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An Introduction to the Study of Rocky Mountain Bees

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living. The population is now better clothed, housed and fed than at any previous time, and its quality is probably much improved.

From a military point of view the decline in the birthrate is important. A reduction of surplus population now utilized for standing armies with which to menace the peace of nations would contribute greatly to international tranquillity. Anything that increases the value of a man and his usefulness to the state, renders his government less disposed to trump up quarrels with other nations which may result in destruction of life. Nations with a stationary population are anxious to avoid war. The declining birthrate, therefore, is one of the factors making for international peace.

It is an error to assume that the present materialistic attitude of the social mind is likely to endure permanently. There is not the slightest evidence that it represents a social psychology that will long obtain. On the contrary, there are indications that at the present time large sections of our population are beginning to question the worth of the sacrifices made in the race for wealth. Exposures of the investigations of the past few years have directed public attention to the questionable sources of many great fortunes, and have made familiar the words "tainted money." Criticism of the manner in which so many fortunes have been made has tended to lessen the social value of wealth, and has done much to direct the attention of the world to the advantages of the simple life. It is coming to be realized that the greatest satisfactions of life are not in extravagant living, but consist rather in the consciousness of duty done and loyalty to high ideals. In so far as these ideas which have been for some time obscured in the struggle for material comforts return again to their proper place in the popular mind, it is likely that there will not be the same antagonism between the birthrate and ambition that has existed during several of the past decades.

Much of the discussion of race-suicide is academic and sentimental and tends to draw public attention away from questions whose study is of vastly more vital interest in their relation to the general welfare. Thus far the improvements in medical and sanitary science have greatly increased the expectation of life and have in some degree compensated for any loss due to the lowering of the birthrate.

AN INTRODUCTION TO THE STUDY OF ROCKY MOUNTAIN BEES

By T. D. A. Cockerell and W. W. Robbins

The Rocky Mountain bee fauna is not only remarkably rich and interesting, but in spite of many years of collecting it continues to yield numerous undescribed forms. Among the species described the nesting habits are known only in a few cases, and there is an immense field for interesting research into the biology of these insects. Tables for the separation of many of the species have been published but there has existed no quite serviceable modern work for the determination of the genera, and consequently the beginner has been discouraged at the outset. Nothing can be written which will make the study of bees easy, in the sense of absolving the worker from attention to numerous minute details or substituting anything for his critical judgment; but it is hoped that the present paper will at least make it possible for him to proceed, supposing him to be reasonably intelligent and industrious.

There is given first a summary of the classification adopted, in which most of the genera are distinguished. As an appendix to this follows a very brief abstract of Robertson's classification, which is of great value, but unfortunately inadequate, being based wholly on Illinois species. Finally there is offered an artificial key, which can be used by one unfamiliar with the classification, or the place in the system of the specimen in hand. The numerous illustrations of venation include nearly all the local genera, and can be used to interpret the tables and confirm determinations. It must be remembered, however, that the venation varies a little within specific limits, and of course still more within a large genus.

For the local species, the student will use the tables of Boulder County bees, published in these *Studies*, Vol. IV, June, 1907. The artificial key is mainly to genera, but species have been run in when convenient, these being nearly all additions to the Boulder County list since June, 1907. Several genera, and some species, not at present known from

Colorado have been included in the tables, largely for purposes of comparison. These nearly all live in New Mexico, and consequently may be considered to belong to the Rocky Mountain fauna.

Numerous fossil bees are known from the Miocene shales of Florissant. These are not included in the keys, but it will be useful to present a list. Those marked with an asterisk belong to extinct genera:

Halictus miocenicus Ckll.
Halictus florissantellus Ckll.
Halictus scudderiellus Ckll.
**Libellulapis antiquorum* Ckll.
**Lithandrena saxorum* Ckll.
**Pelandrena reducta* Ckll.
Andrena sepulta Ckll.
Andrena clavula Ckll.
Andrena hypolitha Ckll.
Melitta willardi Ckll.
**Cyrtapis anomalus* Ckll.
**Protomelecta brevipennis* Ckll.
Anthophora meljordi Ckll.
Megachile prædicta Ckll.
Anthidium scudderi Ckll.
Anthidium exhumatum Ckll.
Dianthidium tertiarium Ckll.
Heriades laminarum Ckll.
Heriades halictinus Ckll.
Heriades bowditchi Ckll.
Ceratina disrupta Ckll.
**Calyptapis florissantensis* Ckll.

Descriptive Terms

Head (See Fig. 2)

Vertex: top of head.
Occiput: region behind the vertex.
Cheeks: region behind the eyes.
Front: region between the vertex and the antennae.
Face: region below the antennae, chiefly occupied by a large central plate, the clypeus.
Ocelli: the three simple eyes on upper part of head.
Malar space: the space between eyes and mandibles.
Antennae: 12-jointed in males, 13-jointed in females; the long basal joint is the scape, the apical part, of many joints, the flagellum.
Facial foveae: depressed areas on each side of face parallel with the eyes.
Labrum: the plate below the clypeus, more or less covered by the mandibles.

The mouth parts are sufficiently explained in the figure. The blade of maxilla (that part of maxilla beyond the palpi) is often called the galea, but it is probably equivalent to the galea and lacinia fused (cf. *Trans. Amer. Ent. Soc.*, Vol. XXIX, p. 185). The tongue is often called the glossa.

Thorax

When the thorax is seen from above, the *prothorax* appears in front, behind the head; it has *lateral lobes*, approaching the *tegulae*, known as the *tubercles*. The large piece following the *prothorax* is the *mesothorax* or *mesonotum;* there may frequently be seen upon it two grooves, the *parapsidal grooves*. The next piece, just behind the level of the wings, is the *scutellum;* the *axillae* are small plates on each side of it, sometimes produced into spines, which are often described as the lateral spines of the scutellum. The *postscutellum*, a short sclerite, follows the scutellum, and behind this is the *metathorax*

propodeum or *median segment*. Morphologically this is considered to be part of the abdomen, but even so, the name metathorax is appropriate. The *basal area* of the metathorax is just behind the postscutellum. The large sclerites at the sides of the thorax constitute the *pleura*. At the base of the anterior wings are round scalelike bodies, the *tegulae*.

Wings

The venation of the wings is explained in Fig. 1.

Legs (See Fig. 3)

The basal part of the leg consists of two short segments, the *coxa* and *trochanter*, followed by the long and robust *femur*, after which comes the *tibia*, with one or more apical spurs. The remaining joints constitute the *tarsus;* of these the first is longer than the others and is called the *basitarsus* or *metatarsus*, the latter term being morphologically incorrect. The last tarsal joint bears the *claws*, between which may be a small pad, the *pulvillus*. The *scopa* is the pollen-collecting apparatus, consisting of modified hairs on the hind legs.

Abdomen

Six dorsal segments are visible in the female, seven in the male. The *ventral scopa* is the brush of hairs covering the under surface in certain females.

Sculpture

The *tegument* or *chitinous surface* is variously sculptured; *punctate, striate, rugose,* etc. The terms are self-explanatory, except punctate or punctured, which refers to small depressions looking like punctures of the surface, but not actual perforations.

Synopsis of Classification

Solitary Bees

A. Tongue short, broad, obtuse, emarginate at apex. *COLLETIFORMES.*

1 Hairy bees; anterior wings with three submarginal cells, COLLETIDAE
Colletes Latr. (P.)

2 Black bees with little hair, nearly always very small, face in nearly all the species with yellow or white markings; only two submarginal cells, PROSOPIDIDAE.
Prosopis Fabr. (P.)

B. Tongue more or less elongate, pointed, not emarginate; no ventral abdominal scopa. *ANDRENIFORMES*

1 Tongue more or less short, dagger-like; marginal cell pointed; usually three submarginal cells; maxillary palpi 6-jointed, ANDRENIDAE.

a Females with facial foveae; basal nervure nearly straight; hind trochanters of females with curved tuft of hair. Andreninae.
Three submarginal cells; mostly black species.
Andrena Fabr. (P.)
Two submarginal cells.
Non-metallic species. **Parandrena** Rob. (P. D.).
Metallic green or blue species.
Diandrena Ckll. (P. D.)

b Andrena-like bees, with three submarginal cells, the second small; tegulae usually large; hind legs in male usually modified; abdomen often with opalescent green or blue bands. Nomiinae.
Nomia Latr.[1] (P.)

[1] The allied genus *Dieunomia* occurs on the plains. *D. marginipennis*, Cresson, occurs at Rockyford (Gillette) and *D. xerophila* Ckll. at Sterling (Johnson). These are large bees, with the male antennae modified

c Females without facial foveae; metallic or black bees, rarely with the abdomen orange or red, distinguished from Andreninae by the strongly curved basal nervure; hind spur of hind tibia in females often with long teeth. HALICTINAE.

aa Colors black or greenish, rarely at all brilliant; size often small; three submarginal cells; species numerous. **Halictus** Latr. (P.)

bb Head and thorax metallic; size very small; like *Halictus*, but with only two submarginal cells. **Dialictus** Rob. (P. D.)

cc Brilliant green (rarely blue or crimson) species, the color not conspicuously different in the sexes; eyes emarginate in front; a group invading North America from the Neotropical region; tongue sometimes quite long. **Augochlora** Smith (S.)

dd Brilliant green species, the abdomen sometimes dark or yellowish; males with abdomen striped with yellow and black. **Agapostemon** Smith (S.)

d Inquilinous or parasitic bees, with the head and thorax black, the abdomen red; three submarginal cells. SPHECODINAE. **Sphecodes** Latr.[1] (P.)

2 Tongue elongate, though not as long as in some of the higher groups; only two submarginal cells except in *Protandrena*, which has three; never brilliantly metallic, though sometimes (*Perdita*) the head and thorax green; often with yellow markings. PANURGIDAE.

a Three submarginal cells; black species, the face with yellow markings; marginal cell truncate at end. **Protandrena** Ckll. (S.)

b Two submarginal cells.

Marginal cell pointed on costa. **Halictoides** Nyl.[2] (P.)

Marginal cell truncate (obliquely in some).

Marginal cell short and very broadly truncate; small species with nearly always light markings on abdomen. **Perdita** Smith (N.)

Marginal cell elongate.

Abdomen with pale markings not due to hair. **Spinoliella** Ashm. (N.)

Abdomen without pale markings.

Truncation of marginal cell little oblique. **Pangurginus** Nyl. (P.)

Truncation of marginal cell conspicuously oblique; first recurrent nervure meeting first transverso-cubital. Only one species,[3] which visits *Malvastrum*. **Greeleyella** Ckll. (N.)

[1] The subgenus *Proteraner* Rob. has males which appear in the spring with the females, which is not the case with other Halictinae. For a list of the species of *Sphecodes*, see *Psyche*, pp. 107–110, October, 1907.

[2] The related Californian genus *Amblyapis* Ckll. (type *A. ilicifoliæ* Ckll.) is separated by the short palpi, second and third joints of labial palpi produced on one side apically, and blade of maxilla very short and obtuse. *A. ilicifoliæ* is a small (5½ mm. long) black bee with greyish-white hair.

[3] Since this was written a second species, collected in Texas, has been received.

3 Tongue elongate; parasitic bees, usually highly ornamented, and with no pollen-collecting apparatus.

a Maxillary palpi 6-jointed; a type derived from the Panurgidae, or rather from an ancestral type related thereto but with three submarginal cells; usually wasp-like in appearance, with bright yellow and often red colors; three submarginal cells in all but one or two species; marginal cell pointed on costa. NOMADIDAE. **Nomada** Fabr.

b Maxillary palpi with two to six joints; usually robust bees, with conspicuous markings due to hair, but without yellow tegumentary markings; a type derived from the Anthophoridae. MELECTIDAE.

Maxillary palpi 6-jointed. **Bombomelecta** Patton (N.)

Maxillary palpi 5-jointed, the last joint minute; genus parasitic on *Anthophora*. **Pseudomelecta** Rads. (N.)

Maxillary palpi 3-jointed; body with conspicuous light markings due to appressed hairs; genus parasitic on the Eucerinae. **Triepeolus** Rob. (N.)

Maxillary palpi 2-jointed; size usually smaller than in the last, and silvery area on end of abdomen of female much smaller. **Epeolus** Latr. (P.)

Like Epeolus, but with only two submarginal cells. **Phileremus** Latr. (P.)

c Maxillary palpi 5- to 6-jointed; small bees usually classed with Phileremus, etc., but apparently forming a distinct group. NEOLARRINAE.[1]

Maxillary palpi 6-jointed.

Marginal cell long, truncate at apex.

Abdomen dull, constricted at the sutures. **Neopasites** Ashm. (N.)

Abdomen shining, not constricted at the sutures; genus parasitic on *Spinoliella*. **Oreopasites** Ckll. (N.)

Marginal cell very small and short. **Neolarra** Ashm. (N.)

Maxillary palpi 5-jointed; only one submarginal cell; very minute bees. **Phileremulus** Ckll. (N.)

4 Tongue very long; first two joints of labial palpi elongate, sheath-like, last two minute; hairy, pollen-collecting bees, the males often with long antennae, and usually with the clypeus yellow. ANTHOPHORIDAE.[2]

a Paraglossae very short; form robust; Neotropical group reaching the southern border of the United States. CENTRINAE (or Hemisiinæ).

Maxillary palpi 6-jointed.

Clypeus not yellow in male. **Exomalopsis** Spin. (S.)

Clypeus yellow in male; usually only two submarginal cells. **Anthophorula** Ckll. (S.)

Maxillary palpi 4-jointed; large robust, swift-flying bees. **Centris** Fabr. = Hemisia Klug. (S.)

(The Fabrician *Centris* was a mixture; Schrottky contends that the name is not applicable to our bees.)

b Paraglossae medium, not or hardly exceeding first joint of labial palpi. ANTHOPHORINAE.

Maxillary palpi 5-jointed; tongue, labial palpi and maxillary blade extremely long. **Melitoma** Lep. & Serv. (S.)

[1] ASHMEAD, *Bull. Colo. Biol. Assoc.*, No. 1. p. 33, 1890.

[2] For a list of the species, see *Trans. Amer. Ent. Soc.*, Vol. XXXII, pp. 97–104, 1906.

Maxillary palpi 6-jointed.
Blade of maxilla broad at base, suddenly narrowing to the slender apical portion.
Clypeus dark in male. **Diadasia** Patt. (S.)
Clypeus light in male. **Dasiapis** Ckll. (S.)
(Vachal includes both *Diadasia* and *Dasiapis* in *Ancyloscelis*, a South American genus.)
Blade of maxilla broad, gradually narrowing to the more or less blunt tip.
First recurrent nervure joining second submarginal cell near middle.
Mandibles simple or bidentate.
Anthophora Latr.[1] (P.)
Mandibles tridentate.
Clisodon Patt. (P. D.)
First recurrent nervure joining second submarginal cell at or very near end.
Emphoropsis Ashm. (P. D.)

c Paraglossae very long, hairy. EUCERINAE.
Maxillary palpi 6-jointed. **Tetralonia** Spin. (P.)
Maxillary palpi 5-jointed.
Maxillary palpi comparatively long and slender; bees usually found on Cucubitaceae.
Xenoglossa Smith (S.)
Maxillary palpi shorter, fifth joint reduced.
Xenoglossodes Ashm. (S. D.)
Maxillary palpi 4-jointed. **Melissodes** Latr. (S.)
(*Xenoglossodes* is nearer to *Melissodes* than to *Xenoglossa*. *Martinella* is a genus found in New Mexico, closely allied to *Melissodes*. The only known species has the flagellum bright yellow in the male.)

C. Tongue long, filiform; two submarginal cells; labial palpi with the basal joints much elongated, the apical minute; under side of female abdomen with a pollen-collecting scopa, except in the parasitic genera. *MEGACHILIFORMES:* MEGACHILIDAE

1 Eyes hairy;[2] parasitic group related to the Megachilinae. COELIOXYNAE.
Coelioxys Latr. (P.)

2 Eyes not hairy.

a Non-metallic,[2] pollen-collecting bees, without colored markings. MEGACHILINAE.

aa Bees of large or medium size.
Marginal cell sharply pointed; face in female with a protuberance; male with a pulvillus.[2]
Lithurgus Berthold (P.)
(One species in our fauna.)
Marginal cell obtuse; face without a protuberance; no pulvillus in either sex; maxillary palpi 3-jointed.
Megachile Latr. (Many species) (part P., part N.)

bb Small bees, with a pulvillus. OSMIINAE.
Maxillary palpi 3-jointed.
Base of first abdominal segment with a smooth area bounded by a strong rim; body coarsely punctured.
Heriades Spin. (P.)
Base of abdomen not thus formed, the basal area not surrounded by a rim; body more delicately punctured.
Chelostoma Latr. (P.)
Maxillary palpi 4-jointed.
Female clypeus smooth and shining, emarginate in the middle; first joint of labial palpi nine-tenths length of second. **Titusella** Ckll. (N.)
Clypeus ordinary.
First abdominal segment at base with a wide impunctate basin; male with abdomen ending in four small teeth.
Ashmeadiella Ckll. (N.)
First abdominal segment at base rounded, with a narrow sulcus; male abdomen not ending in four teeth.
Robertsonella Titus (N.)
Maxillary palpi 5-jointed; male antennae modified.
Alcidamea Cresson (one species) (N.)

cc Rather large bees, resembling Osmia, but black, with long, parallel-sided abdomen; male with clypeus submarginate, and antennae approaching the *Alcidamea* type, but without an apical hook; maxillary palpi 5-jointed.
Monumetha Cresson (one species) (N.)
(The few black species of *Osmia* will come in here and will be distinguished by the 5-jointed maxillary palpi, combined with normal antennae in the male.)

b Metallic, dark or brilliant blue or green, pollen-collecting bees, with a pulvillus; maxillary palpi 5-jointed. OSMIINAE.
Osmia Panzer (P.)

c Metallic or non-metallic parasitic bees, with or without light markings; postscutellum not toothed. STELIDINAE.
Second submarginal cell receiving both recurrent nervures.
Chelynia Provancher (N.)
Second recurrent nervure received at or beyond apex of second submarginal cell. **Stelis** Panzer (P.)

d Non-metallic, sometimes partly red, parasitic bees, rather like *Coelioxys* in form, but eyes not hairy; postscutellum with a median tooth; no pulvilli. DIOXYNAE. **Dioxys** Lepeletier (P.)

e Black bees with conspicuous yellow or whitish markings; pollen-collecting. ANTHIDIINAE.
No pulvillus; cottony material used in preparing nests, which are in burrows. **Anthidium** Fabr. (P.)
Pulvilli present; nests made of resin, on rocks, etc.
Dianthidium Ckll. (P.)

[1] *Anthophoroides* T. & W. Ckll., from New Mexico, is like *Anthrophora*, but with five-jointed maxillary palpi. The only species is *A. vallorum* Ckll.

[2] Exceptions to these characters are found in certain Old-World species.

D. Pollen-collecting bees with three submarginal cells and a long, filiform tongue, making nests in wood or in stems of plants. *XYLOCOPIFORMES.*

1 Large robust bees; mostly tropical. XYLOCOPIDAE.
Xylocopa Latr. (P.)

2 Small bees; not rare in temperate regions. CERATINIDAE.
Ceratina Latr. (P.)

SOCIAL BEES: *APIFORMES*

Eyes hairy; marginal cell very long. APIDAE. **Apis** L. (not native in America.)
Eyes not hairy. BOMBIDAE.
Pollen-collecting bees. **Bombus** Fabr. (P.)
Parasitic bees, the females without polleniferous areas on hind legs; living in nests of *Bombus*. **Psithyrus** Lepeletier (P.)[1]

The North American bees may be divided into three groups according to their supposed origin:

1 *Nearctic genera*, which have probably inhabited North America during the larger part of Tertiary time.

2 *Palaearctic genera*, which have probably reached North America during the Miocene, or derivatives from such genera.

3 *Neotropical genera* and their derivatives, which probably for the most part reached America during the latter part of Tertiary time.

These are marked N., P. and S., respectively, in the list above. D. signifies an American derivative.

A few genera, such as *Lithurgus* and *Megachile*, were doubtless common to the New and Old Worlds prior to the Miocene invasion. There can be no doubt that *Megachile* contains elements of Nearctic as well as Palaearctic origin; the truly Palaearctic types are such species as *M. melanophaea*, *M. vidua*, etc.

Robertson's Classification

Mr. Charles Robertson, in the *Canadian Entomologist*, 1904, has given a classification of the groups of Illinois bees, of which the following is a partial abstract. It is based wholly on the females. Equivalent names in our classification are given within square brackets.

APYGIDIALIA

(Sixth abdominal segment exserted, without a pygidial area)

A. Tongue flat, bilobed; facial foveae present; mandibles bidentate; maxillary palpi longer than blade of maxilla.

[1] Two new species of *Psithyrus* have been collected by Mr. S. A. Rohwer at Eldora, Colorado; they will be published by Mr. H. J. Franklin. One of them extends northward as far as Sitka, Alaska.

COLLETOIDEA [Colletiformes]

PROSOPIDIDAE

(Two submarginal cells; no polleniferous scopa)

COLLETIDAE

(Three submarginal cells; polleniferous scopa present)

B. Tongue filiform; no facial foveae; maxillary palpi shorter than blade of maxilla.

1 Two submarginal cells; labrum longer than wide.

TRYPETOIDEA [Megachiliformes]

STELIDIDAE [Stelidinae and Anthidiinae]

(Claws cleft, inner tooth subapical)

MEGACHILIDAE [Megachilidae, excluding Stelidinae and Anthidiinae]

(Claws simple, sometimes with a basal tooth)

2 Three submarginal cells; labrum wider than long.

a Apex of sixth abdominal segment with a spine or mucro, a little concave before the point; maxillary palpi 6-jointed.

CERATINOIDEA [Xylocopiformes]

CERATINIDAE (Stigma large)

XYLOCOPIDAE (Stigma obsolete)

b Apex of sixth abdominal segment obtuse, without a spine or mucro.

APOIDEA [Apiformes]

APIDAE (hind basitarsus shorter than tibia) [Apidae and Bombidae]

PYGIDIALIA [Andreniformes]

(Sixth abdominal segment exserted or retracted, with a pygidial area)

A. Tongue acute, flat, rarely filiform; second to fourth joints of labial palpi simple; stigma large, rarely middle-sized.

ANDRENOIDEA

Tegulae very large; labial palpi simple; tongue lance-linear, acuminate. Nomiidae [Nomiinae]

Tegulae ordinary. 1

1 Labrum free from mandibles, as large as clypeus, shorter than wide, transversely striate, without basal process; labial palpi simple. Dufoureidae [Halictoides]

Labrum ordinary. 2

2 Hind tibia and basitarsus broad, with dense simple hairs; labial palpi simple. Macropodidae [not in our fauna]

Hind tibia and basitarsus ordinary. 3

3 Marginal cell truncate; two submarginal cells (three in Protandrena); facial foveae present. Panurgidae

Marginal cell pointed; usually three submarginal cells. 4

4 No facial foveae; basal nervure strongly bent or arcuate. Halictidae [Halictinae]

Facial foveae present; basal nervure slightly arcuate. Andrenidae [Andreninae]

B. Tongue filiform; first two joints of labial palpi flat; labrum large, without basal process; stigma small or middle-sized, rarely large.

ANTHOPHOROIDEA

Scopa absent. Melectidae [Melectidae and Nomadidae]
Scopa present; three submarginal cells. 1

1 Marginal cell with apex rounded; stigma obsolete or nearly. Anthophoridae [Anthophorinae]
Marginal cell lanceolate, apex acute, bent away from costa. 2

2 Vertex crested; paraglossae at least as long as first two joints of labial palpi together; basitarsus broad, with a posterior apical appendage. Euceridae [Eucerinae]
Vertex not crested; paraglossae shorter than first two joints of labial palpi together; basitarsus narrow. Emphoridae [Entechnia = Melitoma.]

Protandrena, not found in Illinois, Mr. Robertson would place in Panurgidae, as a subfamily Protandreninae. It has three submarginal cells. Robertson's Emphoridæ includes two subfamilies:

Pulvilli absent. Emphorinæ: *Emphor* [not in our fauna.]
Pulvilli present. Entechiinæ: *Entechnia*.

Vachal has recently argued that *Entechnia* is the same as the prior genus *Melitoma*, and upon going over the description of the latter, this certainly seems to be correct.

Artificial Key

The numbers following the generic names refer to the figures of wings.

Only one submarginal cell; minute parasitic bees. **Phileremulus**
Two submarginal cells. 1
Three submarginal cells. 42

1 Marginal cell sharply truncate at tip, the lower apical corner with an appendicular nervure (Panurgidae). 2
Marginal cell not thus truncate and appendiculate. 8

2 Marginal cell short; small bees with the head and thorax usually metallic, dark green or blue, and the abdomen usually with light spots or bands. **Perdita** (4, 5)
Marginal cell rather long, more narrowly truncate; head and thorax not metallic. 3

3 Abdomen with conspicuous light tegumentary spots or bands. **Spinoliella** (6)
Abdomen without light tegumentary markings. 4

4 Hairy bees, with the abdomen more or less conspicuously banded. **Calliopsis**
Abdomen shining, black, not banded. 5

5 Coarsely punctured; wings very dark; marginal cell obliquely truncate; first recurrent nervure joining second submarginal cell no great distance before its middle. **Pseudopanurgus**
Delicately punctured; wings hyaline or subhyaline. 6

6 First recurrent nervure entering second submarginal cell a considerable distance from its base. **Panurginus** (7)

First recurrent nervure entering first submarginal cell; alpine species (Topaz Butte, Colorado, at flowers of *Drymocallis fissa*, June 23, 1907, S. A. Rohwer). **Panurginus verus** Ckll.
First recurrent nervure joining, or almost joining, first transverso-cubital. 7

7 Smaller, mountain species; upper corner of apical truncation of marginal cell angular; legs of male dark. **Panurginus cressoniellus** Ckll. (7)
Larger species, visiting *Malvastrum* in the foothills and plains; upper corner of apical truncation of marginal cell rounded; legs of male mainly yellow. **Greeleyella beardsleyi** Ckll.

8 Eyes hairy; parasitic bees, without scopa. 9
Eyes not hairy. 15

9 Legs red. 10
Legs dark. 11

10 Male about 8 mm. long, with punctures on middle of fifth abdominal segment conspicuously smaller and denser than those of apical half of fourth. (Boulder, July 20, W. P. Cockerell). **Coelioxys edita** Cresson
Male over 11 mm. long, with punctures on middle of fifth abdominal segment hardly different from those on apical part of fourth (Boulder, August, at flowers of *Grindelia*, W. P. Cockerell). **Coelioxys deplanata** Cresson

11 Very small, about 7 mm. long (Boulder). **Coelioxys deani** Ckll.
Larger, 10 mm. or over (male *gilensis* sometimes 9 mm.). 12

12 Tarsi more or less red. 13
Tarsi dark. 14

13 Last ventral segment of female broad, its lateral margins strongly convex, its apex rounded, with a small projection (Boulder, at flowers of *Melilotus alba*, July, S. A. Rohwer). **Coelioxys gilensis** Ckll.
Last ventral segment of female narrower, its lateral margins nearly straight, each with a notch (Boulder, July 3, Cockerell.) **Coelioxys rufitarsis rhois** Ckll.

14 Last ventral segment of female broad, suddenly narrowing to the conoid apical projection (New Mexico, Cockerell; Milwaukee, Wisconsin, Graenicher). **Coelioxys ribis** Ckll.
Last ventral segment of female narrow, notched but not abruptly narrowed at the beginning of the apical projection. **Coelioxys moesta** Cresson

15 Abdomen with yellow or yellowish-white tegumentary bands or spots. 16
Abdomen not thus ornamented. 22

16 Pulvillus absent; mostly large bees; females with ventral scopa. **Anthidium** (9)
Pulvillus present. 17

17 Dark green or blue, the abdomen with light bands. 18
Not metallic. 19

18 Hair of vertex pale, of pleura black. **Chelynia pulchra** Crawford
Hair of vertex largely black, of pleura pale. **Chelynia elegans** Cresson

19 Second recurrent nervure joining second submarginal cell before its end; parasitic bees, without scopa. 20
Second recurrent nervure going beyond end of second submarginal cell. 21

20 Abdomen with the bands broken into widely separated spots; very small species (Santa Fé, New Mexico). **Chelynia permaculata** Ckll.
Abdomen with the bands nearly entire, or several quite entire. **Chelynia monticola** Cresson and **C. subemarginata** Cresson

21 Very small, about 7 mm. long or less, with bright yellow markings; no scopa (Santa Fé, New Mexico). **Stelis rudbeckiarum** Ckll.
Large, more robust, females with a scopa. **Dianthidium** (10)

22 Marginal cell extremely minute; very small parasitic bees. **Neolarra**
Marginal cell normal. 23

23 Head and thorax metallic, blue or green. 24
Not metallic. 26

24 Basal nervure strongly bent or arched; very small species; females with no ventral scopa. **Dialictus** (11)
Basal nervure straight or little arched. 25

25 Stigma well developed; marginal cell more pointed; females without ventral scopa (only one species in our region, visiting *Nothocalais* and allies). **Diandrena** (12)
Stigma little developed; marginal cell more obtuse at end; females with a ventral scopa on abdomen (many species). **Osmia**[1] (13)

26 Third discoidal cell contracted above, the recurrent nervures joining the second submarginal cell not very far apart; small bees. **Phileremus** (14)
Third discoidal cell not so formed. 27

27 Marginal cell at apex very obtuse or subtruncate; small parasitic bees with hind margins of abdominal segments reddish, and abdomen with pale or white spots of appressed scale-like hairs. 28
Marginal cell pointed. 29

28 Abdominal spots white; abdomen reddish (Colorado Springs). **Neopasites pulchellus** Cresson
Abdominal spots dull; insect rather larger and much darker (Boulder, at flowers of *Grindelia*, July 16, 1908, W. P. Cockerell). **Neopasites heliopsis** Rob. (15)

29 Head and thorax with yellow or yellowish-white markings; small bees with very little hair, the abdomen black without bands. **Prosopis** (16)
Head and thorax without light tegumentary markings. 30

30 Second submarginal cell quadrate, only moderately narrowed above; first recurrent nervure meeting first transverso-cubital; stigma well developed; wings dusky; thorax not hairy. **Prosopis basalis** Smith, female
Second submarginal cell more elongate, more narrowed above; thorax hairy. 31

[1] *Chelynia pavonina* Ckll., from Boulder, is like a bright metallic *Osmia*, without ventral scopa. Only one specimen is known.
The following species of *Osmia* were taken at Tolland in 1909 (Robbins): *O. longula* Cress., *O. brevis* Cress., *O. propinqua* Cress., *O. pentstemonis* Ckll.

31 Marginal cell at apex reaching costal margin of wing; females without ventral scopa. **Halictoides** (17)
Marginal cell at apex more or less distinctly separated from costa; females with a ventral scopa. 32

32 Females with two large protuberances on middle of face, the space below them smooth and shining; males with the abdomen ending in a point; marginal cell sharply pointed, away from costa (one species, a rather large bee, in our region). **Lithurgus** (18)
Females and males not thus distinguished. 33

33 Clypeus smooth and shining, emarginate in the middle; a small bee about 8 mm. long; ventral scopa light fulvous or orange (male unknown). **Titusella pronitens** Ckll. (19)
Clypeus not thus smooth. 34

34 No pulvilli on feet; species usually of medium size or large; ventral scopa usually pale (many species). **Megachile** (25)
Pulvilli present. 35

35 Rather large bees, with a long parallel-sided abdomen; ventral scopa black. 36
Small bees, length 9 mm. or less; ventral scopa pale. 37

36 Male with face largely silvery from appressed hairs, and clypeus shallowly emarginate; females with eyes slightly converging above. **Monumetha** (21)
Male unknown; females with eyes diverging above; clypeus with a strong, smooth and shining, longitudinal median ridge. **Osmia hypocrita** Ckll.

37 Base of first abdominal segment ordinary, rounded, with a narrow longitudinal sulcus. 38
Base of first abdominal segment with a flattened or concave smooth shining plate or basin, the edge of which is well defined. 39

38 Male with flagellum greatly thickened, with a terminal hook. **Alcidamea** (20)
Male with flagellum long and filiform (genus not yet found in Colorado). **Robertsonella** (22)

39 More coarsely punctured; end of first recurrent nervure not more (usually less) distant from base of second submarginal cell than half length of first transverso-cubital; male abdomen not ending in four teeth. 40
Less coarsely punctured; end of the first recurrent nervure more distant from base of second submarginal cell than half length of first transverso-cubital; male abdomen ending in four teeth. 41

40 Anterior legs largely red (Boulder, at flowers of *Monarda*, July 16, 1908, W. P. Cockerell). **Heriades asteris** Ckll.
Legs all black (Boulder, July, W. P. Cockerell, S. A. Rohwer). **Heriades carinatus** Cresson (24)

41 Larger, anterior wings 4½ to 5½ mm. (Boulder, August 28, Rohwer; Rifle, Colo., July, Rohwer; usually taken at flowers of *Grindelia*). **Ashmeadiella denticulata** Cresson (23)
Smaller, anterior wings about 3 mm. (Boulder, May, Rohwer). **Ashmeadiella prosopidis** Ckll

A further table of male *Ashmeadiella* is given:

Larger, 7 mm. long or a little over. **denticulata** Cresson
Small, less than 6 mm. long. 1

1 Tegulae reddish testaceous; length about 5⅓ mm. wings quite clear; abdominal teeth red-tipped, middle ones much longer than broad (Rifle, Colo.). **aridula** Ckll.
Tegulae dark. 2

2 Length nearly 6 mm., tegulae shining piceous; middle abdominal teeth much longer than broad (Florissant, Colo., at flowers of *Senecio cymbalarioides*, June 29, Rohwer). **cactorum** Ckll.
Length about 4½ to 5 mm.; middle teeth of abdomen short. **prosopidis** Ckll.

42 Marginal cell very long, almost reaching apex of wing; eyes hairy. **Apis** (26)
Marginal cell with tip distant from apex of wing. 43

43 First recurrent nervure meeting first transverso-cubital; large bee with bright fulvous hair on thorax and base of abdomen, and abdomen with white hair bands (New Mexico). **Caupolicana yarrowi** Cresson
First recurrent nervure not meeting first transverso-cubital. 44

44 First discoidal cell much longer than marginal cell. 45
First discoidal cell not as long or scarcely longer than marginal cell. 53

45 Marginal cell short, not half the length of the first discoidal, and not or scarcely extending beyond apex of third submarginal cell; parasitic bees. 46
Marginal cell at least half the length of the first discoidal and extending more or less beyond the third submarginal. 47

46 Hair of thorax abundant and erect; first abdominal segment with hair like thorax; rest of abdomen black, in one species with light spots. **Bombomelecta** (46)
Hair of thorax appressed; first abdominal segment black and bare at base; abdomen with interrupted light bands. **Pseudomelecta**

47 Third submarginal cell subquadrate, not or hardly narrower above than beneath; marginal cell obtuse at tip; hairy bees; the clypeus partly or wholly yellow or white in the male; tongue very long. 48
Third submarginal cell narrower above than beneath, or when not so, insect without erect hair; marginal cell extending far beyond apex of third submarginal cell. 49

48 Mandibles tridentate; apex of female abdomen with orange red hair; species nesting in dead wood. **Clisodon terminalis** Cresson (27)
Mandibles simple or bidentate; species nesting in banks. **Anthophora** (47)

49 Robust, pollen-collecting bees, the thorax with abundant erect hairs; similar to *Anthophora* but first recurrent nervure reaching apical corner of second submarginal cell. **Emphoropsis** (28)
Parasitic bees, less hairy, and with conspicuous pale markings, or when these are absent, insect red. 50

50 Abdomen black with conspicuous pale bands due to appressed scale-like hair. 51
Abdomen with tegumentary bands (nearly always yellow) or spots, or red without markings. 52

51 Fifth segment of female abdomen with large patch of silvery hair. **Triepeolus** (29)
Silvery patch reduced to a lumule or band; insects usually smaller. **Epeolus**

52 Mandibles simple. **Nomada**[1] (30)
Mandibles with an inner tooth. **Nomada**, subgenus Gnathias (30)

53 Head and thorax with metallic colors, blue or green. 54
Head and thorax black, rarely with some red, never metallic. 58

54 Head and thorax brilliant emerald green or blue green; basal nervure strongly arched. 55
Head and thorax dark green or blue. 56

55 First recurrent nervure joining second submarginal cell near middle; male abdomen banded with yellow and black, female abdomen green or black. **Agapostemon** (34)
First recurrent nervure reaching apex, or very near apex, of second submarginal cell; abdomen green like thorax in both sexes. **Augochlora** (32)

56 Small, shining dark green bees; first recurrent nervure joining second submarginal cell near apex; tongue long; face in female with an ivory spot, in male with a large tri-lobed ivory mark. **Ceratina** (33)
Minutely punctured bees, with the head and thorax hairy; face without light markings in either sex or (in male *Halictus*) with a small light band on clypeus; tongue dagger-like. 57

57 Basal nervure strongly arched; abdomen often not metallic. **Halictus** (35)
Basal nervure hardly arched. **Andrena** (36, 49)

58 Mouth-parts greatly elongated, held under the body when at rest, like the beak of an Hemipteron (Denver, Colo.). **Melitoma grisella** Ckll. and Porter
Mouth folded and concealed when at rest. 59

59 Marginal cell sharply truncate at tip, the lower corner with an appendicular nervure; face largely pale yellow. **Protandrena**
Marginal cell not thus truncate, but obtuse or pointed. 60

60 Face more or less yellow or white, the color tegumentary; basal nervure nearly straight.[2] 61
Face without light tegumentary color. 65

61 Stigma nearly always well developed; male antennae not greatly elongated; tongue dagger-like. **Andrena** (36, 49)
Stigma little developed; male antennae usually elongated; tongue very long, linear. 62

62 Antennae very long, black; maxillary palpi 6-jointed. **Tetralonia** (37)
Antennae usually shorter, though long, and more or less reddish (in a few species black); maxillary palpi with less than six joints. 63

63 Maxillary palpi 4-jointed (many species). **Melissodes**[3] (38, 48)
Maxillary palpi 5-jointed. 64

64 Maxillary palpi comparatively long and slender. **Xenoglossa** (39)
Maxillary palpi shorter (genus not known in Boulder County). **Xenoglossodes** (40)

[1] For a table of Rocky Mountain *Nomada*, see *Bulletin* 94, *Colorado Agricultural Experiment Station*.

[2] Some male Halictines have yellow on clypeus; these have the basal nervure strongly arched. If bright green with yellow and black abdomen they are *Agapostemon;* if dark green, *Halictus*.

[3] *Anthedon*, a genus scarcely distinct from *Melissodes*, has the male antennae with the last joint elongated. The scopa of the female is simple.

65 Abdomen wholly or largely red. 66
Abdomen not red, or if at all red, that color due to hair. 67

66 Basal nervure strongly arched; small species. **Sphecodes** (43)
Basal nervure nearly straight. **Andrena** (36, 49)

67 Second recurrent nervure with a strong double curve, approaching an S-shape; tongue short and emarginate; hairy bees. **Colletes** (42)
Second recurrent nervure not so formed, straight or with a single gentle curve. 68

68 Lower inner corner of second submarginal cell produced; large hairy bees with very long tongue. 69
Second submarginal cell not thus formed. 70

69 Females with shining pollen-collecting surfaces on hind legs. **Bombus** (45)
Females with unmodified hind legs, covered with hair. **Psithyrus** (44)

70 Basal nervure strongly arched; stigma well developed; tongue dagger-like. **Halictus** (35)
Basal nervure straight or almost. 71

71 Hind margins of abdominal segments with beautiful pale greenish tegumentary bands, the other parts of the abdomen strongly punctured (Boulder). **Nomia universitatis** Ckll.
Abdomen without greenish bands. 72

72 Stigma well developed; apex of marginal cell on or very near costal margin. 73
Stigma little developed; apex of marginal cell away from costal margin. 74

73 Posterior face of metathorax flat, shining, sharply separated from basal area, which is strongly rugose; tibiae and tarsi bright ferruginous; hind tibiae of male deformed, wings yellowish, apical margin strongly dusky (Boulder, September 16, Rohwer; Denver, at flowers of *Solidago*, August 24, Mrs. C. Bennett). **Nomia bakeri** Ckll.
Posterior face of metathorax not thus differentiated; tibiae of male not deformed. **Andrena** (36, 49)

74 Vertex smooth, brilliantly shining; form compact; male abdomen bidentate at extreme apex. **Diadasia** (41)
Vertex less shining; abdomen otherwise formed at apex. 75

75 Maxillary palpi 6-jointed; scopa of hind legs in female simple. **Tetralonia** (37)
Maxillary palpi 4-jointed; scopa plumose. **Melissodes** (38, 48)
Maxillary palpi 5-jointed. **Xenoglossa** (39) and **Xenoglossodes** (40)

The following table separates a series of females of the last two genera:

Abdomen red; large robust species (New Mexico). **Xenoglossa patricia** Ckll.
Abdomen not red. 1

1 Lower margin of clypeus broadly yellow (New Mexico). **Xenoglossodes gutierreziae** Ckll.
Clypeus without yellow. 2

2 Flagellum bright ferruginous beneath, except at base (Roswell, New Mexico). **Xenoglossodes excurrens** Ckll.

Flagellum dark, sometimes obscure reddish. 3

3 Abdomen beyond the second segment covered with ochreous tomentum, not at all banded (New Mexico). **Xenoglossodes imitatrix** Ckll. and Porter
Abdomen beyond the second segment banded. 4

4 Larger and more robust, breadth of thorax about 5 mm.; thorax covered above with fulvous hair; hind basitarsus thinly haired, but the hairs long. **Xenoglossa pruinosa** Say
Smaller and narrower, breadth of thorax 4 mm. or less; hair of thorax above not brilliantly colored; hind basitarsus more densely hairy. 5

5 Middle third of fifth abdominal segment with the hair dark chocolate brown (New Mexico). **Xenoglossodes lippiae** Ckll.
Middle of fifth abdominal segment with the hair wholly pale (Raton, New Mexico). **Xenoglossodes neotomae** Ckll.