Dyke, CAS). COLORADO: Bent Co., La Junta (Hayward, MCZ); El Paso Co., Colorado Springs (Soltau, USNM); Fremont Co., Florence (Soltau, USNM); Pueblo Co., Pueblo (Soltau, USNM). NEVADA: Churchill Co., Humbolt Lake (Wickham, USNM); Clark Co., Las Vegas (Barr, Johnston, CNC, IUM); Pershing Co., Lovelock (Baker, SJSC). NEW MEXICO: Hidalgo Co., Lordsburg (Howden, CNC); McKinley Co., Ft. Wingate (Dow, CAS); Otero Co., Alamogordo (Wickham, USNM); Taos Co., San Juan Valley (Bowditch, MCZ). TEXAS: Cameron Co., Brownsville (many collectors, CNC, INHS, MCZ, UASM, USNM); El Paso Co., Fabens (Howden, CNC); Hidalgo Co., Mission (Gurney, USNM); Reeves Co., Pecos (Johnston, CNC), Pecos River? (Odenbach, USNM). UTAH: Washington Co., St. George (AMNH, CAS, MCZ, USNM).

Tecnophilus croceicollis peigani new subspecies

Holotype - male, Milk River near junction with Lost River, Lost River Ranch, Alberta (12 V/1965, Getty & Larson, CNC).

Allotype - female, same locality (CNC).

Paratypes. - All other specimens from Alberta have been labelled as paratypes (see below for list of localities).

The diagnostic characteristics of this subspecies are presented in the above key, and in the discussion of geographical variation in *T. croceicollis*.

Description. - Values for ratios and measurements of this subspecies are presented in tables 6 to 10.

Color black, with elytra and in some specimens disc of pronotum with dull metallic blue or blue-green lustre; appendages black or piceous (see following discussion for variation in color).

Microsculpture lightly impressed or obsolete on head and disc of pronotum; isodiametric and coarse on elytra.

Vestiture very short and sparse on specimens from Alberta. Specimens from more southerly localities moderately setose.

Head broad; eyes small and little convex (fig. 24). Antenna shorter and stouter than in *c. croceicollis*.

Pronotum strongly cordate (fig. 42), lateral margins strongly constricted behind, lateral reflexion narrow.

Elytra short and oval, with greatest width in apical half; striae deeply impressed and evidently punctate; intervals convex, each bearing an irregular row of coarse punctures.

Male genitalia (fig. 20) and female stylus similar to *c. croceicollis*.

Variation. - Vestiture and color vary over the range of this subspecies. Specimens from the eastern side of the Rocky Mountains are black or at least dark piceous in the color of the head and pronotum. Specimens with this coloration have also been seen from eastern Idaho and extreme northern Utah. However, specimens from central and western Idaho and the Salt Lake region of Utah are much paler in color. In specimens from these regions, the ground color of the head, pronotum and legs is usually rufous, with at least some infuscation occurring on the legs, clypeus and the frons between the eyes. This tendency towards pale coloration in specimens of *peigani* from Idaho and Utah is probably a result of hybridization with *c. croceicollis*.

Specimens of *peigani* from Alberta appear to be almost glabrous dorsally because of the greatly reduced length of the setae. Over the remainder of the range, the dorsal pubescence is longer and quite distinct.

Etymology. - The subspecific name is the latinized form of the word Peigan, the name of a tribe of Indians of the Blackfoot Confederation, which inhabited the prairies of southern Alberta. Confusion exists as to the correct spelling of this name, but the Edmonton office of the Canadian Government Department of Indian Affairs accepts "Peigan" as the correct spelling.

Disposition of type material. - The holotype and allotype have been deposited in the Canadian National Collection, Ottawa. Paratypes have been deposited in California Academy of Sciences, Canadian National Collection, Museum of Comparative Zoology, University of Alberta, Strickland Museum, and the United States National Museum.

Distribution. - Localities from which specimens of *peigani* have been collected are plotted in fig. 63. I have seen 73 specimens of this subspecies from the following localities.

Canada - ALBERTA: Forty Mile Coulee, 5 miles north Etzikom (Getty, Larson, Whitehead, UASM); Milk River near junction with Lost River, Lost River Ranch (Ball, Erwin, Freitag, Getty, Larson, CAS, CNC, MCZ, UASM, USNM); Picture Butte (Getty & Larson, UASM).

United States - COLORADO: "Col." (USNM), IDAHO: Butte Co., Howe (Barr, IUM); Cassia Co., Malta (Henry, IUM); Strevell (Barr, IUM); Owyhee Co., Grandview (Furniss, IUM), MONTANA: Beaverhead Co., Dillon (Jellison, MUB), UTAH: Cache Co., Logan (Henderson, CAS); Davis Co., (Stafford, USNM); Salt Lake Co., Salt Lake City (J.B., Henderson, Huelleman, Klages, Car. M., IUM, WUM), WYOMING: Carbon Co., Medicine Bow (AMNH), Saratoga (Bryant, CAS); Sublette Co., Pinedale (Alexander, MCZ); Sweetwater Co., Creston (Bryant, CAS), Green River (Bowditch, MCZ).

BIOLOGY

Although little is known of the biology of beetles of the subtribe Callidina, members of many of the species and genera appear to be at least partly arboreal. Habu (1960, 1967) summarized what is known of the biology of members of the genus *Callida*. Generally, these insects are arboreal predators, feeding mostly on lepidopterous larvae. These insects do not show any of the parasitic adaptations possessed by the members of the genus *Lebia*.

What I have observed of the biology of the genera *Tecnophilus* and *Philophuga* is presented below.

Biology of *Tecnophilus* Chaudoir

The biology of these insects is poorly known. Adults of this genus tend to be more terrestrial than are adults of any of the other North American callidine genera. This is reflected in the slender legs and tarsi, setose body and the cordate prothorax of *Tecnophilus*; characters which are often found in terrestrial carabids, but seldom found in arboreal forms.

Adults are found on saline or alkaline soils in eroding areas. Table 16 presents some of the physical characteristics of the top six inches of the soils on which these insects have been collected. The high soil salinity and the arid conditions in regions in which members of the genus *Tecnophilus* occur, suggests that desiccation may be an important factor with which these insects must contend. During relaxation of specimens prior to dissection, I noticed that the dried tissues were quite impermeable to water. Immersion in near-boiling water for periods of fifteen minutes to half an hour was not sufficient to soften the abdominal membranes enough to permit the genitalia to be withdrawn easily. This is a longer time than is required to relax most species of carabids. This impermeability may be an adaptation to resist desiccation under arid conditions.

In southeastern Alberta, specimens of *Tecnophilus croceicollis peigani* are usually found along the bases of south facing coulees, where considerable erosion has occurred and alluvial fans have been deposited. These fans are composed of a clay-sand soil which bakes and cracks extensively when dry. The sparse vegetation consists principally of *Bouteloua gracilis* (Lag.) H.B.K., *Atriplex nuttalli* Wats., *Opuntia* spp., *Mamillaria vivipara* Haw., and *Erigonum flavum* Nutt. A more complete description of the region is presented by Lewin (1963).

On sunny days in May and early June, specimens of *c. peigani* were found running over the surface of the ground, or climbing on very low vegetation. Infrequently specimens have been taken under cover or from cracks in the ground. At this time, the insects are often found in copulation, and mating occurs readily among captured specimens. Fertile females collected at this time and brought into the laboratory, usually laid eggs within a week or two. Larvae emerging from these eggs were reared as far as the third instar on the following foods: larvae of several species of curculionids, wheat stem sawfly larvae, wax moths, meal worms, and ant larvae and pupae. Mortality was high on all of these foods.

This subspecies probably hibernates in the adult stage, for one specimen from Green River, Wyoming (20-27/VII/1877), was teneral, indicating that emergence from the pupal stage occurs during the middle of the summer. All specimens are fully winged but flight has not been observed.

The habitats in which specimens of *c. croceicollis* were found, vary over the wide range of this subspecies. The most consistent features of the habitats are saline eroding soils and sparse vegetation.

In the vicinity of San Francisco Bay, beetles have been collected on salt flats, usually in areas dominated by plants of the genus *Salicornia*. During the winter months, these insects are found near or at the surface of the soil, under the *Salicornia* mats or other loose cover (Erwin, pers. comm.). However, on July 5, 1966 (Alviso, California, Larson & Sharp, collectors) seven specimens were collected at depths of four to eight inches in the sandy soil beneath *Salicornia* plants. The beetles were on the upper surface of the clay hardpan, and in company with specimens of *Amara stupida* LeConte and *Pristonychus complanatus* Dejean.

The two teneral specimens that I have seen from the central valley of California (Marysville, Yuba Co., VI/1908; and Mendota, Fresno Co., V-VIII) suggest that the larval stage occurs during the spring and summer in this region.

Specimens of *c. croceicollis* have been collected from the margins of several alkaline playas in the Mojave Desert of southeastern California. A long series of beetles collected at Cuddeback Lake (June 30, 1966, Larson & Sharp) was found among the buried portions of the crowns of bur sage (*Franeria dumosa* Grey) at depths of three to ten inches. Specimens collected at the neighboring Koehn Lake in the spring (April 10, 1965, Erwin) were found at the surface of the soil, under loose cover. I have seen teneral specimens from Lone Pine, California (20/V/1937). The larval stage probably occurs in the early spring as this is the season of greatest rainfall in the Mojave Desert.

All long series of *c. croceicollis* that I have seen from Texas, have been collected at light. I do not know the habitat of this insect in Texas, but it appears to occur only in inland localities and not along the Gulf Coast. On the other hand, *T. pilatei* is found primarily along the coast and only for a short distance inland. A mixed series of both of these species was collected at light in Brownsville, Texas (May 1967).

Outside of Texas, I have seen only one specimen of *croceicollis* (s.e. California) labelled as being collected at light.

Most specimens of the species *pilatei* have been collected at light. However, some at least have been collected by sweeping vegetation along sea beaches (Port Isabel, Ball).

In order to obtain the larvae of *Tecnophilus*, I maintained adults of *c. croceicollis* and *c. peigani* alive. The method of oviposition was observed, and was found to proceed as follows for both subspecies: when ready to lay an egg the female collected a small ball of soil particles on the apex of her abdomen. These particles were first loosened with the mandibles then picked up singly with the apex of the abdomen to which they adhered, probably by means of an adhesive substance produced by the accessory glands. When sufficient material was collected, the female climbed some object such as a twig. When she had climbed to a height of several inches, the beetle turned and faced downward. The abdomen was pressed against the twig, and a drop of fluid was released. The abdomen was then moved away from the twig, drawing the drop of fluid out until it hardened into a silk-like strand. This strand was formed partly by the movement of the abdomen, and partly by means of an appposable motion of the styli. When the thread reached a length of about 1 to 6 mm, the female injected an egg into the ball of soil particles that she still carried on the apex of her abdomen. The egg and soil covering were then released, and were left dangling in the air, suspended from the twig by means of the silken thread. The egg remained suspended in this way until the larva hatched.

This method of oviposition may be related to the peculiar form of stylus that is found in members of the Callidina. *Philophuga viridis amoena*, which possesses a similar form of ovipositor, lays its eggs in the same way. This form of egg laying could certainly be a valuable adaptation for desert species, for it would protect the eggs to some extent from most predators, flash floods, and soil erosion. On the other hand, it would make the eggs more susceptible to desiccation. As the rest of the members of the Callidina possess this form of ovi-

positor, and are more or less arboreal, this form of egg laying was probably an adaptation to an arboreal existence, and has secondarily proved useful to desert dwelling species.

TABLE 16. Some physical characteristics of soils on which specimens of *Tecnophilus croceicollis* Ménériés have been collected.

Locality	Number of soil samples	pH	Electri- cal cond- uctivity	CaCO ₃	Na	Cl	Texture
Lost River, Alberta	5	8.1-8.4	0.9-6.0	high	high	trace	packed clay-sand
Alviso, California	2	4.0-4.4	16+	-	high	200+	friable sand
Cuddeback Lake, California	1	7.5	15.0	high	high	200+	sand
Rockport, Texas	1	8.1	8.0	-	high	180	friable sand

Biology of *Philophuga* Motschoulsky

As I have collected few specimens of the genus *Philophuga*, I know little of the habits of these insects. In general, members of this genus occur in arid and semi-arid regions of western North America. They are not usually found in saline situations as are members of the genus *Tecnophilus*, and they appear to be much more arboreal than the latter, for specimens of *Philophuga* are often found on vegetation.

In southern Alberta, specimens of *P. viridis amoena* are found in the same general region as are specimens of *T. croceicollis peigani*. However, rather than occurring along the bases of coulees in regions of baked soil and sparse vegetation, they are usually found on short grass prairie.

Many of the specimens of *P. viridis horni* that I have examined, are associated with labels indicating that they have been collected on vegetation, usually *Artemisia* or *Atriplex*. I know nothing of the biology of the other subspecies of *viridis* except that most specimens of *v. viridis* that I have examined were collected during the month of December.

The labels associated with many adult specimens of *P. viridicollis* indicate that the beetles were collected on vegetation. Four specimens of this species collected at Monahans, Texas (Larson & Sharp, June 12, 1966) were found on a short legume, in leaf rolls made by a lepidopterous larva. Larvae of *viridicollis* have been collected at Rocky Ford, Colorado (Hamilton, USNM) feeding on the larvae of *Ancylis comptana* W. & R. (Lepidoptera: Olethreutidae). Teneral adults of this species have been collected from April 28 to July 5.

Specimens of *P. brachinoides* have been collected in bromeliads (Ball & Whitehead).

I have not seen any records of specimens of the genus *Philophuga* collected at light.

In this genus, oviposition has been observed only for the subspecies *viridis amoena*. It proceeds in the same way as outlined under *Tecnophilus croceicollis*.

PHYLOGENY

The following discussion is an explanation of the rationale used to construct the phylogenetic diagram presented in table 17. In order to construct this model, two assumptions had to be made: (a) it is possible to discover those characteristics that are widespread in the group due to common ancestry, and to distinguish these from similar characteristics that have resulted from convergence (Cain & Harrison 1960); and (b) the rate of evolution has been uniform throughout the group, so that the degree of difference between two taxa is directly proportional to the length of time for which the two ancestral stocks have been isolated. These assumptions are necessitated by the complete lack of fossil evidence.

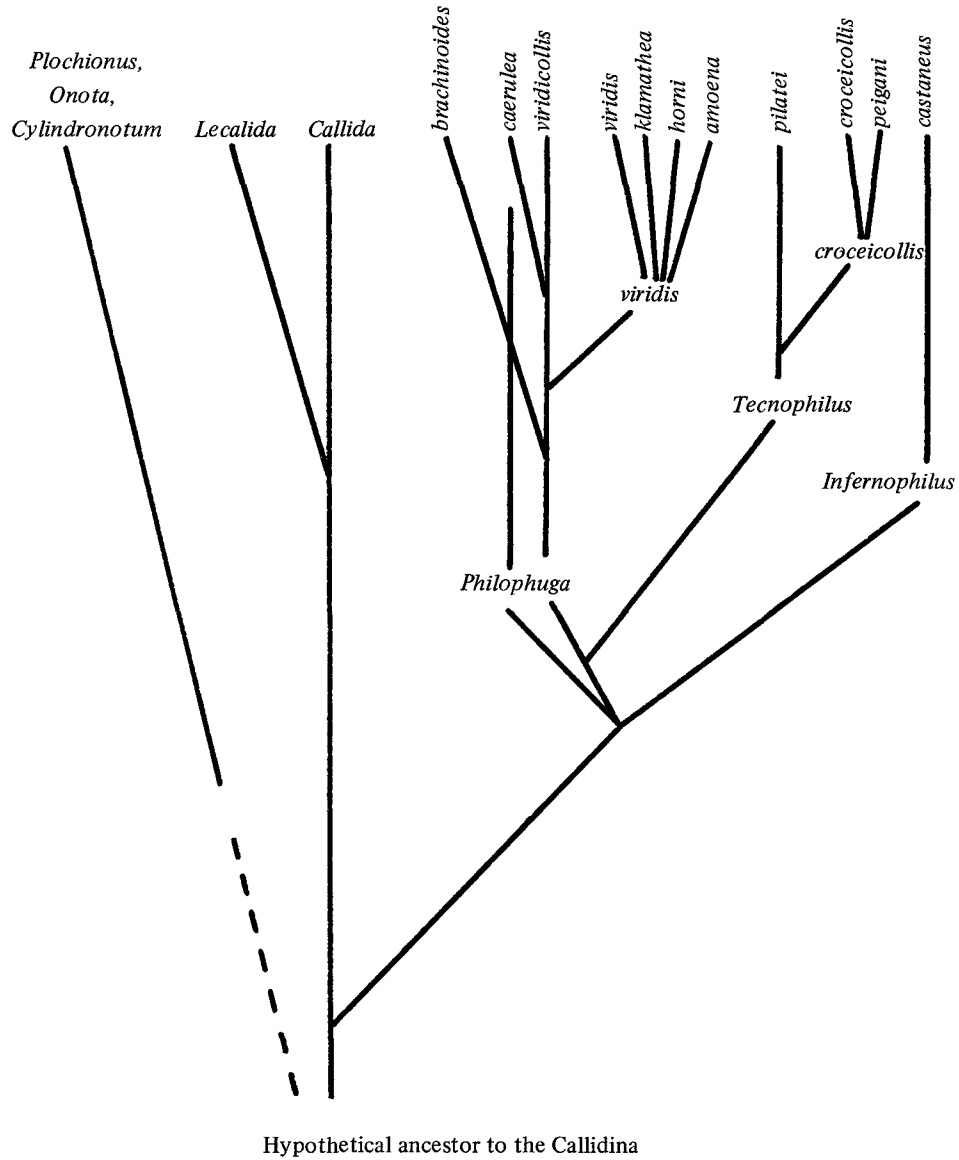
Based on these considerations, the following hypothetical model of the evolution of the North American Callidina is presented. The ancestral stock was probably arboreal, and possessed the following characteristics: color of elytra metallic blue or green, color of remainder of body rufous to black; dorsal surface of body glabrous; labial palpus with terminal article securiform, penultimate article bisetose; ligula bi- or pluri-setose; prothorax broad, with wide lateral reflexion; legs stout, with tarsal article 4 bilobed, claws pectinate, ventral surface of tarsal articles 1 to 4 of front and middle tarsi of male bearing two rows of scales beneath; elytra completely bordered basally and apically, striae evident and punctate, intervals flat or slightly convex; hind wings fully developed and lightly pigmented; abdominal sterna 4, 5, 6 lacking lateral setae, sternum 6 with a small number of anal setae (probably three pairs or less); male genitalia on their right side in repose, with left paramere large; endophallus armed or unarmed; female stylus rectangular, lightly sclerotized, with a setose apical margin.

An early differentiation of the basic callidine stock may have given rise to the ancestor of the *Plochionus-Onota-Cylindronotum* lineage. This group differs in many details from the remaining members of the North American Callidina, and has been included in the Callidina largely on the basis of the structure of the female ovipositor. The structure of the ovipositor as well as other external features of this group may resemble the condition found in the hypothetical callidine ancestor simply through convergence. If this is the case, the Callidina represents a grade, resulting from parallel adaptation to a common way of life, an arboreal habitat. As mentioned above, the affinities of this group are obscure and probably are among the poorly understood neotropical fauna. For this reason, this group will not be considered further.

A later differentiation of the ancestral stock of the Callidina probably gave rise to the genera *Callida* and *Lecalida* with very little additional modification. The genera *Philophuga*, *Infernophilus* and *Tecnophilus* are closely related, and were probably derived from a common stock. This stock differentiated from the main *Callida* lineage by acquiring slender legs (tarsal article 4 not bilobed, but only shallowly emarginate) and a setose body.

The most distinctive of these three genera is the genus *Infernophilus*. For this reason, the ancestor to the genus *Infernophilus* may have diverged from the *Philophuga-Tecnophilus*

TABLE 17. Hypothetical phylogeny of the endemic North American genera of the subtribe Callidina and their included species.



stock early in its history, in order to permit the *Infernophilus* stock sufficient time to acquire the characteristics listed below. This genus exhibits a peculiar form of male genitalia which has undergone 180° rotation. The mechanism which brought this reversal about is unknown, but it seems reasonable to postulate that the initial change involved a 180° shift in the orientation of the aedoeagus. The reversal of the parameres may have accompanied this initial reversal of the aedoeagus or they may have rotated at a later date. In this genus, other peculiar characters include the anal brushes, the non-metallic elytra, and the short, rounded female styli.

The stocks giving rise to *Philophuga* and *Tecnophilus* separated sometime after the separation of the *Infernophilus* stock. The stock giving rise to the genus *Philophuga* remained essentially unmodified after this point, but the stock ancestral to *Tecnophilus* acquired simple tarsal claws, a more cordate pronotum, and a more densely setose body.

The stock giving rise to the genus *Philophuga* probably possessed the following characters, as these are the most widespread characteristics in species of this genus: color of entire body except for basal antennal articles, black with a metallic blue or green lustre dorsally; body sparsely setose; pronotum sub-cordate, bearing posterior-lateral seta on each hind angle; elytra elongate and more or less parallel sided, with greatest width in apical half; hind wings fully developed, lightly pigmented.

An early derivative of this stock gave rise to the ancestor to the *viridis* complex. This stock was characterized by shorter, more oval shaped elytra and by a more cordate pronotum. The stock giving rise to *viridis* has undergone considerable recent diversification to give rise to the four extant subspecies. These four subspecies may have developed simultaneously from four isolated populations, as no subspecies is strikingly distinct.

The other ancestral stock of the genus *Philophuga* gave rise to the extant species *viridicollis*, *caerulea* and *brachinoides*. The ancestor to these species possessed deeply pigmented wings and elongate elytra. This stock gave rise first to the uniquely colored species *brachinoides* which also differs from the other two species in this group by having a more cordate pronotum, and also possesses several patches of setae on the ventral surface of the body. The two extant species *caerulea* and *viridicollis* are the result of relatively recent diversification in the ancestral stock.

The ancestral stock of the genus *Tecnophilus* may have divided early in its history to give rise to the species *pilatei* and *croceicollis*. Recent differentiation has produced two subspecies and a great deal of geographical variation in the species *croceicollis*.

ZOOGEOGRAPHY

The subtribe Callidina is represented in all major zoogeographical regions of the world. However, the greatest diversity in both numbers of genera and species occurs in tropical and subtropical areas. Only two genera contain members in both the Old and New Worlds. The majority of the species included in the genus *Plochionus* are restricted to the New World, but the species *Plochionus pallens* Fabricius has been widely distributed by commerce, and is now almost cosmopolitan. Only the genus *Callida* is represented naturally in Asia, the Americas and perhaps Africa (but see Jeannel 1949).

At present, the range of the genus *Callida* is disjunct. The majority of the American species occur in the tropics, but some species in eastern North America extend north into the southern portion of the cold temperate region. No members of the genus *Callida* occur in western North America, hence the New World species of *Callida* are separated from the oriental members of this genus by a wide geographical gap of apparently unsuitable habitat.

In western North America, the genera *Lecalida*, *Philophuga*, *Infernophilus* and *Tecnophilus*, replace the genus *Callida*.

Many of the morphological and biological adaptations shown by members of the subtribe Callidina, are adaptations for an arboreal existence. It then seems reasonable to assume that present and past distributions of these insects have paralleled the distributions of floral types that have provided suitable habitats.

While no fossil record is available for this group of carabids, adequate fossils have been discovered to enable us to extrapolate the movements of Tertiary floras in North America. Thus, it is necessary to review the events influencing floral dispersal in western North America during the Tertiary and Pleistocene in order to reconstruct the history of the callidine genera which are endemic to this region.

The following review is based largely on a paper by Axelrod (1959). Other papers from which this brief review is drawn are: Axelrod 1948, 1950, 1957, 1958; Blackwelder 1948, 1954; Cohn 1965; Dillon 1956; King 1958; MacGinitie 1958, and Martin 1958.

During the early Cenozoic, three geofloras were found in western North America. The southern portion of the continent was occupied by the broad-leaved evergreen Neotropical-Tertiary Geoflora, while the northern and central portions were covered by the temperate Arcto-Tertiary Geoflora of mixed deciduous hardwoods and conifers. Between them, in central southwestern North America, small areas of semi-arid vegetation of the Madro-Tertiary Geoflora were making their initial appearances.

The Eocene environment was one of low relief and low altitude, and the climate was warm and humid. These conditions permitted widespread distribution and migration of plants, and during this time, the Neotropical-Tertiary Geoflora moved northward along the Pacific coast into Alaska, and to or near the Canadian border interiorly. This Geoflora was dominated by broad-leaved evergreens of tropical families and genera which now find their closest counterparts in subtropical forests such as those presently found from southern Mexico to Panama, and in southern Asia, where annual rainfall is high and the climate is uniformly warm. The Coast Ranges and the eastern Cordilleras did not exist at this time, and the desert flora that now occupies the intervening region was not then in existence.

The cooler, drier climate following the Eocene gradually restricted the Neotropical-Tertiary Geoflora southward, and coastward where it persisted in warm coastal valleys of California and Oregon until into the Miocene, with a few relicts surviving into Pleistocene times. No plants in the United States today represent direct descendants from this flora. However, some genera and species were secondarily derived from it. These derivatives represent subtropical to warm temperate groups that became adapted to the expanding dry subtropical and warm temperate areas of southwestern North America.

During the early Tertiary, the Arcto-Tertiary Geoflora had a holarctic distribution at high and middle latitudes, and probably was continuous across the Bering Land Bridge that was

present during early Eocene times. In western North America, three principal elements comprised this Geoflora: the western American element consisting of species related to present day dominants of the coastal and mountain forests; the eastern North American element consisting of deciduous hardwoods related to those of present eastern North America; and the East Asian element consisting of mixed deciduous forest species which are no longer native to North America, or have a discontinuous distribution in eastern North America and eastern Asia.

Species of these three elements were mixed in a forest of a rather generalized floristic composition. However, the Geoflora was not homogeneous throughout its area. It was composed of several forest types, depending upon geographical occurrence and climatic conditions. In response to gradual development of increasingly more emergent continents following early Tertiary, and to the accompanying trend toward lower temperature, this Geoflora gradually migrated southward from near the Canadian border where it occurred in the early Eocene, to central Nevada and northern California by the middle Oligocene. During the Miocene and early Pliocene, the increasing aridity further restricted this flora to more humid coastal and upland sites. Species belonging to the eastern North American and eastern Asian elements were rapidly reduced in western North America during the late Tertiary due to the reduction in summer rains brought about by uplifts in the coast ranges and Sierra Nevadas. Only a few of these forms lingered on into the late Pliocene in the mild coastal strip from central California north, becoming extinct here in the early part of the Pleistocene.

The species now dominating the western coniferous forests represent the surviving western American element of the old Arcto-Tertiary Geoflora. In the west, its species became adapted to a climate which was typified by winter rain and summer drought. Its major communities were differentiated chiefly in the latter Pliocene when important topographical changes such as the rise of the Sierra Nevada and the coast ranges produced more diverse climates.

The Madro-Tertiary Geoflora which originated in southwestern North America, was comprised of small-leaved, drought-deciduous, sclerophyllous plants. These plants were derived primarily from the Neotropical-Tertiary Geoflora and to a lesser extent from the Arcto-Tertiary Geoflora in response to the expanding dry climate. Fossil plants, apparently ancestral to Madro-Tertiary species have been discovered in late Cretaceous and Paleocene floras of southwestern North America. This Geoflora had come into existence by the middle Eocene, and spread over the southwestern part of the continent during succeeding epochs as dry climates expanded. Part of the desert flora as well has been derived from this Geoflora.

In the middle Pliocene, the rapid expansion of dry climates almost completely eliminated woodland and chaparral from the lowlands of the present desert regions. In the later Pliocene and Pleistocene, the rapidly rising Cascades, Sierra Nevada and more easterly mountain ranges brought a drier climate to their lee, and a desert flora came into existence. Its species were derived from those represented in the Geofloras that dominated the area earlier in the Pliocene. The colder Great Basin received increments from the surviving Arcto-Tertiary Geoflora; the Sonoran and Mojave Deserts from the Madro-Tertiary Geoflora.

Considering the present distribution of the genus *Callida*, it seems that the coniferous

forests, semi-arid regions and colder climates of northern and western North America provide unsuitable habitats for the species of this genus, and effectively isolate the few Asian species of *Callida* from the diverse American fauna. This distribution suggests that a faunal connection between Asia and North America occurred in the past.

The Bering Land Bridge which existed during Eocene times was probably forested by elements of the Arcto-Tertiary Geoflora, which at this time had a holarctic distribution at high latitudes. This would provide a pathway through which the ancestors of the Oriental species of *Callida* could disperse from the New World. At this time, the ancestral stock of *Callida* was probably trans-continental in North America. Following the Eocene, cooler climates restricted the Arcto-Tertiary Geoflora southward, away from the Bering region, permanently isolating the American and Asian callidine faunas. The latest at which this separation could have occurred was the Oligocene or the early Miocene. During the Miocene and Pliocene epochs, increasing aridity in western North America gradually eliminated much of the deciduous element of the Arcto-Tertiary Geoflora from this region, and with this sector of the flora, the ancestral species of *Callida* were restricted to the eastern and southern portions of the continent.

With the expansion of dry climates and the Madro-Tertiary Geoflora during the late Tertiary, a stock of the ancestral *Callida* developed adaptations for a more terrestrial existence, and occupied the semi-arid and arid regions of the west.

The descendants of this stock, *Philophuga*, *Tecnophilus*, and *Infernophilus*, more closely resemble eastern North American species of *Callida* than they do Mexican species. Hence, they were probably derived from the Arcto-Tertiary fauna, rather than from a Neotropical-Tertiary ancestor. On the other hand, the genus *Lecalida* resembles many of the Mexican species of *Callida*, and may be a northern extension of this group into the North American deserts. Thus, it is probably derived from a Neotropical-Tertiary ancestor.

The time and place of origin of the genus *Infernophilus* are obscure, for I know nothing of the habits of this genus and hence cannot trace the development of the necessary habitat.

After acquiring the basic terrestrial adaptation of slender legs, the ancestral stock of *Philophuga* has persisted with little modification. The derivative stock giving rise to *Tecnophilus* has acquired a number of specializations. This stock was derived from the stock ancestral to *Philophuga* probably during the Pliocene, as increased aridity resulted in the production of suitable habitats in the form of large salt flats and alkaline playas.

During the early Pliocene, the environment of western North America was one of low relief, and extensive plains covered much of this region. Mountains were not effective barriers at this time. During this period, the ancestral stock of *Philophuga* may have ranged widely throughout this area. Crustal unrest and the renewed mountain building processes of the later Pliocene probably isolated populations that evolved into the ancestors of *brachinoides*, *viridis* and *caerulea-viridicollis*.

The subspecies of *viridis* and the species *caerulea* and *viridicollis* do not appear to be completely separated from one another at present by geographical barriers such as mountains. The isolations that led to the evolution of these groups probably developed during glacial periods of the Pleistocene when mountain glaciers separated populations in the northern deserts and increased rainfall resulted in expanding forests which produced ecological bar-

riers in the southern deserts.

At this time, the same factors isolated populations of *Tecnophilus croceicollis*, and produced the geographical variation now shown by this species. I do not know what factors led to the isolation of *croceicollis* and *pilatei*. Perhaps *pilatei* was isolated on the Gulf Coast of Texas, and the presence of *croceicollis* in Texas is the result of a recent invasion from the west.

Floral movements have profoundly influenced the distribution and evolution of the Callidina. Thus, the endemic callidine fauna now found in western North America is the result of climatic, geological and resulting floral changes which have occurred in this region in Tertiary times.

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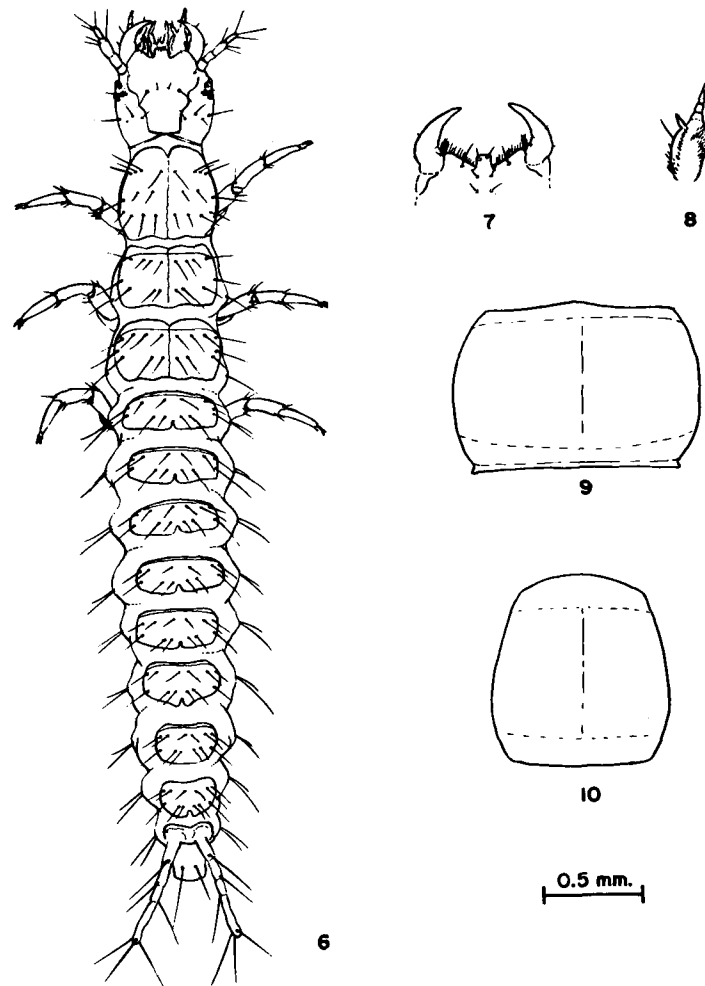
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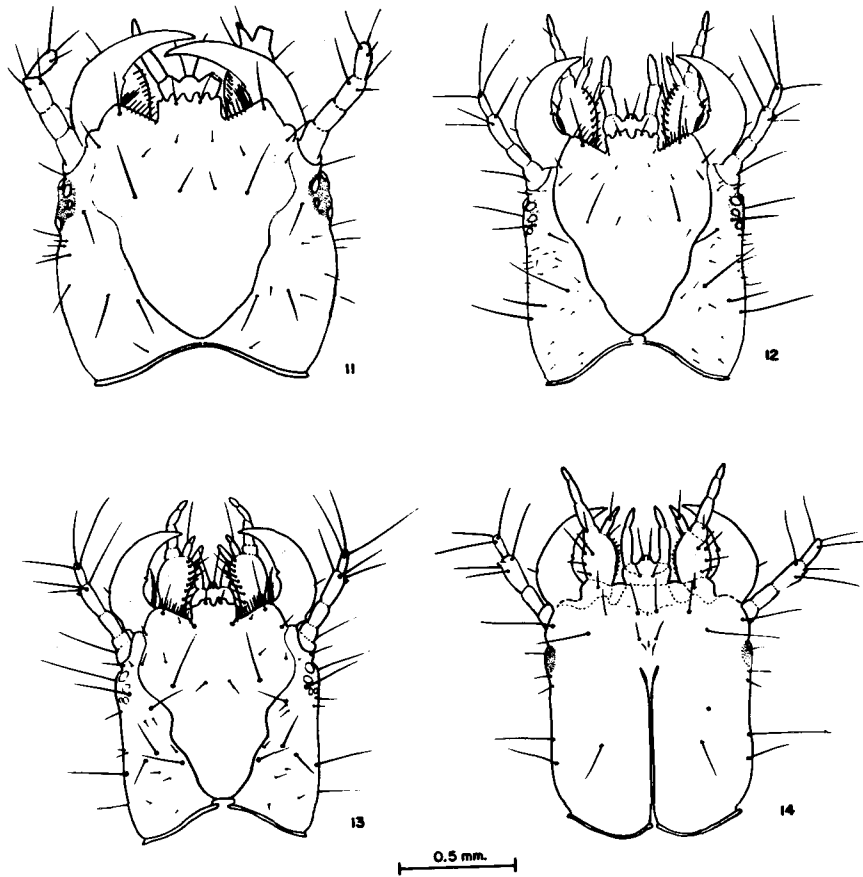
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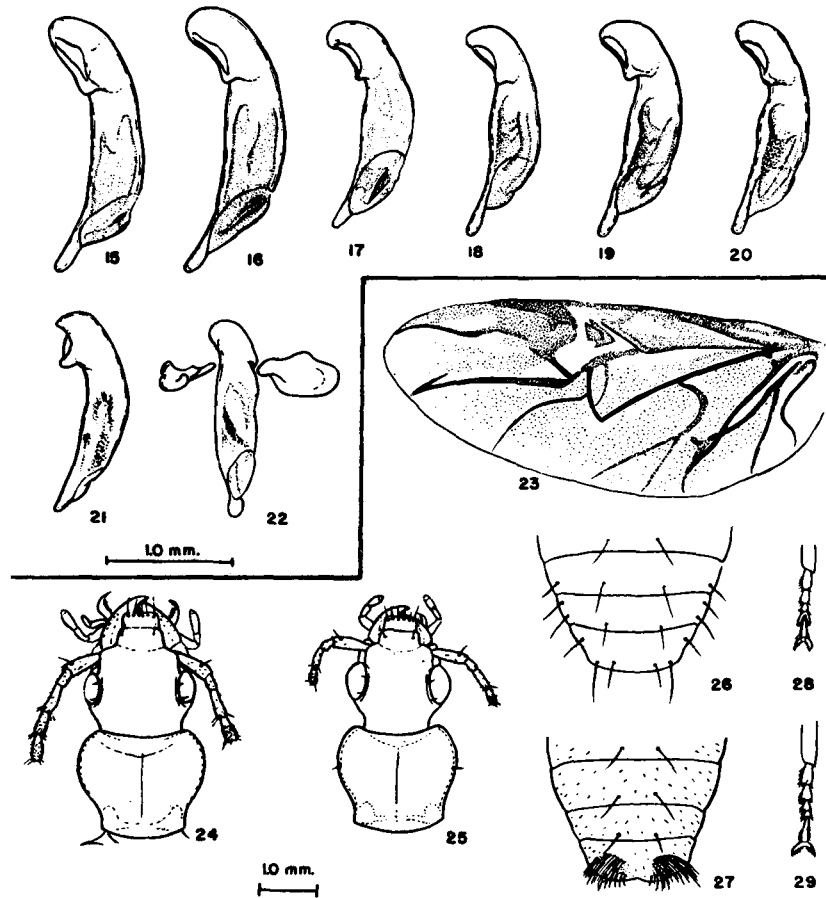
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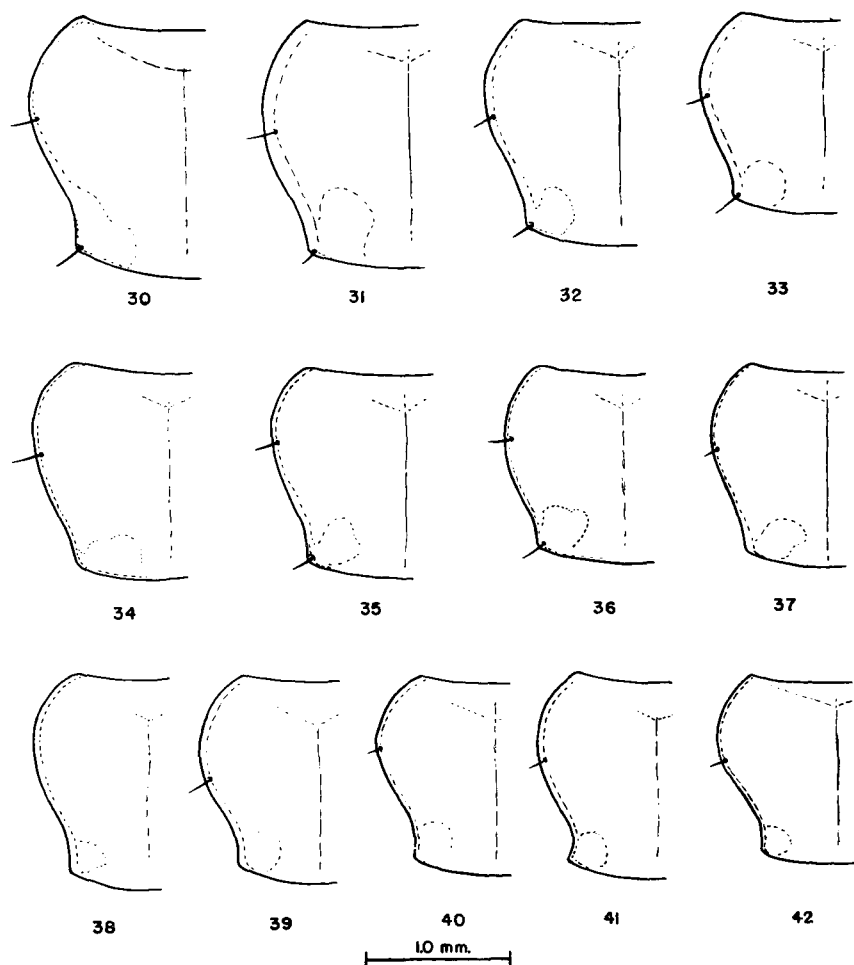
Figs. 6-10. 6. Larva of *Tecnoophilus croceicollis croceicollis* Ménétriés, first instar (Newark, California). 7. Nasale and mandibles of *Plochionus timidus* Haldeman. 8. Maxilla of *Plochionus timidus* Haldeman. 9. Pronotum of larva of *Philophuga viridicollis* LeConte, third instar, dorsal aspect. 10. Same of *Tecnoophilus croceicollis* Ménétriés.



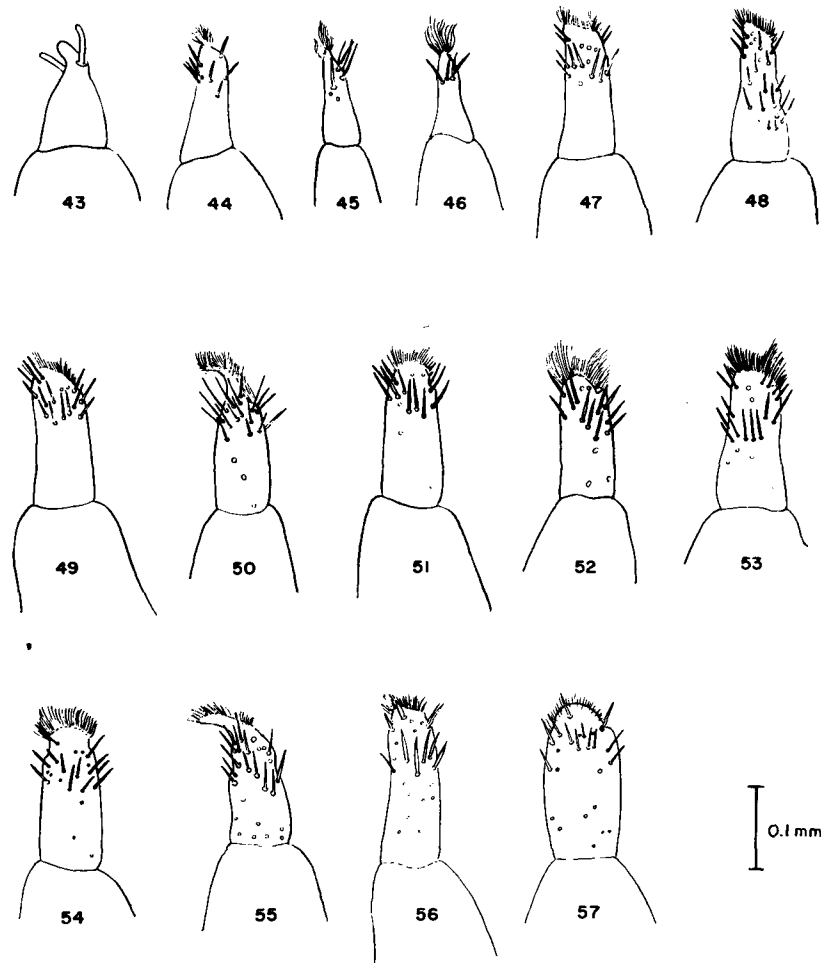
Figs. 11-14. Head capsule, third instar larva. 11. *Phophuga viridicollis* LeConte. 12. *Tecnophilus croceicollis croceicollis* Ménétriés. 13. *Tecnophilus croceicollis peigani* new subspecies, dorsal aspect. 14. Same, ventral aspect.



Figs. 15-29. 15. Male genitalia of *Philophuga viridicollis* LeConte, lateral aspect. 16. Same of *Philophuga caerulea* Casey. 17. Same of *Philophuga viridis viridis* Dejean. 18. Same of *Tecnophilus pilatei* Chaudoir. 19. Same of *Tecnophilus croceicollis croceicollis* Ménériés. 20. Same of *Tecnophilus croceicollis peigani* new subspecies. 21. Same of *Infernophilus castaneus* Horn, dorsal aspect, parameres included. 23. Left wing of *Philophuga caerulea* Casey. 24. Head and pronotum of *Tecnophilus croceicollis peigani* new subspecies, dorsal aspect. 25. Same of *Tecnophilus croceicollis croceicollis* Ménériés (Brownsville, Texas). 26. Abdomen of *Plochionus timidus* Haldeman, ventral aspect. 27. Same of *Infernophilus castaneus* Horn. 28. Front tarsus of *Callida decora* Fabricius. 29. Same of *Philophuga viridicollis* LeConte.



Figs. 30-42. Pronotum, left half, dorsal aspect. 30. *Infernophilus castaneus* Horn (Coleville, California). 31. *Philophuga viridicollis* LeConte (Monahans, Texas). 32. *Philophuga caerulea* Casey (Nogales, Arizona). 33. *Philophuga brachinoides* Bates (Nochixtlan, Oaxaca). 34. *Philophuga viridis amoena* LeConte (Medicine Hat, Alberta). 35. *Philophuga viridis horni* Chaudoir (Stockton, Utah). 36. *Philophuga viridis klamathea* new subspecies (holotype, Klamath Fall, Oregon). 37. *Philophuga viridis viridis* Dejean (San Francisco, California). 38. *Tecnophilus pilatei* Chaudoir (Brownsville, Texas). 39-41. *Tecnophilus croceicollis croceicollis* Ménétriés: 39. Brownsville, Texas; 40. Cuddeback Lake, California; 41. Alviso, California. 42. *Tecnophilus croceicollis peigani* new subspecies (paratype, Lost River Ranch, Alberta).



Figs. 43-57. Right stylus of female ovipositor, dorsal aspect. 43. *Euproctinus trivittatus* LeConte. 44. *Onota floridana* Horn. 45. *Plochionus amandus* Newman. 46. *Plochionus timidus* Haldeman. 47. *Callida punctata* LeConte. 48. *Callida viridipennes* Say. 49. *Callida purpurea* Say. 50. *Callida decora* Fabricius. 51. *Philophuga viridicollis* LeConte. 52. *Philophuga viridis viridis* Dejean. 53. *Philophuga viridis klamathea* new subspecies. 54. *Philophuga brachinoides* Bates. 55. *Tecnophilus pilatei* Chaudoir. 56. *Tecnophilus croceicollis croceicollis* Ménétriés. 57. *Infernophilus castaneus* Horn.

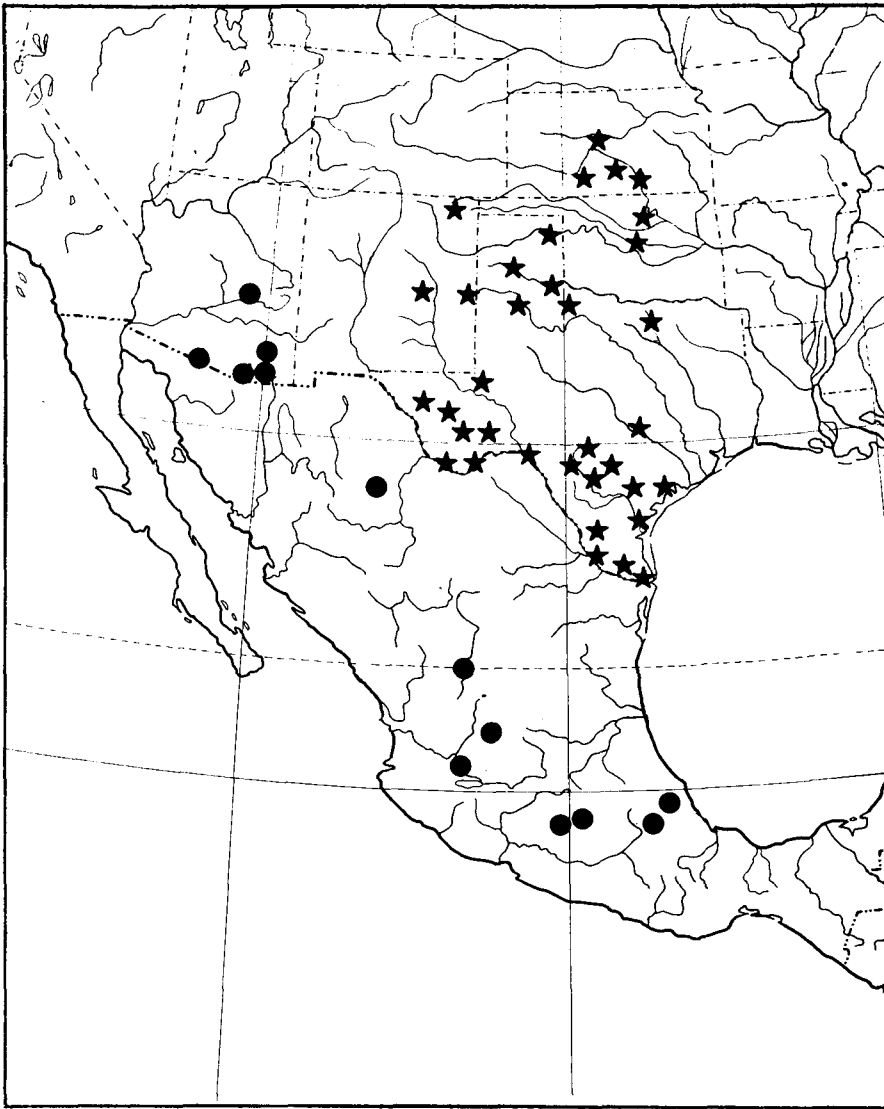


Fig. 58. Distribution of *Philophuga viridicollis* LeConte (★), and *Philophuga caerulea* Casey (●).

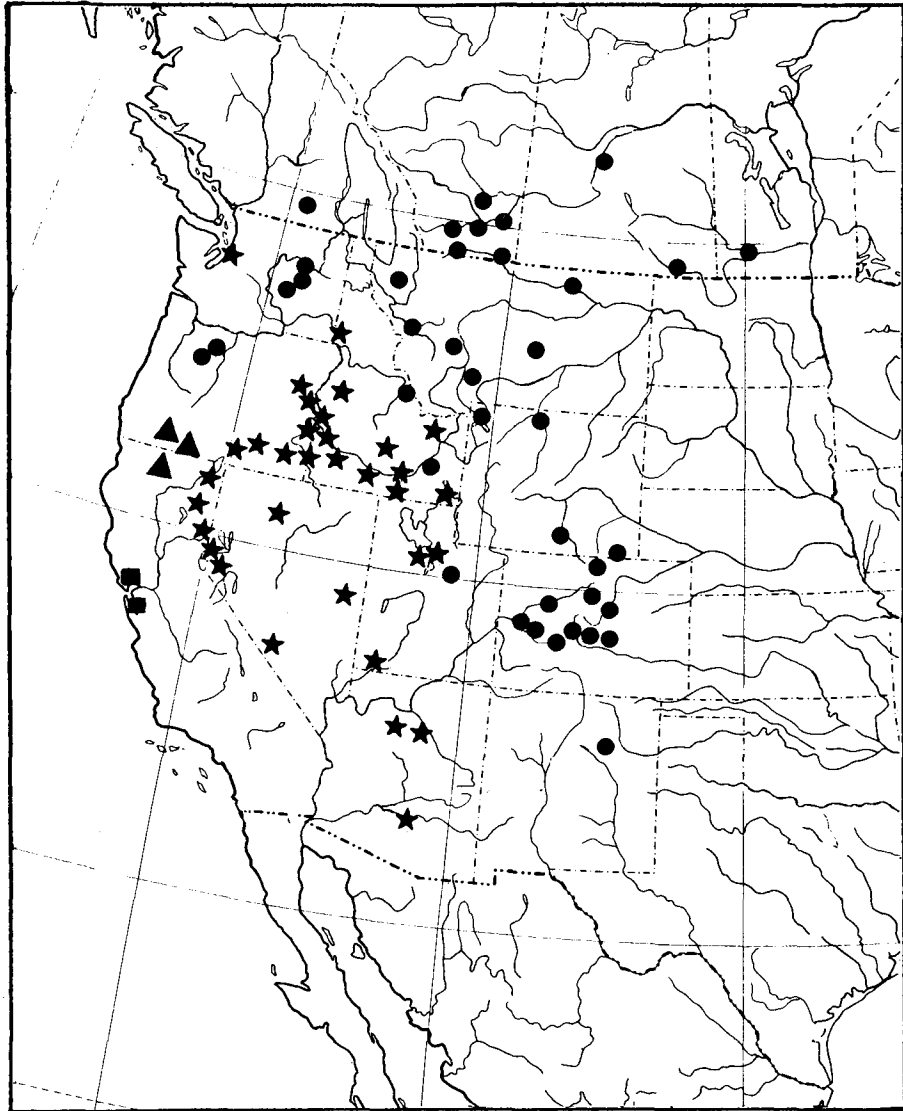


Fig. 59. Distribution of the subspecies of *Philophuga viridis* Dejean: ■, *v. viridis* Dejean; ▲, *v. klamathea* new subspecies; ★, *v. horni* Chaudoir, *v. amoena* LeConte.

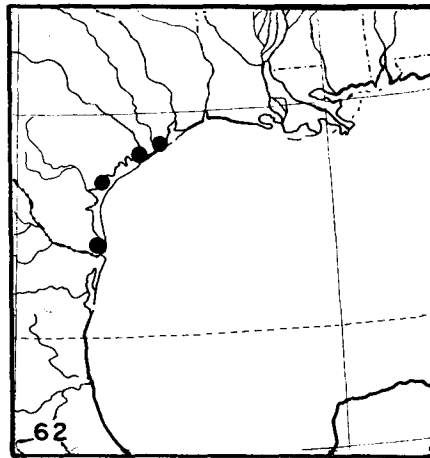
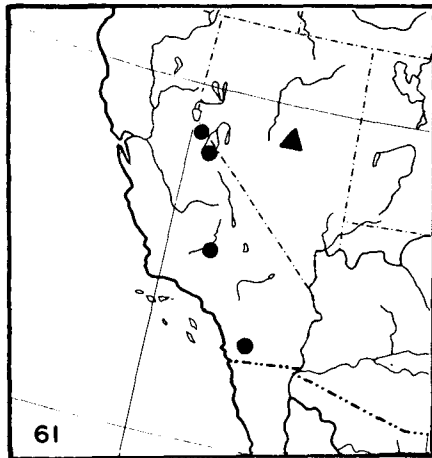


Fig. 60. Distribution of *Philophuga brachinoides* Bates. Fig. 61. Distribution of *Inferophilus castaneus* Horn. ▲ represents a state locality only. Fig. 62. Distribution of *Tecnophilus pilatei* Chaudoir.

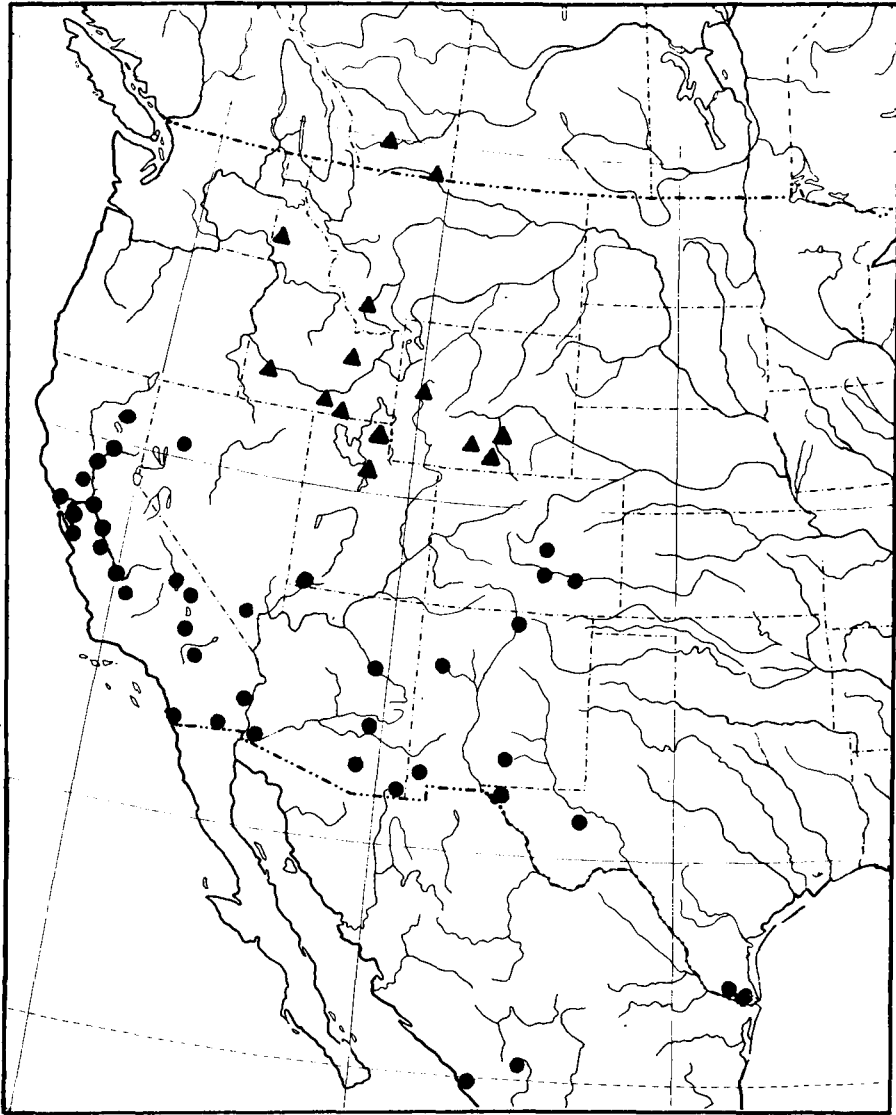


Fig. 63. Distribution of the subspecies of *Tecnoophilus croceicollis* Ménétriés: ● *croceicollis croceicollis* Ménétriés; ▲ *croceicollis peigani* new subspecies.