COMPARATIVE MORPHOLOGY OF NEW WORLD GENERA OF HALICTINE BEES (HYMENOPTERA: HALICTIDAE)

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ABSTRACT

COMPARATIVE MORPHOLOGY OF NEW WORLD GENERA OF HALICTINE BEES (HYMENOPTERA: HALICTIDAE)

by George Campbell Eickwort

Selected species from 25 of the principal New World Halictine genera were studied for the following morphological characters: compound eyes, epistomal sutures, occipital and hypostomal structure, labrum, mouthparts, pronotal and mesoscutal structure, front wings, tibial spurs of the hind legs, and male sternites. Most characteristics were clinal in nature; the male sternites, mouthparts, and tibial spurs proved most useful in relating genera.

A brief history and description of each genus based upon the literature was given. Several natural generic complexes were ascertained based upon the characters studied. The *Halictus-Lasioglossum* complex, primarily Holarctic and containing *Halictus*, *Seladonia*, *Lasioglossum*, *Hemihalictus*, *Evylaeus*, *Sphecodogastra*, *Dialictus*, and *Paralictus*, seems to have formed the base from which the endemic American genera arose. The *Agapostemon* complex, containing *Ruizantheda*, *Pseudagapostemon*, *Agapostemon*, and *Paragapostemon*, followed one line of evolution that included *Corynura*, *Callochlora*, and an unnamed genus "*A*", while the *Augochlora* complex, containing *Augochlorella*, *Augochora*, *Paroxystoglossa*, *Caenaugochlora*, and *Augochloropsis* followed another

line. The parasitic genera Sphecodes and Temnosoma arose from the Halictus and Augochlora complexes, respectively. The relationships of Neocorynura, Habralictus, and Megalopta could not be ascertained. Conclusions are tentative until more characters and more species can be studied.

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By

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I. INTRODUCTION

Interest in the sweat bees of the subfamily Halictinae (Hymenoptera: Halictidae) has recently been revived by the discovery of their primitively social biology. However, comparative biology within the group has been handicapped by ignorance concerning the natural limits of the genera and their phylogenetic relationships based upon their morphology. Indeed, no key is presently available for the South American genera.

Revisionary work on the genera of New World Halictinae has for the most part been limited in geographic scope and concerned only with gross general morphology. Michener (1944) presented a key to North American genera based upon a good number of valid characteristics and later (1954) extended his studies to genera of Central America. Mitchell (1960) contributed a great deal to the knowledge of eastern North American genera with his careful observations and drawings of the more important characteristics, particularly the genitalia and male sternites.

Even less work has been done on the group in South America. Moure recently has surveyed the Brazilian Halictines and has presented keys (1943b, 1950) to certain of the genera as well as describing a large number of new genera. But no published accounts on the genera of bees south of Brazil exist, and there are no published attempts to tie in North and South American genera. No authors have compared characteristics upon which genera are based across the whole range of the subfamily in the Western Hemisphere and no detailed discussions of the phylogeny of the group exist.

This study attempts to contribute to a better understanding of the New World Halictine genera and their phylogeny by selecting certain species from the principal genera of both North and South America and comparing certain morphological characteristics, some of which are often used for generic descriptions and some of which the author believes should be used more frequently.

This study is preliminary in scope. More characters (particularly genitalia) and more species per genus will have to be studied before conclusions as to the phylogeny of the group can be drawn.

II. PROCEDURE

Halictine bees of selected species from 25 New World genera and subgenera were examined critically as to the morphology of the following: compound eyes, epistomal sutures, occipital and hypostomal structure, labrum, mouthparts, pronotal and mesoscutal structure, front wings, tibial spurs of the hind legs, and male sternites. All but the last character were studied only in the females. The labra, mouthparts, wings, tibial spurs, and sternites were removed from the bees and studied on microscope slides; drawings of these parts were made from microprojections.

Results are reported character by character rather than genus by genus. In the ensuing discussion, a brief summary of the validity of the characters studied is followed by a genus by genus discussion, in which the history and previously used generic characteristics are denoted and the results of this study discussed. The conclusion summarizes the suspected phylogeny of the group, based upon the characters studied.

Determinations of unnamed specimens in the Michigan State University collection upon which this study is based were made by direct comparison with named species in the American Museum of Natural History and the United States National Museum and from specimens loaned by Dr. Charles D. Michener of the University of Kansas and by Mr. Robert R. Dreisbach of Midland, Michigan. Translations of pertinent literature in German, Spanish, and Portuguese were made by the author, with student help as acknowledged in the Latin and French translations. All literature pertaining to South American Halictines in the Michigan State University library was examined, and most of the remainder was obtained on inter-library loan or examined at the University of Michigan.

The following species have been utilized in this study. Species denoted by (♀) or (♂) indicate that those species were only studied in the female or male sex, respectively.

"*A*" *smaragdula* (Friese)
Agapostemon virescens (Fabricius) (♀)
Agapostemon cockerelli Crawford (♂)
Agapostemon nasutus Smith (♀)
Augochlora pura (Say)
Augochlora nigrocyanea Cockerell
Augochlora seitzi Cockerell (♀)
Augochlorella striata (Provancher)
Augochloropsis metallica (Fabricius)
Augochloropsis ignita (Smith)
Augochloropsis callista (Smith) (♀)
Caenaugochlora graminea (Fabricius) [= *nigromarginata* (Spinola)]
Caenaugochlora costaricensis (Friese) (♀)
Dialictus pilosus (Smith)
Dialictus imitatus (Smith) [= *inconspicuus* (Smith)]
Callochlora chloris (Vachal)
Callochlora aureoviridis (Friese) (♀)
Corynura chilensis (Spinola)
Corynura corynogaster (Spinola) (♀)
Evylaeus foxii (Robertson)
Evylaeus cinctipes (Provancher) [= *arcuatus* (Robertson)] (♀)

Habralictus maculiventris (Crawford) (♂)
Habralictus sp.
Halictus rubicundus (Christ)
Halictus parallelus Say
Halictus ligatus Say
Halictus (*Seladonia*) *confusus* Smith
Halictus (*Seladonia*) *hesperus* Smith (♀)
Hemihalictus lustrans (Cockerell) (♀)
Lasioglossum zonulum (Smith)
Lasioglossum coriaceum (Smith) (♀)
Megalopta genalis Meade-Waldo
Neocorynura pubescens (Friese) (♀)
Neocorynura sp.
Paragapostemon bruneri (Crawford)
Paralictus platyparius (Robertson) (♂)
Paralictus sp. (♀)
Paroxystoglossa brachycera Moure
Paroxystoglossa transversa Moure (♀)
Pseudagapostemon citrinicornis (Vachal) (♀)
Pseudagapostemon perzonatus (Cockerell) (♀)
Pseudagapostemon sp. (♂)
Ruizantheda mutabilis (Spinola)
Ruizantheda proxima (Spinola)
Sphecodes granulosus Sichel (♀)
Sphecodes spp.
Sphecodogastra texana (Cresson)
Temnosoma smaragdina Smith

III. RESULTS

HEAD

COMPOUND EYES (Females)

The inner margins of the compound eyes of the females converge both dorsally and ventrally, creating a more or less distinct indentation above the center of the inner margin. The eyes are clothed with widely and rather evenly scattered hairs, usually very short and fine and visible only under high magnification.

The eyes of *Halictus rubicundus* converge only feebly dorsally and ventrally, creating a weak rounded indentation on the inner margin about one-third the distance from the top (fig. 7). The hairs are very short and fine, visible only microscopically.

Within the species examined, the eyes vary as to the degree of emargination of the inner margin, the length of the hairs, and the size of the eyes. Unusually large eyes seem to be correlated with night vision, being present only in night-flying bees. These characters vary across a gradient, and there seems to be no well-defined boundaries around which to form natural groupings. The groupings delimited below should be considered arbitrary and probably artificial.

HALICTUS Grouping: Inner margins about as emarginate as in *H. rubicundus*. Hairs on eyes very short and fine, similar to *H. rubicundus*.

Halictus (*Seladonia*) *confusus*, *Halictus parallelus*, *Evylaeus foxii*, *Lasioglossum zonulum*, *Hemihalictus lustrans*, *Dialictus imitatus*, *Dialictus pilosus*, *Pseudagapostemon citrinicornis*, and *Habralictus sp.* are similar to *H. rubicundus*.

Halictus ligatus, *Paralictus sp.*, and *Sphecodes sp.* show slightly less emargination on the inner margins than does *H. rubicundus*, as illustrated by *Sphecodes granulosus*, fig. 1. The face is broad and the mandibles set farther apart than usual in the above groups, probably resulting in a secondary decrease of convergence in the eyes.

Sphecodogastra texana has unusually large eyes, probably correlated with its night-flying habits.

Paroxystoglossa brachycera and *Temnosoma smaragdina* have eyes slightly more emarginate than does *H. rubicundus*.

Agapostemon virescens displays an even more emarginate condition (fig. 2) and approaches the condition shown by the less emarginate members of the next grouping.

Megalopta genalis has greatly enlarged eyes, similar in emargination to *Agapostemon*. The hairs on the eyes are unusually small and scarcely visible even under the best conditions. *Megalopta* is also a night-flying bee.

AUGOCHLORA Grouping: Inner margins strongly emarginate. Hairs on eyes very short and fine, similar to those of *H. rubicundus*.

Augochlora pura represents the extreme in eye emargination in the Halictine species examined, as shown in fig. 4. *Augochlora nigrocyanea*, *Augochlorella striata*, *Neocorynura sp.*, and *Corynura chilensis* are similar.

Slightly less emarginate, approaching the condition of *Agapostemon*, are *Augochloropsis metallica* (fig. 3), *Augochloropsis callista*, *Augochloropsis ignita*, and *Corynura corynogaster*.

PARAGAPOSTEMON Grouping: Eyes usually slightly emarginate, similar to Halictus grouping. Hairs on eyes distinct, long, surrounded by border of eye surface with only microscopic hairs.

Ruizantheda proxima and *Ruizantheda mutabilis* have patches of long hair placed ventrad and caudad of center, surrounded by areas of eye surface with only microscopic hair (fig. 5). The eyes appear slightly more emarginate than in *H. rubicundus*. "*A*" *smaragdula* is similar but the long hair patches extend farther dorsad above the inner marginal notch.

Paragapostemon bruneri appears similar to *Ruizantheda* with the long hair patches extending farther dorsad. The eyes are shallowly emarginate, similar to *Agapostemon*. These observations are based on one specimen and must be considered tentative.

Callochlora chloris appears similar to *Ruizantheda*, although long hairs appear at least sporadically above the inner marginal indentation. The inner margin is quite strongly emarginate with an unique rounded notch, approaching the degree of emargination shown by *Augochloropsis*. *Callochlora aureoviridis* is similar. *C. chloris* is shown in figure 6.

CAENAUGOCHLORA Grouping: Eyes strongly emarginate, similar to *Augochlora*. Hair on eyes distinct, ranging from very short to long, without a well-defined border of only microscopic hairs.

This grouping contains bees whose eyes are virtually indistinguishable from *Augochlora*, such as *Caenaugochlora graminea*, to those with long eye hairs, similar in length to those of the Paragapostemon grouping, as *Caenaugochlora costaricensis*.

Probably *Caenaugochlora* does not deserve a separate ranking but is only an extreme in eye hairiness of the *Augochlora* grouping.

EPISTOMAL SUTURES (Females)

The epistomal sutures of the head delineate the clypeus dorsally and laterally. Three portions of the suture are apparent, one extending transversely across the head between the bases of the antennal sutures and delineating the clypeus dorsally, the other two extending on a curved surface from the dorso-lateral angles of the clypeus posteriorly and ventrally to the lateral angles of the clypeus at the anterior mandibular articulations, forming the boundaries of the clypeus laterally (fig. 7).

This study is concerned only with the latter portions of the epistomal suture. They are divided into two distinct parts by the anterior tentorial pits, the mesal sector running from the pit to the dorso-lateral angle of the clypeus and the lateral sector running from the pit to the lateral angle of the clypeus (fig. 8). There is a more or less distinct angle between the two sectors at the pit. The mesal sector is usually the weaker sector.

Figures used to illustrate the epistomal sutures are attempts to lay a line inscribed on the three-dimensional curved face of the insect onto a flat plane and therefore do not represent any one angle of view of the bee's head.

The mesal sector of the epistomal sutures of *Halictus rubicundus* is only slightly shorter than the lateral sector and is somewhat more deeply impressed or stronger. The two sectors meet in a broad obtuse angle at the anterior tentorial pit (fig. 8).

Within the species examined, the epistomal sutures vary as to relative length of the two sectors, the strength or depth of impression of the sutures, and the angle at which the two sectors meet. The relative length of the two sectors seems to be dependent upon the width of the head; those forms with wide heads have the lateral sectors considerably longer than the mesal sectors. The strength of the sutures seems to vary over a gradient and will be discussed only in extremes.

The angle formed at the anterior tentorial pit varies from a nearly straight angle to acute and forming a deep rounded lobe at the pit. The gradient between these extremes is nearly complete, and only two groupings could be formed. There does not appear to be any fundamental difference between the groupings and the division is probably entirely artificial.

HALICTUS Grouping: Angle between sectors varies from nearly a straight angle to about a right angle, with at most a weak rounded lobe.

The sectors form nearly a straight line at the anterior tentorial pit in *Callochlora chloris* (fig. 9), also in *Callochlora aureoviridis*. The suture is only slightly and gently bent at the pit in *Corynura corynogaster*, although less deeply impressed, especially laterally. *Corynura chilensis* is similar to *C. corynogaster*, with the angle slightly more rounded and the sutures slightly deeper impressed. *Neocorynura sp.* is essentially similar to *C. chilensis*, as is *Neocorynura pubescens*, approaching the condition of *H. rubicundus*.

Sphecodes sp. shows a broadly obtuse angle at the pit with the lateral sector of the suture weak. The lateral sector is often considerably longer than the mesal portion, as in *Sphecodes granulosus*, fig. 10, due to the broad head of many bees of this genus. Similar is *Paralictus sp.*, with weakly impressed sutures.

Halictus rubicundus shows a broadly obtuse angle at the pits, only slightly more angulate than *Paralictus*. Similar are *Halictus parallelus*, *Halictus (Seladonia) confusus*, *Halictus (Seladonia) hesperus*, *Evylaeus cinctipes*, and *Habralictus sp.* *Halictus ligatus* is similar but the sutures are weakly impressed.

Augochloropsis metallica shows a gently rounded curve at the pit, forming a very gradual obtuse angle (fig. 11) with well-defined sutures. *Augochloropsis callista* and *Augochloropsis ignita* are similar.

In *Ruizantheda mutabilis* the angle is slightly sharper than in *H. rubicundus* but the lateral sector still slants downwards, while in *Ruizantheda proxima* the angle is nearly a right angle and the lateral sector does not slant downwards. *Paroxystoglossa brachycera* is similar to *R. proxima*, while *Paroxystoglossa transversa* more closely approximates *R. mutabilis*. "*A*" *smaragdula*, *Augochlorella striata*, *Caenaugochlora graminea* (fig. 12), and *Caenaugochlora costaricensis* are also similar to *R. proxima*.

In *Lasioglossum zonulum* the lateral sector slants slightly upwards from the anterior tentorial pit, creating a right or slightly acute angle at the pit and a slightly lobed appearance at the angle (fig. 13). Bees with similar epistomal sutures are *Evylaeus foxii*, *Hemihalictus lustrans*, *Sphecodogastra texana*, *Dialictus pilosus*, and *Lasioglossum coriaceum*.

AUGOCHLORA Grouping: Angle between sectors acute, defining a distinct lobe.

A well-rounded lobe is found in *Megalopta genalis*. The lobe appears to be defined by more than one suture (fig. 14).

Agapostemon virescens exhibits a deep rounded lobe at the anterior tentorial pit, with the end of the lateral sector nearly at the level of the dorso-lateral angle of the clypeus. The sutures are comparatively deeply impressed (fig. 15). Similar are *Agapostemon cockerelli*, *Agapostemon nasutus*, *Paragapostemon bruneri*, *Pseudagapostemon citrinicornis*, and *Pseudagapostemon perzonatus*.

Augochlora pura also exhibits a deeply lobed condition, with the angle at the base of the lobe sharper, creating a less rounded lobe than in *Agapostemon*, as in fig. 16. The sutures are also comparatively deeply impressed. *Augochlora seitzi* and *Augochlora nigrocyanea* are similar.

Due to the heavily punctured condition of the face of *Temnosoma smaragdina*, the epistomal sutures could not be discerned below the anterior tentorial pits.

OCCIPITAL AND HYPOSTOMAL STRUCTURE (Females)

The occiput of the posterior portion of the head forms a cup-shaped concave depression, separated from the genal areas and vertex by a more or less well defined preoccipital ridge. At the bottom of the occipital depression the foramen magnum provides the passageway for internal organs connecting with the prothorax. The foramen magnum is surrounded by a narrow sclerite, the postocciput, with lateral and dorsal lobes projecting into the foramen. The posterior tentorial pits lie along the lower lateral borders of the postocciput (fig. 17).

The proboscidial fossa forms a deep depression on the ventral portion of the head as a receptacle for the mouthparts. The fossa is bordered by the hypostomal sutures and carinae which curve laterally to form the posterior margins of the mandibular sockets. Most of the floor of the proboscidial fossa is sclerotized, forming the hypostomal bridge. A suture which I am calling the hypostomal bridge suture extends along the mesal line of the hypostomal bridge and branches into a V to end near the base of the mandibles. Another suture runs from the center of the posterior border of the hypostomal suture towards the foramen magnum, branching in a V to join the ventral border in the postocciput. This I am calling the postoccipital bridge suture (fig. 18).

In Halictus rubicundus the preoccipital ridge is rounded and not at all carinate and the occiput is gradually concave. The postoccipital bridge suture is closed about two-thirds of its distance from the hypostomal suture before opening into a V. The hypostomal bridge is comparatively long, with the hypostomal bridge suture closed over half of its distance from the posterior margin of the fossa before branching into a V. The hypostomal suture posterior to the mandibles is gently rounded.

In the species studied, the preoccipital ridge varies from being rounded and poorly defined to carinate. The occiput may be gradually concave to deeply indented, almost parallel to the long axis of the body. The postoccipital bridge suture varies in the length of its open V, as does the hypostomal bridge suture. The proboscidial fossa varies in its relative length and width, and the hypostomal suture varies in its shape posterior to the mandibles. The postocciput was not studied.

The groupings described below are not clearly limited and should be viewed as arbitrary and probably largely artificial.

HALICTUS Grouping: Preoccipital ridge rounded, not carinate. Proboscidial fossa variable in relative length and width, but hypostomal bridge covering most to nearly all of its floor behind the mandibles. Hypostomal suture posterior to the mandibles gently rounded or transverse. Hypostomal bridge suture notched from slightly half of its length to completely open, with no fused portion. Postoccipital bridge suture very slightly notched to notched about two-thirds of its length.

In bees similar to *Halictus rubicundus*, the hypostomal bridge suture is notched about half of its length and the postoccipital bridge suture is notched about one-third of its length or less. *Halictus ligatus*, *Halictus parallelus*, and *Hemihalictus lustrans* are similar. *Sphecodogastra texana* is similar although the occiput is more deeply sunken. *Megalopta genalis* is similar, with the hypostomal bridge suture notched only about one-third of its length. *Paragapostemon bruneri* has the base of the postoccipital bridge suture expanded and surrounding the base of the postocciput (fig. 20).

The hypostomal bridge suture is notched about two-thirds of its length and the postoccipital bridge suture is notched up to half of its length in *Halictus* (*Seladonia*) *confusus*, *Lasioglossum zonulum*, and *Lasioglossum coriaceum*.

The hypostomal bridge suture is notched to its apex and the postoccipital bridge suture is notched about two-thirds of its length in *Dialictus pilosus*, *Evylaeus foxii*, and *Evylaeus cinctipes*. *Paralictus sp.* is similar but the occiput is more deeply sunken. *Pseudagapostemon citrinicornis* is similar with the hypostomal bridge slightly shorter.

"*A*" *smaragdula* differs in its wider occiput.

Sphecodes sp. probably belongs here. It differs from the above by the preoccipital ridge which is sharp-angled although not carinate. The hypostomal bridge suture is open to its apex and the hypostomal suture behind the mandibles is transverse, fig. 23, while the postoccipital bridge suture is similar to that of *H*. *rubicundus*. *Sphecodes granulosus* is similar except that the hypostomal suture behind the mandibles is gently curved.

CORYNURA Grouping: Preoccipital ridge rounded, not carinate. Occiput not deeply indented. Proboscidial fossa wide with hypostomal bridge covering comparatively little of its floor. Hypostomal suture posterior to the mandibles gently rounded. Hypostomal bridge suture notched from two-thirds of its length to its entire length. Postoccipital bridge suture notched from two-thirds of its length to completely notched.

Ruizantheda proxima and *Ruizantheda mutabilis* have the hypostomal bridge suture notched about two-thirds of its length and the postoccipital bridge suture notched about three-fourths of its length (fig. 22).

In *Corynura chilensis* the hypostomal bridge suture is closed before its apex, while in *Callochlora chloris* the suture is notched to its apex. Both have the postoccipital bridge suture notched about two-thirds of its length. *Corynura corynogaster* has both the hypostomal bridge suture and postoccipital bridge suture notched to their apices (figs. 24 and 21).

Habralictus sp., on the basis of one poor specimen, appears also to be of this grouping. The postoccipital bridge suture is notched to its base and broadly rounded. The hypostomal bridge suture is difficult to discern but may be of the same configuration.

AGAPOSTEMON Grouping: Preoccipital ridge sharp-angled but not definitely carinate. Proboscidial fossa variable in relative length and width, but hypostomal bridge covering most to nearly all of its floor behind the mandibles. Hypostomal suture posterior to the mandibles strongly rounded. Notch in hypostomal bridge suture varies from nearly absent to completely open with almost no fused portion. Postoccipital bridge suture varies from very slightly notched to two-thirds notched.

Temnosoma smaragdina exhibits a very sharply angled preoccipital ridge dorsally, more rounded laterally. The occiput is deeply sunken. The hypostomal bridge suture and postoccipital bridge suture are similar to those of *H. rubicundus*.

Agapostemon virescens shows a long hypostomal bridge with its suture notched less than half-way (fig. 25). The postoccipital bridge suture is similar to that of *H. rubicundus*.

Caenaugochlora graminea may show a slight carina dorsally on the preoccipital ridge. The occiput is deeply sunken. The hypostomal bridge suture is notched about two-thirds of its length and the postoccipital bridge suture is similar to that of *H. rubicundus*.

The hypostomal bridge is short and its suture notched about three-fourths of its length in *Augochlorella striata*. The postoccipital bridge suture is notched about two-thirds of its length. *Paroxystoglossa brachycera* is similar but the hypostomal bridge is longer and its suture is notched nearly to its apex.

AUGOCHLORA Grouping: Preoccipital ridge sharp-angled and at least partially carinate. Proboscidial fossa variable in relative length and width, but hypostomal bridge covering most to nearly all of its floor behind the mandibles. Hypostomal suture posterior to mandibles varies from strongly rounded to transverse. Hypostomal bridge suture notched from half to two-thirds of its length, postoccipital bridge suture similar to that of *H. rubicundus*.

Augochloropsis metallica is arbitrarily placed in this group; it closely resembles the *Agapostemon* grouping. The preoccipital ridge is weakly carinate and the occiput is deeply sunken. The hypostomal carinae are strong, particularly in the most posterior portion. The hypostomal suture posterior to the mandibles is rounded similar to that of *Agapostemon* and the hypostomal bridge suture is notched for half of its length.

Neocorynura sp. also has a weakly carinate preoccipital ridge. The hypostomal sutures resemble those of *H. rubicundus*. The hypostomal bridge suture is notched about two-thirds of its length.

Augochlora pura has a strongly carinate preoccipital ridge (fig. 27). The hypostomal carinae are also strong and the hypostomal suture is pointed at its angle between the posterior base of the mandible and the edge of the proboscidial fossa. The hypostomal bridge suture is notched about half of its length (fig. 26). *Augochlora nigrocyanea* is similar.

LABRUM (Females)

The labrum hangs as a movable sclerite from the apex of the clypeus. In the females the labrum consists of two distinct parts, a raised base and a depressed projection extending from its apex, called the apical process. The base is provided with a central raised area, the basal tubercle. The apical process is provided medially with a perpendicular rounded lobe extending its length, the apical lobe. The lower margins of the base and outer margins of the apical process are provided with a single row of setae, the labral fimbria.

In *Halictus rubicundus* the base is approximately rectangular with a central basal tubercle which is weakly bilobed dorsally. The apical process is in the form of a rounded triangle, longer than broad. An apical lobe is present. Labral fimbria line the apical process and lower margins of the base (figs. 28 and 29).

Labra vary in the species studied as to the shape of the base and the nature of the basal tubercle, the shape of the apical process, and rarely as to the presence or absence of the apical lobe. All diagrams with the exception of that of *H. rubicundus* do not show the labral fimbria.

HALICTUS Grouping: Base essentially rectangular, with basal tubercle centrally located and not or slightly divided. Apical process triangular or forming a rounded lobe, longer than wide, pointed or rounded at apex, and narrower than base. Apical lobe present, similar to that of *H. rubicundus* or rarely flat-topped. Labral fimbria present, similar to that of *H. rubicundus*.

In *Neocorynura sp.* the apical process is triangular and little wider than the apical lobe. The basal tubercle is oblong, longer than wide (fig. 30). *Habralictus sp.* displays a similar apical process, but on the basis of one specimen it was impossible to determine the nature of the basal tubercle.

The apical process is triangular and pointed at its apex and the basal tubercle is wider than long or as wide as long in *Evylaeus cinctipes*, *Evylaeus foxii*, *Dialictus pilosus*, *Lasioglossum zonulum*, *Sphecodogastra texana*, *Halictus* (*Seladonia*) *confusus*, *Ruizantheda mutabilis*, "*A*" *smaragdula*, *Augochlorella striata*, *Augochlora pura*, and *Augochlora nigrocyanea*. *Callochlora chloris* is similar except that the apical lobe is flat-topped (fig. 31). *Caenaugochlora graminea* has a concavity in the basal tubercle, giving it a ridged surface (fig. 32). In *Pseudagapostemon citrinicornis* the base is comparatively long, making the basal tubercle longer than wide (fig. 33). In *Paroxystoglossa brachycera* the basal tubercle is weakly bilobed.

The apical process is triangular and rounded at its apex and the basal tubercle is wider than long or as wide as long in *Halictus rubicundus*, *Halictus parallelus*, *Halictus ligatus*, *Lasioglossum coriaceum*, *Hemihalictus lustrans*, *Paragapostemon bruneri*, and *Ruizantheda proxima*. The apical process forms a rounded rectangular lobe in *Agapostemon virescens* (fig. 34).

CORYNURA Grouping: Base essentially triangular, with basal tubercle centrally located and not divided. Apical process triangular, as wide as the base and pointed at its apex. Apical lobe present, similar to that of *H. rubicundus*, as is the labral fimbria. This grouping may not be distinct from the *Halictus* grouping.

This grouping includes *Corynura corynogaster* and *Corynura chilensis* (fig. 35).

AUGOCHLOROPSIS Grouping: Base essentially rectangular with basal tubercle centrally located, divided medially to form two parallel longitudinal tubercles. Apical process broadly rounded to form a lobe as wide as the base. Apical lobe present, similar to that of *H. rubicundus*. Labral fimbria present.

This grouping includes *Augochloropsis metallica* and *Augochloropsis callista* (fig. 36).

MEGALOPTA Grouping: Base essentially rectangular with central basal tubercle occupying most of base, weakly bilobed. Apical process broadly triangular, equal in width to base, rounded at apex. Labral fimbria weak, on outer surface of apical process rather than on margins. Apical lobe two-parted, a small lobe superimposed basally on the usual large lobe (figs. 37 and 38).

This grouping contains *Megalopta genalis*.

SPHECODES Grouping: Base rectangular to linear, with basal tubercle either weakly defined, running width of base, or apparently absent. Apical process as wide as base, may not be separated from same, forming a broadly rounded or emarginate lobe. Apical lobe absent. Labral fimbria line outer margin of apical process, weaker than in *H. rubicundus*. This grouping contains the parasitic genera of Halictinae.

Paralictus sp. most closely resembles the *Halictus* grouping. The base is rectangular to weakly triangular with a slightly raised basal tubercle, longer than broad. The apical process is somewhat rectangular, rounded and emarginate at apex (fig. 40).

Sphecodes sp. has a linear base bordered apically by a linear basal tubercle. The apical process is spatulate, narrowed towards the apex and rounded and bilobed apically (fig.   ). *Sphecodes granulosus* is similar but not bilobed apically (fig. 41).

On the basis of one specimen, Temnosoma smaragdina could not be completely described. The base does not appear to be separated from the apical process and the labrum is emarginate apically (fig. 42).

MOUTHPARTS (Females)

At rest the mouthparts fold inside the proboscidial fossa with the exception of the mandibles which fold across the fossa anteriorly, also overlapping the labrum. The mandibles in the females may be toothed or not. The maxillae, labium, and hypopharynx function jointly as a proboscis or sucking tube. The maxillae and labium are jointed at about their centers so that they may fold into the proboscidial fossa at rest; this joint is the posterior extremity of the proboscis at rest and also marks the basic dividing point between the sclerites of the maxillae and labium. Basad to this joint the mouthparts are mostly membranous and fused. Anterior conjunctival thickenings and associated membrane joins the apical portion of the proboscis distad of the joint and joins the anterior end of the mouth cavity, forming the anterior portion of the base of the sucking tube and providing a mechanism for withdrawing the proboscis. These were not studied. The posterior portion of the base of the sucking tube is formed by the conjunctival thickening, analogous to the mentum, attached apically to the prementum of the labium, and the cardines of the maxillae which are joined laterally to the conjunctival thickening (fig. 43). The cardines attach basally to the head and apically to the stipites of the maxillae. The floor of the mouth cavity contains the pharyngeal plate which is connected by membrane to the basal portion of the proboscis and basally has two sclerotized rods, the pharyngeal rods, which extend into the pharynx (fig. 44).

The apical portion of the proboscis is formed by the more heavily sclerotized apical halves of the maxillae which enclose laterally the equally sclerotized apical half of the labium, forming the only visible parts of the proboscis when at rest and folded in the proboscidial fossa. The stipes of the maxilla joins the cardo basally; at its apex the six-segmented maxillary palpus arises from a membranous area, the "tasterausschnitt". The galea is obliquely joined to the stipes along its inner margin. The apical portion of the galea is margined with hairs and may be flexed along a line just distad of the maxillary palpus (fig. 46).

The prementum of the labium joins the conjunctival thickening basally. Ventrally the prementum is entire; dorsally the prementum shows two infolded flaps under which appear apically two slender sclerotized rods of uncertain origin. A composite view of the prementum is shown in fig. 45. Ventrally two four-segmented labial palpi arise from membranous areas just distad of the prementum, called the palpigers. A sclerotized brace, the subligular plate, arises ventrally from the center of the apex of the prementum, divides into two branches just basal of the glossa, and each branch extends around the labium to the dorsal surface, where they juncture below the glossa to form the ligular arms. Dorsally two paraglossae arise distad of the prementum. The paraglossae are flat, largely membranous, folded structures lined apically with hairs. The opening of the salivarium may be seen between the paraglossae. The glossa arises just distad of the ligular arms; it is striated transversely and lined with longitudinal hairs. Ventrally the glossa exhibits a median differentiated "tube". The glossa and paraglossae together constitute the ligula. The ligula and apical portion of the prementum are shown dorsally in figure 48, ventrally in figure 47. The glossa can be withdrawn into the labium.

In Halictus rubicundus the conjunctival thickening of the base of the labium is weakly sclerotized and divided medially, being fused indefinitely near its base. The cardines are slender and heavily sclerotized and are joined laterally to the conjunctival thickening by membrane. The pharyngeal plate is very weakly sclerotized while the pharyngeal rods are more heavily sclerotized, linear, and bowed to form an arch with the "tips" (actually the base) converging.

The prementum and the apical portions of the maxillae are of medium length; the prementum about 4-1/2 times as long as wide at its widest point and the galea and stipes about 6 times as long as wide at their widest point. The maxillary palpi are of medium length, about one-third that of the galea and stipes, with segment 3 extending to the apex of the galea. Segments 2 through 6 are subequal in length; segment 6 is the narrowest; and segment 1 is shorter than the others. The tip of the galea is differentiated into a rounded lobe.

The subligular plate and the ligular arms are as figured, with the ligular arms forming a heavily sclerotized broadly V-shaped brace. Segments 2 through 4 of the labial palpi are subequal in length, 4 narrowest and 1 longer and subequal in length to the second and third combined. The glossa is flattened, triangular, about twice as long as wide at its widest point, and is subequal in length to the labial palpi. The paraglossae are flat and blade-like, folded, largely membranous and not excessively hairy, and are subequal in length to the glossa. The mandibles have a subapical tooth (fig. 49).

In the species studied, the conjunctival thickening at the base of the prementum varies in sclerotization from two weakly sclerotized strips to a heavily sclerotized well-defined structure fused laterally to the cardos. This characteristic was not studied intensively over the range of species, although the extreme in sclerotization is illustrated by that of *Agapostemon virescens*, fig. 50. The pharyngeal rods vary in width and may be hooked at their "tips".

The mouthparts may be lengthened by lengthening the prementum and apical portions of the maxillae and by lengthening the ligula. The prementum, galea, and stipes may vary in relative length versus width. In extreme cases the prementum may be so narrow as to appear triangular in cross-section, deeper than wide; in this condition the labium does not lie flat on a microscope slide and the ligula consequently is very difficult to decipher. The glossa and paraglossa may be very long, linear in shape, and very hairy. The ligular arms may differ in structure, sometimes forming a deeply notched V.

The relative length of the first segment to the remaining segments of both the labial and maxillary palpi may vary. In addition, the ratio of the length of the palpi to the apex of the galea may vary so that various segments of the maxillary palpus would reach the apex if extended parallel. The mandibles are usually toothed similar to those of *H. rubicundus*, occasionally the subapical tooth may be situated apically, forming a bidentate condition, or be absent. In one case more than one subapical tooth is present.

HALICTUS Grouping: Conjunctival thickening at base of prementum weakly sclerotized. Pharyngeal rods narrow and arched, without basal hooks, similar to those of *H. rubicundus*. Prementum and galea and stipes of medium to rather short length, length of prementum 3-1/2 to 5 times width, length of galea and stipes 5 to 8 times width. Palpi of variable length, maxillary palpus 1/2 to 2/7 length of galea and stipes. First segment of maxillary palpus shorter than others, first segment of labial palpus as long as second plus third to as long as second, third, and fourth. Ligular arms form a broad V, similar to those of *H. rubicundus*. Glossa triangular and flat, length 1-1/2 to 2-1/2 times width, similar to that of *H. rubicundus*. Paraglossae similar to those of *H. rubicundus*. Mandibles with subapical tooth.

The length of segment 1 of the labial palpus is equal to 2 plus 3, and the third to the fourth segment of the maxillary palpus reaches the apex of the galea when parallel in *Halictus rubicundus*, *Halictus (Seladonia) confusus*, *Sphecodogastra texana*, *Evylaeus foxii*, *Lasioglossum zonulum*, *Lasioglossum coriaceum*, *Dialictus pilosus*, *Dialictus imitatus*, *Ruizantheda proxima*, *Ruizantheda mutabilis*, and "*A*" *smaragdula*. *Evylaeus cinctipes* has somewhat longer maxillary palpi, half as long as the galea and stipes and with 2-1/2 segments reaching the apex of the galea when parallel.

The length of segment 1 of the labial palpus is equal to 2, 3 and 4, and the fourth segment of the maxillary palpus reaches the apex of the galea when parallel in *Halictus parallelus* and *Hemihalictus lustrans*. In *Halictus ligatus* the length of segment 1 of the labial palpus is equal to 2, 3, and 4, and the fifth segment of the maxillary palpus reaches the apex of the galea when parallel.

SPHECODES Grouping: Similar to the *Halictus* grouping, mouthparts tend to be shorter. Mandibles slender and curved, sickle-shaped, subapical tooth small or missing. Probably not distinct from the above grouping.

Sphecodes sp. and *Paralictus sp.* have shorter mouthparts than is usual with the *Halictus* grouping, with galea and stipes about 5 times longer than wide and the prementum about 3-1/2 times longer than wide. The maxillary palpi are about half as long as the galea and stipes and 2-1/2 segments reach the apex of the galea when parallel. The mandibles are long with no subapical tooth (fig. 55).

However, other *Sphecodes spp.* have longer mouthparts and subapical teeth. *Sphecodes granulosus* has the galea and stipes about 7-1/2 times longer than wide and the prementum 4 times longer than wide, with the maxillary palpus 2/5 as long as the galea and stipes with segment 3 reaching the apex when parallel. Its mandibles have no subapical teeth.

HABRALICTUS Grouping: Similar to the *Halictus* grouping except mouthparts are very short. Galea and stipes about 4 times longer than wide, prementum about 3 times longer than wide (figs. 58 and 61). Maxillary palpus about half as long as galea and stipes, segment 3 reaching apex when parallel. Probably not distinct from the *Halictus* grouping.

This grouping contains *Habralictus sp.*

CORYNURA Grouping: Similar to *Halictus* grouping except for distinct row of thick hairs on galea opposite maxillary palpus (fig. 59). Galea and stipes and prementum of medium length, maxillary palpi tend to be longer than usual, from 1/2 to 2/5 as long as galea and stipes and with 2-1/2 to 3 segments reaching the apex of the galea when parallel.

This grouping includes *Corynura chilensis*, *Corynura corynogaster*, and *Callochlora chloris*.

AUGOCHLORA Grouping: Conjunctival thickening at base of prementum usually strongly sclerotized. Pharyngeal rods slightly expanded and arched with basal hooks usually well defined (fig. 51). Prementum and galea and stipes long to very long, length of prementum 5-1/2 to 10-1/2 times its width, length of galea and stipes 7-1/2 to 15 times their width. Palpi of variable length, maxillary palpus 2/5 to 1/4 length of galea and stipes, first segment of palpus as long as or longer than others. First segment of labial palpus about as long as second plus third to as long as second, third, and fourth. Ligular arms form a long narrow V, as in fig. 54. Glossa narrowly triangular to linear, length usually over 3 times its width, longer than labial palpi. Glossa and paraglossae with long hairs. Mandibles with subapical tooth or two apical teeth (bidentate).

Neocorynura sp. exhibits some characteristics of the *Halictus* grouping. Its glossa is short, length about twice its width although longer than the labial palpi. The structure of the glossa and paraglossae resemble that of *Halictus* although the ligular arms are typically *Augochlora*-like structure. The prementum and the galea and stipes are the shortest of this grouping. The third segment of the maxillary palpus reaches the apex of the galea when parallel, and the first segment is shorter than the others. The pharyngeal rods have small basal hooks.

The glossa of *Augochlorella striata* is also short, length about twice its width, but its structure resembles that of *Augochlora* in other characteristics. The first segment of the labial palpus is equal in length to the second, third, and half of the fourth.

Augochlora pura, *Augochlora nigrocyanea*, *Augochloropsis metallica*, *Augochloropsis callista*, and *Paroxystoglossa brachycera* have long glossae, length 3 or more times their width, with the prementum up to 8 times longer than wide and the galea and stipes up to 10 times longer than wide (figs. 63 and 60). The first segment of the maxillary palpus is subequal or nearly so to the others and the length of the first segment of the labial palpus varies from slightly shorter than 2 plus 3 (*A. pura* and *A. metallica*) to as long as 2, 3, and half of 4 (*P. brachycera*). The second or third maxillary palpus segment reaches the apex of the galea when parallel. The mandibles of *A. pura* and *A. nigrocyanea* are bidentate apically (fig. 56).

Caenaugochlora graminea exhibits the extreme in elongation of this grouping. The glossa is very long, the prementum about 10-1/2 times longer than wide and triangular in cross-section, as deep as wide. The galea and stipes are about 15 times longer than wide with the first segment of the maxillary palpus longer than the others, the fifth reaching the apex of the galea when parallel. The first segment of the labial palpus is as long as the second, third, and fourth.

AGAPOSTEMON Grouping: Similar to the *Augochlora* grouping, but pharyngeal rods not hooked at "tips", expanded basally (fig. 52), and ligular arms form a narrow V of somewhat different structure (fig. 53). Prementum and galea and stipes long to very long, glossa 3 to 4 times longer than wide. First segment of labial palpus as long as second, third and half or all of fourth. Maxillary palpus short, 1/4 to 1/5 as long as galea and stipes, 5 to 5-1/2 segments reach the apex of the galea when parallel, first segment shorter than the others. Mandibles with subapical tooth. Possibly not distinct from the *Augochlora* grouping.

Pseudagapostemon citrinicornis has the shortest mouthparts, with the galea and stipes about 9-1/2 times longer than wide and the prementum about 5-1/2 times longer than wide.

Agapostemon virescens and *Paragapostemon bruneri* have very long narrow mouthparts, with the galea and stipes 10-1/2 to 12 times longer than wide and the prementum about 7-1/2 times longer than wide.

TEMNOSOMA Grouping: Similar to the *Augochlora* grouping except mandibles without subapical teeth. Mouthparts shorter than in the *Augochlora* grouping, length of prementum about 4-1/2 times width, length of galea and stipes about 7-1/2 times width. Maxillary palpus long, about 2/3 length of galea and stipes, 2-1/2 segments reach apex of galea when parallel, first segment subequal in length to others. First segment of labial palpus shorter than 2 plus 3. Glossa short and triangular, length about 1-1/2 times width, shorter than labial palpi.

This grouping includes *Temnosoma smaragdina*.

MEGALOPTA Grouping: Conjunctival thickening at base of prementum strongly sclerotized. Pharyngeal rods narrow, strongly arched, no basal hooks. Prementum and galea and stipes very narrow and long, prementum about 8 times longer than wide, triangular in cross-section and deeper than wide (fig. 62), galea and stipes about 10 times longer than wide. Maxillary palpus of medium length, about one-third of galea and stipes, 2-1/2 segments reaching apex of galea when parallel, first segment longer than the others. First segment of labial palpus as long as second, third, and half of the fourth. Glossa very long, linear, glossa and paraglossae with plentiful long hairs. Mandibles with irregular cutting edge, several subapical teeth (fig. 57).

This grouping contains *Megalopta genalis*. The structure of the apical portion of the proboscis strongly suggests that of *Caenaugochlora graminea*.

MESOSOMA

PRONOTAL AND MESOSCUTAL STRUCTURE (Females)

The pronotum forms a narrow collar immediately behind the head. With the head removed, the pronotum can be seen to terminate anteriorly in a raised pronotal lip, colored yellow or light brown. Dorsally the pronotum is seen to be angulate, with two projections, one on either side of a lateral projection of the mesoscutum, the antero-lateral process of the mesoscutum. The anterior of these projections is the lateral angle of the pronotum, the posterior is the dorsal surface of the posterior lobe of the pronotum. The dorsal ridge, often carinate, joins these projections. The posterior lobe, which covers the first thoracic spiracle, extends below the tegula, which covers the base of the wings. Below the posterior lobe the pronotum tapers to a point. The pronotum may be angulate laterally, with a lateral ridge running ventrally from the lateral angle of the pronotum. Immediately behind the lateral ridge and separating the posterior lobe anteriorly an impression or weak suture, the lateral suture, may run parallel to the lateral ridge. Dorsally the pronotum is concave between the pronotal lip and the mesoscutum, and a weak impression or dorsal suture may run along the bottom of the concavity. The mesoscutum usually overhangs the pronotum dorsally, forming a mesoscutal lip. See the diagrams of *Halictus rubicundus*, figs. 65 and 66.

In *Halictus rubicundus* the lateral angle and posterior lobe are rounded, with the lateral angle obtuse from dorsal view. The dorsal ridge is rounded, not strongly produced, and not carinate. The lateral ridge is sharply angulate but not carinate. The pronotal lip is yellow. The mesoscutum overlaps the pronotum slightly, forming a rounded mesoscutal lip of medium height (fig. 64). The tegulae are rounded posteriorly.

In the species examined, the dorsal and lateral ridges of the pronotum may vary in strength from gradually rounded to sharply angulate and carinate. Correlated with the development of these ridges the lateral angle of the pronotum may vary from a gradually rounded obtuse angle to a sharply acute projection and the posterior lobe of the pronotum may be carinate dorsally. The lateral and dorsal sutures or impressions vary somewhat; these variations are slight and are not discussed, as are the color variations of the pronotal lip from yellow to brown. The mesoscutal lip varies in the amount of overhang and its roundedness in relation to the mesoscutum, and in extreme cases the mesoscutum may be produced medially. The tegulae are usually constant in basic structure but may be strongly punctate and truncate posteriorly.

HALICTUS Grouping: Dorsal ridge rounded to carinate, not produced nor lamellate. Lateral ridge gradually rounded to carinate and angulate. Lateral angle obtuse and broadly rounded dorsally to sharply angulate, forming a right angle. Posterior lobe carinate or rounded. Mesoscutum basically similar to _H. rubicundus_, with a medium rounded lip, not produced. Tegulae rounded posteriorly.

The lateral ridge and dorsal ridge are both rounded, creating rounded lateral angles and posterior lobes in "_A_" _smaragdula_,

Paragapostemon bruneri, and *Sphecodogastra texana*. *Callochlora chloris* has very weak and rounded dorsal and lateral ridges, with a very shallow and rounded lateral angle (fig. 69). *Callochlora aureoviridis* is similar.

Similar, with the lateral ridge sharply angulate, are *Halictus rubicundus*, *Evylaeus foxii*, and *Evylaeus cinctipes*.

The lateral ridge is rounded, more so than in *H. rubicundus*, but the dorsal ridge is strongly angulate and somewhat carinate, as is the posterior lobe, in *Halictus (Seladonia) confusus*, *Dialictus imitatus*, *Pseudagapostemon citrinicornis*, and *Augochlorella striata*. Similar with the lateral ridge sharply angulate are *Halictus parallelus*, *Halictus ligatus*, *Lasioglossum zonulum*, *Lasioglossum coriaceum*, *Hemihalictus lustrans*, *Paralictus sp.*, *Sphecodes granulosus*, and *Halictus (Seladonia) hesperus*. The lateral and dorsal ridges are particularly sharp in *Sphecodes sp.*

In *Augochlora pura* the dorsal ridge is strongly carinate and the lateral angle sharply angulate, but the lateral ridge is rounded. Similar are *Caenaugochlora graminea*, with a more rounded lateral angle, and *Augochlora nigrocyanea*, with a higher mesoscutal lip. The lateral ridge is more strongly angulate in *Caenaugochlora costaricensis*.

Agapostemon differs from others in the *Halictus* grouping by the presence of striae laterally. The dorsal ridge is carinate and the lateral ridge sharp-angled in *Agapostemon cockerelli*; the lateral ridge is rounded and the dorsal ridge weakly carinate in *Agapostemon virescens*. Both ridges are rounded in *Agapostemon nasutus*.

AUGOCHLOROPSIS Grouping: Dorsal ridge strongly produced into a lamellate ridge running from the lateral angle across the posterior lobe.

Lateral ridge very weak and rounded. Mesoscutum basically similar to that of *H. rubicundus*, with medium rounded lip, not produced. Tegulae produced posteriorly, strongly punctate (figs. 70 and 71). This grouping suggests in its pronotal structure an extreme of *Augochlora*.

Augochloropsis metallica, *Augochloropsis callista*, and *Augochloropsis ignita* belong to this grouping.

CORYNURA Grouping: Dorsal ridge rounded to carinate, lateral ridge rounded to sharply angulate. Lateral angles vary from rounded, similar to those of *H. rubicundus*, to sharply and acutely angulate. Posterior lobe rounded or carinate. Mesoscutum more or less produced forward, creating a deep and often abrupt mesoscutal lip, usually notched at median mesoscutal line. Tegulae rounded posteriorly. This grouping closely resembles the *Halictus* grouping when the mesoscutum is only slightly produced and probably should not be separated from it.

Corynura corynogaster resembles *Callochlora chloris* in its weak rounded lateral and dorsal ridges and its broadly rounded lateral angles. The mesoscutal lip is high and notched medially, although the mesoscutum is not noticeably produced, making this species a doubtful inclusion in the *Corynura* grouping.

Paroxystoglossa brachycera has a carinate dorsal ridge and a rounded lateral ridge. The mesoscutum is slightly produced forward but the lip is not higher than in *H. rubicundus* and is not notched.

The dorsal ridge is carinate and the lateral ridge angulate, with a sharply angulate lateral angle and carinate posterior lobe in *Corynura chilensis* (fig. 72), *Ruizantheda proxima*, and *Paroxystoglossa transversa*. The mesoscutum is more or less produced forward and the mesoscutal lip is high and notched medially (fig. 67). Similar, with more rounded lateral ridge and a less angulate lateral angle, is *Ruizantheda mutabilis*. Similar to *Corynura chilensis*, with a distinctly narrowed and produced mesoscutum and a high but unnotched mesoscutal lip, is *Neocorynura sp*. (fig. 68 and 73) and *Neocorynura pubescens*.

TEMNOSOMA Grouping: Dorsal ridge carinate, posterior lobe carinate, lateral angle broadly obtuse although carinate. Lateral ridge weak, gradually rounded. Mesoscutum not produced forward, almost confluent with pronotum, almost no mesocutal lip formed. Tegulae rounded, strongly punctate.

This grouping includes *Temnosoma smaragdina* (fig. 74).

MEGALOPTA Grouping: Dorsal ridge very rounded, nearly absent. Lateral ridge carinate, pronotum laterally striate posterior to lateral ridge. Posterior lobe not carinate. Mesoscutum not produced, confluent with pronotum, no mesoscutal lip formed. Tegulae rounded posteriorly.

This grouping includes *Megalopta genalis* (fig. 75).

FRONT WINGS (Females)

The nomenclature of the wing veins and of the wing cells is shown in figure 76. The veins appear under a microscope to consist of two parallel dark lines enclosing a lighter central shaft. They appear light brown to yellow in color except for the base of the Radius (R) which is dark brown from the base of the wing to the prestigma. The Radius and the Costa (C) are thickened basally at their junction to the thorax. Axillary sclerites are present at the thoracic junction, not shown. Both membrane and wings are evenly equipped with small hairs.

The arched basal vein (M) is characteristic of the subfamily Halictinae. The condition of the marginal ($2R_1$) and submarginal cells ($1R_1$, $1R_s$, $2R_s$) and their enclosing veins are considered in this study.

In Halictus rubicundus all veins are strong, none obsolescent. The first submarginal cell ($1R_1$) is slightly shorter than the second plus the third ($1R_s$ and $2R_s$) together on their lower (Medial) border. The first and second intercubiti (first abscissa R_s and 1 r-m) are subparallel. The third intercubitus (2 r-m) arches outwards so that the third submarginal cell is wider on its Medial border than on its Radial border. The second and third submarginal cells are subequal on their Radial border. The first recurrent vein (1 m-cu) joins the distal portion of the Medial border of the second submarginal cell, while the second recurrent vein (2 m-cu) joins the distal portion of the Medial border of the third submarginal cell. The marginal cell is rounded very slightly away from the Costal border, with its enclosing vein (R_s) obliquely truncate on its outer margin (fig. 81).

In the species studied, the wings may vary by some of the outer veins being obsolescent. The relative lengths of the second and third submarginal cells on their Radial border may vary, and the first recurrent vein may enter either the second or third submarginal cells or join the second intercubitus. These last two characteristics are highly variable even within one species and even between the wings of one bee. Two or three submarginal cells may be present, although in many species with normally three submarginal cells the second intercubitus may drop out, leaving only two submarginals. Again, this may happen on only one wing of a bee, leaving the other wing in the normal state. The marginal cell may terminate acutely on the Costal border or it may be truncate and appendiculate, with all extremes in between.

HALICTUS Grouping: All veins strong, none obsolescent. Normally three submarginal cells. Relative size of second and third submarginal cells and point of junction of first recurrent vein variable. Marginal cell acute on Costal border to truncate and appendiculate. This grouping is highly variable, but no distinct points of separation to form subgroupings could be found.

The marginal cell ends acutely on the Costal border or is very narrowly rounded, not truncate (fig. 80), with the second and third submarginal cells subequal on the Radial border and the first recurrent vein usually entering the second submarginal cell in *Corynura chilensis*, *Corynura corynogaster*, *Ruizantheda mutabilis*, *Callochlora chloris* and *Callochlora aureoviridis*. In *Habralictus sp.* the second submarginal cell is narrower on the Radial border than the third and the first recurrent vein is usually nearly interstitial with the second intercubitus. In *Temnosoma smaragdina* and *Augochlorella striata* the second submarginal cell is very narrow and the first recurrent vein may be received by either cell or be interstitial.

The marginal cell is narrowly rounded off the Costal border with the outer edge of vein R_s more or less obliquely truncate, sometimes with a very short appendiculation, in *Halictus rubicundus*, *Halictus parallelus*, *Halictus ligatus*, *Halictus (Seladonia) confusus*, *Halictus (Seladonia) hesperus*, *Ruizantheda proxima*, *Pseudagapostemon citrinicornis*, and "*A*" *smaragdula*. The above have the second and third submarginal cells subequal on the Radial border and the first recurrent vein usually received by the second submarginal cell, while *Paroxystoglossa brachycera*, *Paroxystoglossa transversa*, *Neocorynura sp.*, and *Neocorynura pubescens* have the second and third submarginals subequal and the first recurrent vein usually approximately interstitial with the second intercubitus. *Sphecodes sp.* has the second submarginal cell narrowed and the first recurrent vein approximately interstitial with the second intercubitus. Species of *Neocorynura* and *Corynura chilensis* are unique in having the front one-third of their wings clouded with brown.

The marginal cell is definitely truncate and strongly appendiculate (fig. 82), with the second and third submarginal cells subequal on their Radial border and the second submarginal cell usually receiving the first recurrent vein, in *Agapostemon virescens*, *Agapostemon nasutus*, and *Paragapostemon bruneri*. Similar, with the second and third submarginal cells subequal or the second slightly shorter on its Radial border and the first recurrent vein usually interstitial with the second intercubitus or entering the third submarginal cell, are *Augochlora pura*, *Augochlora nigrocyanea*, *Augochloropsis metallica*, *Augochloropsis ignita*, *Augochloropsis callista*, and *Caenaugochlora graminea*. In *Sphecodes granulosus* the second submarginal cell is very narrow (fig. 77).

LASIOGLOSSUM Grouping: At least the third intercubitus, base (M) of the third submarginal cell, and second recurrent vein obsolescent, due to absence of borders on veins and general weakening of sclerotization of remainder of vein. Two or three submarginal cells normal. Relative size of second and third submarginal cells and point of junction of first recurrent vein variable. Marginal cell nearly acute on costal border or narrowly rounded with outer margin of vein R_s obliquely truncate, like in *H. rubicundus*. This grouping may not be distinct from the *Halictus* grouping.

Lasioglossum zonulum and Lasioglossum coriaceum do not have the second intercubitus appreciably obsolescent. The marginal cell terminates similar to that of H. rubicundus, and the second submarginal cell usually receives the first recurrent vein, the second and third submarginal cells being subequal on their Radial border. Sphecodogastra texana is similar but the marginal cell is acute or narrowly rounded.

Hemihalictus lustrans is the only member of this grouping studied with normally two submarginal cells. The second submarginal cell normally receives both recurrent veins and the marginal cell is similar to that of H. rubicundus (fig. 78).

The remainder of the species of this grouping studied have the second intercubitus also obsolescent, similar to the third intercubitus. All have the marginal cell terminating similar to H. rubicundus or slightly more rounded. In Evylaeus foxii, Evylaeus cinctipes, and Dialictus pilosus the second and third submarginal cells are subequal on their Radial border and the first recurrent vein usually enters the second submarginal cell, while in Paralictus sp. and Dialictus imitatus the second submarginal cell is usually narrowed and the first recurrent vein is interstitial with the second intercubitus.

MEGALOPTA Grouping: All veins strong, none obsolescent. Three submarginal cells. Second and third submarginal cells subequal on their Radial border. First and second intercubiti slanting towards base of wing, third intercubitus slanting towards apex of wing, not arched. First recurrent vein usually joins second intercubitus. Marginal cell terminates similar to that of H. rubicundus. The unusual shape of the intercubiti make this a doubtful grouping separate from the Halictus grouping.

This grouping contains Megalopta genalis (fig. 79).

TIBIAL SPURS OF HIND LEG (Females)

The hind tibia of the female bee has two spurs projecting from the inner angle of its apex. Each spur has a double row of serrations along its inner edge, the edge nearest the basitarsis. The outer row (the row nearest the body) of the inner spur (nearest the body) is variously toothed.

The conformation of the inner spur and its significance in generic discrimination has been previously discussed by Eickwort and Fischer (1963) for Eastern United States and the genera Augochlora, Augochlorella, Agapostemon, Augochloropsis, Sphecodes, Halictus, Halictus (Seladonia), Lasioglossum, Evylaeus, Sphecodogastra, Dialictus, and Paralictus were illustrated. This report will attempt to fit the bees outside of these genera into the framework developed previously.

HALICTUS Grouping: (Halictus complex of Eickwort and Fischer). Insufficient samples were taken to allow statistical analysis. On the basis of gross observation, Callochlora chloris (fig. 83) closely resembles Dialictus or Evylaeus in spur form and size, as does Callochlora aureoviridis, Neocorynura sp., Neocorynura pubescens, and Habralictus sp. "A" smaragdula belongs in this grouping, with short but linear teeth resembling Evylaeus (fig. 84). Statistical analysis on large samples would be required to place these bees more exactly in the Halictus complex.

AUGOCHLOROPSIS Grouping: Caenaugochlora graminea is a doubtful inclusion with Augochloropsis. The teeth of its spur are shorter than in *Augochloropsis metallica*, but the general configuration is the same (fig. 89). Possibly *Caenaugochlora* should be included in the *Halictus* complex, or the *Augochloropsis* and *Halictus* groupings combined.

AGAPOSTEMON Grouping: *Paragapostemon bruneri* belongs here; the one specimen available is in poor condition and does not allow further discussion. *Pseudagapostemon citrinicornis* probably belongs in this grouping; the teeth of its spur are narrower than in *Agapostemon* but still somewhat lamellate (fig. 85). *Megalopta genalis* may belong in this grouping; the teeth are narrower and more closely spaced than in *Agapostemon* but still lamellate (fig. 88).

RUIZANTHEDA Grouping: This is a new grouping resembling somewhat *Agapostemon*. The first tooth of the spur is linear but the second and following are quadrate or lobate. Apparently when only two teeth are present, the second is in the form of a small lobe running parallel to the axis of the spur (fig. 86), but where three are present, the second tooth is quadrate and lamellate and the third is lobate (fig. 87).

In *Ruizantheda mutabilis* two teeth prevail, while three teeth may be as or more common in *Ruizantheda proxima*.

CORYNURA Grouping: This new grouping resembles somewhat *Sphecodes*. The teeth are very short or the spur is serrate, with a considerably longer basal distance than is common in *Sphecodes*. The teeth are usually longer than serrations in *Corynura corynogaster* (fig. 91) but the spur is definitely serrate in *Corynura chilensis*, *Paroxystoglossa brachycera* (fig. 90), and *Paroxystoglossa transversa*. This grouping may not be distinct from the *Sphecodes* grouping.

SPHECODES Grouping: *Temnosoma smaragdina* belongs with *Sphecodes*; the spur differs by having a curved apex.

METASOMA

ABDOMINAL STERNITES (Males)

The first abdominal segment, the propodeum, is fused with the thorax to form the mesosoma. Consequently, the first metasomal segment is actually the second abdominal segment. To avoid confusion, the numbering of all segments will be on a metasomal, rather than abdominal, basis. The fourth through the eighth metasomal sternites were studied.

The fourth, fifth, and sixth sternites are similar in structure. All are nearly flat sclerotized plates adorned with hairs. Basally the sternites have lateral projections, the apodemes. Extending between the apodemes on the basal margin is a thickened ridge, the antecosta. The sternites are divided transversely by the gradulus; the ends of the gradulus curve apically and run longitudinally towards the apical margin. The pregradular area extends between the gradulus and the antecosta and the postgradular area extends between the gradulus and the apical margin of the sternite. The sternites decrease in size towards the end of the metasoma; the fourth and fifth are usually transverse or slightly concave or emarginate apically while the sixth is somewhat convex apically (figs. 92, 93, and 94).

The seventh and eighth sternites are small thin sclerites partially joined together and attached to the base of the genitalia. The seventh sternite is generally narrow and transverse with lateral apodemes and a median lobe projecting opposite the apodemes. The eighth sternite, superimposed on the seventh, is also transverse but lacks the apodemes

and is usually longer, giving it a greater expanse of area. These are not separated in the diagrams. They are drawn to about the same scale as the other sternites of H. rubicundus in figure 97; usually they are drawn to a larger scale.

Sternite 4 of Halictus rubicundus is broadly emarginate or concave on its apical margin and sternite 5 is more narrowly concave medially on its apical margin. In sternite 4 the gradulus is some distance from the antecosta basally, while in sternite 5 the gradulus nearly touches the antecosta. Sternite 6 is broadly convex on its apical margin, and the gradulus touches the antecosta. Sternite 7 is narrow with a median triangular lobe projecting apically, while sternite 8 is transverse, over twice as wide as long, convex apically with an irregular margin and is broadly concave basally. Sternites 7 and 8 are shown separately in figures 96 and 95, superimposed in figure 97.

Sternites 4, 5, and 6 may vary in the shape of their apical margins and gradulus in the species studied, but in some cases they are strongly modified, with special hairs, projections, or emarginations. Sternite 6 and to a lesser extent sternite 5 may have what appear to be two lateral lobes directed apically on the internal surface of the postgradular area, formed of coarse hair. These are usually poorly defined and appear variable even within one species. Such a formation in sternite 6 of Sphecodogastra texana is shown in figure 110. Sternite 4 was only examined as to its apical margin unless strongly modified. Sternite 7 usually varies only in the shape of its apodemes and medial lobe, but sternite 8 varies over a wide range of shapes. Both remain as small thin superimposed sclerites.

HALICTUS Grouping: Sternites 4 to 6 usually not modified, occasionally with modified hairs or small structural modifications. Sternites 4 and 5 transverse apically or slightly to deeply concave, sternite 6 convex apically, often with internal hair markings in postgradular area. Sternite 7 narrow with median apical lobe, similar to that of *H. rubicundus*. Sternite 8 transverse, usually narrow, nearly as wide as sternite 7 and irregularly convex apically, concave basally, occasionally somewhat expanded medially, in any case width between ends is over twice the length at its median point.

Neocorynura sp. has a very narrow eighth sternite. Sternite 7 is unique for this grouping in having a small pointed median lobe directed basally, opposite the apical median lobe (fig. 119). Sternites 4 and 5 are transverse apically, with the gradulus of sternites 5 and 6 reaching the antecosta.

Dialictus pilosus has a narrow transverse eighth sternite not irregularly convex apically and surpassed by the median apical lobe of sternite 7 (fig. 120). Sternites 4 and 5 are very shallowly emarginate and the gradulus does not reach the antecosta in sternites 5 and 6. *Dialictus imitatus* is similar. *Paralictus platyparius*, on the basis of one specimen, is similar with transverse sutures running from the lateral edge of the gradulus to the lateral edges of sternites 5 and 6.

Sternite 8 is transverse and irregularly convex apically in *Halictus rubicundus*. The medial lobe of sternite 7 is comparatively short and does not surpass the apex of segment 8. Similar are *Halictus ligatus* and *Halictus parallelus*. Sclerites 4 and 5 of *H. ligatus* are transverse apically and are shallowly emarginate in *H. parallelus*; the graduli are similar to those of *H. rubicundus*.

Sternites 7 and 8 are similar in *Halictus* (*Selandonia*) *confusus*, except that the median apical lobe of sternite 7 is not projected, being present merely as a truncate apex to the sclerite (fig. 121). Sternites 5 and 6 are modified, 5 being deeply emarginate medially with hairs bordering the emargination and 6 with a medial depression in the postgradular area bordered basally by a small ridge and lined laterally with hairs (fig. 111). Sternite 4 is shallowly emarginate with tufts of hair at the corners of the emargination. The gradulus reaches the antecosta in sternites 5 and 6.

Sternite 8 is transverse, medially concave at its base, and surpassed by the long median lobe of sternite 7 in *Evylaeus foxii* (fig. 123). Sternites 4 and 5 are shallowly emarginate and the gradulus of 5 and 6 does not reach the antecosta. *Sphecodogastra texana* is similar, but sternite 8 is not concave basally and is somewhat produced apically to beyond the tip of the median lobe of sternite 7 (fig. 124).

Sternite 8 of *Lasioglossum zonulum* is expanded medially into a broad truncate lobe (fig. 125). Sternite 6 is modified slightly, adorned with a central tuft of hairs and two transverse tufts placed medially on the apical margin of the postgradular area (fig. 112). Sternites 4 and 5 are shallowly emarginate apically and the gradulus does not reach the antecosta in sternites 5 and 6.

HABRALICTUS Grouping: Sternites 4 to 6 not modified; sternite 6 may have internal hair markings in postgradular area. Gradulus not defined or defined only basally. Sternites 4 and 5 transverse or slightly emarginate apically, sternite 6 convex apically. Sternite 7 similar to that of *H. rubicundus*, sternite 8 narrow basally with apical spatulate lobe, longer than wide (fig. 126). This grouping is related to the *Halictus* grouping and may not be distinct.

The gradulus is not defined in sternites 5 and 6 of *Habralictus maculiventris* (fig. 105), but is defined as a basal line with apical bent ends in *Habralictus sp*.

AGAPOSTEMON Grouping: Sternites 4 to 6 modified or not, with or without (usually) internal hair markings in postgradular area. Sternite 7 narrow with median apical lobe, similar to that of *H. rubicundus*. Sternite 8 in approximate form of truncated triangle or isosceles trapezoid, usually less than twice as wide as long and not as wide as sternite 7, convex or transverse basally. This appears to be an artificial grouping with some members resembling the *Halictus* grouping.

Sphecodes sp. is the only member of this grouping with internal hair markings in the postgradular area of sternite 6. Sternite 8 is truncate apically and medially convex basally (fig. 127). The gradulus does not reach the antecosta in sternites 5 and 6 and sternites 4 and 5 are not emarginate apically.

Sternite 8 in "*A*" *smaragdula* is short, concavely truncate apically and more or less transverse basally (fig. 128). Sternites 4 and 5 are transverse apically and the gradulus does not reach the antecosta in sternites 5 and 6.

Sternite 8 is narrowly truncate and concave at its apex in *Ruizantheda mutabilis*; its base is more or less transverse and it is laterally emarginate (fig. 129). Sternite 4 is strongly emarginate while sternite 5 is shallowly emarginate. The gradulus in sternites 5 and 6 is defined only basally and does not reach the antecosta.

Sternite 8 of Ruizantheda proxima is similar but less emarginate laterally and with two strong hairs projecting from the apex (fig. 130). Sternite 4 is emarginate apically with a medial marginal projection bordered by a row of stiff setae. A medial notch extends from this projection basally and then laterally parallel to the gradulus, marking the border of an apical raised area of the postgradular area (fig. 98). The gradulus is only basally defined in sternites 4 to 6 and irregularly reaches the antecosta in sternite 5 (fig. 106).

Sternites 7 and 8 of Pseudagapostemon sp. closely resemble those of R. proxima, even to the apical hairs. Sternites 4 to 6 are modified. Sternite 4 has two raised lobes in the apical portion of the postgradular area, which is emarginate between the lobes and lined with strong hairs in the emargination (fig. 99). Sternite 5 is deeply concave apically and basally with patches of long hair at the lateral apices of the postgradular area (fig. 107) and sternite 6 is convex with strong hairs or setae medially and laterally on the apical margins (fig. 113). The gradulus does not reach the antecosta in sternites 5 and 6.

Sternite 8 is narrowly truncate and trilobed at its apex in Agapostemon cockerelli; its base is more less transverse (fig. 131). Sternite 4 is broadly emarginate with a row of strong setae near the edges of the concavity, and sternite 5 is transverse apically. Sternite 6 tapers to a rounded point apically and has a poorly defined transverse row of long hairs in the postgradular area near the antecosta (fig. 114). The gradulus reaches the antecosta in sternites 5 and 6. Sternite 8 is similar in Paragapostemon bruneri although it is wider at the apex with more rounded lobes (fig. 132). Sternite 4 is modified, deeply concave basally and short, with a row of setae on its apical margin (fig. 100).

Sternites 5 and 6 resemble those of *Agapostemon cockerelli*, without the postgradular line of hairs in sternite 6.

AUGOCHLORA Grouping: Sternites 4 to 6 modified or not, 6 often with internal hair markings on postgradular area. Sternite 7 basically similar to that of *H. rubicundus*, median lobe often small. Sternite 8 narrow and transverse with basal median projection opposite apical lobe of sternite 7, sometimes with lateral apical projections in addition.

Sternite 8 of *Augochlorella striata* is narrowly transverse with a long narrow median projection opposite the small apical lobe of sternite 7 (fig. 133). Sternite 6 has internal hair markings in the postgradular area; sternites 4 and 5 are broadly emarginate. The gradulus of sternites 5 and 6 reaches the antecosta. *Augochlora pura* is similar; the apodemes of sternite 7 project farther basally so their tips are nearly at the level of the basal spine of sternite 8 (fig. 134). Sternites 4 and 5 are transverse apically and the gradulus does not reach the antecosta in sternites 5 and 6. *Augochlora nigrocyanea* is similar to *A. pura* with the basal projection of sternite 8 pointed and the apical lobe of sternite 7 longer. Sternites 4 to 6 are similar to those of *A. pura*.

Sternites 7 and 8 of *Temnosoma smaragdina* are similar to those of *Augochlora pura*. The median basal projection of sternite 8 is narrow and pointed (fig. 135). Sternite 6 is strongly bilobed in its postgradular area with strong hairs projecting from the apices of the lobes externally (fig. 115). Sternites 4 and 5 are transverse apically and the gradulus does not reach the antecosta in sternites 5 and 6, which have a unique diagonal suture running from each lateral edge of the gradulus to the lateral margin of the sternite.

Sternite 7 has a rounded median lobe and sternite 8 has a long truncate median basal lobe bordered laterally by small basal projections and with a small pointed median apical projection superimposed on the apical lobe of sternite 7 in Paroxystoglossa brachycera (fig. 136). Sternites 4 to 6 are modified; sternite 6 with a medial apical notch bordered laterally by long hairs (fig. 116) and sternite 5 with a median groove bordered laterally by thickened "lips" at the apical margin (fig. 108), and sternite 4 emarginate apically with a raised "lip" in the center of the emargination. The gradulus reaches the antecosta in sternites 5 and 6.

Sternite 7 in Caenaugochlora graminea is unique in having two pointed lateral apical projections and no median projection. Sternite 8 has a long medial projection and two small lateral projections opposite the apical projections of sternite 7 (fig. 137). Sternites 4 and 5 are modified; sternite 4 is emarginate apically with a median V-shaped notch enclosing a strong brush of dark hairs (fig. 101), and sternite 5 is strongly emarginate apically with two brushes of dark hair extending obliquely from either side of the median on the apical border and a row of hairs near the apex of the postgradular area (fig. 109). Sternite 6 has numerous dark hairs near its apex and the gradulus is notched medially on its base (fig. 117). The gradulus reaches the antecosta in sternites 5 and 6.

AUGOCHLOROPSIS Grouping: Sternite 4 strongly modified, emarginate apically with long narrow lateral appendages lines with hairs and gradulus broadly rounded, extending to antecosta, with base of sternite strongly concave. Sternite 5 emarginate; gradulus of sternites 5 and 6 reaches antecosta. Sternite 7 narrow, with apical median lobe. Sternite 8 trilobed apically, medially produced basally.

Augochloropsis metallica has slender diverging lateral appendages on sternite 4 (fig. 102) and a rounded median apical projection on sternite 7. *Augochloropsis ignita* is similar, with the lateral arms of sternite 4 shorter, thicker, and converging (fig. 103), and the median apical projection of sternite 7 pointed (fig. 138).

MEGALOPTA Grouping: Sternites 3 to 6 strongly modified, sternites 3, 4, and 6 notched apically with patches of raised hair. Gradulus reaches antecosta in sternites 5 and 6. Sternite 7 narrow with two apical lobes on either side of median. Sternite 8 more or less narrow with long basal median projection and two smaller lateral basal projections. This grouping approaches the *Augochlora* grouping, particularly *Caenaugochlora graminea*, and perhaps should be joined to it.

In *Megalopta genalis* sternite 4 has a V-shaped notch medially and quadrate notches laterally on the apical border of the postgradular area, with a median groove. Strong hairs border the apical margins, notches, and groove, and also a basal projection and two latero-basal patches on the postgradular area. The basal margin of the sclerite is strongly concave (fig. 104). Sternite 5 is emarginate apically. Sternite 6 is emarginate apically with a raised median area and is lined with hairs apically (fig. 118). Sternite 7 has two rounded lobes apically and sternite 8 has a long pointed median basal projection and two smaller lateral projections (fig. 139).

CORYNURA Grouping: Sternites 4 to 6 unmodified. Sternite 7 narrow, sternite 8 produced basally into a broad truncate lobe.

In *Corynura chilensis* the basal lobe of sternite 8 is narrow and slightly bilobed (fig. 141). The gradulus reaches the antecosta in sternites 5 and 6 and is notched basally in sternite 6. Sternite 4 is shallowly notched apically and sternite 5 is slightly convex.

Callochlora chloris is similar with a wider basal lobe on sternite 8 (fig. 140). The gradulus does not reach the antecosta in sternites 5 and 6 and sternites 4 and 5 are more or less transverse apically.

PLATE I--Head Characteristics (Females). Not drawn to scale.

1 - 6: Compound eyes; 1. *Sphecodes granulosus*; 2. *Agapostemon virescens*; 3. *Augochloropsis metallica*; 4. *Augochlora pura*; 5. *Ruizantheda proxima*; 6. *Callochlora chloris*. 7. Anterior view of head of *Halictus rubicundus*. 8 - 16: Epistomal sutures; 8. *Halictus rubicundus*; 9. *Callochlora chloris*; 10. *Sphecodes granulosus*; 11. *Augochloropsis metallica*; 12. *Caenaugochlora graminea*; 13. *Lasioglossum zonulum*; 14. *Megalopta genalis*; 15. *Agapostemon virescens*; 16. *Augochlora pura*. 17 - 19: *Halictus rubicundus*; 17. Posterior view of head; 18. Postoccipital bridge suture; 19. Hypostomal bridge. 20 - 22: Postoccipital bridge sutures; 20. *Paragapostemon bruneri*; 21. *Corynura corynogaster*; 22. *Ruizantheda proxima*. 23 - 26: Hypostomal bridges; 23. *Sphecodes sp.*; 24. *Corynura corynogaster*; 25. *Agapostemon virescens*; 26. *Augochlora pura*. 27. Posterior view of head of *Augochlora pura*.


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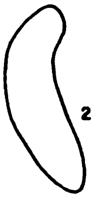
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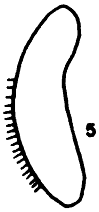
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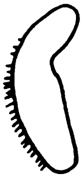
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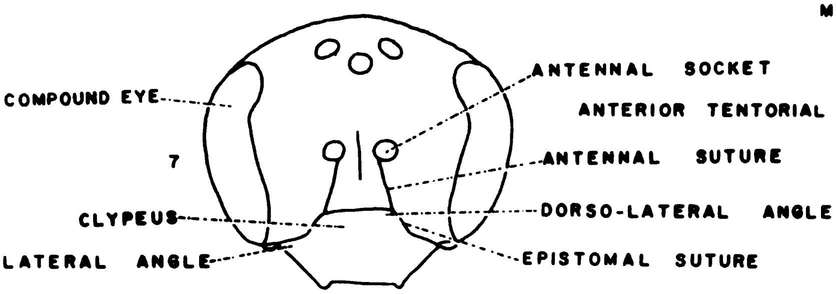

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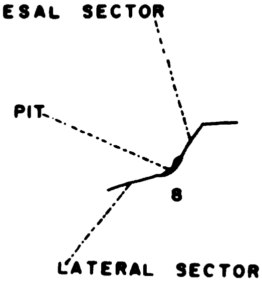

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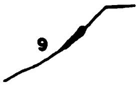
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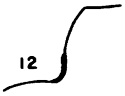
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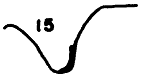
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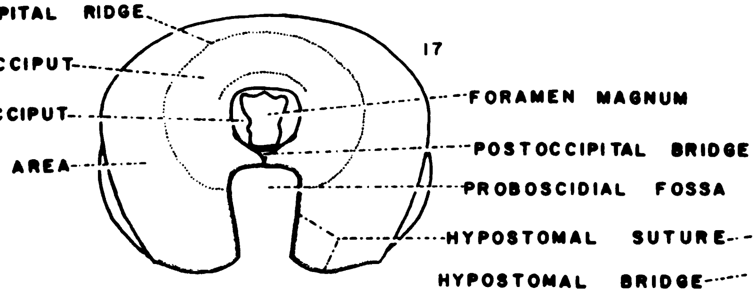

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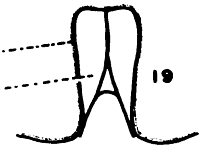
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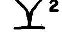
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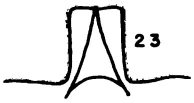
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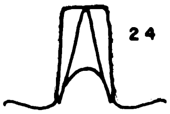
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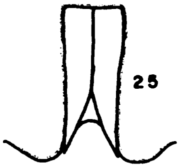
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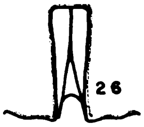
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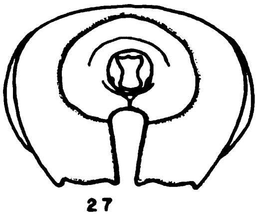
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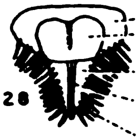
PLATE II--Labra and Mouthparts (Females). Not drawn to scale.

28 - 42: Labra; 28, 29. *Halictus rubicundus*; 30. *Neocorynura sp.*; 31. *Callochlora chloris*; 32. *Caenaugochlora graminea*; 33. *Pseudagapostemon citrinicornis*; 34. *Agapostemon virescens*; 35. *Corynura chilensis*; 36. *Augochloropsis callista*; 37, 38. *Megalopta genalis*; 39. *Paralictus sp.*; 40. *Sphecodes sp.*; 41. *Sphecodes granulosus*; 42. *Temnosoma smaragdina*. 43 - 49: *Halictus rubicundus*; 43. Basal portion proboscis, posterior view; 44. Pharyngeal plate; 45. Apical portion labium; 46. Apical portion maxilla; 47. Ligula and apex of prementum, ventral view; 48. same, dorsal view; 49. Mandible.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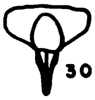
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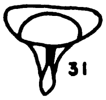
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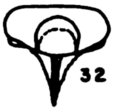
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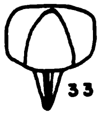
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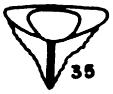
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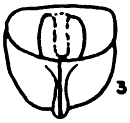
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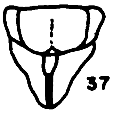
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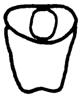
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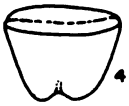
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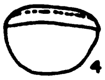
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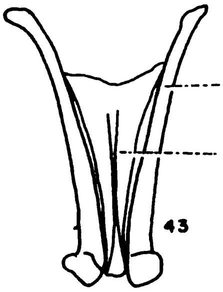
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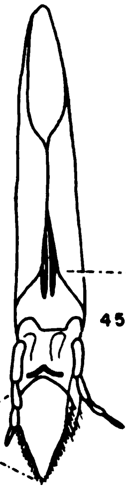
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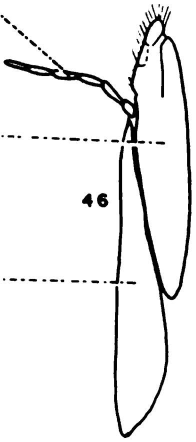
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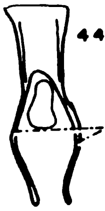
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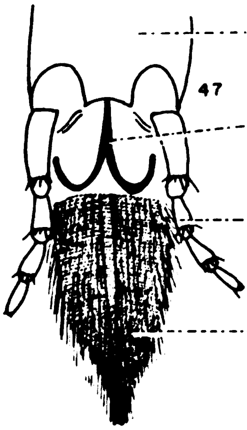
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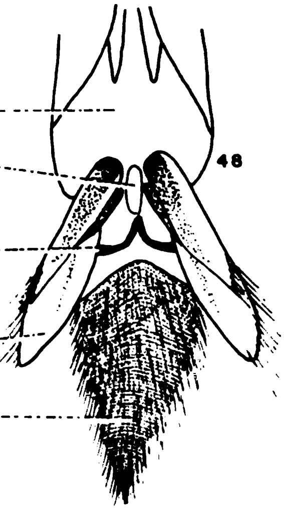
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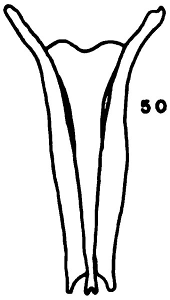
PLATE III--Mouthparts and Pronotal and Mesoscutal Structure (Females). Not drawn to scale.

50. Basal portion proboscis, posterior view, of *Agapostemon virescens*. 51 - 52: Pharyngeal plates; 51. *Augochlora pura*; 52. *Agapostemon virescens*. 53 - 54: Ligular arms; 53. *Agapostemon virescens*; 54. *Augochlora pura*. 55 - 57: Mandibles; 55. *Paralictus sp.*; 56. *Augochlora nigrocyanea*; 57. *Megalopta genalis*. 58 - 60: Apical portions of maxillae; 58. *Habralictus sp.*; 59. *Corynura chilensis*; 60. *Augochlora pura*. 61 - 63: Apical portions of labia; 61. *Habralictus sp.*; 62. *Megalopta genalis*; 63. *Augochlora pura*. 64 - 66: *Halictus rubicundus*; 64. Mesoscutal lip; 65, 66. Pronotum and anterior portion of mesoscutum. 67 - 68: Mesoscutal lips; 67. *Corynura chilensis*; 68. *Neocorynura sp*. 69 - 75: Pronota and anterior portions of mesoscuta; 69. *Callochlora chloris*; 70, 71. *Augochloropsis metallica*; 72. *Corynura chilensis*; 73. *Neocorynura sp.*; 74. *Temnosoma smaragdina*; 75. *Megalopta genalis*.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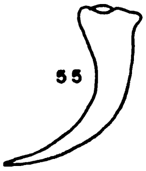
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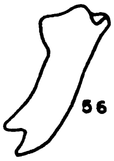
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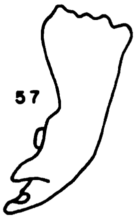
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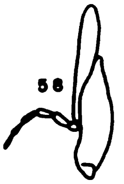
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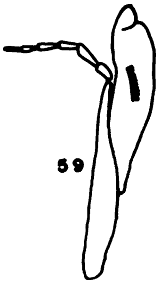
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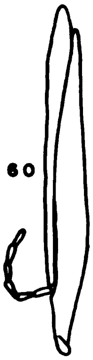
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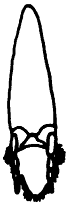
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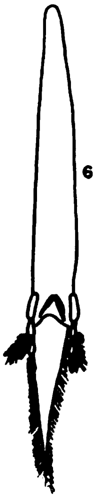
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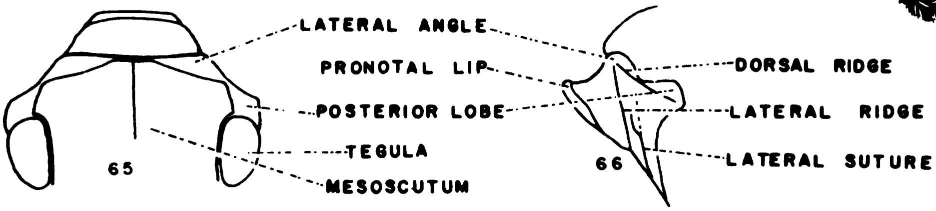


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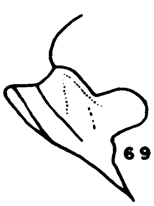
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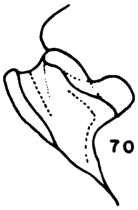
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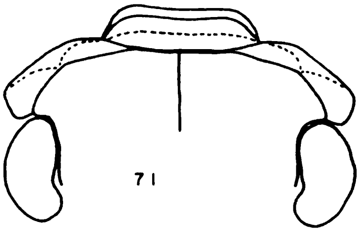
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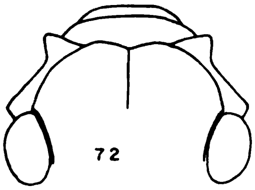
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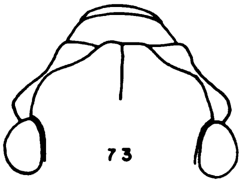
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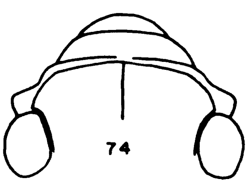
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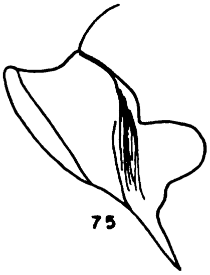
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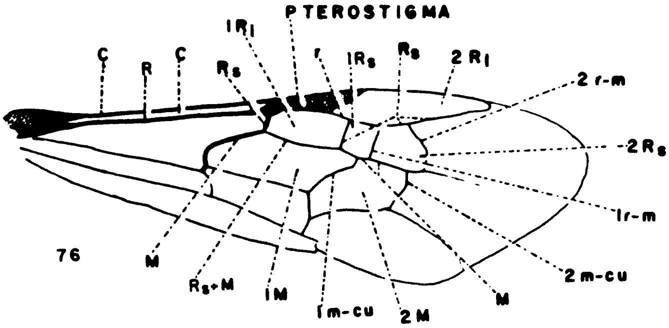
PLATE IV--Front Wings and Tibial Spurs of Hind Legs (Females).

Not Drawn to Scale.

76 - 79: Front wings; 76. *Halictus rubicundus**; 77. *Sphecodes granulosus*; 78. *Hemihalictus lustrans*; 79. *Megalopta genalis*. 80 - 82: Apices of marginal cells; 80. *Callochlora chloris*; 81. *Halictus rubicundus*; 82. *Augochlora pura*. 83 - 91: Tibial spurs of hind legs; 83. *Callochlora chloris*; 84. "*A*" *smaragdula*; 85. *Pseudagapostemon citrinicornis*; 86. *Ruizantheda mutabilis*; 87. *Ruizantheda proxima*; 88. *Megalopta genalis*; 89. *Caenaugochlora graminea*; 90. *Paroxystoglossa brachycera*; 91. *Corynura corynogaster*.

*Wing venation of *Halictus rubicundus*: Veins: C--Costa; R--Radius; M--Medius; first abscissa Rs--first intercubitus; 1 r-m--second intercubitus; 2 r-m--third intercubitus; 1 m-cu--first recurrent vein; 2 m-cu--second recurrent vein; M between M + Cu and Rs + M - Basal vein. Cells: $2R_1$--Marginal cell; $1R_1$--first submarginal cell; 1Rs--second submarginal cell; 2Rs--third submarginal cell.



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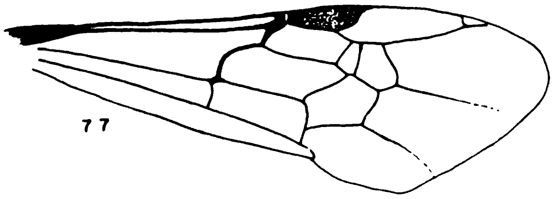

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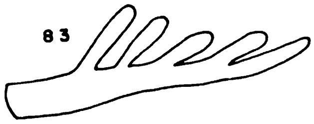

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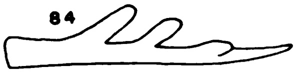

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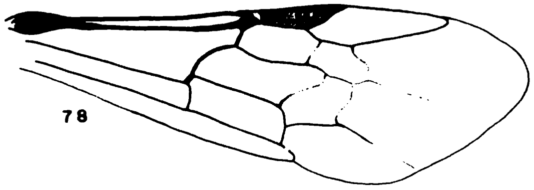

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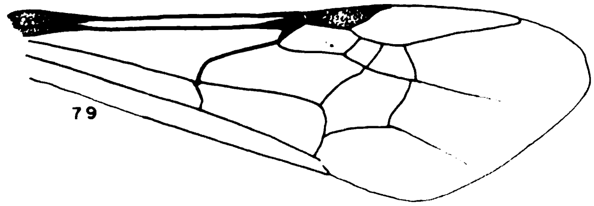

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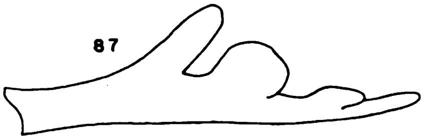

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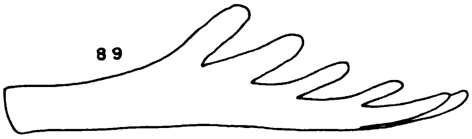

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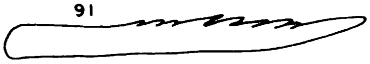

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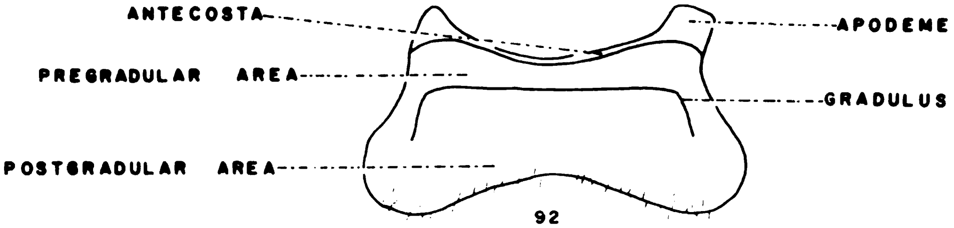
PLATE V--Abdominal Sternites (Males). Not drawn to scale except figs. 92 - 97.

92 - 97: *Halictus rubicundus*; 92. Sternite 4; 93. Sternite 5; 94. Sternite 6; 95. Sternite 8; 96. Sternite 7; 97. Sternites 7 and 8.

98 - 104: Sternites 4; 98. *Ruizantheda proxima*; 99. *Pseudagapostemon sp.*; 100. *Paragapostemon bruneri*; 101. *Caenaugochlora graminea*; 102. *Augochloropsis metallica*; 103. *Augochloropsis ignita*; 104. *Megalopta genalis*.

105 - 107: Sternites 5; 105. *Habralictus maculiventris*; 106. *Ruizantheda proxima*; 107. *Pseudagapostemon sp.*



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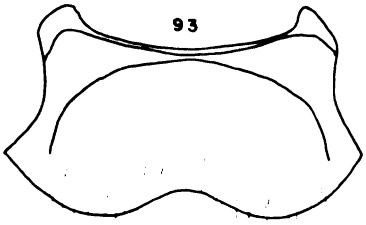

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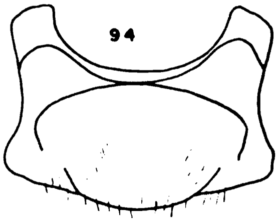

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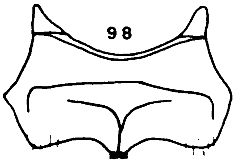

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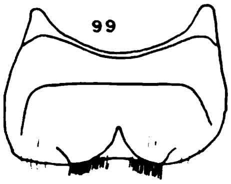

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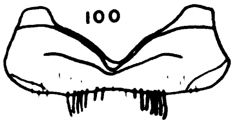

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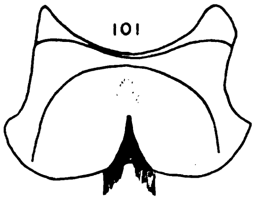

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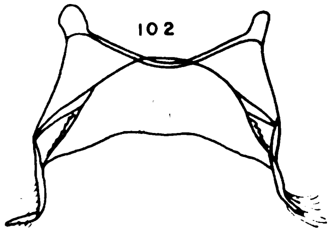

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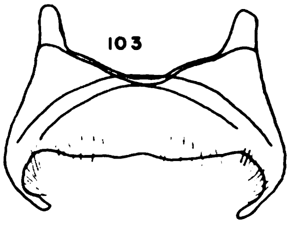

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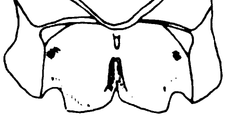

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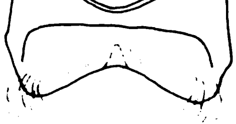

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PLATE VI--Abdominal Sternites (Males). Not drawn to scale.

108 - 109: Sternites 5; 108. *Paroxystoglossa brachycera*; 109. *Caenaugochlora graminea*. 110 - 118: Sternites 6; 110. *Sphecodogastra texana*; 111. *Halictus* (*Seladonia*) *confusus*; 112. *Lasioglossum zonulum*; 113. *Pseudagapostemon sp.*; 114. *Agapostemon cockerelli*; 115. *Temnosoma smaragdina*; 116. *Paroxystoglossa brachycera*; 117. *Caenaugochlora graminea*; 118. *Megalopta genalis*. 119 - 141: Sternites 7 and 8; 119. *Neocorynura sp.*; 120. *Dialictus pilosus*; 121. *Halictus* (*Seladonia*) *confusus*; 122. -; 123. *Evylaeus foxii*; 124. *Sphecodogastra texana*; 125. *Lasioglossum zonulum*; 126. *Habralictus maculiventris*; 127. *Sphecodes sp.*; 128. "*A*" *smaragdula*; 129. *Ruizantheda mutabilis*; 130. *Ruizantheda proxima*; 131. *Agapostemon cockerelli*; 132. *Paragapostemon bruneri*; 133. *Augochlorella striata*; 134. *Augochlora pura*; 135. *Temnosoma smaragdina*; 136. *Paroxystoglossa brachycera*; 137. *Caenaugochlora graminea*; 138. *Augochloropsis ignita*; 139. *Megalopta genalis*; 140. *Callochlora chloris*; 141. *Corynura chilensis*.

IV. DISCUSSION

COMPARATIVE VALUE OF CHARACTERS

In contrast to the opinions implied by most generic descriptions and keys, most of the characters of this study vary in a clinal fashion with no natural divisions between groups. Although extremes can be differed, no fundamental differences should be inferred. These clines may (but not necessarily do) indicate evolutionary trends. Emargination and hairiness of the eyes, angle of the epistomal sutures, sharpness of the preoccipital ridge and other occipital and hypostomal structures, sharpness of the dorsal ridge of the pronotum and shape of the mesoscutum anteriorly, and shape of the submarginal cells and apex of the marginal cell of the forewings are of this nature.

More distinct differences are found in the labrum and the mandibles, which may be highly labile in response to ecological pressures. The tibial spurs seem to fall into certain distinct groupings but interpretation of the significance of these groupings is risky, particularly in the absence of knowledge of the exact function of the spurs.

The proboscis structure and male sternites seem to indicate best natural groupings. Unfortunately, little use of characteristics of these parts has been made for generic descriptions in the past, except by Mitchell (1960).

HALICTUS (HALICTUS) Latreille

Halictus Latreille 1804. Nouv. Dict. Hist. Nat., v. 24, p. 182.

Odontalictus Robertson 1918. Ent. News v. 29, p. 91.

The limits of the type genus of the family Halictidae are by no means settled, with American workers splitting *Halictus* *s.l.* into *Lasioglossum* *s.l.* and several subgenera of *Halictus*, *Seladonia* and *Halictus*, while European workers dispute the validity of dividing the genus. This study follows the American system of Michener (1944) as modified by Mitchell (1960). For a discussion of the European point of view, see Bluthgen (1955).

Halictus *s.s.* as limited by Michener (1944) includes those species with subapical fasciae of pale pubescense on the abdominal terga and black color without metallic reflections. In North America three species represent three slightly different trends of development. *Halictus rubicundus*, a Holarctic bee, apparently represents the basic pattern of the genus (see Michener, 1954). It can be distinguished from the others by the strongly emarginate fourth and fifth sternites and the tibial spur (Eickwort and Fischer, 1963). *Halictus* *parallelus*, a large bee with yellowish wings, has very shallowly emarginate fourth and fifth sternites and a serrate tibial spur. Robertson (1918) erected a new genus, *Odontalictus*, for the third species, *Halictus* *ligatus*, on the basis of "the cheeks of the female being produced into a tooth." In *H.* *ligatus* the fourth and fifth sternites are not emarginate and the tibial spur is distinctive.

The present author agrees with Michener (1954) in that there is not sufficient grounds for subdividing the subgenus farther or recognizing

Odontalictus. The toothed genal areas are found in other genera, such as the recently discovered *Evylaeus absurdiceps* (Timberlake, 1960), and with the exception of the above characteristics, the three species show only minor differences in the characters studied. The tibial spurs, although different, are closely related and the differences in the sternites minor. Nevertheless, there is more difference between these three species than between members of such closely knit genera as *Dialictus* and *Augochlora* and *Halictus* should be viewed as heterogeneous. Indeed, it is a genus defined principally by "negative" characteristics, the only positive point being the tenuous one of the subapical fasciae on the abdominal terga. A study of Old World species would be necessary to understand the genus.

Halictus s.s. is most closely related to *Seladonia* and the *Lasioglossum* complex, forming the *Halictus*-*Lasioglossum* complex jointly which will be referred to throughout this discussion.

Halictus includes one other species in the New World, *H. farinosus* Smith, closely resembling *H. parallelus*. The subgenus is principally Holarctic, one species (*H. ligatus*) occurring as far south as Colombia. Spot characteristics for *Halictus s.s.* are the black non-metallic coloring and subapical fasciae on the abdominal terga. Sandhouse (1941) revised the North American species of *Halictus s.l.*

HALICTUS (SELADONIA) Robertson

Seladonia Robertson 1918. Ent. News v. 29, p. 91.

Pachyceble Moure, 1940. Arq. Zool. Estado Sao Paulo v. 2, p. 54.

Robertson (1918) described *Seladonia* as distinct from *Halictus*

and characterized its members as "rather small, greenish species." Michener (1944) considered Seladonia as a subgenus of Halictus on the basis of its metallic coloring and median depression on the sixth metasomal sternite of the male. Later (1954) he added the characteristic of the tibial spurs (see Eickwort and Fischer, 1963) and defended the fundamental nature of the subgenus. Moure (1940) described Pachyceble on the basis of a new female Brazilian bee, Pachyceble lanei Moure. Michener (1954) synonymized Pachyceble with Seladonia. Like Halictus s.s., Seladonia is characterized by subapical fasciae of pale pubescence on the abdominal terga.

This study confirms both the close relationship of Halictus s.s. and Seladonia and the validity of maintaining Seladonia as a separate grouping. Seladonia resembles Halictus in most characteristics studied, but differs in the wider notching of the bridge suture of the hypostoma and postocciput, the pointed apical process of the labrum, and the absence of an apical median lobe on sternite 7, as well as the important sternite and tibial spur characteristics mentioned above. The labrum, tibial spur, and bridge sutures all suggest a resemblance to members of the Lasioglossum complex, particularly Dialictus. On the basis of this study, there seems to be almost as much reason to consider Seladonia a separate genus as to consider the Lasioglossum complex genera distinct or, conversely, to consider the Lasioglossum genera as subgenera of Halictus. Moure compared Pachyceble with Pseudagapostemon on the basis of the wings, propodeum, and tibial spurs. Although the tibial spurs are somewhat similar, other important characteristics of this study do not indicate a close relationship.

Michener (1951) lists four species of this Holarctic subgenus for the United States. In addition, *H. hesperus* is known from Mexico south to Colombia and *H. lanei* is known from Brazil. The best spot characteristics for *Seladonia* appear to be the metallic coloring and subapical fasciae on the abdominal terga.

LASIOGLOSSUM Curtis

Lasioglossum Curtis 1833. Brit. Ent. v. 10, p. 448.
Curtisapis Robertson 1918. Ent. News v. 29, p. 91.

Michener (1944) lumped *Lasioglossum*, *Sphecodogastra*, *Paralictus*, *Dialictus*, *Chloralictus*, *Hemihalictus*, and *Evylaeus*, previously considered separate genera, as subgenera of *Lasioglossum* *s.l.* on the basis of the faint distal veins of the forewings of the female and the absence of apical bands on the abdominal terga. Mitchell (1960) considered the subgenera as genera but closely related largely on the basis of a ventral membranous lobe on the male genitalia. This study follows Mitchell's system.

Robertson (1902b) restored *Lasioglossum* *s.s.* to generic standing in America and characterized it in a key as having the veins in the female forewing beyond the first recurrent vein obsolescent, except for the second intercubitus, the marginal cell subappendiculate, the tibial spurs finely serrate, and the bee usually smooth and opaque with the abdominal terga 2 to 4 with basal pubescent fasciae. He characterized the males by their black coloring, clypeus with yellow marks or thin pubescence, antennal joint 4 shorter than 2 plus 3, broad cheeks, smooth metathorax (propodeum?), and basal pubescent fasciae on the abdominal terga. Michener (1944) mentioned that not all species are non-metallic and Mitchell (1960) noted that not all have basal fasciae on the abdominal terga. Neither Michener nor Mitchell separated the males from *Evylaeus* on a generic basis. Mitchell stated that *Evylaeus* and *Lasioglossum* are closely related, and both authors gave the strong second intercubitus as the only separating point.

Robertson (1918) separated *Curtisapis* from *Lasioglossum* on the basis of the serrate hind spurs of the females and characterized the females of *Curtisapis* as being more opaque and smaller. Michener (1944) synonymized the genera and Eickwort and Fischer (1963) showed that both *Lasioglossum* and *Curtisapis* species have serrate tibial spurs. Sandhouse (1933) separated the two groupings in her key to Eastern species but called all species *Halictus*. Her species of *Lasioglossum* *s.s.* (*zonulum* and *leucozonium* Schrank) exhibit modified abdominal sternites in the males and shiny thorax in the females, while her four species of *Curtisapis* (including *coriaceum*) had unmodified male sternites and dull female thorax.

Lasioglossum is obviously closely related to the other genera once included in *Lasioglossum* *s.l.*, which are called the *Lasioglossum* complex in this study. However, it shows as many characteristics in common with the *Halictus* subgenera. The hypostomal and postoccipital bridge sutures are midway between *Halictus* *s.s.* and other *Lasioglossum* complex genera and resemble most closely *Seladonia* and the labrum may resemble both groups. The epistomal suture more closely resembles other *Lasioglossum* complex genera. The expanded area of sternite 8 of the males seems constant within the genus (see figure 87 of Mitchell, 1960) and places this characteristic nearest *Evylaeus*. The serrate tibial spurs resemble closely those of *Halictus* *parallelus*. The modified fifth and sixth sternites do not occur throughout the genus (Sandhouse, 1933) but more closely resemble *Halictus*. The wings resemble other *Lasioglossum* complex genera.

This study has not shown any fundamental dividing points between the *Halictus* and *Lasioglossum* complexes. There seems to be as much justification for considering *Lasioglossum* a subgenus of *Halictus* as there is for considering *Seladonia* a subgenus. However, the argument cannot be settled on the basis of a few characteristics drawn from a few species. A wider range of characteristics including genitalia must be drawn from many species, including some from the Palearctic fauna.

Curtisapis may or may not represent a distinct grouping within *Lasioglossum*. This study did not delve into sufficient detail regarding *Lasioglossum coriaceum* or any other *Curtisapis* species to give any evidence.

Michener (1951) lists 21 species of this Holarctic genus for the United States and Canada and at least four species occur in Mexico and Central America. Sandhouse (1933) revised the eastern North America species.

Spot characteristics for *Lasioglossum* females include black coloring, no apical fasciae but usually basal pubescence on the abdominal tergites, serrate tibial spurs, and wings with three submarginal cells and the outer veins except 1 r-m weak.

EVYLAEUS Robertson

Evylaeus Robertson 1902. Canad. Ent. v. 34, p. 244.

Robertson (1902b) described *Evylaeus* in a key. For female bees, the obsolescent wing veins beyond the first recurrent vein, including the second intercubitus, and the black coloring were given as characters; while the lack of apical fasciae on the abdominal terga, yellow marked or thinly pubescent clypeus, the fourth joint of the antennae longer than 2 plus 3 or a little longer than 3, and strongly rugose metathorax (propodeum?) if abdominal terga have basal pubescence were given for the males.

Michener (1944) considered *Evylaeus* to be a subgenus of *Lasioglossum s.l.*, while most authors have considered *Evylaeus* to be a subgenus of *Halictus* or a separate genus. Mitchell (1960) maintained *Evylaeus* as a separate genus and stated that it is closely related to *Lasioglossum*, differing it by the weak second intercubitus wing vein. He did not separate the males from *Lasioglossum*.

Evylaeus appears to be a rather heterogenous genus closely related to *Lasioglossum*, and nearer to *Dialictus* than to *Halictus*. The epistomal sutures, deeply notched hypostomal and postoccipital bridge sutures, tibial spurs, and labrum point to this, while sternites 7 and 8 very closely resemble *Lasioglossum* and probably cannot be differed from the sternites of that genus over a wide range of species.

Sixty-seven species of this Holarctic genus are recorded from the United States and Canada and five species from Mexico and Central America. Female *Evylaeus* can be spotted by their black coloring, weak outer wing veins including the second intercubitus and three submarginal cells, lack of apical fasciae on the abdominal terga, and shallowly pectinate tibial spurs.

SPHECODOGASTRA Ashmead

Sphecodogastra Ashmead 1899. Amer. Ent. Soc. Trans. v. 26, p. 92.

Ashmead (1899) described *Sphecodogastra* in a key and distinguished it from Halictus on the basis of its very large ocelli. Michener (1944) considered *Sphecodogastra* to be a subgenus of *Lasioglossum* *s.l.* and separated it on the basis of the sparse scopa of the females consisting of a row of simple bristles on the trochanters and lower edges of the femora, shorter bristles on the upper femora, and long nearly simple hairs on the tibiae. He included three species which do not have enlarged ocelli. Linsley and MacSwain (1962) placed the bees without enlarged ocelli in *Evylaeus*, pointing out that the modified scopa is an adaptation for collecting pollen of Onagraceae. They described *Sphecodogastra* as containing only *texana* and a new species, *noctivaga* Linsley and MacSwain, characterized by the enlarged ocelli, reduced scopa, ferruginous abdomen, and lack of a lateral carina on the propodeum. Both species are nocturnal, collect pollen from *Oenothera* (Onagraceae), and closely resemble each other.

The present study indicates no fundamental differences in the characters studied between *Evylaeus* and *Sphecodogastra*. Apparently *Sphecodogastra* is little more than an *Evylaeus* especially adapted for night flying (enlarged ocelli) and collecting pollen from a night-blooming plant, *Oenothera* (specialized scopa).

The genus is known from western and central United States. *Sphecodogastra* can be easily spotted by the enlarged ocelli and ferruginous abdomen.

HEMIHALICTUS Cockerell

Hemihalictus Cockerell 1897. Canad. Ent. v. 29, p. 288.

Cockerell (1897) described *Hemihalictus* on the basis of female specimens of *Panurgus lustrans* by a key and short note. He evidently considered the two submarginal cells as the important characteristic. Michener (1947) described the male, noting its short broad body and short antennae (resembling a female), female-like labrum, very long slender mandibles, and genitalia. He then and in 1944 considered *Hemihalictus* to be a subgenus of *Lasioglossum* *s.l.*, on account of its weak distal wing veins. Mitchell (1960) considered *Hemihalictus* to be a separate genus and noted that the basal segment of the flagellum is longer than segment 2 in both sexes. Daly (1961) described its nesting and foraging habits and described the larva. The one species known, *Hemihalictus lustrans*, is a matinal oligolege on *Pyrrhopappus* (Daly, 1961).

This species is obviously closely related to *Lasioglossum* and *Evylaeus*. Michener (1944) mentioned that *Evylaeus* will fall as a synonym of *Hemihalictus* if the character of the number of submarginal cells is not held as generically important, as would *Chloralictus* with *Dialictus* (which see, following). However, vein 1 r-m is missing in *Hemihalictus* and the strength of this vein differs *Evylaeus* and *Lasioglossum* by Michener's system. The present study indicates a slightly closer relationship with *Lasioglossum* based on the female, as determined by the postoccipital and hypostomal bridge sutures, labrum, and particularly the tibial spurs (Eickwort and Fischer, 1963).

The male looks so much like a female bee that it was overlooked in the Michigan State University collection until too late to be included in this study. Its sternites as pictured by Mitchell (1960, fig. 93) resemble those of *Evylaeus*. A study of the male which has several interesting characters might confirm the reality of this genus. On the basis of the female characters studied, no real separating points from *Lasioglossum* were found.

Hemihalictus occurs across most of the United States, apparently following the distribution of *Pyrrhopappus*. Its best distinguishing marks are its black coloring and wings with two submarginal cells and outer veins weak.

DIALICTUS Robertson

Dialictus Robertson 1902. Canad. Ent. v. 34, p. 48.
Chloralictus Robertson 1902. Canad. Ent. v. 34, p. 248.
Halictus subg. *Gastrohalictus* Ducke 1902. Zeitschr. System. Hymen. Dipt. v. 2, p. 102.
Halictomorpha Schrottky 1911. Rev. Mus. Paulista v. 8, p. 81.

Robertson described *Dialictus* (1902a) to receive *Halictus anomalus* Robertson, the females of which have two submarginal cells and the males have short antennae, joints hardly longer than wide, and joint 3 hardly longer than 2. He thus differed *Dialictus* from "the ordinary dull greenish *Halictus*" (*Chloralictus*?). In the same year Ducke described *Gastrohalictus*, distinguished by the two submarginal cells in the female, but his type species, *Halictus osmioides* Ducke, has long antennae in the male. He described his genus from South America. Moure (1941) synonymized *Gastrohalictus* with *Dialictus*.

Soon after he described *Dialictus*, Robertson (1902b) described

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Chloralictus in a key; the females on the basis of the obsolescent outer wing veins including the second intercubitus, dull greenish or bluish color, hind tibial spur with 3 to 5 long teeth, lobate labrum with strong labral fimbria ("apex of labrum produced, laterally compressed, pectinate"), and dentate mandibles.. The males were distinguished by no apical pubescent fasciae on the abdominal terga, dull greenish or bluish color, presence of the second intercubitus and flagellar joint 4 equal to 2 plus 3, and convex clypeus. He distinguished it from *Dialictus* on account of the presence of the second intercubitus and the longer antennae of the male. Schrottky described *Halictomorpha* for South American species in 1911. Moure (1941) synonymized *Halictomorpha* with *Chloralictus*.

Michener (1944) considered *Dialictus* and *Chloralictus* to be subgenera of *Lasioglossum* *s.l.* on account of their weak outer wing veins and separated the two on the basis of number of submarginal cells. He noted that *Chloralictus* would be a synonym of *Dialictus* if that were not considered to be of subgeneric value. Mitchell (1960) made the synonymization, noting that the wing venational characteristic "is an unreliable character." The present author agrees; several species of *Chloralictus* are on hand in which vein 1 r-m is wholly or partially missing in one or both wings. Sandhouse (1923) cited other examples in *Dialictus parvus* (Cresson) and *D. occidentalis* Crawford. Mitchell considered *Dialictus* to be closely related to *Evylaeus*, differing by its metallic color.

Dialictus appears to be about the most distinct and homogenous of the *Lasioglossum* complex. The epistomal sutures, hypostomal and post-occipital bridges, labrum, and tibial spurs resemble *Halictus* least of the *Lasioglossum* complex and show close relationship to *Evylaeus*. However, in its metallic coloring and eighth sternite form, the genus more closely resembles Seladonia. The form of the eighth sternite, if constant, may be a valid separating point from Evylaeus.

Dialictus is a very large genus occurring both in the Old World and throughout the New World, with over 180 species currently recognized in the United States and Canada alone. This taxonomically difficult genus was partially revised by Sandhouse (1923 and 1924) for the United States.

Dialictus can be recognized by its metallic color and lack of apical fasciae on the abdominal terga and weak outer wing veins (females).

PARALICTUS Robertson

Paralictus Robertson 1901. Canad. Ent. v. 33, p. 299.

Robertson (1901) proposed Paralictus for female bees with the venation, tibial spurs, and general characteristics of "small dull greenish species of Halictus" (Chloralictus?) and with broad cheeks, simple mandibles, concave labrum with broad flat apical process without an apical lobe, and obsolete anal rima and scopa. He suspected that the females do not collect pollen and that P. cephalicus (Robertson) is an inquiline of Halictus zephyrus (Chloralictus). Later (1902b), in his key to Halictinae, he keyed out Paralictus next to Chloralictus, separating it in the males by the flat clypeus.

Michener (1944) considered Paralictus to be a subgenus of Lasioglossum s.l. on account of its weak outer wing veins. Mitchell (1960) called Paralictus a genus, closely related to Dialictus. He pointed out that the long slender mandibles of the females may have a small inner tooth and the cheeks are usually, but not always, very broad and more or less angulate. He stated that in the males the antennae are widely separated and the clypeus rather flat and projecting little below the sub-orbital line, unlike *Dialictus*. Mitchell pointed out that sternites 7 and 8 closely resemble those of *Dialictus* but differ slightly in the form of the median apical lobe of sternite 7. The one male specimen dissected in the present study did not permit detailed observation of sternite 7.

In general, the results of this study corroborate Mitchell's observations and conclusions. There seems to be little doubt that *Paralictus* is closely related to *Dialictus* and probably descended from it. This genus should prove extremely valuable to bee evolutionists in studying the comparative rates of modification of a genus in evolving from a pollen-collecting biology to a social parasitic biology. Both the ancestral genus (*Dialictus*) and an older parasitic genus (*Sphecodes*) whose form *Paralictus* is supposedly evolving towards are available for comparison. In the characters studied, the mandibles and labrum show strong modification. The labrum retains the comparatively long base of *Dialictus* and a low basal tubercle, but has lost the apical lobe and the apical process is broad and spatulate similar to *Sphecodes*. The male sternites show almost no change. The tibial spurs seem to be gradually but slowly losing their teeth (Eickwort and Fischer, 1963). Five species are known from eastern and central United States. The bees resemble *Dialictus* with pointed mandibles and reduced scopa.

SPHECODES Latreille

Sphecodes Latreille 1804. Nouv. Dict. Hist. Nat., v. 24, p. 182.

Depranium Robertson 1903. Ent. News v. 14, p. 103.

Proteraner Robertson 1903. Ent. News v. 14, p. 103.

Sphecodium Robertson 1903. Ent. News v. 14, p. 104.

Machaeris Robertson 1903. Ent. News v. 14, p. 104.

Dialonia Robertson 1903. Ent. News v. 14, p. 104.

Sphecodes has long been recognized as a genus related to pollen-collecting Halictinae and strongly modified for social parasitism. Ashmead (1899) placed Sphecodes and Temnosoma in a subfamily (Sphecodinae) separate from the Halictinae on account of the absence of scopa on hind legs and abdomen and the absence of a rima on the last dorsal segment of the abdomen in the females. The males were separated on the basis of the wide head, flat clypeus, and coarse sculpturing of the metathorax (propodeum?).

Robertson (1903) also put Sphecodes into a separate subfamily and split the genus into six genera, based largely on whether the mandibles are dentate or not, the length of antennal joint 4, and the presence or absence of the first intercubitus. Michener (1944) considered these names as being of subgeneric value and said that the species of the genus are too poorly known to make a key to subgenera. He gave as further distinguishing marks of male Sphecodes the lack of yellow markings on the face and legs, and for the females the strong distal wing veins and obsolete basitibial plates. The head and thorax are black and coarsely punctured and the abdomen is usually red. The legs are slender and wasplike.

Sphecodes evidently descended from a Halictus or Halictus-like ancestor, as evidenced by its Holarctic distribution and mouthpart structure, as well as the absence of any structures (metallic coloring, lobed epistomal sutures, lamellate dorsal ridge of pronotum, sternite structure) resembling typically South American genera. The majority of its distinguishing characteristics are adaptations for social parasitism: reduced hair and absence of scopa, coarse sculpturing, spatulate labrum (why?), slender pointed mandibles, toothless tibial spurs, and possibly sharply angulate preoccipital ridge (see Temnosoma). The usually shorter mouthparts of this and Paralictus may be an adaptation for parasitism. Other characters that differ Sphecodes from the Halictus-Lasioglossum complex appear to be more conservative. The often appendiculate marginal cell and form of sternites 7 and 8 do not suggest any immediate ancestor in North American Halictinae. This is not surprising; the ancestral Halictus was probably Old World in distribution and any living descendents are probably found there. The narrowed second submarginal cell appears characteristic of Sphecodes but is also found in miscellaneous other genera.

The few species included in this study suggest that Sphecodes is a heterogenous genus and may be capable of subdivision into valid subgenera. This study is too limited in scope to suggest any limits or validate Robertson's genera. On admittedly scant evidence, this author believes that the Sphecodes species in the New World are monophyletic from a single genus or species.

Sphecodes is a large genus widely distributed throughout the world. Over 70 species are recorded from the United States and Canada and over 30 species from Mexico south to Argentina. The black coarsely punctate appearance, usually red abdomen, absence of scopa in the females and absence of yellow markings in the males will serve to identify most Sphecodes.

HABRALICTUS Moure

Habralictus Moure 1941. Arq. Mus. Paranaense v. 1, p. 59.

Moure described *Habralictus* in 1941 from the "Halicti coarctati" of Vachal. He was not the first to recognize the validity of the grouping; Cockerell in 1918 discussed the group as simulating the Old World *Nomioides* and differing from it by the sharply pointed marginal cell. He included ten species and noted that they were not typical *Halictus*, *Augochlora*, or *Neocorynura*, but did not propose a name because he thought that *Ctenocorynura* Schrottky might be applicable, whose description he could not obtain.

Moure noted that *Habralictus* is composed of small delicate bees with numerous yellow markings and almost imperceptible hair on the eyes. The females have a long propodeum and flattened abdomen with yellow tergite markings and a pectinate tibial spur while the males have very long antennae and a narrow long abdomen with the seventh tergite elongate and bearing a rounded terminal lamina with upturned edges. He noted that the genus, particularly the males, resembles *Neocorynura* superficially, but its true relationship is with *Paragapostemon*, particularly the smaller species of same. *Habralictus* is distinguished from *Paragapostemon* (probably not the *Paragapostemon* of this study) by the numerous yellow markings on the clypeus, legs, and pectinate tibial spur, basally distant antennae, and lack of frontal carina in the males. Michener (1954) noted that the bees resemble *Perdita* in size and markings.

Unfortunately this interesting genus is very poorly represented in the Michigan State University and only two males and one female were available for dissection. All observations must be considered tentative until longer series are available and better dissections made.

This present study shows no strong relationships between *Paragapostemon* as considered here and *Habralictus*. On the contrary, *Habralictus* seems closest related to the *Halictus-Lasioglossum* complex, although not identical with it. The mouthparts are typically *Halictus* in general conformation although shorter and broader and the tibial spur resembles that of *Dialictus*. The marginal cell is acute and the labrum more closely resembles *Dialictus* than *Agapostemon*. The eyes more closely resemble *Halictus* and are not more noticeably hairy, while the epistomal suture is not lobed. The male sternites are not identical with the *Halictus* grouping but are nearer to it than to the *Agapostemon* grouping. Probably *Habralictus* descended from a *Dialictus* prototype, but evidence is scant for this assumption.

About ten species are known from Central America south to Bolivia and Brazil. The small *Perdita*-like aspect coupled with the yellow markings on the abdomen and flattened abdomen in the females, and long narrow abdomen in the males, distinguish this genus.

"A"

The members of this undescribed genus, which I have labeled "*A*", have been placed in *Halictus*, *Caenohalictus*, *Caenaugochlora*, *Paragapostemon*, and *Augochlora*, due to the long hair on their eyes and bright green coloring. Superficially these bees resemble small *Augochlora* with a densely granular thorax which is nearly impunctate and without striae on the basal portion of the propodeum, at least in the females. The long hair on the eyes resembles several other genera of Halictines.

However, "*A*" seems to be closest related to the *Halictus-Lasioglossum* complex, although not a member of it, and rather distinct from *Augochlora* and *Paragapostemon*. The epistomal sutures, occipital structure, labrum, pronotal structure, wing venation, and tibial spur all closely resemble *Halictus*. The mouthparts are particularly *Halictus*-like in structure rather than like *Agapostemon* or *Augochlora*. The sternites appear more closely related to *Halictus* although not in the same grouping; sternites 4 to 6 are not modified nor maculated with color like most of the *Agapostemon* grouping, and the structure of sternites 7 and 8 is unlike that of *Augochlora*. The hair on the eyes resembles that of *Paragapostemon* but the eyes are emarginate similar to *Halictus* and long hairs on the eyes seem to have developed independently in several groups. On the basis of the tibial spur structure and geographical range, a *Dialictus* prototype seems most likely to have developed into "*A*". Possibly "*A*" developed along parallel lines with the *Augochlora* complex for a short period of evolutionary time, but I do not find evidence to indicate that "*A*" is ancestral to *Augochlora*.

About 14 species from Peru, Argentina, and Chile can be assigned to this genus. "*A*" can be distinguished by its granular usually impunctate appearance, usual lack of striae on the propodeum, and hairy eyes which are not deeply emarginate. The coloring is usually bright green.

CALLOCHLORA Moure

Callochlora appears to be a genus of Moure's, although I cannot find a generic description. Specimens of *Halictus chloris* borrowed from the University of Kansas carry Moure's determination of "*Callochlora chloris*".

Callochlora is rather similar to "*A*" and varies chiefly in a direction away from the *Halictus* characteristics. It is closely related to *Corynura*. Like "*A*", *Callochlora* is composed of bright green species with hairy eyes, although *Callochlora* is punctate and not granular. The eyes are haired like in "*A*" but more deeply emarginate. The nearly straight epistomal sutures, very rounded ridges on the pronotum, and acute marginal cell indicate definite trends away from *Halictus* but not similar to *Augochlora*. The structure of the occiput and hypostoma suggest an extreme of "*A*" or *Dialictus*. The tibial spur suggests that of *Dialictus*. The mouthparts are typically *Halictus* in form except for the added modification of the galear comb. The labrum suggests a modified *Dialictus* labrum. Most modified of the structures studied are the sternites. The unmodified appearance of sternites 4 to 6 suggests *Halictus*, but the shape of 7 and 8 are unique to this genus and *Corynura*.

Callochlora is represented by two species in Argentina and Chile. Its members can be distinguished by their shiny green appearance with notched haired eyes and pectinate tibial spurs. Externally similar but probably unrelated is *Caenaugochlora*, which can be distinguished by the sharply angled preoccipital ridge and appendiculate marginal cell.

CORYNURA Spinola

Corynura Spinola 1851. Historia fisica y politica de Chile por Claudio Gay, Zool. v. 6, p. 269.

Corynogaster Sichel 1867. Reise der Novara Zool. Theil v. 2 suppl.,

p. 146.

Rhopalictus Sichel 1867. Reise der Novara Zool. Theil v. 2 suppl., p. 146.

The standing of *Corynura* has been greatly disputed taxonomically. According to Alfken (1926), Spinola described *Corynura* on the basis of an Halictine male and a Thynniden wasp female. Alfken believed that the male must stand as the type, with *Corynura gayi* Spinola as type species. Alfken had earlier shown that *Corynura gayi* is the male of *Halictus rubellus* Haliday. (Meade-Waldo, 1916).

Alfken (1926) mentioned that Sichel described *Rhopalictus* on the basis of *Corynura flavofasciata* Spinola male, whose female is *Halictus chilensis* Spinola. Alfken considered *Rhopalictus* as synonymous with *Neocorynura* and separate from *Corynura*. According to Dalla Torre (Sandhouse, 1943), *Rhopalictus* is a synonym of *Corynura* and not synonymous with *Neocorynura*. Moure (1944) agreed.

Sichel also described *Corynogaster* in 1851. Sandhouse designated *Corynura gayi* as genotype in 1943 and thus *Corynogaster* is isogenotypic with *Corynura* and a synonym of it.

Vachal (1905) described *Manuelia* as close to *Ceratina*. Sandhouse (1943) designated *Halictus gayi* Spinola as type and believed consequently that *Manuelia* should be a synonym of *Corynura*. However, Moure (1944) pointed out that Spinola did not cite *Halictus* (*Corynura*) *gayi* in *Corynura*, but just *Corynura gayi*; consequently *Halictus gayi* refers to a separate species. An examination of Vachal's (1905) work makes this obvious by his reference to other species of *Halictus* and references to Spinola's female *Halictus gayi*, obviously a Ceratinid bee and not a wasp.

Moure (1944) listed the synonymy of *Corynura*.

Rhopalictus as described by Alfken (1926) includes only one true *Corynura* species, *Corynura chilensis*, which is the type. The other species included in *Rhopalictus* by Alfken are probably *Neocorynura*. In general appearance *Corynura chilensis* is an unusual bee, dark blue-black, impunctate and granular, with clear apical bands on the abdominal tergites overlying basal bands of white pubescence, and orange wings and legs. The males have an elongate clavate abdomen, rugose but granular propodeum, and orange antennae in addition. *Corynura corynogaster*, not a *Rhopalictus*, has a red abdomen and metallic green thorax with the propodeum granular and without striae in the female. Male *Corynura sp*. has a rugose granular propodeum, long abdomen, and long orange antennae.

Moure (1950) in his key to the "Halicti falcati" of Vachal placed *Corynura* near *Paroxystoglossa* on account of the comparatively long male and female antennae, lack of preoccipital carina and micropectinate tibial spurs and slightly rugose or reticulate propodeum (females), and the lengthened abdomen of the males. He separated *Corynura* from *Paroxystoglossa* on the basis of the rounded mesonotum, straight epistomal sutures, acute marginal cell, obsolete basitibial plate, and large smooth microreticulate propodeum (females) and very long clavate abdomen and unmodified sternites 4 to 6 (males).

This study does not substantiate placing *Corynura* near *Paroxystoglossa*. On the contrary, *Corynura* appears closely related to *Callochlora* and quite different from the *Augochlora* complex. The epistomal sutures, occipital structure, mouthpart structure, wing venation, and particularly the sternite structure are nearly identical with *Callochlora*. Several factors suggest that *Corynura Corynogaster* is closer related to *Callochlora* than is Corynura chilensis. The pronotal and mesonotal structure is very similar in Corynogaster to Callochlora, while being modified to form carinate or sharp-angled pronotal ridges and a high notched mesoscutal lip in chilensis. The tibial spurs present one of the sharpest distinctions between Corynura and Callochlora, but the long serrations of Corynogaster may represent an intermediate state. The labrum and emarginate eyes represent further slight modifications, and the long eye hairs are not present.

Rhopalictus may have subgeneric value within Corynura. Unfortunately only one male Corynura s.s. specimen was available and could not be sacrificed for sternital structure. The tibial spurs and mesoscutal and pronotal structure may represent valid subgeneric characters, along with the gross color and puncturation patterns.

Because of the many misidentifications of this genus, the author hesitates to cite the number of named species or extend the genus's range beyond Argentina and Chile. The genus may be distinguished in the females by the granular non-striate propodeum, serrate tibial spurs, emarginate eyes without long hairs, and slightly bent epistomal sutures. The males have long often clavate abdomens with sternites 4 to 6 unmodified. They closely resemble Neocorynura, whose males usually have a shiny propodeum.

RUIZANTHEDA Moure

Ruizantheda was probably named by Moure. I have not been able to find the generic description, but specimens of Halictus mutabilis, Halictus proxima, and Halictus nigrocaeruleus Spinola have been labeled

"*Ruizantheda*" by Moure in the American Museum of Natural History (J. G. Rozen, pers. comm.).

Ruizantheda has the general appearance of *Corynura* with hairy eyes. *Ruizantheda mutabilis* resembles *Corynura corynogaster* in general morphology, with a blue nearly impunctate thorax and a granular non-striate propodeum and a red abdomen. The males of *R. mutabilis* are similar to the females, with a striate but granular propodeum and yellow markings on the legs, clypeus, and antennae. The antennae are not extremely long nor the abdomen particularly slender. *Ruizantheda proxima* is non-metallic; black in color with white basal pubescence on the sides of the abdominal terga and orange legs and wings in the females. The males have an orange abdomen and the general markings and shape of *R. mutabilis*. These species had previously been placed in *Paragapostemon*.

Ruizantheda belongs to the *Agapostemon* complex which also includes *Agapostemon*, *Paragapostemon*, and *Pseudagapostemon*. However, it also bears strong resemblance to *Corynura* and *Callochlora*. Quite possibly *Ruizantheda* has shared a common line of descent from the *Halictus-Lasioglossum* complex with *Callochlora* and *Corynura*, and has branched off away from them to form the base of the *Agapostemon* complex. Evidence also exists to suggest that *Pseudagapostemon* may form the base of the *Agapostemon* complex, however.

The eyes bear long hairs similar to *Callochlora* but are less emarginate. The epistomal sutures resemble *Halictus* and are thus more angled than in *Corynura*. The occipital and hypostomal-structure resembles *Corynura*, as does the pronotal and mesoscutal structure and wings. The mouthparts are *Halictus*-like but lack the galear comb of *Callochlora* and *Corynura*. The chief factors which place *Ruizantheda* near to *Agapostemon* are the tibial spurs and sternites. The tibial spurs are partially lamellate, representing an intermediate form between the *Halictus* complex and *Agapostemon*. Sternites 7 and 8 are quite different from *Corynura* and closely resemble *Agapostemon*. Sternites 4 and 5 are strongly modified in *Ruizantheda proxima*, a common trend in the *Agapostemon* complex, although they are unmodified in *R. mutabilis*.

There is as much reason to separate *R. mutabilis* and *R. proxima* into different subgenera as there is to separate *Seladonia* from *Halictus*. More characters will have to be studied before such a split is made. *R. proxima* seems the more advanced of the two.

The three species of *Ruizantheda* are known from Argentina and Chile. The species may be spotted by their hairy eyes, granular propodeum without striae and partially lamellate tibial spurs (females) and yellow maculations on the legs and clypeus (males). The non-lobate epistomal sutures and acute marginal cell are additional points.

PSEUDAGAPOSTEMON Schrottky

Pseudagapostemon Schrottky 1909. Rev. Mus. La Plata v. 16 (ser. 2, vol. 3), p. 145.

Moure (1943a) discussed *Pseudagapostemon* and its history and gave the following characteristics for the females: glabrous eyes which are little emarginate, clypeus projecting, first recurrent vein received a little before the apex of the second submarginal cell, posterior portion of the propodeum not encircled by carina, basal area of propodeum strongly "vermiculate", and tibial spur with three largely lamellate teeth. He separated the males from *Agapostemon* with these additional characteristics:

clypeus, legs, antennae, and some sternites with yellow markings, the third segment of the flagellum as long as the first two together, and the last tergite with a more or less emarginate "careniform" border.

Pseudagapostemon represents one of the least modified genera of the Agapostemon complex and is apparently related to both *Agapostemon* and *Ruizantheda*. In general appearance *Pseudagapostemon* simulates *Seladonia*. In certain of its characteristics *Pseudagapostemon* more closely resembles the *Halictus-Lasioglossum* complex than does *Ruizantheda*; these are the hypostomal structure, pronotal structure, and tibial spurs. The differences are slight and may represent convergence or specific differences within a genus, or they may indicate that *Pseudagapostemon* is closer to the ancestral *Agapostemon* prototype than is *Ruizantheda*. *Ruizantheda* more closely resembles *Corynura*. The marginal cell of *Pseudagapostemon* is intermediate between *Ruizantheda* and *Agapostemon*, while the tibial spur is intermediate between *Dialictus* (or *Seladonia*?) and *Agapostemon*. The mouthparts show a greater modification away from *Halictus* into an *Agapostemon* type but are still shorter than *Agapostemon*. Sternites 7 and 8 are remarkably similar to *Ruizantheda proxima*, while sternites 4 and 5 are modified in a manner similar to both *R. proxima* and *Agapostemon*. The epistomal sutures are lobed similar to *Agapostemon*. A prototype of *Pseudagapostemon* probably was ancestral to *Agapostemon* and descendent from (or ancestor to) a prototype of *Ruizantheda*.

Over fifteen species are recorded from Brazil and southwards. The females can be spotted by their *Seladonia*-like appearance (without apical pubescence on the abdominal tergites), lamellate tibial spurs, lobed epistomal sutures, and propodeum without enclosing carina; the males can be spotted by their yellow maculations and epistomal sutures.

AGAPOSTEMON Guerin-Meneville

Andrena subg. Agapostemon Guerin-Meneville 1844. Iconogr. Regne
Anim., Ins., v. 3, p. 448.

Smith (1853) was the first to give Agapostemon generic rank and he described the genus, noting Guerin's failure to give generic characters. He noted the long proboscis and labral characteristics. Sandhouse (1936) described in detail the genus characteristics; she and Dreisbach (1945) noted the bright green coloring and yellow maculations on the male, the posterior tibia being as long as or longer than the entire tarsus, the thickened and often greatly modified hind femora of the males, the spatulate tibial spur teeth, lack of basitibial plate, and carina enclosing the posterior portion of the propodeum. Michener (1944) noted the second and third submarginal cells each received a recurrent vein, although Sandhouse said the wing venation varied little from related genera. Michener also noted that the marginal cell is narrowly truncate and appendiculate.

Agapostemon shows strong modifications away from Halictus in the trend established by Pseudagapostemon. More emarginate eyes, lobate epistomal sutures, sharper preoccipital ridge and more closed bridge sutures, longer mouthparts, appendiculate marginal cell, broadly lamellate teeth on the tibial spurs, and modified sternites 4 to 6 with 7 and 8 similar to Pseudagapostemon confirm this trend.

Agapostemon is present in North America through Central America to northern South America. Eight species are recorded from the United States and about eighteen species from Mexico south to Brazil. The long posterior tibiae and spatulate tibial spurs in the female and the thickened hind femora and yellow and black abdomen in the male mark this distinctive genus. Both sexes have the posterior portion of the propodeum encircled by carinae. Sandhouse (1936) revised the genus for North America.

PARAGAPOSTEMON Vachal

Halictus subg. *Paragapostemon* Vachal 1903. Misc. Ent. v. 11, pp. 89 and 96.

The present author has not been able to obtain Vachal's description nor see a specimen of the species designated as genotype by Cockerell (1905), *Halictus podager* Vachal. The bees which are called *Paragapostemon* in this study resemble *Agapostemon* closely but have long hairs on the eyes and metallic, rather than black and yellow, abdomens in the males. The male antennae may be strongly modified.

No important differences were found between *Agapostemon* and *Paragapostemon* in this study except for the hairiness of the eyes. *Paragapostemon* seems at best to be valid as a subgenus of *Agapostemon* and probably descended from it.

The author has seen two species from Mexico. Most others recorded in the literature as *Paragapostemon* probably do not refer to that genus as understood here. The species are easily spotted, looking like *Agapostemon* with long hair on the eyes and metallic male abdomens.

NEOCORYNURA Schrottky

Cacosoma Smith 1879 (not Felder, 1874) Descriptions of new species of Hymenoptera in the collection of the British Museum, p. 39, preocc.

Neocorynura Schrottky 1910. Deutsche Ent. Zeitschr., p. 540.

Smith described Cacosoma in 1879 to include bees with clavate abdomens. He noted that the first three joints of the maxillary palpi are short, stout, and clavate, and the fourth, fifth, and sixth joints are slender. He also described the short glossa and narrowed second submarginal cell. Neocorynura was proposed by Schrottky to replace Cacosoma, which was preoccupied.

Neocorynura simulates Corynura in the narrowed abdomen and produced mesoscutum, but there is no evidence of close relationship. Neocorynura seems to have evolved from the Halictus-Lasioglossum complex in the same direction as the Augochlora complex, which follows in this discussion. However, no definite ties with any genus of that group could be identified. Neocorynura seems to be closest related to the Halictus-Lasioglossum complex from which it has undergone considerable specialization, particularly in the produced mesoscutum, petiolate abdomen, and color patterns. The epistomal sutures, wing venation, tibial spurs, and sternites resemble quite closely the Halictus-Lasioglossum complex, while the emarginate eyes represent a modification. The mouthparts indicate best a relationship to Augochlora although of the size of Halictus. Study of more characteristics and species will be necessary to determine more accurately the position of this genus.

Over twenty species of this rather large genus have been recorded from Mexico, Central America, and Northern South America. The emarginate eyes, petiolate abdomen, produced mesoscutum, and pectinate tibial spurs are the best spot characteristics. Neocorynura contains both metallic and non-metallic species.

AUGOCHLORELLA Sandhouse

Augochlorella Sandhouse 1937. Wash. Acad. Sci. Jour. v. 27, p. 66.

Pereirapis Moure 1943. Rev. de Ent. v. 14, p. 461.

Oxystoglossidia Moure 1943. Rev. de Ent. v. 14, p. 473.

Sandhouse (1937) described Augochlorella in detail, separating it from Augochlora. She separated the genus on the basis of the narrow head, weakly defined preoccipital ridge, irregularly foveate mesopleura and non-carinate metapleural suture, and pointed marginal cell. For the females she noted in addition the subapical mandibular tooth, lack of carina or tooth on the first sternite and lack of a sixth ternite triangular polished area, and inner surface of hind femur with several rows of short unilaterally branched hairs. In the males she noted that the first and second flagellar joints are subequal, the sides of the propodeum indistinctly and sparsely punctured, and the caudal margin of the fourth sternite is usually emarginate. Michener (1944) considered Augochlorella a subgenus of Augochlora, but later (1954) raised it to generic rank on the basis of the unlobed epistomal sutures and pointed marginal cell. He then also mentioned that the clypeus in Augochlorella is beveled, black on the lower half and more coarsely punctate on that half, in contrast to Augochlora, and the hypostomal carinae are low and uniform in height, while in Augochlora they are elevated at the angles.

Moure (1943b) described Pereirapis and Oxystoglossidia on the basis of Brazilian species. Michener (1954) synonymized Pereirapis with Augochlorella. Moure (1944) synonymized his genus Oxystoglossidia with Augochlorella upon receipt of some North American specimens.

Augochlorella consists of bright green bees resembling Augochlora in general appearance and evidently closely related to it. The characters studied here indicate that *Augochlorella* is nearer to the *Halictus-Lasioglossum* complex. The unlobed epistomal sutures, non-carinate preoccipital ridge and rounded hypostomal sutures, shorter proboscis and mandibles with subapical tooth, less strongly carinate dorsal ridge of the pronotum, and pointed marginal cell show this trend. The sternites, tibial spur, and emarginate eyes indicate the close relationship of *Augochlorella* and *Augochlora*. For a discussion of relationships within the *Augochlora* complex, see *Augochlora*.

Augochlorella is known from North America south to central South America. Four species are recorded from the United States and Canada and about seven species south of the United States border. The green bees of this genus may be separated by the serrate tibial spurs, unlobed epistomal sutures, pointed marginal cell, and emarginate eyes. Sandhouse (1937) revised the species in the United States.

AUGOCHLORA Smith

Augochlora Smith 1853. Cat. Hym. Brit. Mus. v. 1, p. 73.
Oxystoglossa Smith 1853. Cat. Hym. Brit. Mus. v. 1, p. 83.
Odontochlora Schrottky 1909. La Plata Mus. Rev. v. 16, p. 14.

Smith described *Augochlora* in 1853 for bright green bees with emarginate eyes and the first recurrent vein joining the second intercubitus. He differed *Oxystoglossa* on the basis of the elongate mouthparts. Ashmead (1899) synonymized the two genera. Schrottky separated *Odontochlora* in 1909. Sandhouse (1937) synonymized *Odontochlora* with *Augochlora* and gave characteristics of *Augochlora*. She noted the broad head, carinate preoccipital ridge, bidentate mandibles, flagellum of male with joints beyond fourth progressively longer, carinate transverse suture of the metapleuron, and appendiculate marginal cell, and in the females the first sternite with a median carina or tooth and the sixth with a median triangular polished area, and in the males the first sternite with a median furrow or carina and caudal margins of the second to the sixth truncate. Michener (1944) noted the serrate tibial spurs and labrum structure, and later (1954) mentioned that the epistomal sutures are lobed, the hypostomal carinae are elevated at the angles, the clypeus is flat with no abrupt change in puncturation, although the preoccipital carina does not reach the hypostomal carina in some species and the mandibles sometimes resemble those of *Augochlorella*.

Augochlora has been the basis from which a large number of Halictine genera have been described. *Augochlorella*, *Caenaugochlora*, *Augochloropsis*, and *Paroxystoglossa* of this study fit this category. These form the *Augochlora* complex, apparently related via the sternite structure and mouthparts. The interrelations between these genera are very difficult to discern, however. Three distinct types of tibial spur structure are found, and other characteristics studied herein do not indicate noticeable trends. The one exception is the relationship between *Augochlora* and *Augochlorella*. Cockerell (1900) recognized that diverse groups exist within *Augochlora* *s.l.*, although he recognized only *Augochloropsis* as being subgenerically distinct. Moure (1943b) apparently named the *Augochlora* complex "tribe *Augochlorini*" and gave a key to separate the South American genera *Augochlora*, *Paroxystoglossa*, *Rhopalictus*, *Ceratalictus*, *Pereirapis*, *Oxystoglossa*, and *Oxystoglossidia*; the latter three of which are now considered synonyms of other genera.

Ceratalictus is not included in the present study and *Rhopalictus* is considered congeneric with *Corynura* and not of this tribe in this study. He placed *Augochloropsis* in a separate tribe.

Augochlora *s.s.* represents one of the more modified forms in the *Augochlora* complex and is apparently descended from an *Augochlorella* prototype. The deeply lobed epistomal sutures, carinate preoccipital ridge and hypostomal sutures, long proboscis, strongly carinate dorsal ridge of the pronotum, and appendiculate marginal cell noted in this study confirm this statement. The bidentate apex of the mandible may be an adaptation for nesting in wood.

Augochlora is very numerous in species throughout South and Central America, with four species reaching the United States. The serrate tibial spurs, lobed epistomal sutures, carinate or toothed first abdominal sternite, appendiculate marginal cell, and usually bidentate mandibles identify these bees. Sandhouse (1937) revised the bees for the United States.

PAROXYSTOGLOSSA Moure

Paroxystoglossa Moure 1940. Arq. Zool. Est. Sao Paulo v. 2, p. 59.

Moure described Paroxystoglossa in 1940 as being near to *Oxystoglossa*, with glabrous emarginate eyes, mesonotum produced and notched, and no carina nor tooth on the first sternite. The males are distinctive due to the very long antennae and modified abdominal sternites, and the mesonotum is not produced. The epistomal suture is not lobed. Later (1950) Moure added that the tibial spurs are practically simple and that the abdomen is moderately elongate in the males.

The relationships of Paroxystoglossa within the Augochlora complex are uncertain. The eyes, epistomal sutures, hypostomal and occipital structure, and wing venation suggest a less advanced modification away from the Halictus-Lasioglossum complex. The serrate tibial spurs and modified sternites 4 to 6 offer no clues, and the tongue structure is advanced. The tibial spurs and produced mesoscutum resemble Corynura, but the resemblance is probably superficial.

Nine species are known from central and southern South America. The females may be recognized by the serrate tibial spurs, eyes not deeply emarginate, marginal cell not appendiculate, and the more or less produced mesoscutum. The males may be recognized by their long antennae and modified sternites. Moure (1960) revised the genus.

CAENAUGOCHLORA Michener

Caenaugochlora Michener 1954. Bull. Am. Mus. Nat. Hist. v. 104, p. 76.

Caenaugochlora subg. Caenaugochlora Michener 1954. Bull Am. Mus. Nat. Hist. v. 104, p. 76.

Caenaugochlora subg. Pseudaugochlora Michener 1954. Bull. Am. Mus. Nat. Hist. v. 104, p. 77.

Schrottky (1906) described Pseudaugochloropsis as a subgenus of Augochloropsis characterized by the apical borders of the abdominal tergites without hair borders (vibrissae). He later designated nigromarginata (Spinola) as type species. Moure (1940) raised Pseudaugochloropsis to genus on the strength of the characteristics of the type species; other species included by Schrottky were relegated to Augochloropsis. Michener (1954) pointed out that Schrottky's type species was not originally included and the designation consequently invalid. Sandhouse's later designation of a type species (*Augochloropsis sthena* Schrottky) made the genus unrelated to *nigromarginata*. Michener consequently named the group *Caenaugochlora*. He noted that most of the species were previously included in *Caenohalictus* on account of the hairy eyes. *Caenohalictus* is quite a different genus. Michener noted that *Caenaugochlora* is related to *Augochlora*, differing by the pectinate tibial spurs, reduced preoccipital carina, hairs on eyes, long slender male antennae, and fourth sternite of males modified. He named two subgenera on the basis of the length of the eye hairs and whether the male antennae are pointed or not. For the purposes of this study, bees were not separated to subgenera.

The present study indicates that *Caenaugochlora* is an advanced member of the *Augochlora* complex which retains some *Halictus-Lasioglossum* complex characteristics. The epistomal sutures are not lobed, the preoccipital ridge is weakly carinate, and the tibial spurs represent only a slight modification over *Neocorynura* or *Dialictus*. However, the emarginate hairy eyes, appendiculate marginal cell, modified sternites, and very long proboscis suggest an advanced genus. There is inadequate evidence to suggest any relations with other genera; *Caenaugochlora* shares some common characteristics with *Augochloropsis* and may have branched off a line of descent that later gave rise to that genus.

Over ten species are known from Mexico south to Brazil. The hairy eyes, pectinate tibial spurs, modified male sternites, and long proboscis separate this genus.

AUGOCHLOROPSIS Cockerell

Augochlora subg. *Augochloropsis* Cockerell 1897. Canad. Ent. v. 29, p. 4.

Augochloropsis subg. *Paraugochloropsis* Schrottky 1906. Zeitschr. Syst. Hymen. Dipt. v. 6, p. 312.

Augochloropsis subg. *Pseudaugochloropsis* Schrottky 1906. Zeitschr. Syst. Hymen. Dipt. v. 6, p. 313.

Augochlora subg. *Tetrachlora* Schrottky 1909. Deutsche Ent. Zeitschr., p. 481.

Augochlora subg. *Glyptobasis* Moure 1940 (not M'Lachlan, 1871; not Koninck, 1881). Arq. Zool. Est. Sao Paulo v. 2, p. 48. preocc.

Glyptobasia Moure 1941. Arq. Mus. paranaense v. 1, p. 98.

Augochloropsis subg. *Glyptochlora* Moure 1958. Journ. N.Y. Ent. Soc. v. 66, p. 188.

Cockerell differed *Augochloropsis* from *Augochlora* in 1897 on the basis of the pectinate tibial spurs. Schrottky's *Paraugochloropsis* included those species with apical vibrissae on the abdominal terga and his *Pseudaugochloropsis* those without. *Paraugochloropsis* is properly a synonym of *Augochloropsis* (Sandhouse, 1937) and so is *Pseudaugochloropsis* if Michener's (1954) opinion on the type species is upheld (see discussion of *Caenaugochlora*). Schrottky later synonymized his *Tetrachlora* with *Augochloropsis*. *Glyptobasia*, a new name for *Glyptobasis* Moure, was differed from *Augochloropsis* on the basis of a carina surrounding the basal area of the propodeum and coarse sculpturing. Michener (1954) recognized *Glyptobasia* as a subgenus. Moure (1958) differed *Glyptochlora* from *Augochloropsis* by its coarse puncturation, carinate enclosure of the basal portion of the propodeum, and lack of abdominal vibrissae.

Sandhouse (1937) noted the apical vibrissae on the first and second abdominal tergites, truncate tegulae, emarginate eyes, broad labrum, lammelate dorsal ridge on the pronotum, obsolete basitibial plate, pectinate tibial spurs, and the unusual structure of the fourth sternite (pictured by Moure, 1940). Michener (1944) noted that the marginal cell is appendiculate. Mitchell (1960) also pictured the fourth sternite and noted that the labrum is colored black in the males. Moure (1943b) considered *Augochloropsis* to be in a separate tribe, *Augochloropsini*, from the *Augochlorini* on the basis of the above characteristics.

Augochloropsis is a very distinctive genus, apparently highly modified and separated from the other *Augochlora* complex genera. Nearly all the characteristics of the present study indicate a highly advanced state. Of particular interest is the unusually form of the labrum and the fourth sternite. The tibial spurs suggest some possible relation to *Caenaugochlora*, and other characteristics might be derived from a state similar to that of *Caenaugochlora*, but the evidence for a congruous line of descent is tenuous indeed.

Augochloropsis ranges throughout the New World with a great number of species in the tropical regions. The pectinate tibial spurs, truncate tegulae, labrum, and lamellate pronotal ridge separate these metallic bees. Sandhouse (1937) revised the United State species.

TEMNOSOMA Smith

Temnosoma Smith 1853. Cat. Hym. Brit. Mus. v. 1, p. 38.

Smith (1853) described the short tongue and narrowed second submarginal cell of *Temnosoma*. Ashmead (1899) placed *Temnosoma* in Sphecodinae and described the deeply punctate abdomen, lack of scopa, lack of anal rima, and appendiculate marginal cell. Ducke (1906) stated that *Temnosoma* differs essentially only in its green coloring from *Sphecodes* and may be a subgenus of *Sphecodes*.

Temnosoma is a remarkably distinct bee, resembling more a Chrysidid than an Halictine. The heavily punctate condition, possibly the prolonged preoccipital ridge (to protect the neck?), the labrum, short mouthparts, slender mandibles, and untoothed tibial spur all denote adaptation to a parasitic habit even more drastic than that noted in *Sphecodes*. However, the sternital structure closely resembles *Augochlora*. *Temnosoma* most likely is descended from an *Augochlora* complex ancestor and has converged towards *Sphecodes*.

Temnosoma is known from Brazil, Argentina, and Mexico, and recently (Timberlake, 1958) has been recorded from Arizona. The extremely heavily punctured condition including the tegulae, lack of scopa and teeth on the tibial spur, and green Chrysidid-like appearance distinguish *Temnosoma*. Cockerell (1901) revised the genus.

MEGALOPTA Smith

Megalopta Smith 1853. Cat. Hym. Brit. Mus. v. 1, p. 81.

Megalopta subg. *Megaloptidia* Cockerell 1900. Proc. Acad. Nat. Sci. Philadelphia v. 52, p. 323.

Megalopta subg. *Megaloptella* Schrottky 1906. Zeitschr. Syst. Hym. Dipt. v. 6, p. 312.

Tmetocoelia Moure 1943. Rev. de Ent. v. 14, p. 481.

Smith (1853) described *Megalopta* for bees with very large ocelli. He noted the elongate tongue, singular labrum, and wing venation. Cockerell (1900) described *Megaloptidia* for black species with the first recurrent vein interstitial with the second intercubitus, hairy wings, and the convex but not bituberculate scutellum. Schrottky described *Megaloptella* in 1906 but later synonymized it with *Megalopta*. Moure synonymized his own genus *Tmetocoelia* in 1958 in a study of Smith's *Megalopta* species. He then recognized the synonymy of *Megaloptella* and confirmed the validity of *Megaloptidia*, as well as discussing three other genera in the *Megalopta* complex, *Megommation*, *Ariphanarthra*, and *Megaloptodes*.

Megalopta is an unusual genus of night-flying bees, characterized by enlarged eyes and ocelli. The present study indicates many unique features which show considerable modification from a typical *Halictus* ancestor. The lobate epistomal sutures, unique labrum, greatly elongate mouthparts, unique pronotum, mesoscutum, and wing venation, and greatly modified sternites do not suggest any near relatives. The tibial spurs resemble *Agapostemon* somewhat, but sternites 7 and 8 resemble the *Augochlora* complex more. *Megalopta* supposedly nests in branches of trees (Bates, cited in Moure, 1958) which might account for the highly developed mandibles (R. L. Fischer, pers. comm.).

The genus is known from Central America south to Brazil. *Megalopta* can be easily distinguished by the enlarged ocelli and multidentate mandibles in the females and modified sternites in the males.

V. SUMMARY AND CONCLUSIONS

Twenty-five genera and subgenera of New World Halictine bees have been compared morphologically in characters that have been or should be used for generic discrimination. Most characters are clinal in nature; the male sternites, proboscis structure, and tibial spurs seem to be most valuable in discriminating generic difference and relationships.

On the basis of the characters studied, certain natural complexes of genera are found which probably indicate evolutionary groupings within the subfamily. The *Halictus-Lasioglossum* complex of genera is believed to be the most primitive in the New World and probably has formed the base for evolution of the other genera. The group is principally Nearctic, with *Halictus*, *Seladonia*, *Lasioglossum*, *Evylaeus*, and *Dialictus* being Holarctic. *Paralictus*, *Hemihalictus*, and *Sphecodogastra* are believed to be recent offshoots of the above genera in North America. *Dialictus* is the largest genus and the only one to range in considerable numbers in South America; it may have formed the base for evolution of the other generic complexes in the New World. All genera of the *Halictus-Lasioglossum* complex are closely related and may not represent true genera. *Sphecodes* is also Holarctic, probably an old offshoot of the complex in the Old World which also migrated to the New World and has spread throughout both continents.

Two main evolutionary complexes of genera seem to have developed in South America from the *Halictus-Lasioglossum* complex base. One line terminates in *Agapostemon*-like bees (the *Agapostemon* complex) and the other in *Augochlora*-like bees (the *Augochlora* complex). The more advanced offshoots of these complexes have invaded North America. "*A*", *Callochlora*, and *Corynura* represent a line of development in southern South America which may have given rise to the *Agapostemon* complex, with *Ruizantheda* and *Pseudagapostemon* less developed and *Agapostemon* and its probable offshoot *Paragapostemon* very advanced.

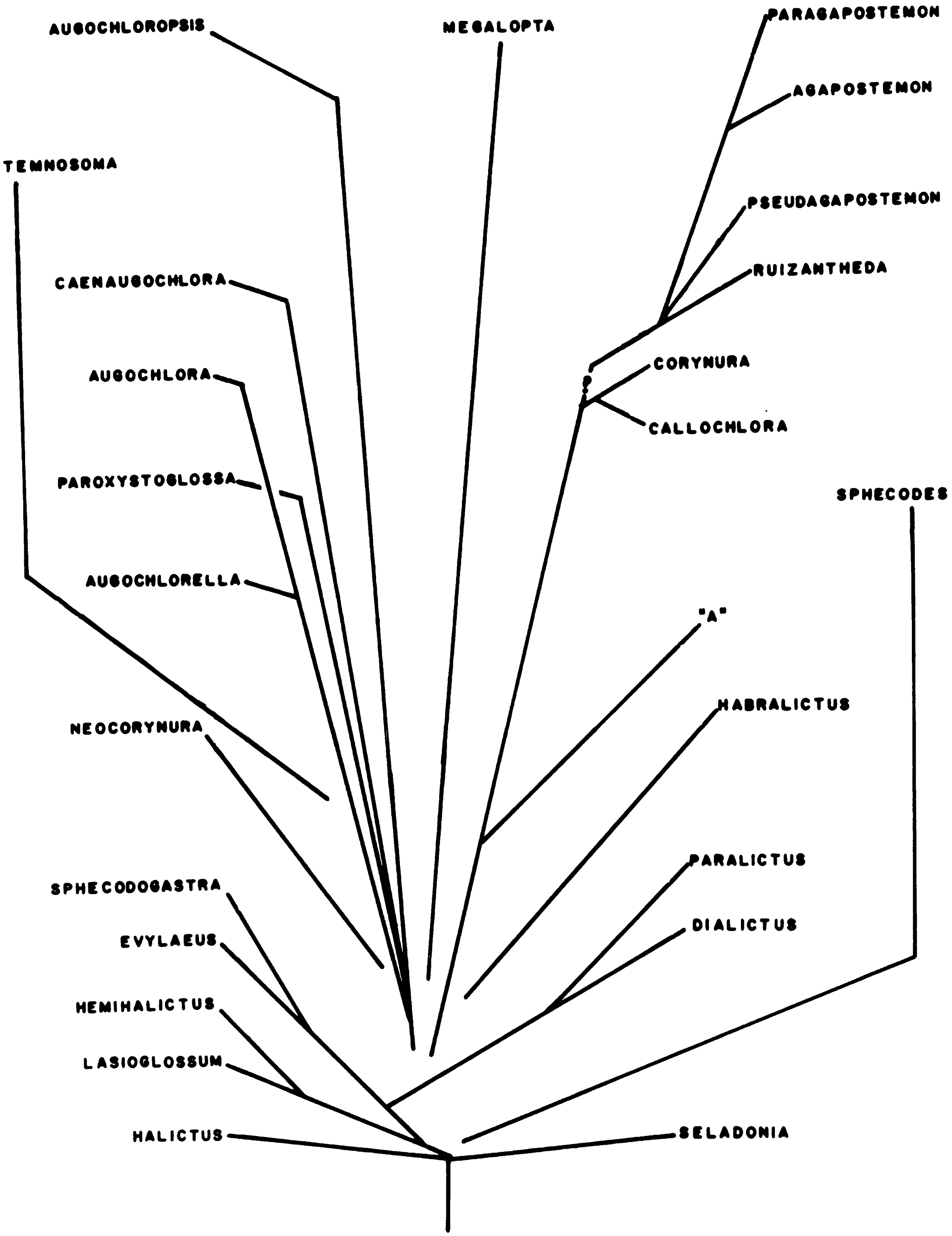
The *Augochlora* complex interrelations are difficult to decipher. *Augochlorella* is less advanced than *Augochlora* which has spread widely. *Paroxystoglossa* is a less advanced member of the complex confined to South America, while the more highly modified *Caenaugochlora* occurs also in Central America and the very advanced genus *Augochloropsis* occurs throughout the hemisphere. The parasitic genus *Temnosoma* probably has its origins in the *Augochlora* complex.

A number of genera do not fit easily into either complex. *Neocorynura* is not structurally greatly advanced beyond the *Halictus*-*Lasioglossum* complex and may have shared a common line of descent with the *Augochlora* complex. *Habralictus* is also not greatly advanced. *Megalopta* is structurally very advanced and no clue as to its origin exists. These three genera are of Central American and northern and central South American distribution.

A chart showing the morphological relationships of these genera and their degree of difference from a hypothetical *Halictus*-like ancestor is given in plate 7. Any interpretations as to the relationships between genera must be highly tentative. More species per genus and more characters, particularly genitalia, will have to be studied before conclusions can be drawn. In addition, 17 small genera were not included in this study.

PLATE VII--Morphological Relationships of Genera.

Degree of difference from hypothetical *Halictus*-like ancestor is indicated by distance from bottom of page.


AUGOCHLOROPSIS
MEGALOPTA
PARAGAPOSTEMON
AGAPOSTEMON
TEMNOSOMA
PSEUDAGAPOSTEMON
CAENAUGOCHLORA
RUIZANTHEDA
AUGOCHLORA
CORYNURA
CALLOCHLORA
PAROXYSTOGLOSSA
SPHECODES
AUGOCHLORELLA
"A"
HABRALICTUS
NEOCORYNURA
PARALICTUS
SPHECODOGASTRA
DIALICTUS
EVYLAEUS
HEMIHALICTUS
LASIOGLOSSUM
HALICTUS
SELADONIA

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