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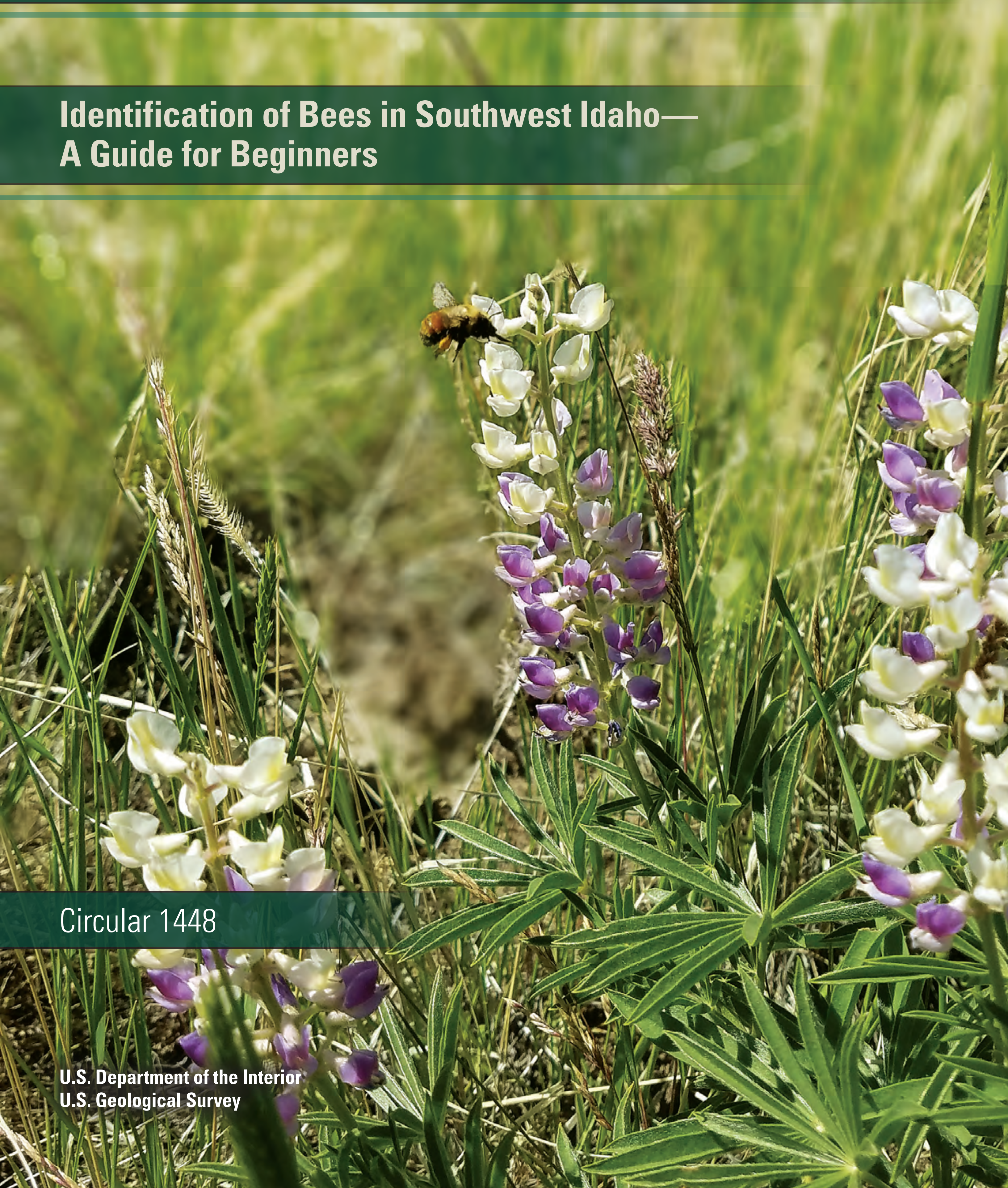
Identification of Bees in Southwest Idaho—A Guide for Beginners



Circular 1448

U.S. Department of the Interior
U.S. Geological Survey

Cover: A female *Bombus* sp. foraging on *Lupinus*.

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

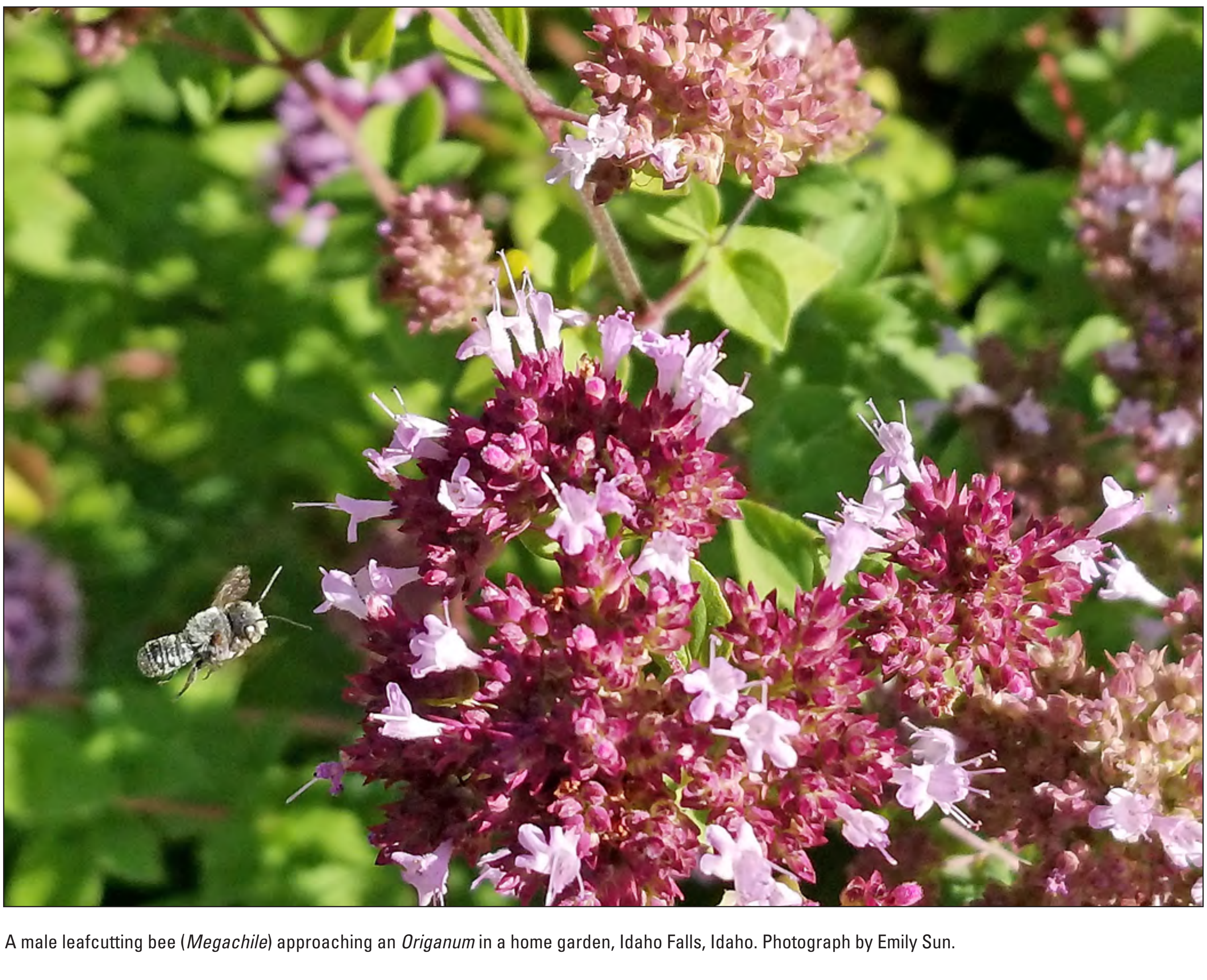
Altitude, as used in this report, refers to distance above the vertical datum.

Identification of Bees in Southwest Idaho—A Guide for Beginners

By Emily R. Sun and David S. Pilliod

Abstract

This document was prepared to help scientists and the public, both of whom may not be familiar with bee taxonomy, learn how to practically identify bees in sagebrush steppe and shrubland habitats in southwest Idaho. We provide information to identify bees to the level of family and genus. A tentative list of the bee genera captured at sites used for insect community studies is included.



A male leafcutting bee (*Megachile*) approaching an *Origanum* in a home garden, Idaho Falls, Idaho. Photograph by Emily Sun.

Introduction

What Are Bees?

Bees are insects represented by the superfamily Apoidea within the order Hymenoptera—this order includes bees, ants, and wasps. The order Hymenoptera contains more than 153,000 described species, with many more yet undiscovered (Aguiar and others, 2013). Life history strategies are diverse within the hymenoptera, and include predators, pollinators, and parasitoids (Triplehorn and Johnson, 2005). All bees consume nectar and pollen, except for one tropical genus of stingless bee, *Trigona*. Contrary to popular belief, not all bees consume honey. Only honey bees (genus *Apis*) produce and store honey as a food source for the hive. Stingless bees, *Melipona marginata* (which are not native to the United States) also can produce honey, and these bees are becoming more popular in apiculture. Bumble bees live in colonies like honey bees, but do not produce honey. Instead, they keep some nectar and pollen in wax pots for short-term storage (Wilson and Messinger Carril, 2016). Most bees are solitary and do not store food except for the pollen collected for offspring, which is packed into nest cells (Wilson and Messinger Carril, 2016).

To the untrained eye, bees and wasps often look similar. The easiest characteristic to use for distinction between these two groups is the body hair. Bees are usually, but not always (fig. 1), hairier than wasps. These hairs will be branched at one or many parts of the body (fig. 2). The hair in bees is used to collect pollen. Many female bees have hair bunches called scopa on the hind thoraxes or under the abdomen. Scopa are specialized hairs that are used to collect pollen for larval bees. Male bees and parasitic female bees (see *Nomada* in fig. 1) do not have scopa because they do not construct nest cells or provision eggs with food. Wasps generally are sparsely haired, and the hairs are simple, not branched.

Bees and wasps also are mimicked by various other insects, including flies (Order Diptera; fig. 3). In such instances, mimicry is a form of defense whereby harmless organisms (for example, flies) have evolved to appear similar to organisms that have defense mechanisms (for example, stingers on bees and wasps). These disguises can deter potential predators. Bees can be differentiated from fly mimics by their antennae and their wings. Fly antennae typically are shorter and shaped differently than bee antennae (fig. 4). The shape of fly antennae often is “aristate,” which refers to the combination of a short club with a lateral bristle (fig. 4). Flies also have only one pair of wings, whereas bees have two pairs (fig. 5). Lastly, although some flies are hairy, they never have the branched hairs like bees. Interestingly, some flies consume nectar and pollinate plants.

A male bumble bee (*Bombus huntii*) on *Origanum*.

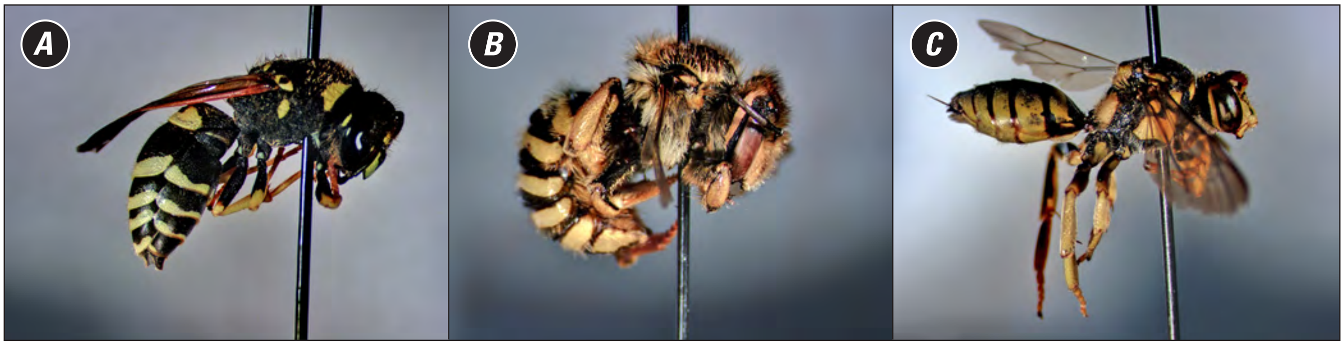


Figure 1. A similar-looking wasp and two bees. (*A*) A wasp (Vespidae: Eumeninae). (*B*) An *Anthidium* bee with many branched hairs. (*C*) A *Nomada* bee is strikingly wasp-like. This female, like other *Nomada*, lacks scopa because she lays her eggs in the nests of other bees, where they steal the nectar and pollen store that the host mother left for her offspring. Although they do not have scopa, *Nomada* bees often have branched hairs on the thorax.

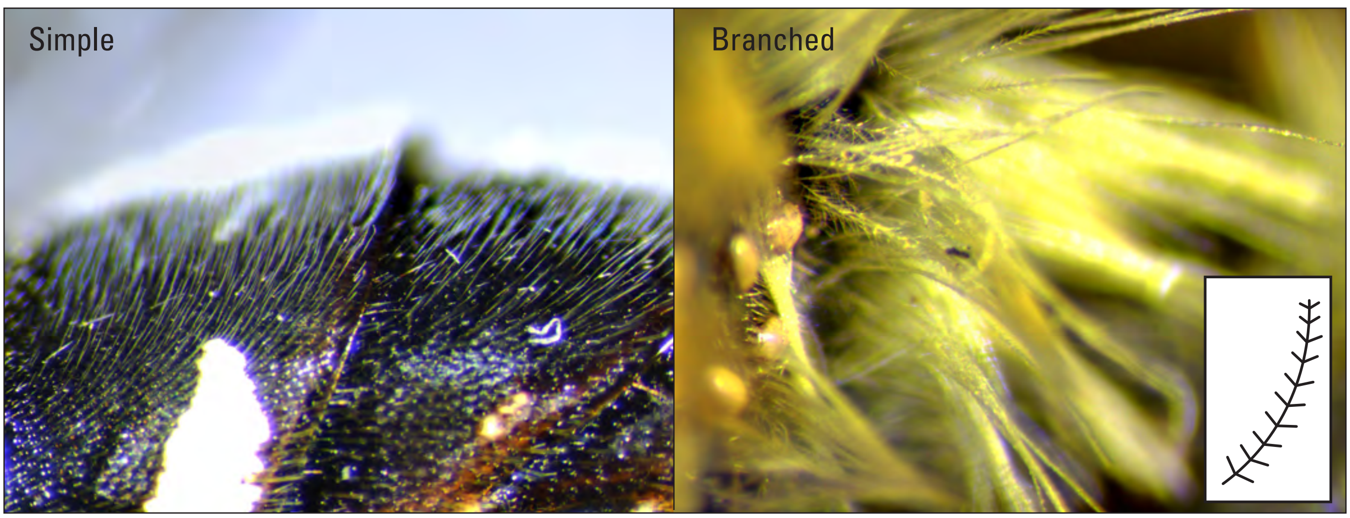


Figure 2. Simple and branched hairs on a crabronid wasp (family Crabronidae) abdomen and bumble bee (family Apidae) thorax. Simple hairs (left) appear as silvery, continuous lines, whereas branched hairs (right) have a feathery or "shimmering" appearance under the microscope. Inset shows the general structure of branched hairs.

Figure 3. A honey bee (*Apis mellifera*, left) and a mimic fly (*Eristalis tenax*, right). These two insects look similar, because they are both hairy, full-bodied, and orange-brown in color. However, bees have longer antennae, two pairs of wings, and branched hairs on parts of their body.

Figure 4. Comparisons between fly and bee antennae. (*A*) A fly antenna (family Bombyliidae) with a terminal bristle, (*B*) a fly antenna with a subterminal bristle, and (*C*) a typical bee antenna, long with many segments.

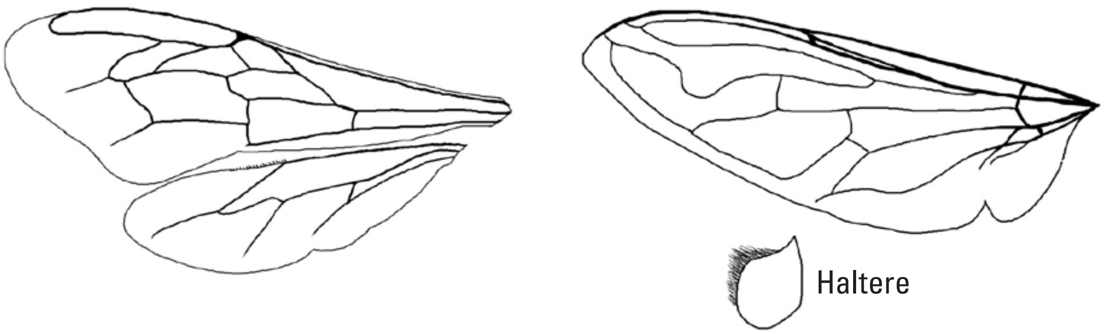


Figure 5. Drawings of (left) a bee wing (*A. mellifera*) and (right) a fly wing (*E. tenax*). Bees have a well-developed fore- and hindwing. The fly forewing is reduced to a knob-like club called a haltere.

Why Are Bees Important in Southwest Idaho?

Bees are vital pollinators of many plant species, both wild and cultivated (Klein and others, 2007; Gilgert and Vaughan, 2011). Southwest Idaho is home to many native bee species, as well as, some introduced species. Examples of common introduced species include the European honey bee (*A. mellifera*, fig. 3) and alfalfa leafcutting bees (*Megachile rotundata*). European honey bees originate from the old world, most likely from northeastern Africa or the Middle East (Cridland and others, 2017). These bees are successful pollinators of various crops and have been imported to North America for use in agriculture and beekeeping. In southwest Idaho, honey bees are important pollinators of many cultivated crops, including fruit trees. Honey bees often escape to the wild, where they may form feral colonies. However, these colonies often succumb to the cold winter conditions in Idaho. Although feral colonies, as well as managed hives, can hypothetically compete with native bees for resources, evidence for such interference is historically scarce (Goulson, 2003), mainly due to experimental design problems. Recently, Cane and Tepedino (2016) addressed this issue using bee-harvested pollen. They determined that from June to August, the amount of pollen collected by a thriving honey bee colony could produce 100,000 solitary bee offspring. *M. rotundata* was unintentionally introduced in the United States before 1940, but is now managed as an important pollinator of alfalfa and other crops (Wilson and Messinger Carril, 2016). These bees are thought to be an insignificant competitor with native bees, because they often are intensively farmed and do not stray far from the managed sites (Pitts-Singer and Cane, 2011).

Research has shown that native bees also provide critical ecosystem services to cultivated crops in agricultural areas (Morandin and Winston, 2006). However, because native bees are unmanaged, they require alternative nectar sources when crops are not in flower. A diverse native plant community adjacent to agricultural areas helps maintain native bee populations. Dense and diverse plant communities attract more pollinators (including honey bees) than degraded ones, partly because of the greater nectar resources (Potts and others, 2003; Ebeling and others, 2008). Native (and some nonnative) flowering forbs also provide important food resources for Idaho wildlife, including Greater Sage-Grouse (*Centrocercus urophasianus*) during the critical brood rearing period (Drut and others, 1994), pronghorn (*Antilocapra Americana*) (Johnson, 1979), and mule deer (*Odocoileus hemionus*) (Gill and others, 1983). Other wildlife, such as insectivorous birds, prey on bees directly. In sum, native bee species (and to a lesser extent introduced species) both play important roles in natural and agricultural systems in southwest Idaho and other areas of the United States.

What Are the Conservation Threats for Native Bees in Southwest Idaho (and Elsewhere)?

Current threats to bee populations include, but are not limited to, habitat fragmentation, habitat degradation, pesticides, and pathogens (Potts and others, 2010). Habitat fragmentation that adversely affects bee populations can have negative consequences for the reproduction of some flowering plants (Aguilar and others, 2006). Sufficiently isolated habitat fragments can result in decreased pollinator richness and abundance (Steffan-Dewenter and Tscharntke, 1999). Habitat degradation may decrease resources available to bees, especially when degradation is associated with decreases in native flowering forbs (Potts and others, 2003; Ebeling and others, 2008). Habitat degradation through ground disturbance from tillage can result in direct mortality to brood cells in ground nesting bee species (Roulston and Goodell, 2011; Ullmann and others, 2016).

Bees may be unintentionally killed by pesticides intended for pest insect species. For example, neonicotinoid compounds often are used to deter aphids and other hemipterans away from crops, but are effective against all insects, including bees (Henry and others, 2012). Repeated use (more than once) of the pesticide, fenitrothion, causes species richness of wild bees to decline (Brittain and others, 2010). Some pathogens have been spread by intentionally introduced bee species like honey bees (Klee and others, 2007), and bumble bees, for example *Bombus terrestris* (Schmid-Hempel, 1998). These insects can bring with them a variety of pathogens including *Varroa* mites, viruses, and fungi like *Nosema* and may "spill over" to native, wild bees (Colla and others, 2006; Sokolova and others, 2010). The introduction of these pathogens has been implicated in the decline of native bumble bee populations (Goulson, 2010).

In southwest Idaho, loss and degradation of native shrubland and grassland habitats is pervasive. Increased frequency of wildfires and the propensity of native sagebrush shrublands to convert to exotic annual grasslands after repeated burning is a major conservation problem in southwest Idaho (Balch and others, 2013). Wildfires have the potential to kill bees hiding in nests that are often located in dead twigs or plant stems (Wilson and Messinger Carril, 2016). However, bees that dig nests deep underground may be safe from the heat and smoke (Cane and Neff, 2011). Cheatgrass (*Bromus tectorum*), Medusahead (*Taeniatherum caputmedusae*) and other nonnative annual grasses often proliferate following wildfires and outcompete the forbs upon which bees depend. Hence, the grass-fire cycle that is now the dominant disturbance regime across much of southwest Idaho may be unfavorable to bee populations, although more research on this topic is needed.

Introduction to Bee Families and Identification

Identifying bees can be a daunting task, so readers can start with a foundation of basic knowledge and access the resources listed at the end of this document (section, "Recommended Resources"). Learning the basic anatomy of insects, and particularly bees, is an important first step. Next, readers can learn how to determine the sex of the specimen because most generic-level identification keys are sex-specific. Most identification keys use characters that can be seen with a 10× hand lens, but a dissecting microscope is the ideal tool for this task.

Bee Anatomy

Bees have three major body sections: the head, thorax, and abdomen (fig. 6).

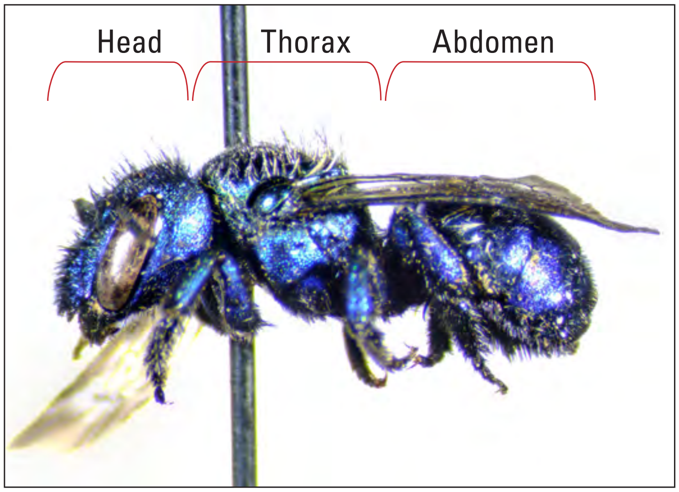


Figure 6. Basic bee anatomy, with major body parts labeled.

- Head: Contains eyes, mouthparts, and antennae.
- Thorax: Composed of three segments, each with a pair of legs. Wings, when present, are located are the second and third segments only.
- Abdomen: Composed of numerous segments and houses the reproductive organs and part of the digestive tract.

Determining Sex

1. Females: 12 antennal segments and 6 abdominal tergites (fig. 7). Stingers are present, but may or may not be visible in dead specimens. Scopa (pollen-collecting hairs) are located on the hind legs, on sides of the thorax, or under the abdomen (fig. 8), but are absent in all parasitic bees, as these females do not collect pollen for their young.
2. Males: Have 13 antennal segments and 7 abdominal tergites (fig. 9), do not have stingers or scopa, and lobed genitalia (sometimes protruding in dead specimens and sometimes not, fig. 10).

Note: Males of the genus Holcopasites in the family Apidae have 12 segments.

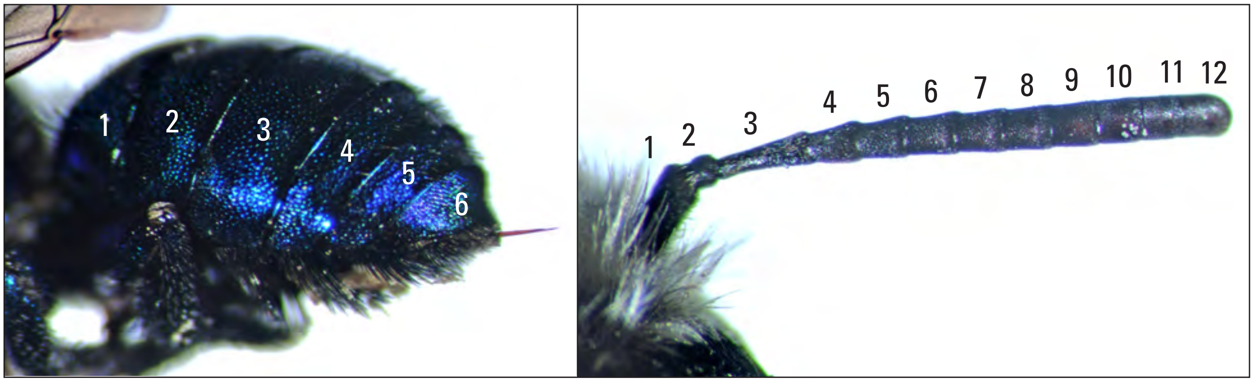


Figure 7. Abdomen of female *Osmia* (left) showing the 6 tergites and stinger. Antenna (right) of female *Eucera* with the 12 segments labeled, including the scape (segment 1) and pedicel (segment 2).

Figure 8. Examples of scopa in female bees. On many specimens, pollen may be seen packed onto scopa (left). The hind leg scopa of a female *Eucera* bee. The arrow points to the tibial scopa; however, more scopa are beneath the arrow on the basitarsus (called a basitarsal brush) (right). The abdominal scopa of a female *Megachile*. In this specimen, the orange pollen coats the hairs.

Figure 9. Male *Eucera* abdomen with the 7 tergites labeled (left). Male *Megachile* antennae with 13 segments labeled, including the scape and pedicel (right).

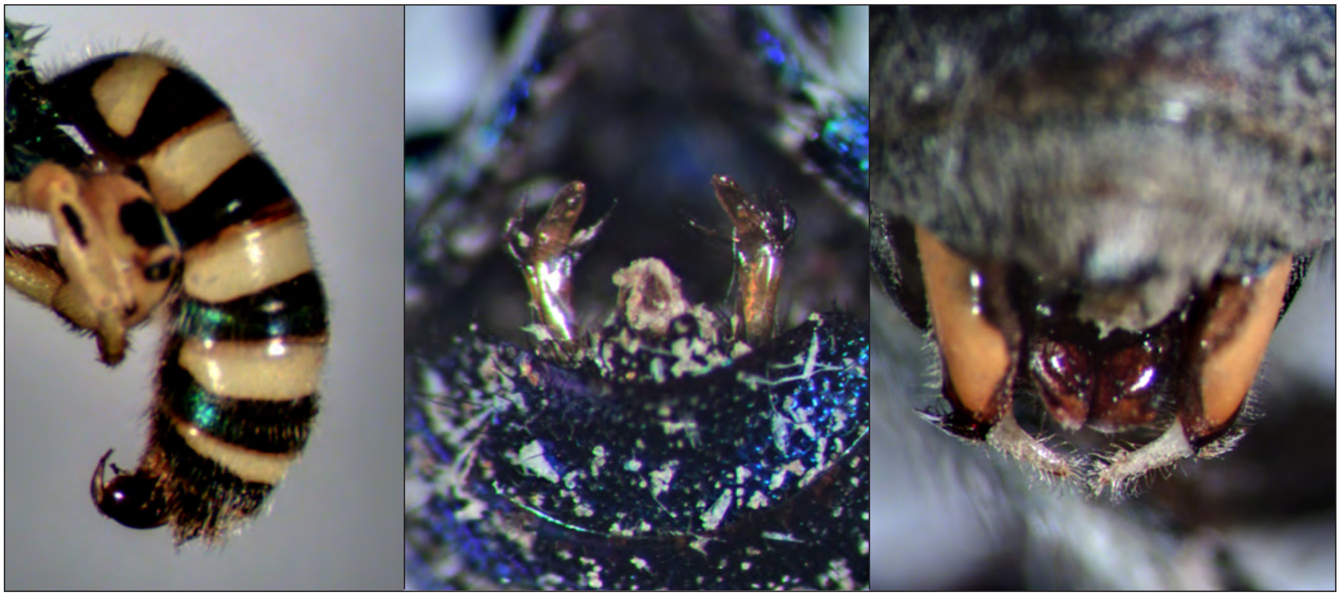


Figure 10. Various appearances of extended male genitalia (left to right: *Agapostemon*, *Osmia*, and *Anthophora*). These structures usually are easy to distinguish from a stinger (fig. 7).

Relevant Bee Anatomy for Identification

Head (figs. 11 and 12).

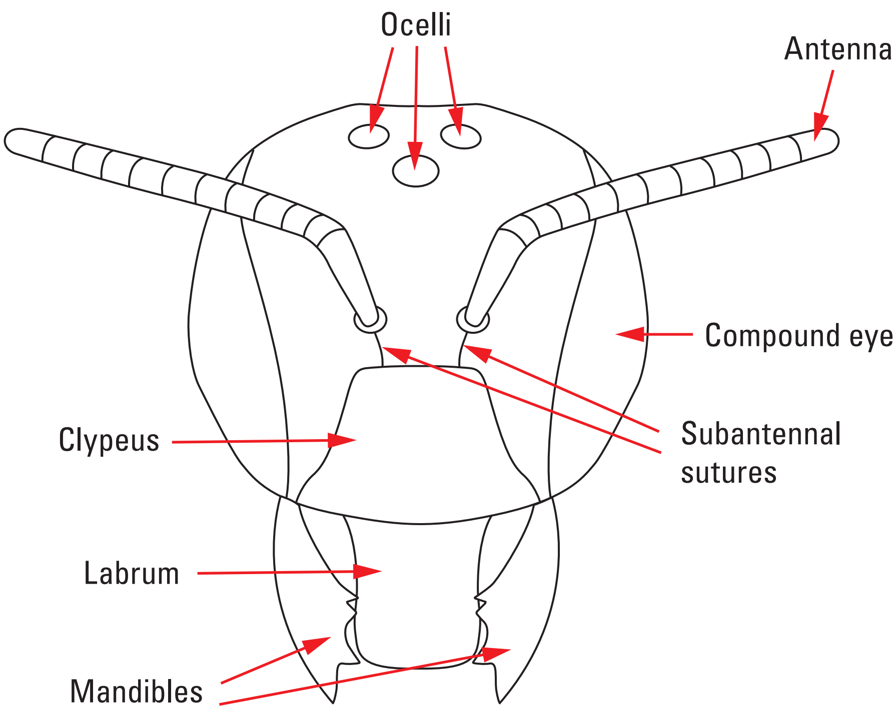


Figure 11. Head diagram of a female *Osmia*. Important features are labeled.

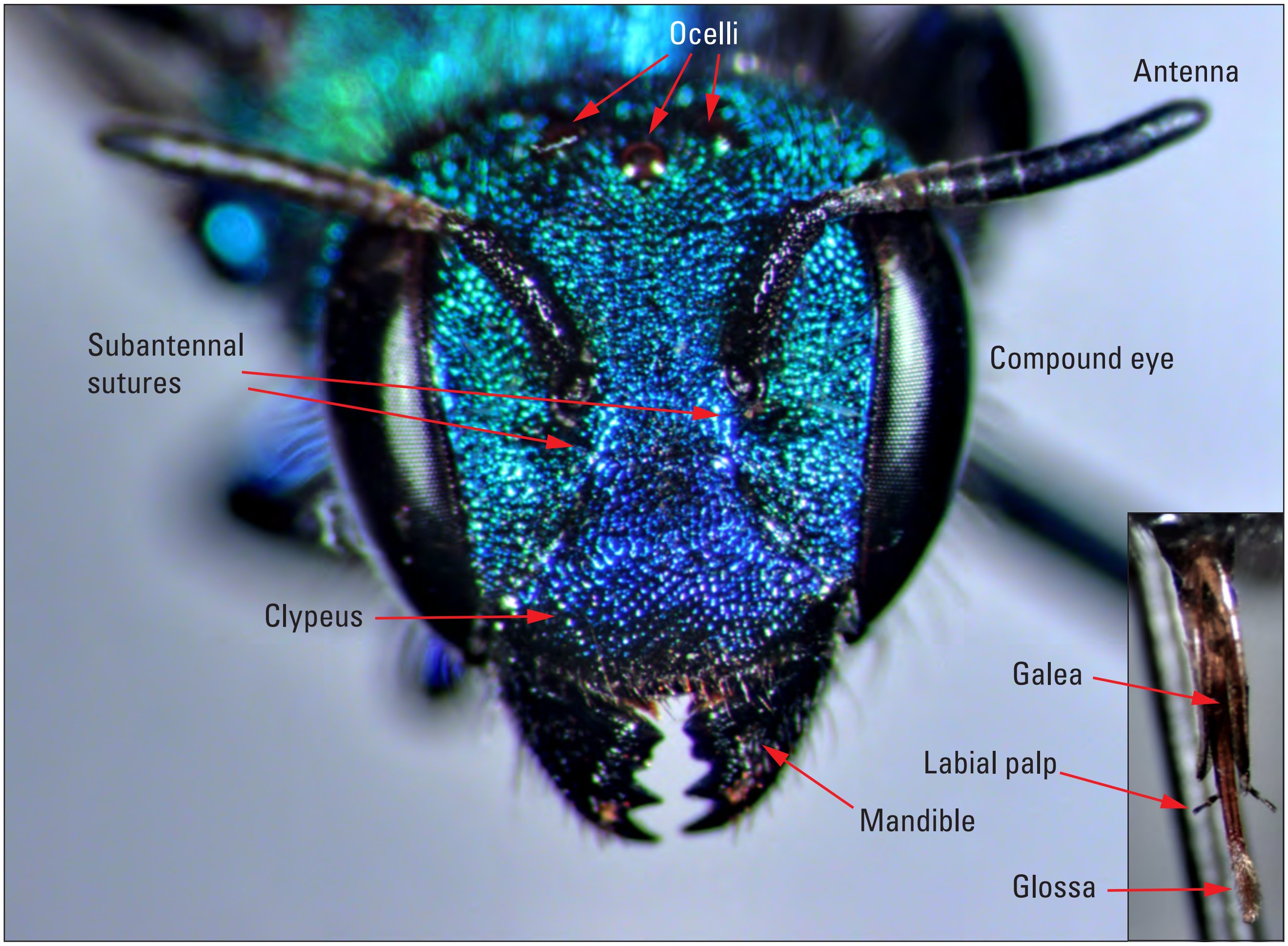


Figure 12. Anatomy of a female *Osmia's* head and mouthparts. The facial sutures can sometimes be hard to see, and the position of the specimen may need to be adjusted under magnification. The labrum is not visible from this angle, but would be if the bee is tipped backward. A clearly visible labrum can be seen on a male *Anthophora* in figure 43.

1. Clypeus: Plate directly below the antennae.
2. Labrum: Plate below the clypeus and between the mandibles (not shown in fig. 12).
3. Subantennal suture: Line from the bottom of the antennae to the top of the clypeus.
4. Mandibles: Toothed mouthparts, usually folded on the bottom of the head when viewed from the front.
5. Ocelli: Simple eyes on the top of the head, in sets of three.
6. Glossa: Terminal section of the “tongue” of a bee, usually the longest structure in the middle of all other “tongue-looking” mouthparts (fig. 12).
7. Labial palps: Segmented mouthparts (fig. 12).

8. Short-tongued: Four segments are equal in length (fig. 13, left).
9. Long-tongued: First two segments are longer than the last two (fig. 13, right).
10. Maxillary palps: Segmented mouthparts (fig. 13) located closer to the base than the labial palps.
11. Galea: Outer mouthparts that surround the base of the glossa (fig. 12).

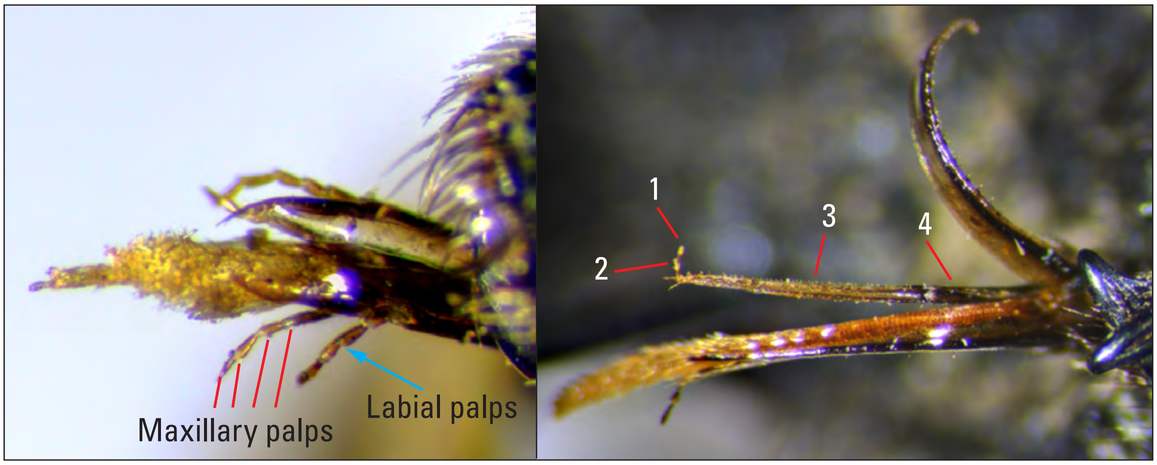


Figure 13. "Short tongue" labial palps of a female *Agapostemon* (left). The maxillary palps can be seen next to the labial palps (arrow). "Long tongue" labial palps of a female *Osmia* with each segment numbered (right).

Thorax (fig. 14).

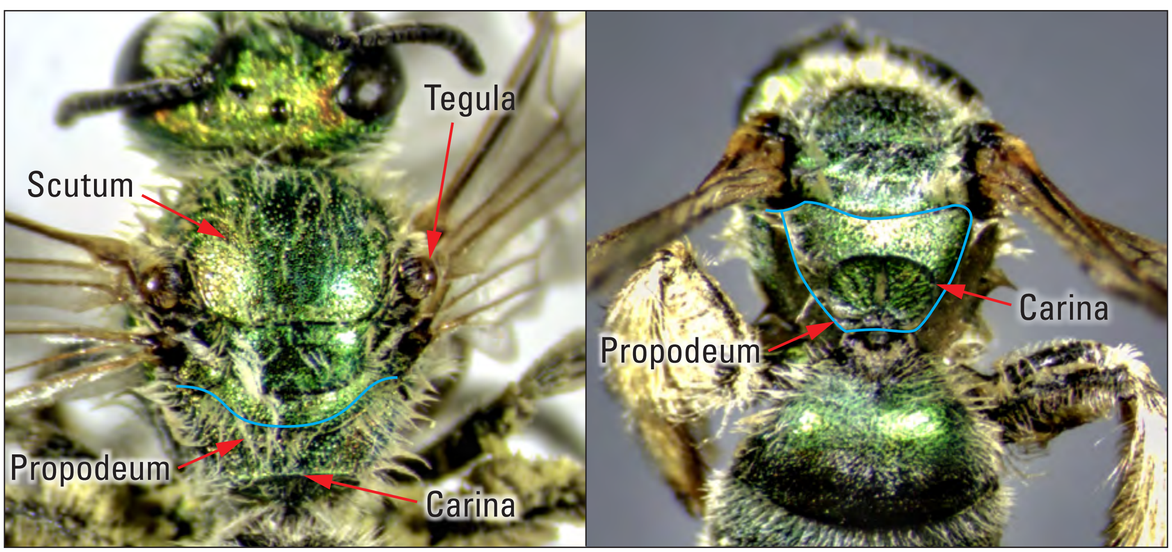


Figure 14. Anatomy of an *Agapostemon* thorax with a few relevant features highlighted. The scutum, which is found above the line on left, and propodeum (left, under line) often have important punctuations or other features needed for identification. Only the top of the carina (ridged structure) is visible (left), which is a feature in *Agapostemon* bees. Because the specimen is tipped forward (right), the entire carina is visible; the propodeum is outlined.

1. Scutum: Large, often convex plate that composes most of the thorax (located on the middle thorax segment called the mesothorax), may be covered in hair (fig. 14).
2. Tegula: Small, oval plates covering the base of the forewing, where they connect to the thorax (fig. 14).
3. Propodeum: Last segment of the thorax, connecting immediately to the abdomen (fig. 14).

Legs (fig. 15).

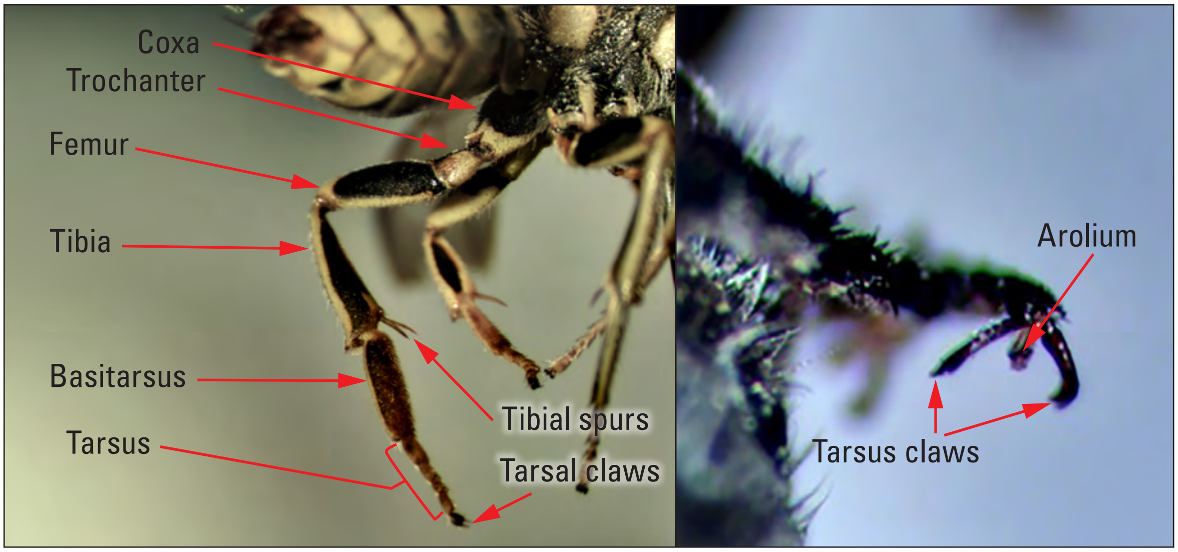


Figure 15. Bee legs with all segments and associated structures labeled. No scopa are present on this particular bee (a female *Nomada*).

1. Arolium: Pad between the tarsal claws, not present in all species (plural: arolia; fig. 15).
2. Basitarsus: Segment of the tarsus immediately below the tibia, longer than other tarsal segments (plural of tarsus: tarsi).
3. Scopa: Pollen-collecting hairs present in various places of non-parasitic female bees. If present on legs, can be found on the trochanter, femur, tibia, and basitarsus (fig. 8).
4. Corbicula: Pollen basket found only on the hind tibia of non-parasitic female bumble bees and honey bees or on the sides of the thorax of *Andrena*. The inside of the basket is concave, shiny, and surrounded by a “fence” of stiff bristles (fig. 16; see section, “Apidae”).

Figure 16. The corbicula of a non-parasitic female *Bombus*.

Figure 17 shows a pair of wings from a bee. The fore- and hind-wings are connected by hooks called hamuli. Each wing has various cells and veins whose shapes and curves are important for identification.

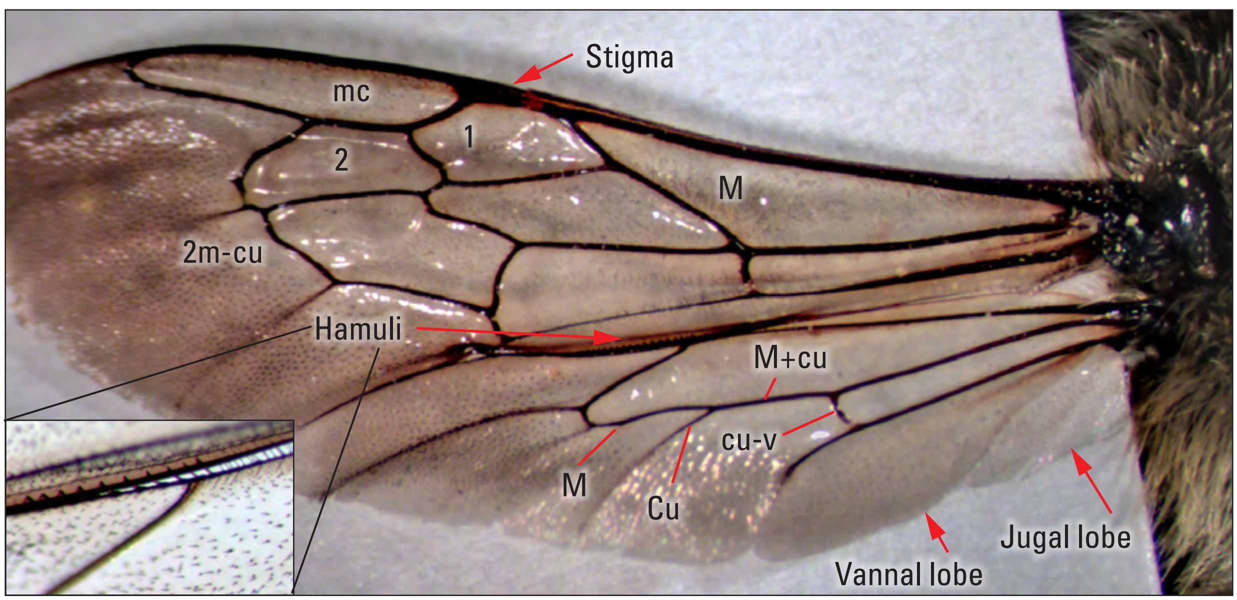


Figure 17. Megachilid bee wing with important veins, cells, and lobes labeled. Abbreviations: mc, marginal cell; 1,2, submarginal cells 1 and 2 (bees in this region have 2 or 3 of these submarginal cells); M, basal vein or media (notice that there are two M's, typically fore- and hindwing venations are counted separately); 2m-cu, second recurrent vein; M+cu, media+cubitus veins merged here; cu-v, cubitus-vannal vein connector. Abbreviations are from Michener and others (1994).

1. Stigma: Thick cell next to marginal cell of various size, depending on species.
2. Hamuli: Hooks that keep the pair of wings (fore- and hindwing) together (fig. 17, see inset).
3. M: Curvature of the basal vein (M) is an important feature and degrees of curvature are defined in figure 18.
4. Cu: Abbreviation for the cubitus vein.

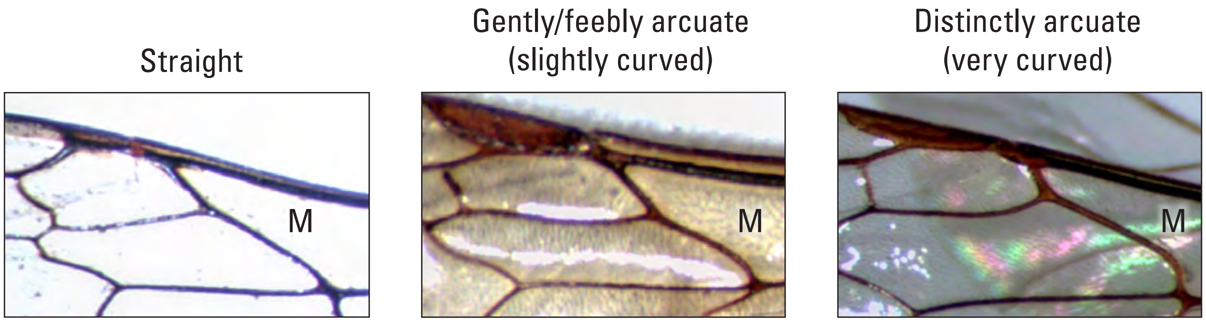


Figure 18. Curvature of the basal veins, M, of various Apoidea. The distinct, nearly “J-shaped”, curve on the right are found only in the family Halictidae. Some andrenids and other bees have feebly arcuate basal veins.

Abdomen (fig. 19).

1. Tergites: Individual segments of the abdomen (for example, T1 refers to the first abdominal segment as viewed dorsally).
2. Sternites: Abdominal segments as viewed ventrally (for example, S1, S2, which refer to the first and second abdominal segments as viewed ventrally, which are counted in the same fashion as the tergites).
3. Pygidial plate: A triangular plate on the last abdominal segment of many bee species; it is used to push down dirt when digging a nest burrow.

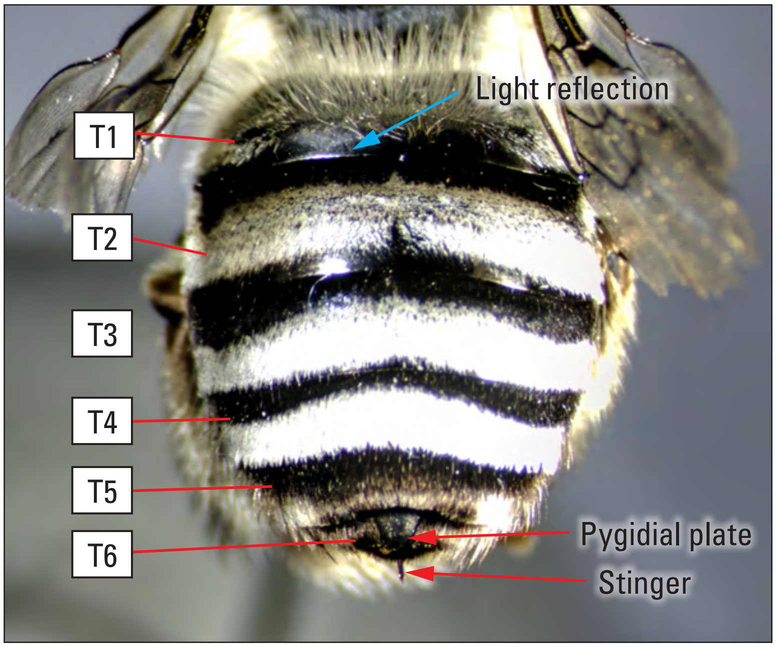


Figure 19. Abdomen of a female *Eucera*. The pygidial plate is the triangle on the last tergite. The stinger is partly visible directly below the pygidial plate. In this specimen, it is easy to tell where the tergites come together. Most of the white hair bands are apical (located at the end of the tergite). However, in the photograph, light reflects off the apical end of T1 (arrow). This effect is also seen at the end of T2. Proper light placement will make location and identification of structures easier.

Bee Families

Andrenidae (Mining Bees)

Andrenidae is a large bee family, hosting more than 4,500 (more than 40 genera) species worldwide, with 80 percent of them belonging to either genus *Andrena* or *Perdita* (Wilson and Messinger Carril, 2016). This family has a wide range of generalists and specialists—alternative terms in the literature include polylege (generalist) and oligolege (specialist). All species in this family are ground nesters (hence the name, mining bees) and line their nests with a waterproof substance (Wilson and Messinger Carril, 2016).

Characteristics

- Short-tongued: All four segments of the labial palps are equal in length (fig. 13).
- Two subantennal sutures (fig. 20). This feature is perhaps the most defining of the Andrenidae, but can be difficult to see through hair on the face.
- Female of some genera with facial fovea, short suppressed pubescence in patches on face, sometimes difficult to see (fig. 21).
- Forewing with straight or feebly arcuate basal vein (fig. 22).
- Forewing with two or three submarginal cells (fig. 22).
- Female sometimes with scopa on trochanter of hind leg—usually found in *Andrena* females (fig. 23).

Figure 20. Subantennal sutures of a male *Andrena*. They extend from the base of the antennal socket to the top of the clypeus.

Figure 21. The golden-colored facial fovea of a female *Andrena*. Fovea are dense patches of hair, often with a “velvet-like” appearance. These patches are present in all *Andrena*.

Figure 22. An *Andrena* wing with three submarginal cells and a feebly arcuate basal vein.

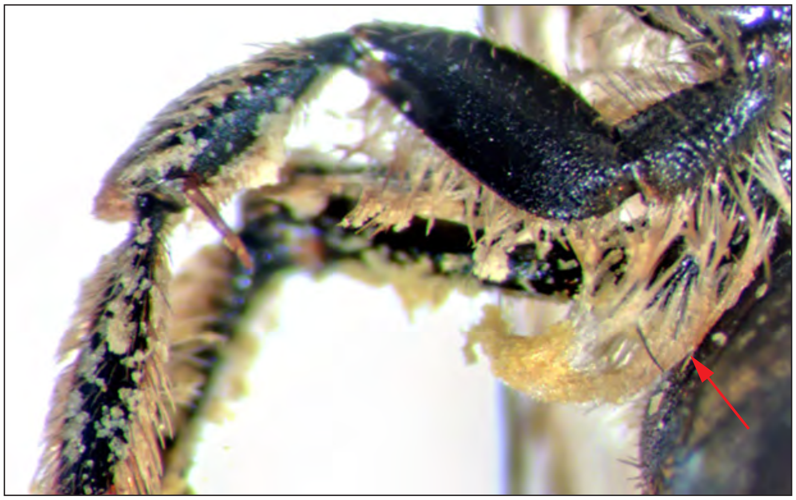


Figure 23. The horn-shaped scopa, on a female *Andrena's* trochanter.

Apidae (Honey, Bumble, Carpenter, and Cuckoo Bees)

The family Apidae contains more than 5,700 species (200+ genera) of bees (Wilson and Messinger Carril, 2016), including the iconic honey bee and bumble bees. However, this family is large and diverse (fig. 24). Some of the genera, most notably *Nomada* (fig. 24*D*), look like wasps instead of their fuzzy bumble bee cousins. Apidae contains both specialists and generalists and typically nest in the ground. Two examples of non-ground nesters include *Xylocopa*, commonly called carpenter bees, which nest in wood, and *Ceratina*, which nest in the soft pith of plant stems.

Characteristics

- Long-tongued: The first two segments of the labial palps are much longer than the other two (fig. 13, right panel).
- Hind legs have corbiculae (fig. 25) or scopa (fig. 26), unless parasitic.

Figure 24. Representative apids. The Apidae family is quite diverse, but all have long tongues. (*A*) *Apis mellifera*, (*B*) *Bombus* sp., (*C*) *Eucera* sp., and (*D*) *Nomada* sp.

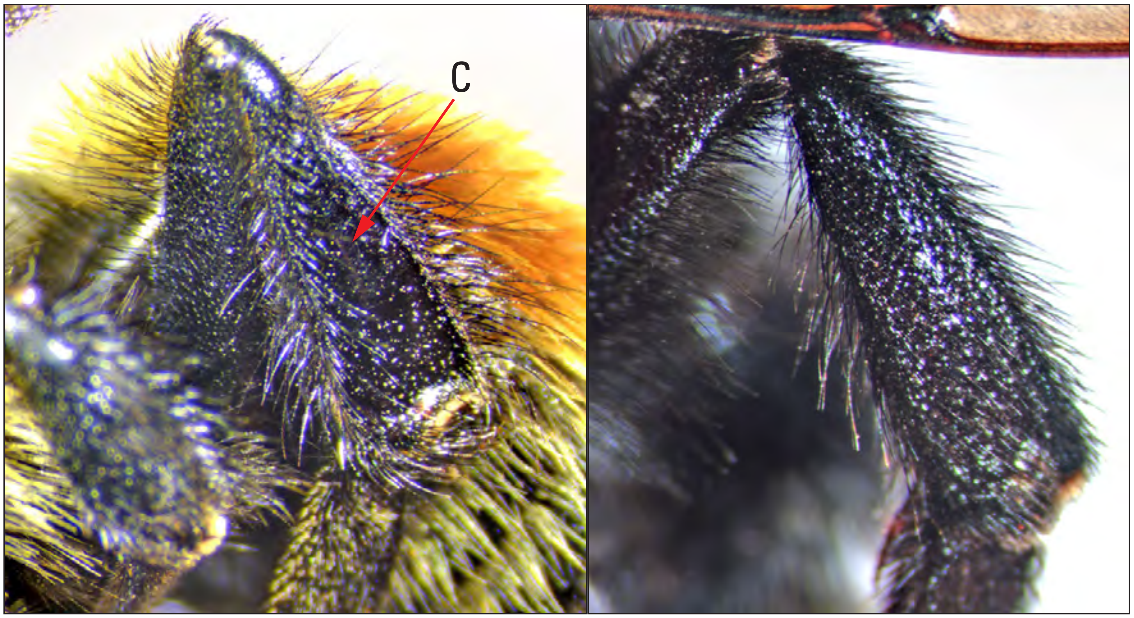


Figure 25. The hind tibia of a female *Bombus huntii* (left) and a parasitic female *Bombus insularis* (right). *B. huntii* has a corbicula or "pollen basket" (C in the figure). This feature is characterized by a shiny, concave surface surrounded by stiff, long hairs. The parasitic bee on the right has no corbicula because she does not collect pollen for her offspring.

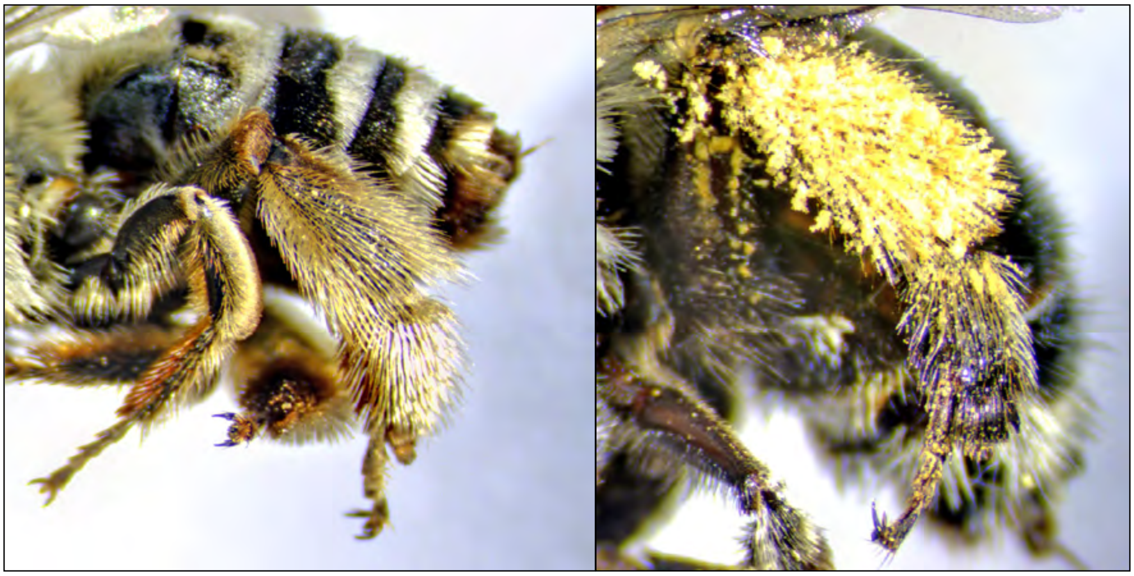


Figure 26. The hind leg scopa of a *Eucera* female (left) and the pollen-filled hind leg scopa of a female *Anthophora* (right). The scopa of both these bees are located on the tibia (upper hair bunch) and the basitarsus (lower hair bunch, also called a basitarsal brush).

Colletidae (Plasterer Bees)

Family Colletidae is relatively small, with about 2,000 species in 56 genera (Wilson and Messinger Carril, 2016). As in other bee families, this one contains both specialists and generalists. Colletid bees typically are solitary ground nesters. In some species, the unique bi-lobed tongue is used to coat the walls of their burrows with a waterproof compound, protecting the developing eggs from moisture and fungi (Wilson and Messinger Carril, 2016).

Characteristics

1. Short-tongued, glossa is bi-lobed (fig. 27).

Figure 27. Characteristics of Colletidae, most notably the short, bi-lobed glossa (left). A *Colletes* head (right) is shown because this is a common genus of colletid bee found in Idaho. *Colletes* have a heart-shaped head with the eyes at an angle to each other (lines) instead of parallel, as in most other bees.

Halictidae (Sweat Bees)

The Halictidae family contains more than 3,500 species (76 genera) that live in nearly every habitat around the world (Wilson and Messinger Carril, 2016). As with other families, these species can be generalists or specialists. Lifestyles include both solitary nesters and a few primitively eusocial species, including the European halictid *Lasioglossum malachurum*. In eusocial bees, one colony will live together in one nest, splitting nest and reproductive duties. Honey bees (Apidae) are considered the most "highly eusocial" of all bees because their workforce is divided into distinct castes, whereas other more primitively eusocial species (like bumble bees and some sweat bees) divide labor based on size—typically larger individuals do the foraging and smaller ones tend to the nest.

Characteristics

1. Short-tongued (fig. 13).
2. Both sexes have one fewer visible tergite than other bee families (females will have five visible and males have six, fig. 28).

- Forewing with distinctly arcuate basal vein.

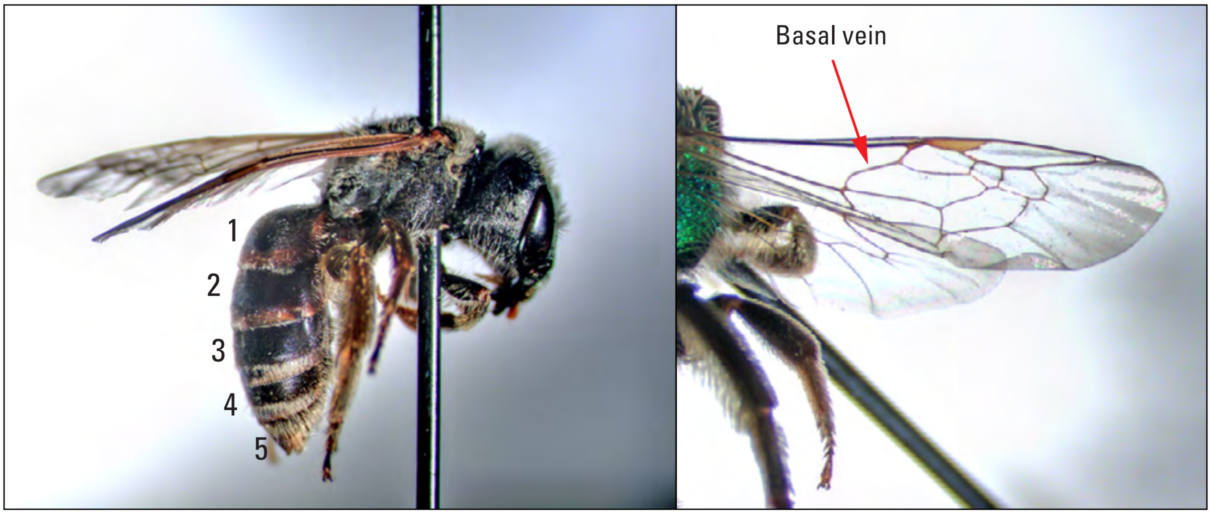


Figure 28. Characteristics of Halictidae. Females have only five visible tergites (Halictus, left). Distinctly arcuate basal vein (right).

Megachilidae (Leafcutter and Mason Bees)

Family Megachilidae comprises more than 4,000 species from more than 76 genera (Wilson and Messinger Carril, 2016). As with the other families, megachilids are a combination of generalists and specialists. Many specialists of this group are used by farmers for pollination of alfalfa, almonds, cherries, and blueberries. Many species are "squatters" and reuse any tunnel that was previously constructed including abandoned bee nests and even old snail shells. Some bees will cut pieces of leaves or petals, hence the name leafcutter bees, to line their nest cells. Other bees are "masons," collecting mud and constructing their own nests.

Characteristics

1. "Stout" looking bees, compared to other families.
2. Long-tongued (fig. 13).
3. Labrum is longer than wide (fig. 29).

- Forewing with two submarginal cells (fig. 30).
- Female with scopa on ventral side of abdomen (fig. 31).

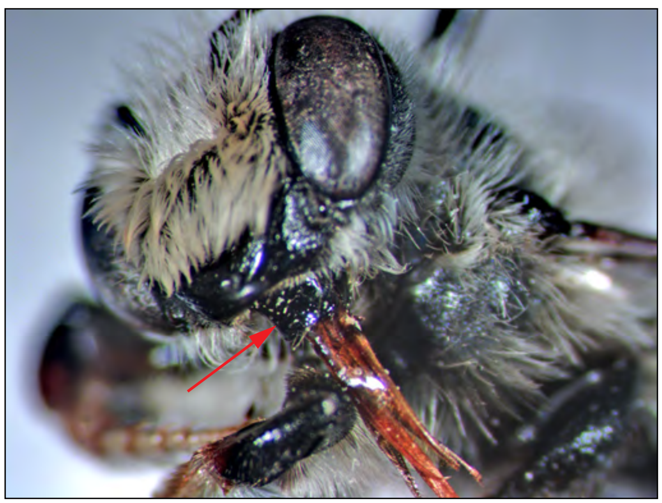


Figure 29. The longer than wide labrum (arrow) of a *Megachile*.

Figure 30. All Megachilidae (in southwest Idaho) wings have two submarginal cells, labeled 1 and 2.

Figure 31. The ventral abdominal scopa of a female *Megachile*.

Melittidae (Oil-Collecting Bees)

Melittidae is the rarest of all bee families, with approximately 200 species in 15 genera worldwide (Wilson and Messinger Carril, 2016). Most species are specialists, and one genus, *Macropsis*, collects floral oils for nest building and feeding offspring. All bees in this family are solitary ground-nesters. These bees are not commonly collected in traps and typically are more difficult to identify than the other families.

Characteristics

1. Uncommon family and most difficult to identify (rule out other families before moving to this one, fig. 32).
2. Short-tongued (fig. 13).

Figure 32. Characteristics of Melittidae are difficult to distinguish, but they all have short tongues.

Common Bee Genera of Southwest Idaho

A list of 30 genera of bees from six families were found from nine sample sites in southwest Idaho (fig. 33; table 1, used a sampling protocol from Lowe and others [2010]). Bees were collected using pitfall traps (250 mL mason jars) and Japanese beetle flight traps (Great Lakes IPM, Inc.). This list is incomplete as there are estimated to be at least 33 genera of bees in the region. For more information about these other genera, please see section, “Recommended Resources” at the end of this document.

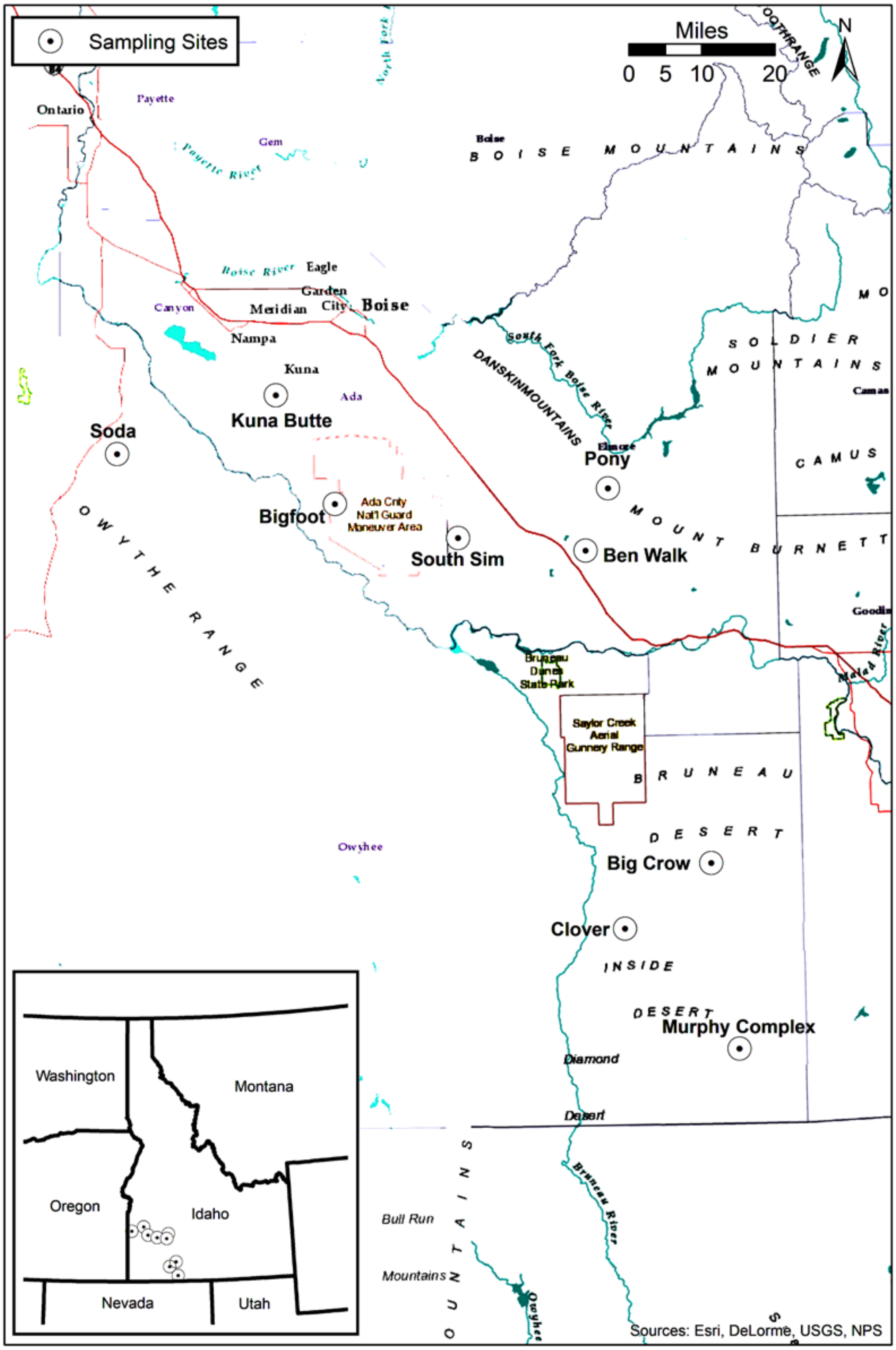


Figure 33. Approximate locations of all sampled sites in southwest Idaho. Sites ranged in altitude from approximately 2,700–5,400 feet.

Table 1. List of all genera detected at nine sample sites in southwest Idaho.

Andrenidae	Apidae	Colletidae	Halictidae	Megachilidae	Melittidae
Andrena	*Anthophora*	*Colletes*	*Agapostemon*	*Anthidium*	*Hesperapis*
Calliopsis	*Apis mellifera*		*Dufourea*	*Coelioxys*	
Perdita	*Bombus*		*Halictus*	*Dianthidium*	
Pseudopanurgus	*Ceratina*		*Lasioglossum*	*Hoplitis*	
	Diadasia		*Sphecodes*	*Megachile*	
	Epeolus			*Osmia*	
	Eucera			*Stelis*	
	Melecta				
	Melissodes				
	Nomada				
	Triepeolus				
	Xeromelecta				

Important note: Subsequent photographs of females and males for each genus are not necessarily of the same species. However, they do illustrate key features.

Andrenidae

Andrena

1. Female:

Figure 34. A female *Andrena*. On left, the trochanter scopae are visible (pale yellow tufts of hair that are curved outward).

2. Male:

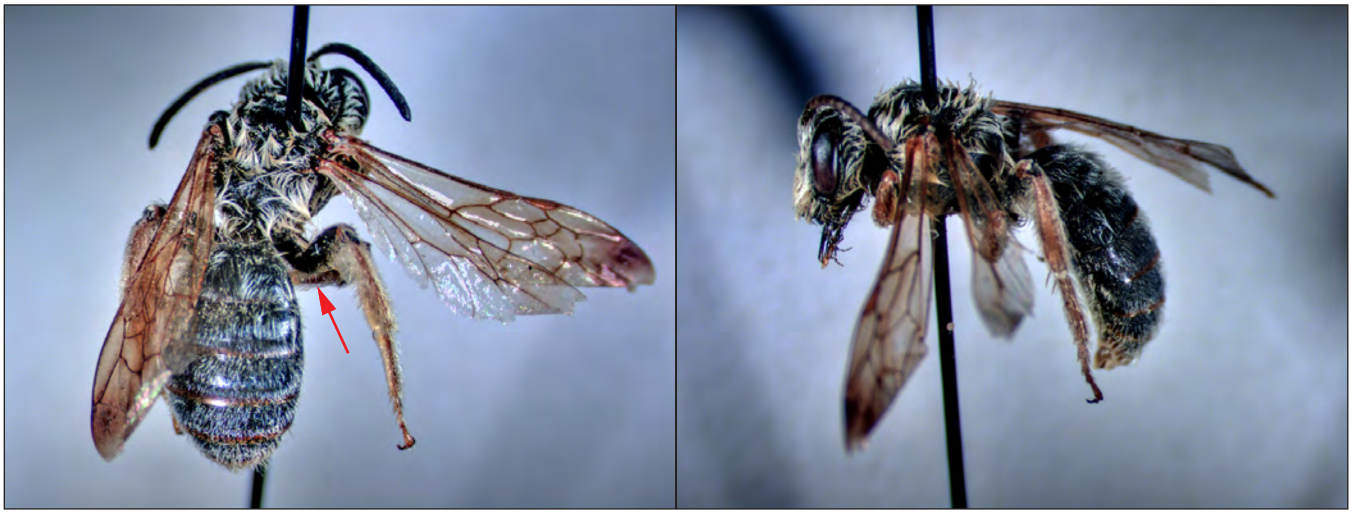


Figure 35. A male *Andrena*. Arrow on left shows that males do not have the scopa as seen on the female in figure 34.

3. General identification criteria:

   a. Females have facial fovea (sometimes the hairs are worn and harder to see) and scopa on the trochanter (figs. 19 and 34). The males have no scopa (fig. 35).

   b. Two or three submarginal cells.

   c. Various sizes, colors, and abdominal hair patterns.

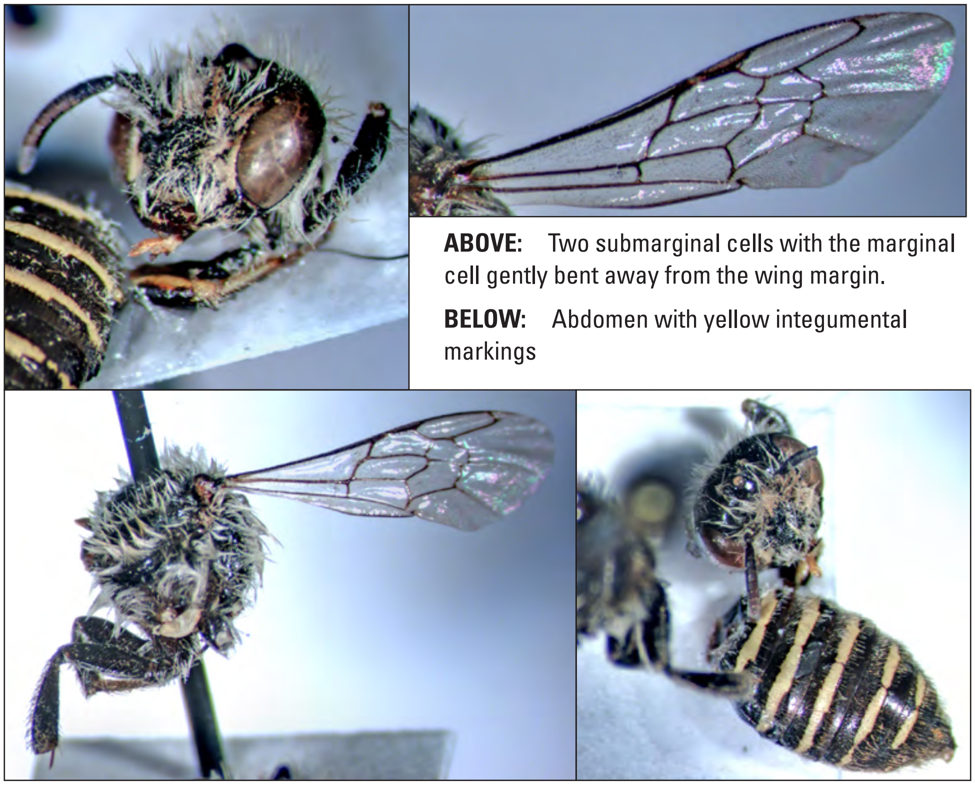
4. Life history information:

   a. Nesting habits: Ground nesters, sometimes nest in aggregations or communally (Wilson and Messinger Carril, 2016).

   b. Diet: many species of generalists and specialists (Wilson and Messinger Carril, 2016).

Calliopsis

1. Male:



ABOVE: Two submarginal cells with the marginal cell gently bent away from the wing margin.

BELOW: Abdomen with yellow integumental markings

Figure 36. A male *Calliopsis* with important features for identification of this genus.

2. General identification criteria:
   a. Two submarginal cells (fig. 36).
   b. Marginal cell gently bent away from wing margin, either ending in a gently rounded or blunt manner (fig. 36).
   c. Yellow or ivory color on exoskeleton (not colored hair): can include abdomen, face, and legs (fig. 36).
3. Life history information:
   a. Nesting habits: solitary nests, sometimes clustered nearby in aggregations (Wilson and Messinger Carril, 2016).
   b. Diet: Specialists (Wilson and Messinger Carril, 2016).

Perdita

1. Female:

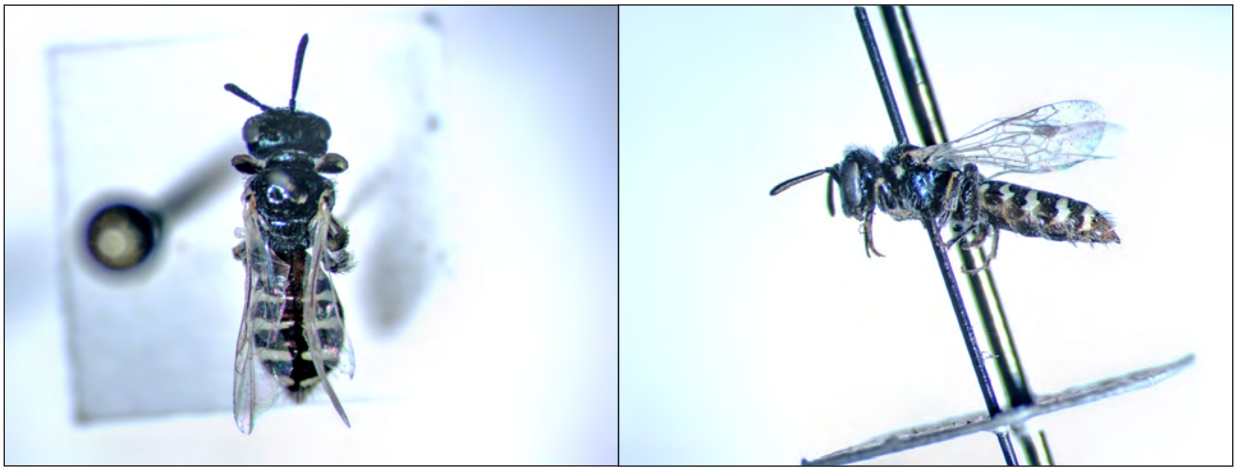


Figure 37. A female *Perdita*.

2. Male:

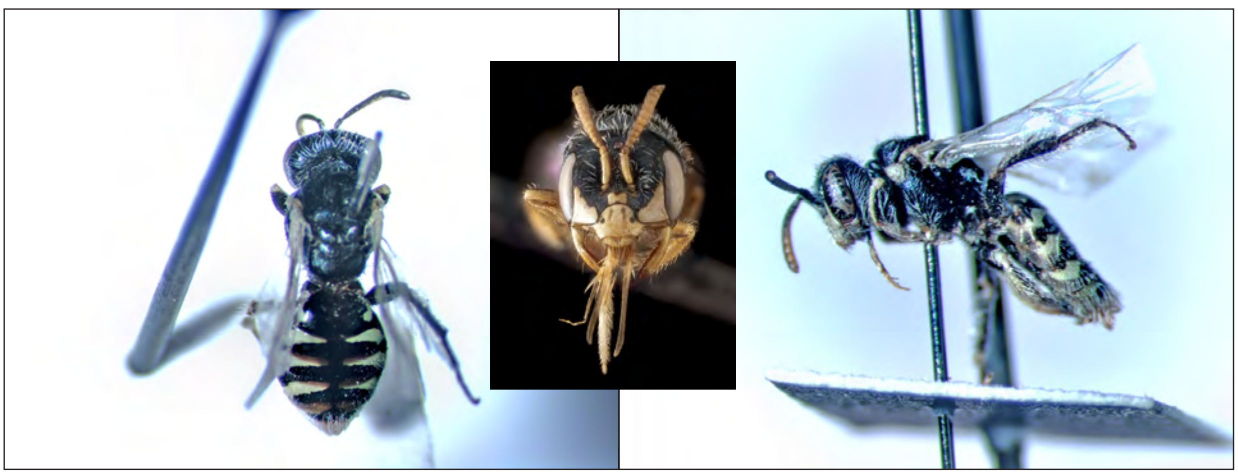


Figure 38. A male *Perdita*. Inset: *P. halictoides* face with yellow coloration. From the U.S. Geological Survey Bee Inventory and Monitoring Lab (https://www.flickr.com/photos/usgsbiml/).

3. General identification criteria:

    a. Very small bees (2–10 mm), often with yellow markings on the abdomen and face (figs. 37 and 38; Michener and others, 1994).

    b. Short, truncated marginal cell in the forewing (fig. 39; Michener and others, 1994).

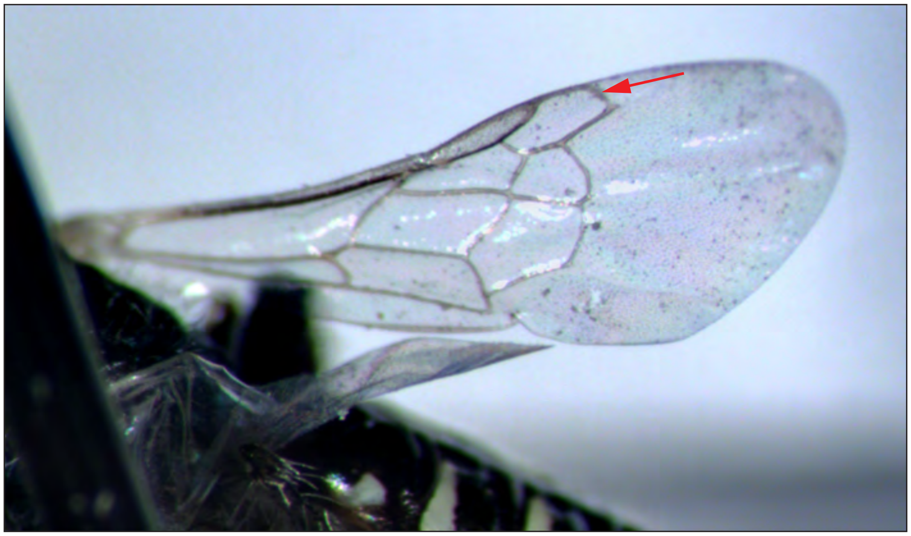


Figure 39. A *Perdita* forewing with two submarginal cells, a straight or gently arcuate basal vein, and a truncated marginal cell (shown by arrow).

4. Life history information:

    a. Nesting habits: Ground nesters, some nest communally but most are solitary (Wilson and Messinger Carril, 2016).

    b. Diet: Nearly all are specialists (Wilson and Messinger Carril, 2016).

Pseudopanurgus

1. Female:

Figure 40. A female *Pseudopanurgus*. The head was separated from the body during handling.

2. General identification criteria:

   a. A smaller bee, may be mistaken for similar genera like *Andrena*, look at features carefully (fig. 40).

   b. Truncated marginal cell (fig. 41; Wilson and Messinger Carril, 2016).

   c. Two subantennal sutures (fig. 16; Wilson and Messinger Carril, 2016).

Figure 41. A *Pseudopanurgus* forewing with the truncated marginal cell (arrow).

3. Life history information:

   a. Nesting habits: solitary ground nesters (Wilson and Messinger Carril, 2016).

   b. Diet: specialists on daisies (Asteraceae) (Wilson and Messinger Carril, 2016).

Apidae

Anthophora

1. Female:

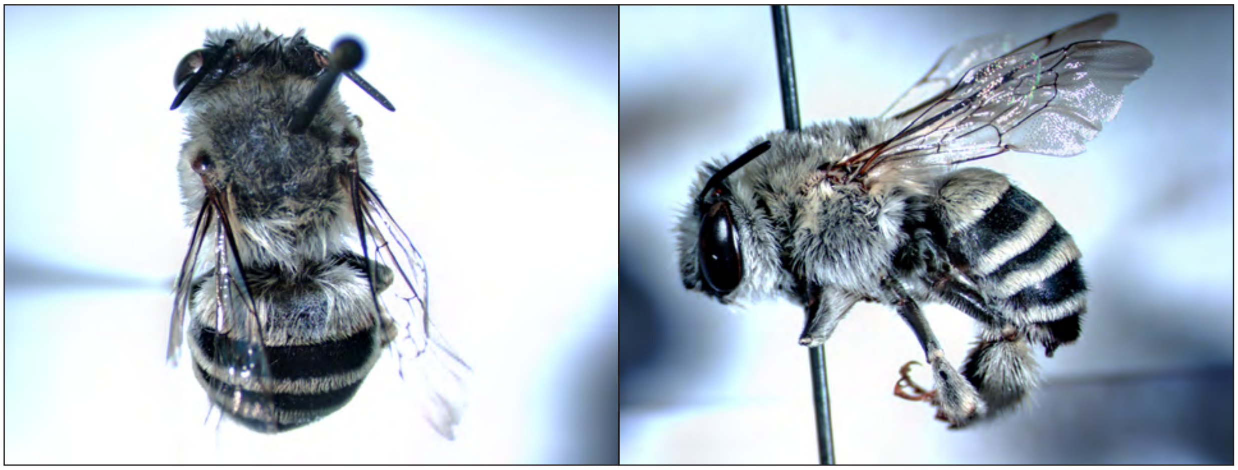


Figure 42. A female *Anthophora.*

2. Male:

Figure 43. A male *Anthophora.* The middle picture shows the male's yellow markings on the face, clypeus, and labrum (the plate between the two extended mandibles).

3. General identification criteria:

    a. Typically, small-to-medium sized bees, and often very fuzzy with white or pale-yellow hair bands on abdomen (fig. 42; Michener and others, 1994).

    b. Males often have distinctive yellow markings on the face, clypeus, labrum, and antennae (fig. 43).

    c. Forewing with short, rounded marginal cell, and closed cells are mostly hairless; wing surface beyond veins are hairless and coarsely papillate, which means "covered with small, rounded bumps" (fig. 44; Michener and others, 1994).

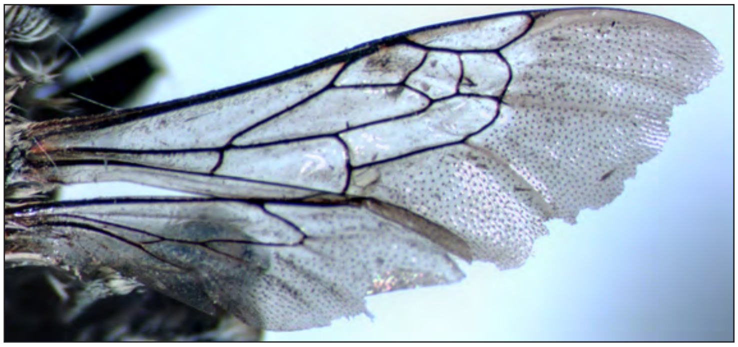


Figure 44. *Anthophora* wing.

4. Life history information:

    a. Nesting habits: Mostly ground nesters, usually in aggregations and some nest. communally; one species, *Anthophora furcata*, is known to nest in twigs (Wilson and Messinger Carril, 2016).

    b. Diet: Mostly generalists on pollen and nectar, but some specialists (Wilson and Messinger Carril, 2016).

Apis mellifera

1. Female worker:

Figure 45. A female *A. mellifera* worker. On right, the yellow square is a pollen-filled corbicula.

2. General identification criteria:

   a. Corbicula on hind tibia (fig. 45; Wilson and Messinger Carril, 2016).

   b. Extremely hairy eyes (fig. 46; Wilson and Messinger Carril, 2016).

   c. Long marginal cell (Wilson and Messinger Carril, 2016).

Figure 46. The hairy eyes of an *A. mellifera.*

3. Life history information:

   a. Nesting habits: highly eusocial hive bees, nest in large cavities (Wilson and Messinger Carril, 2016).

   b. Diet: Generalists (Wilson and Messinger Carril, 2016).

Miscellaneous note: Most likely visitors from nearby managed hives. Males (drones) are unlikely to be caught in the field.

Bombus

1. Female:

Figure 47. A female *Bombus fervidus.* Arrow points the female's corbicula.

2. Male:

Figure 48. A male *B. fervidus.* The hind legs do not have corbiculae nor are any of his legs particularly hairy.

3. General identification criteria:

   a. An iconic type of bee—large, fuzzy, and black, yellow, sometimes red or orange stripes (figs. 47 and 48).

   b. Corbicula on hind tibia (except for parasitic subgenera, like *Psithyrus*).

   c. No jugal lobe on hind wing (fig. 49, see fig. 17 for comparison; Wilson and Messinger Carril, 2016).

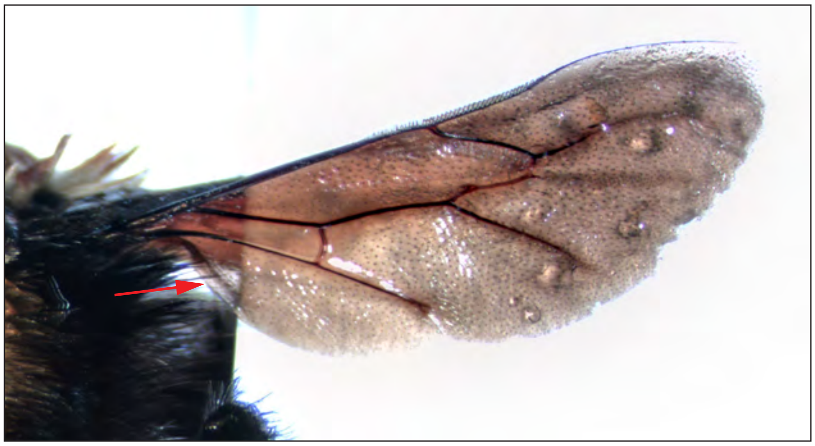


Figure 49. *Bombus* hind wing, with no jugal (arrow) lobe.

4. Life history information:

   a. Nesting habits: primitively eusocial hive bees, nest in large cavities (Wilson and Messinger Carril, 2016).

   b. Diet: Generalist (Wilson and Messinger Carril, 2016).

Ceratina

1. Female:

Figure 50. A female *Ceratina.*

2. Male:

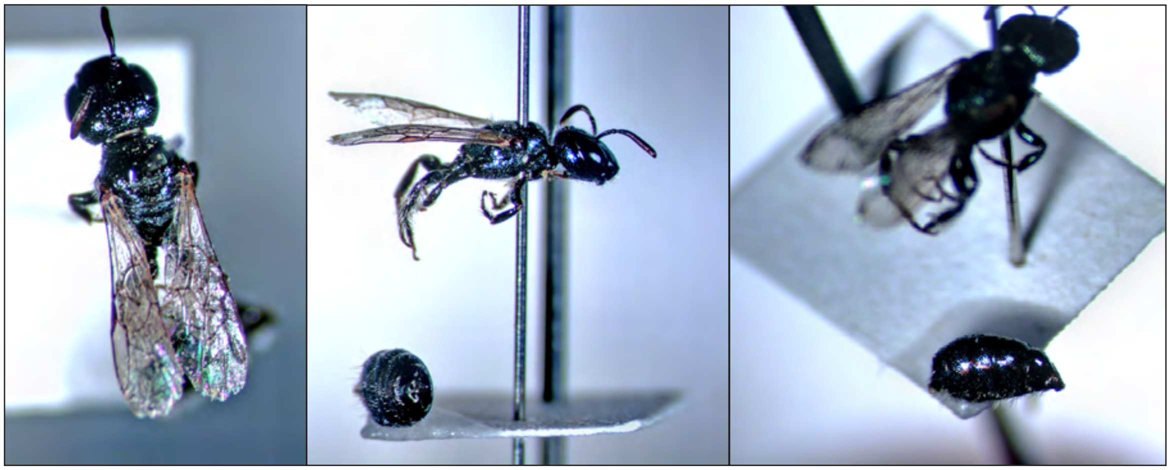


Figure 51. A male *Ceratina.*

3. General identification criteria:

    a. Generally, very small, nearly hairless bees (figs. 50 and 51).

    b. Black or light metallic green/blue integument color often with yellow or ivory facial marks (fig. 52; Wilson and Messinger Carril, 2016).

    c. Have very long tongues as opposed to other similar-looking small bees.

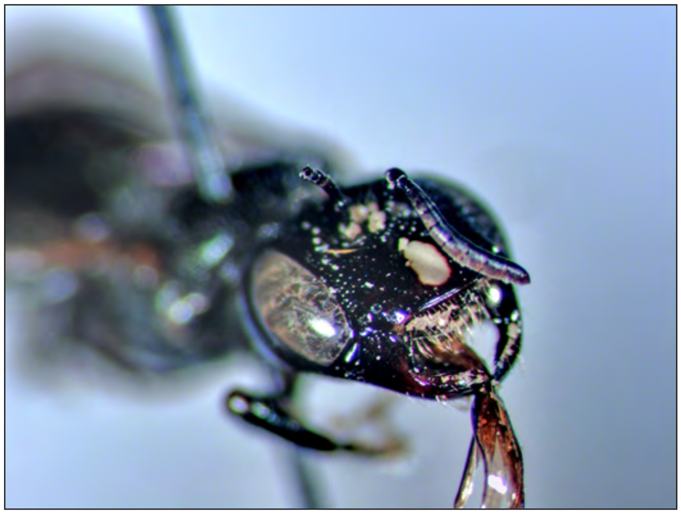


Figure 52. Face of a female *Ceratina* with a cream-colored oval on her clypeus.

4. Life history information:

   a. Nesting habits: solitary cavity nesters, use hollow twigs and stems; female will guard nest cells until they are completely developed (Wilson and Messinger Carril, 2016).

   b. Diet: Generalist (Wilson and Messinger Carril, 2016).

Diadasia

1. Female:

Figure 53. A female *Diadasia.*

2. Male:

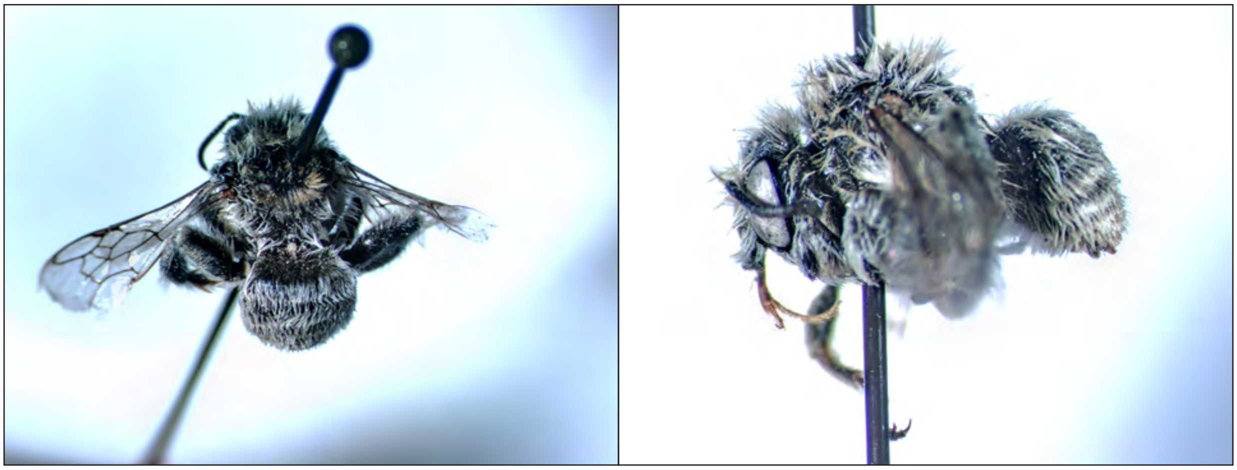


Figure 54. A male *Diadasia.*

3. General identification criteria:

   a. Medium-to-large fuzzy bees, often with colored hair bands (figs. 53 and 54; Michener and others, 1994).

   b. Hind wing veins: second abscissa of M+Cu is less than two-thirds as long as M and often the same length as cu-v (fig. 55, these features are very specific and help distinguish *Diadasia* from other Apidae; Michener and others, 1994).

   c. Vertex of head is convex from front view (fig. 56; Michener and others, 1994).

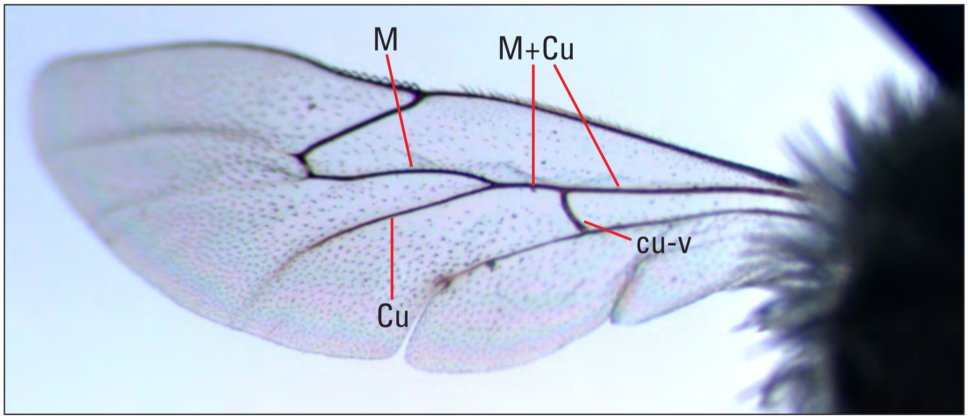


Figure 55. A *Diadasia* hindwing. The length of these veins is important in distinguishing this genus from other closely related genera, like *Eucera*. (M, basal vein or media; M+Cu, media+cubitus veins; Cu, cubitus vein; cu-v, vubitus-vannal vein connector. Abbreviations are from Michener and others (1994).

Figure 56 The convex head of a *Diadasia* bee (left), contrasted with the "concave" head of a *Melissodes* bee (right). The concave head is characterized by a concave shape between the compound eyes; the ocelli are located on a conspicuous central hump interrupting the head's curvature.

4. Life history information:

    a. Nesting habits: solitary nest in the ground, often with an elongated tunnel or "turrets" built a few centimeters into the air, and often in aggregations (Wilson and Messinger Carril, 2016).

    b. Diet: many specialists (some forage only on globemallow (*Sphaeralcea* sp.; Wilson and Messinger Carril, 2016).

Epeolus

1. Female:

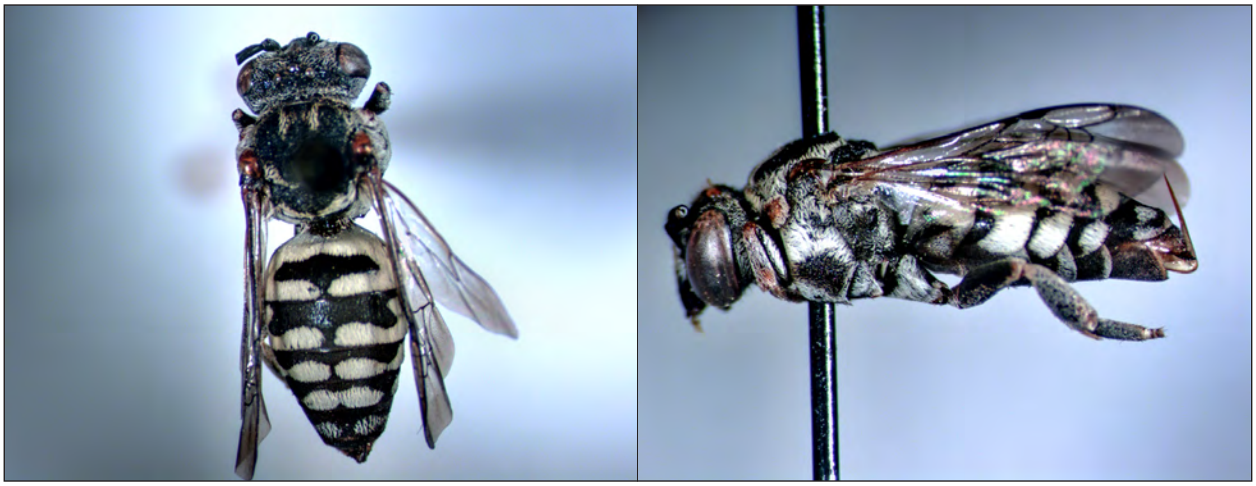


Figure 57. A female *Epeolus*.

2. Male:

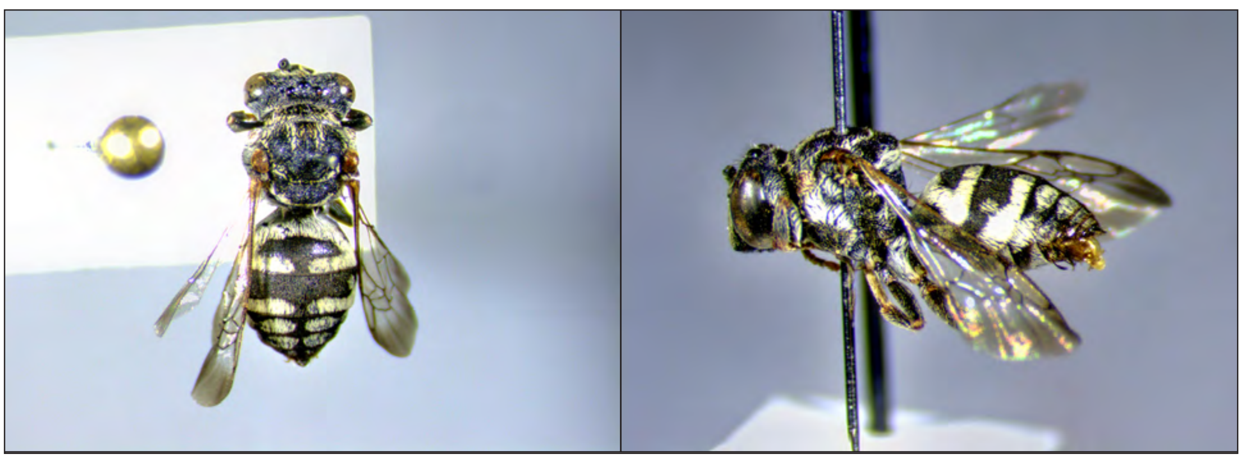


Figure 58. A male *Epeolus.*

3. General identification criteria:

   a. Small-to-medium sized bees, appear non-fuzzy, but have abdominal hair bands made of appressed hair (figs. 57 and 58).

   b. Look very similar to *Triepeolus*, another genus in the Epeolini tribe.

   c. Females' T5 has a short, silvery pubescence and the pygidial plate directly below (on T6) has a sinuous margin (fig. 59). This is an important characteristic when distinguishing *Epeolus* from *Triepeolus*, whose T5 on females has a dark, beveled area of pubescence resembling a pygidial area, and the pygidial plate sides are nearly parallel.

   d. Males' pygidial plate resembles a female *Triepeolus*, with the margins being parallel, not sinuous (fig. 59).

   e. Females have no scopa because they are parasitic.

4. Life history information:

   a. Nesting habits: parasitize nests of *Colletes* exclusively.

   b. Diet: visit flowers for nectar only, not pollen.

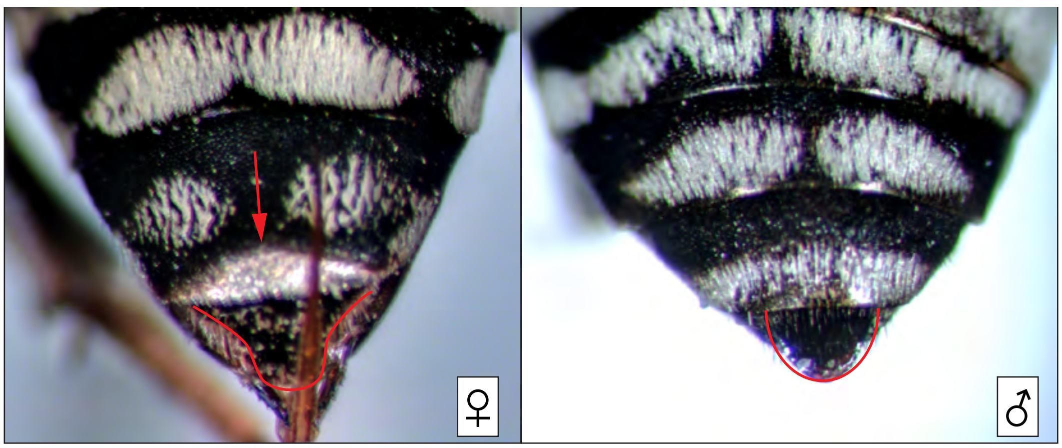


Figure 59. Characteristics on terminal abdominal segments of female (left) and male (right), *Epeolus.* The female's silvery pubescence is pointed at with an arrow, while the pygidial plate is outlined.

Eucera

1. Female:

Figure 60. A female *Eucera.*

2. Male:

Figure 61. A male *Eucera.*

3. General identification criteria:
    a. Medium-sized, moderately fuzzy bees (figs. 60 and 61; Wilson and Messinger Carril, 2016).
    b. Males have very long antennae (fig. 61; Wilson and Messinger Carril, 2016).
    c. Forewings have minute hairs on entire wing (fig. 62; Michener and others, 1994).
    d. Tegulae are not anteriorly narrowed—oval shaped (fig. 63; Michener and others, 1994).
4. Life history information:
    a. Nesting habits: Solitary ground nesters, some nest communally (Wilson and Messinger Carril, 2016).
    b. Diet: Both generalists and specialists (specialists often prefer peas [Fabaceae]; Wilson and Messinger Carril, 2016).

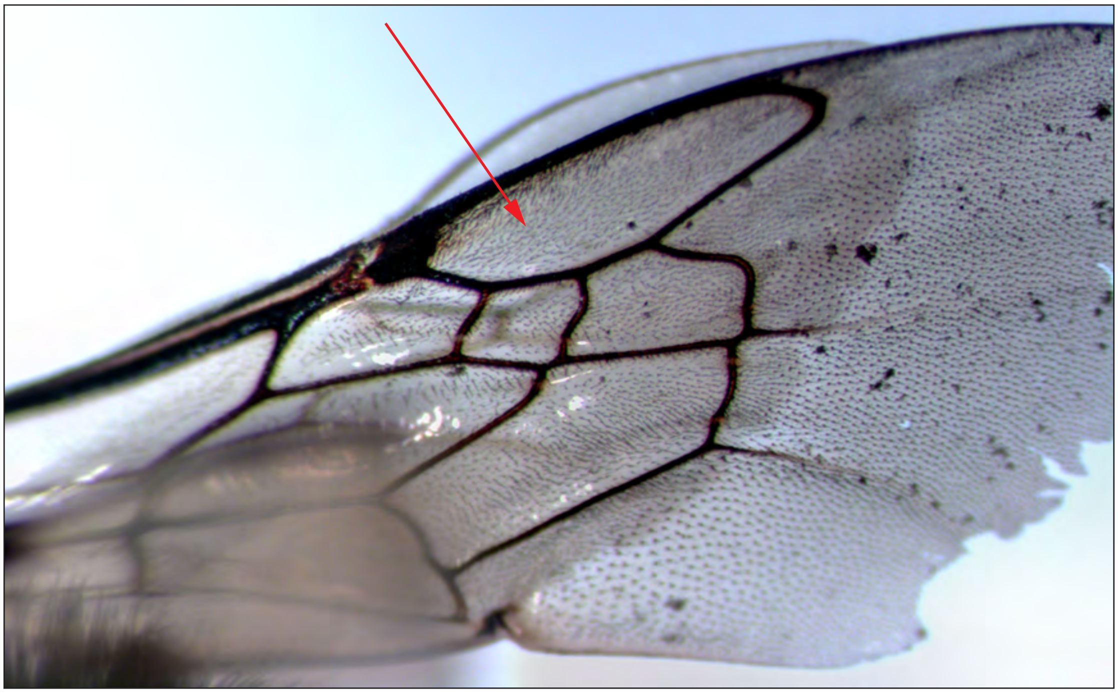


Figure 62. *Eucera* forewings are covered with tiny hairs both in the cells and on the wing margins. The enclosed cells have visible hair (arrow points to the hairs in the marginal cell). An example of a wing with no hair is shown in figure 65.

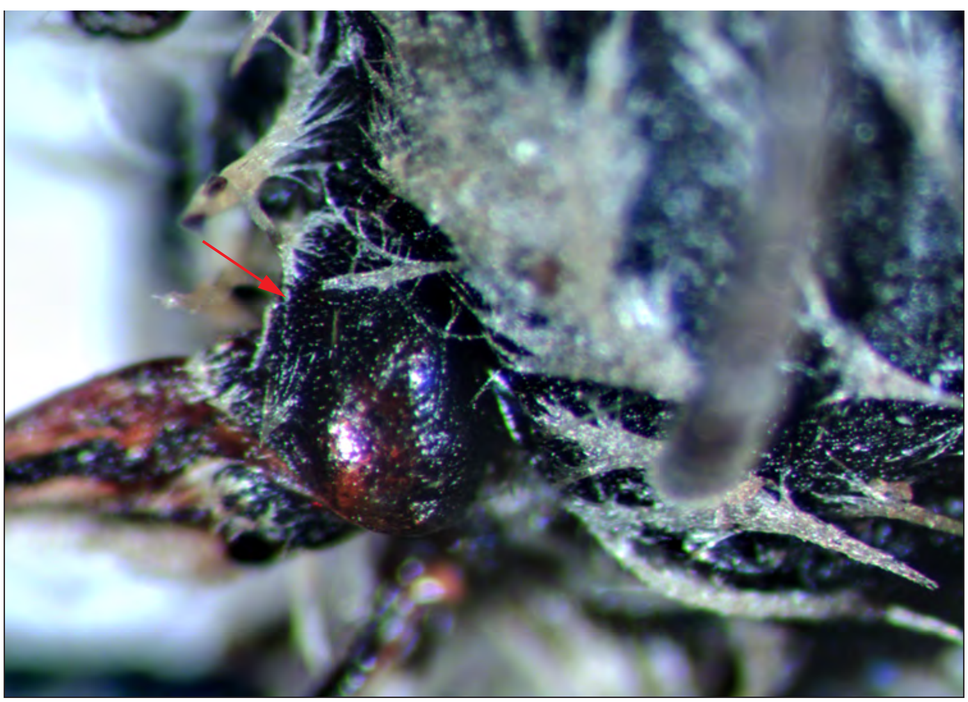


Figure 63. *Eucera* tegulae do not narrow anteriorly—they are completely oval-shaped. Please note that this character is often obscure and may require manipulation of the specimen to see.

Melecta

1. Female:

Figure 64. A female *Melecta.*

2. General identification criteria:

   a. Look like *Anthophora* (see figs. 42–44); however, females lack scopa (fig. 64; Wilson and Messinger Carril, 2016).

   b. Wings have hairless cells and coarsely papillate (dots on the wing) on wing margins (fig. 65; Wilson and Messinger Carril, 2016).

Figure 65. A *Melecta* wing, with the outer edges papillate (arrow).

3. Life history information:

   a. Nesting habits: Parasitize nests of Anthophorini (*Anthophora* and *Habropoda*; Wilson and Messinger Carril, 2016).

   b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Melissodes

1. Female:

Figure 66. A female *Melissodes.*

2. Male:

Figure 67. A male *Melissodes.*

3. General identification criteria:

   a. Medium-sized, fairly fuzzy bees (figs. 66 and 67; Wilson and Messinger Carril, 2016)—look very similar to *Eucera* (see figs. 60–61) bees.

   b. Males have very long antennae (fig. 67; Wilson and Messinger Carril, 2016).

   c. Forewings have minute hairs on entire wing (as in *Eucera*; fig. 62).

   d. Tegulae are anteriorly narrowed—tear-drop shaped (fig. 68; Michener and others, 1994):

      - This is a very subtle characteristic, and hair may need to be removed with a pin to see the tegula shape clearly.

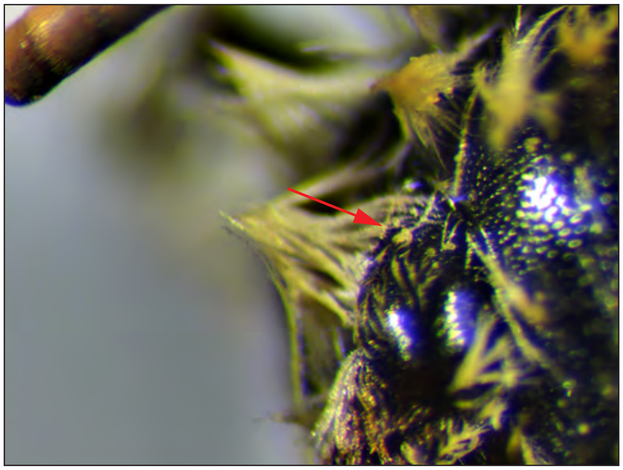


Figure 68. The anteriorly narrowed (or tear-drop shaped) tegula of a *Melissodes*. Compare to figure 63, the *Eucera* tegula.

4. Life history information:

   a. Nesting habits: Solitary ground nesters (Wilson and Messinger Carril, 2016).

   b. Diet: Mostly specialists, with some generalists (Wilson and Messinger Carril, 2016).

Nomada

1. Female:

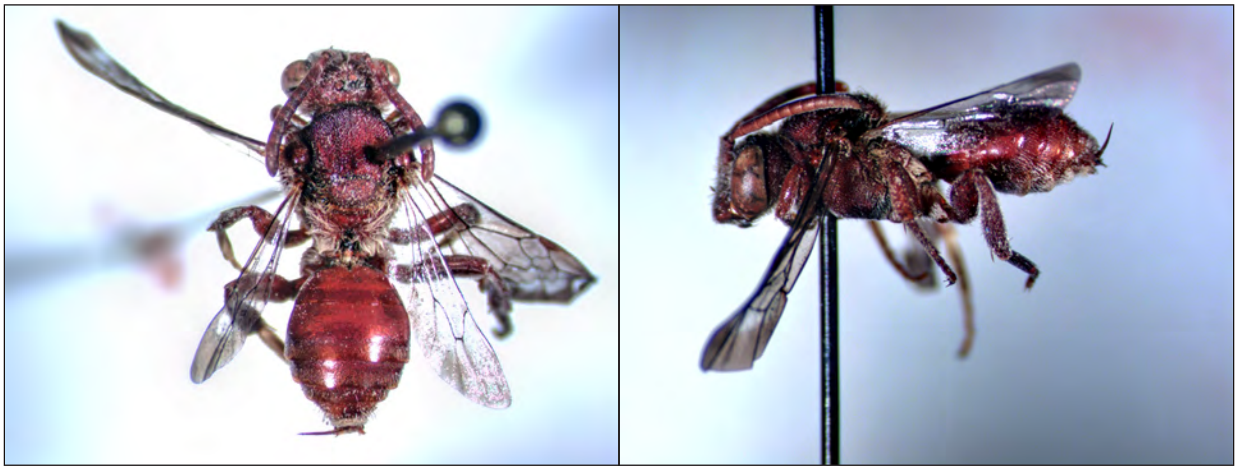


Figure 69. A female *Nomada*.

2. Male:

Figure 70. A male *Nomada*.

3. General identification criteria:

    a. Wasp-like in appearance, often with black and bright yellow markings or entire body reddish-brown (figs. 1*C*, 69, and 70; Wilson and Messinger Carril, 2016).

    b. No scopa.

4. Life history information:

    a. Nesting habits: Mostly parasitize *Andrena* nests, but also *Melitta*, *Colletes*, *Agapostemon*, *Lasioglossum*, *Halictus*, *Exomalopsis*, and *Eucera* (Wilson and Messinger Carril, 2016).

    b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Triepeolus

1. Female:

Figure 71. A female *Triepelous*. On T5, she has a dark brown, pseudopygidial area (arrow—inset) above the large pygidial plate on T6.

2. Male:

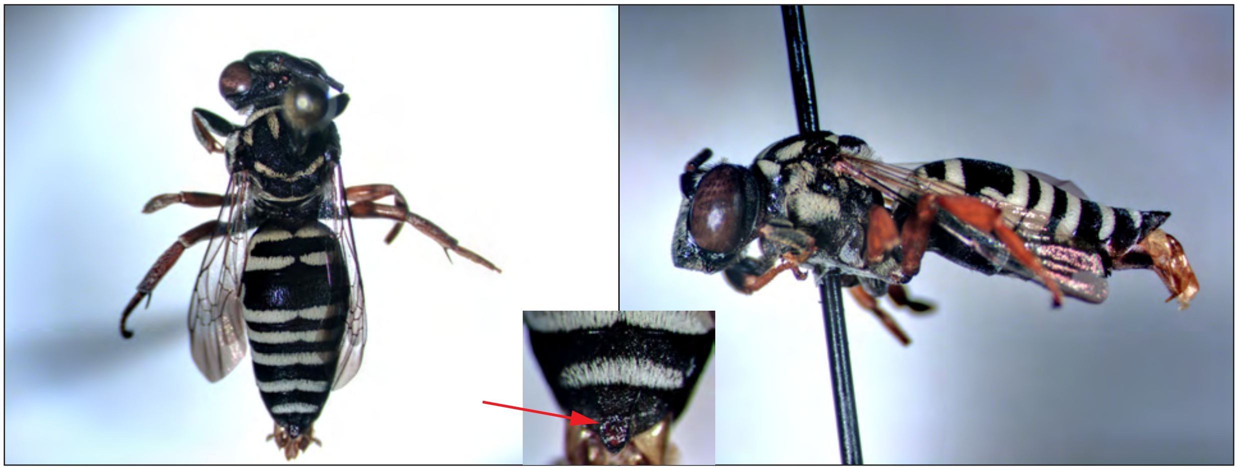


Figure 72. A male *Triepeolus*. The pygidial plate on T7 (arrow—inset) has sinuate sides.

3. General identification criteria:

    a. Small-to-medium sized (about 5–15 mm) bees, appear non-fuzzy, but have integumental hair bands made of appressed hair (figs. 71 and 72; Michener and others, 1994).

    b. Appear to have a "smiley face" on the dorsal side of the thorax, made of the same appressed hairs (Wilson and Messinger Carril, 2016).

    c. Females have no scopa.

    d. Females have a dark, pseudopygidial area on T5 above the large pygidial plate on T6.

    e. Males have a pygidial plate with sinuate sides on T7, similar to the sinuate pygidial plate of *Epeolus* females (see fig. 59).

4. Life history information:

    a. Nesting habits: Parasitize various bee nests, including Eucerini and *Anthophora* (Wilson and Messinger Carril, 2016).

    b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Xeromelecta

1. Female:

Figure 73. A female *Xeromelecta californica*.

2. General identification criteria:

   a. Generally medium-sized (about 10 mm or 1 cm or larger) bees, with black exoskeleton and white abdominal patterns of appressed hairs, and a fuzzy thorax of longer white hairs (fig. 73; Michener and others, 1994).

   b. Forewing with no hairs, dark coloration, and edges coarsely papillate (fig. 74; Wilson and Messinger Carril, 2016).

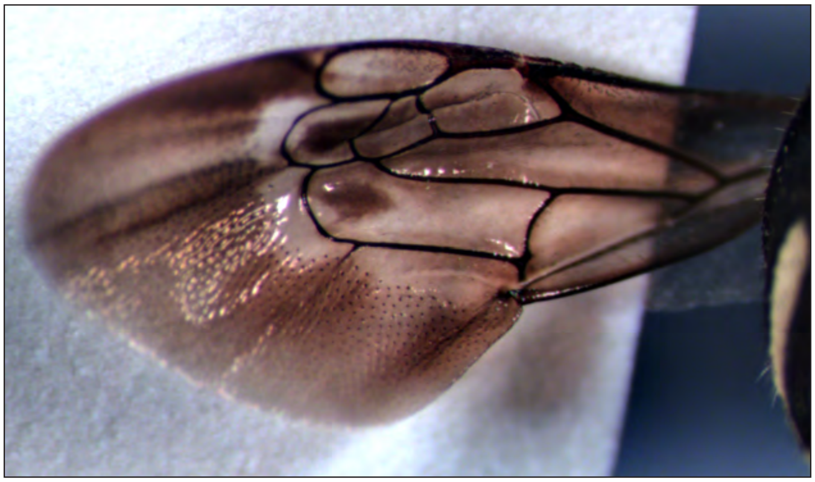


Figure 74. *Xeromelecta* wing.

3. Life history information:

   a. Nesting habits: Parasitize nests of *Anthophora* (Wilson and Messinger Carril, 2016).

   b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Colletidae

Colletes

1. Female:

Figure 75. A female *Colletes*.

2. Male:

Figure 76. A male *Colletes*.

3. General identification criteria:

    a. Southwest Idaho *Colletes* often are mistaken for other bees (like *Andrena*) due to the black and yellow abdominal stripes (figs. 75 and 76).

    b. Have a distinctive bi-lobed tongue (fig. 27).

    c. Forewing has a curved second recurrent vein (fig. 77).

    d. "Heart-shaped" head (fig. 27).

    e. The combination of these distinctive characters will help distinguish *Colletes* from other genera.

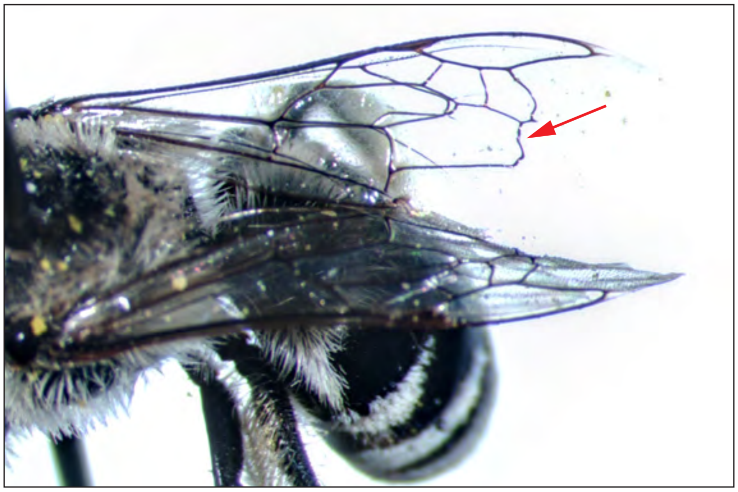


Figure 77. Colletidae forewing. Arrow points to the distinctively curved second recurrent vein.

4. Life history information:

    a. Nesting habits: Make solitary nests in the ground, sometimes in aggregations, line the nest cells with a mixture of saliva and glandular secretions. This covering is hardy and resistant to moisture and mold (Wilson and Messinger Carril, 2016).

    b. Diet: Both generalists and specialists (Wilson and Messinger Carril, 2016).

Halictidae

Agapostemon

1. Female:

Figure 78. Female *Agapostemon*.

2. Male:

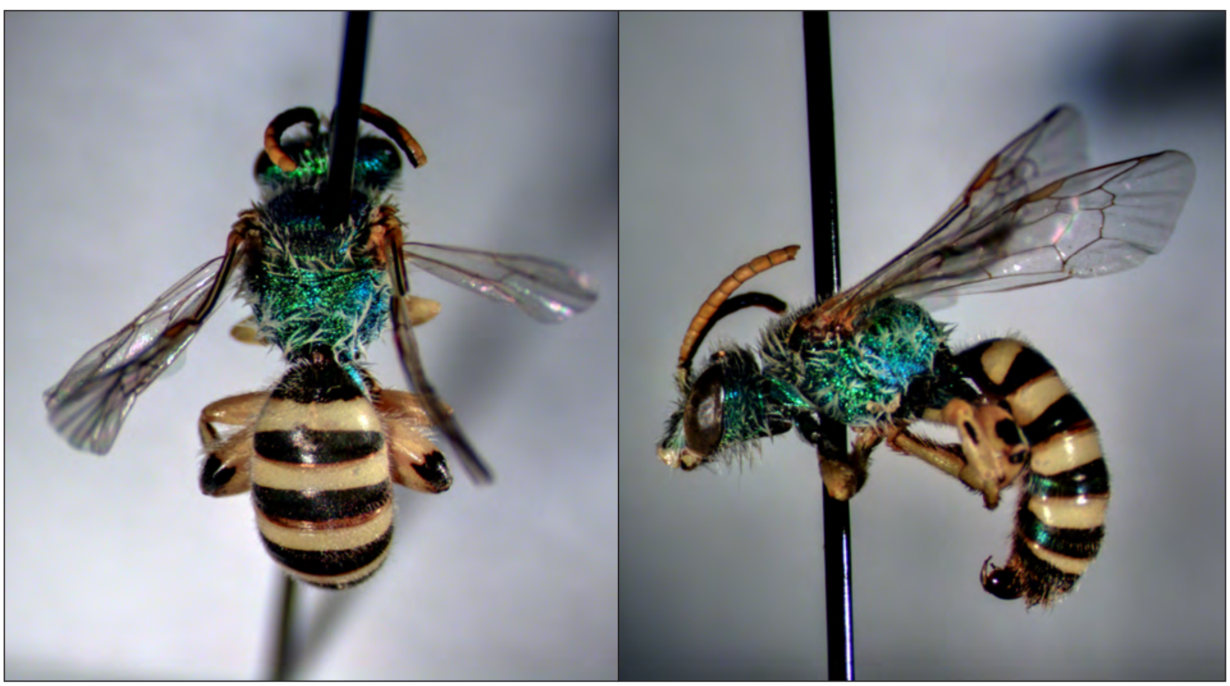


Figure 79. Male *Agapostemon*.

3. General identification criteria:

   c. Bright metallic green (figs. 78 and 79; Michener and others, 1994).

   d. Carina (a ridge) enclosing propodeum (fig. 80; Michener and others, 1994).

   e. Inner hind tibial spur with large teeth (fig. 81; Michener and others, 1994).

Figure 80. Distinct carina encloses the propodeum (arrow—on posterior side of thorax) of *Agapostemon*.

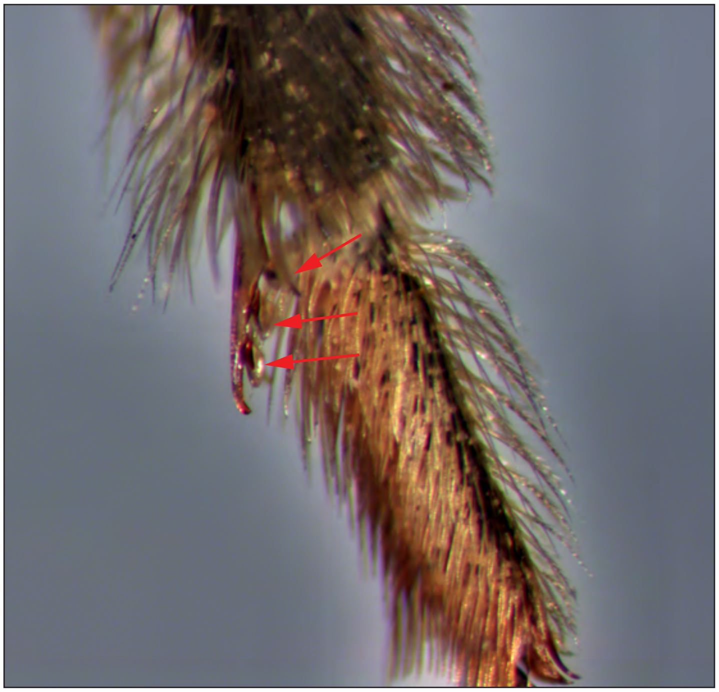


Figure 81. Inner hind tibial spur with large, distinct teeth. There are three teeth on this specimen (arrows), but the top tooth is obscured by hair.

4. Life history information

    a. Nesting habits: Ground nester; nests individually or communally (Wilson and Messinger Carril, 2016).

    b. Diet: Generalist, frequently seen on Asteraceae (Wilson and Messinger Carril, 2016).

5. Miscellaneous information.

    a. We frequently captured *Agapostemon* in passive traps, but they were not caught many times when netting; similar patterns have been determined by other studies (Wilson and others, 2008).

Dufourea

1. Male:

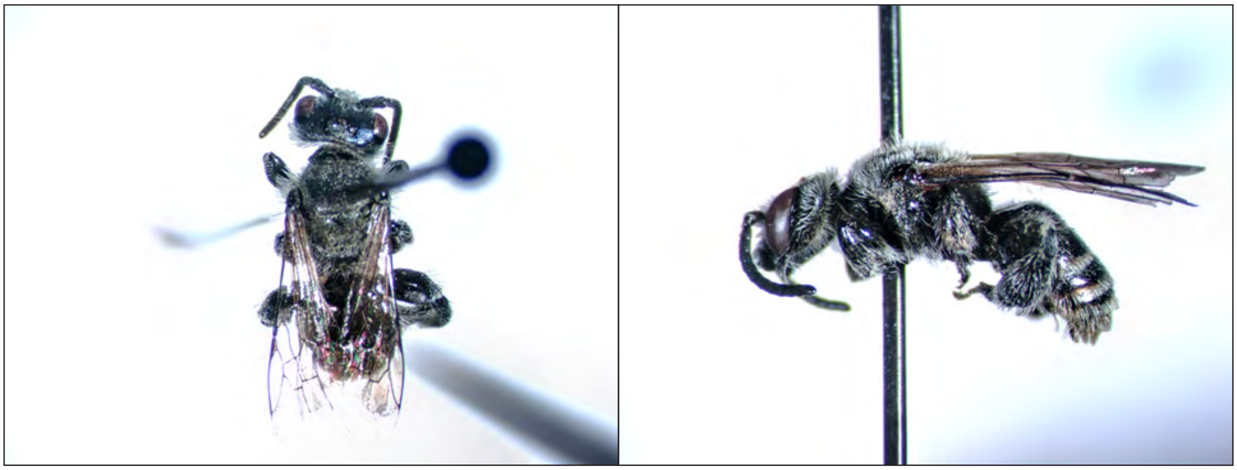


Figure 82. A male *Dufourea*.

2. General identification criteria:

   a. Typically, very small (3–10 mm), often black or metallic blue or green (fig. 82; Wilson and Messinger Carril, 2016).

   b. Antennae set low on the face (fig. 83).

   c. Males have enlarged hind legs (fig. 84).

   d. Have two submarginal cells and a distinctly arcuate basal vein (fig. 85).

Figure 83. The head of a *Dufourea*, with antennae set lower on the face than in other halictids.

Figure 84. The hind leg of a male *Dufourea* with the femur and tibia notably enlarged.

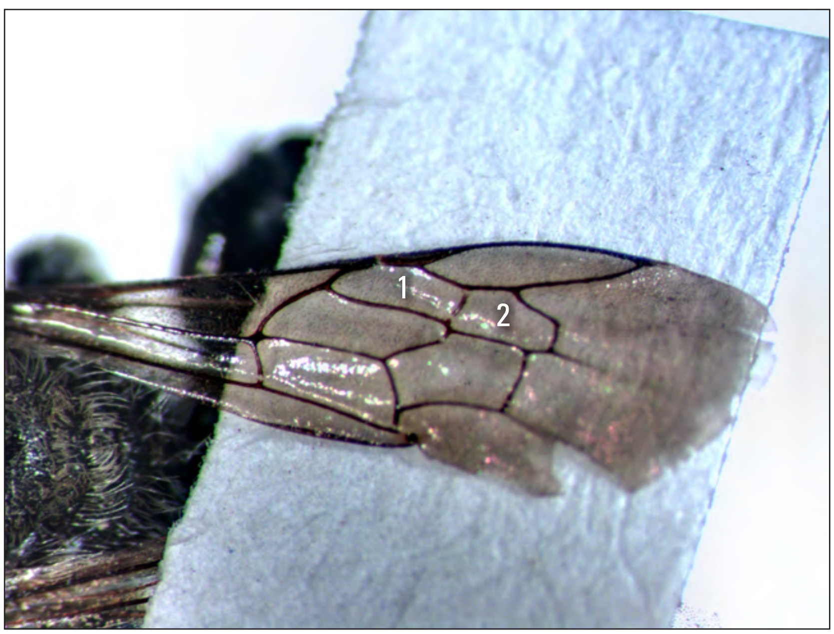


Figure 85. A *Dufourea* wing with two submarginal cells and the arcuate basal vein of all halictids. The submarginal cells are numbered (1, 2).

3. Life history information:
    a. Nesting habits: Solitary ground nesters (Wilson and Messinger Carril, 2016).
    b. Diet: Specialists on a variety of plant families including peas (Fabaceae), globemallow (Malvaceae), and lilies (Liliaceae) (Wilson and Messinger Carril, 2016).

Halictus

1. Female:

Figure 86. A female *Halictus*.

2. Male:

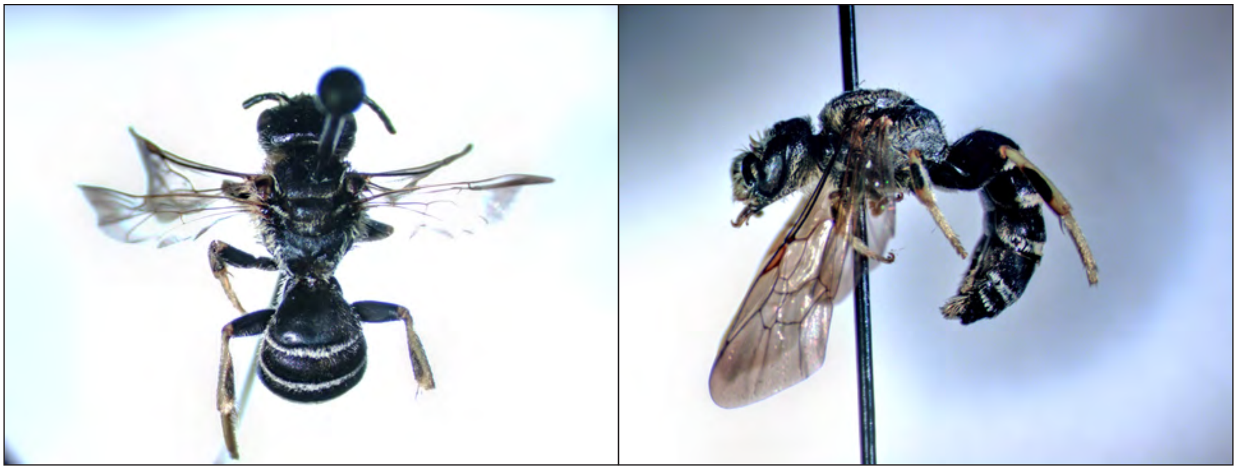


Figure 87. A male *Halictus*.

3. General identification criteria:

    a. Small (typically less than 5 mm, but sometimes up to 10 mm) bees, either black or dull metallic green (figs. 86 and 87).

    b. Look very similar to *Lasioglossum*, but the following differences distinguish them:

Halictus	*Lasioglossum*
Abdomen with apical hair bands (fig. 88; Michener and others, 1994)	Abdomen with basal hair bands (see section, "*Lasioglossum*" figs. 91 and 92)
Broad-looking heads (fig. 89; Wilson and Messinger Carril, 2016)	Smaller-looking heads
Wing veins are robust throughout the wing in both sexes (fig. 90; Michener and others, 1994)	Wing veins are weak distally in females

Figure 88. Apical hair bands on a *Halictus*. Apical bands begin at the end of the tergites, whereas basal bands begin at the beginning of tergites.

Figure 89. The broad head of a *Halictus*.

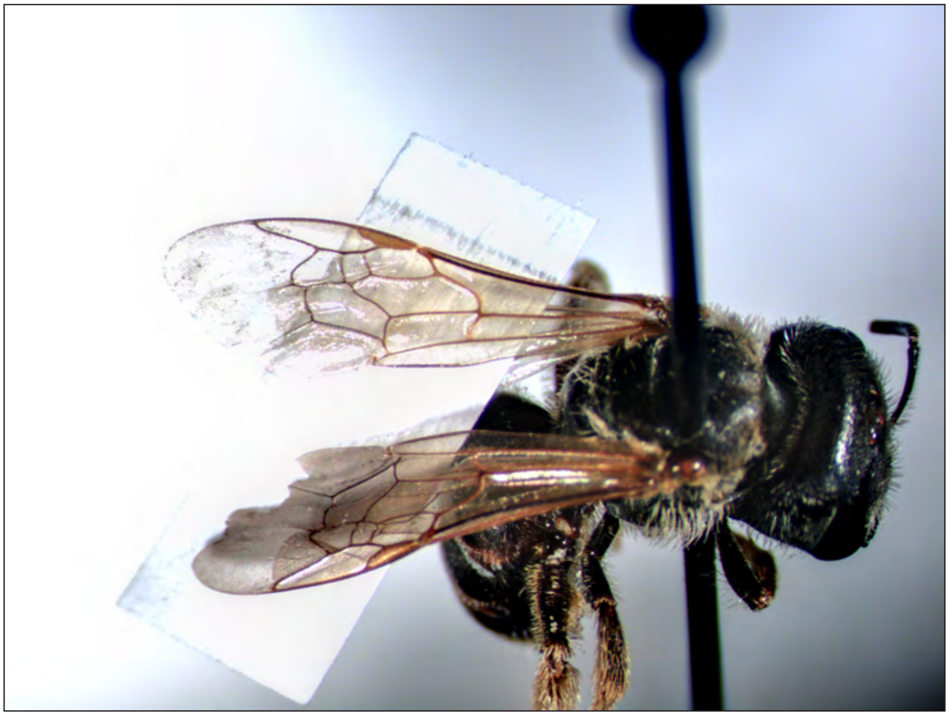


Figure 90. Forewing veins of *Halictus* females are robust throughout.

4. Life history information:

   a. Nesting habits: Ground nesters; some are social, but some species exhibit flexible sociality in which a queen and fully fertile females will live together in a cooperative nest (Wilson and Messinger Carril, 2016).

   b. Diet: Generalists (Wilson and Messinger Carril, 2016).

Lasioglossum

1. Female:

Figure 91. A female *Lasioglossum*.

2. Male:

Figure 92. A male *Lasioglossum*.

3. General identification criteria:

   a. Small (typically less than 5 mm, but sometimes up to 10 mm) bees, either black or dull metallic green (figs. 91, 92)

   b. Look very similar to *Halictus*, but use the following differences to distinguish them:

Lasioglossum	***Halictus***
Abdomen with basal hair bands (fig. 93)	Abdomen with apical hair bands (see section, "Halictus" figs. 86 and 87)
Smaller-looking heads (fig. 94)	Broad-looking heads
Wing veins are weak distally in females (fig. 95)	Wing veins are robust throughout the wing in both sexes

   c. Abdomen with basal hair bands or pale pubescence covering tergites 3–6.

   d. Females have weakened (that is, lighter in color or thinner in width) distal veins, but males do not.

Figure 93. Abdomen with basal hair bands—at the beginning of the tergites the hair bands appear to be "tucked under" the previous tergites.

Figure 94. *Lasioglossum* heads typically are smaller and less broad or stocky than *Halictus* heads.

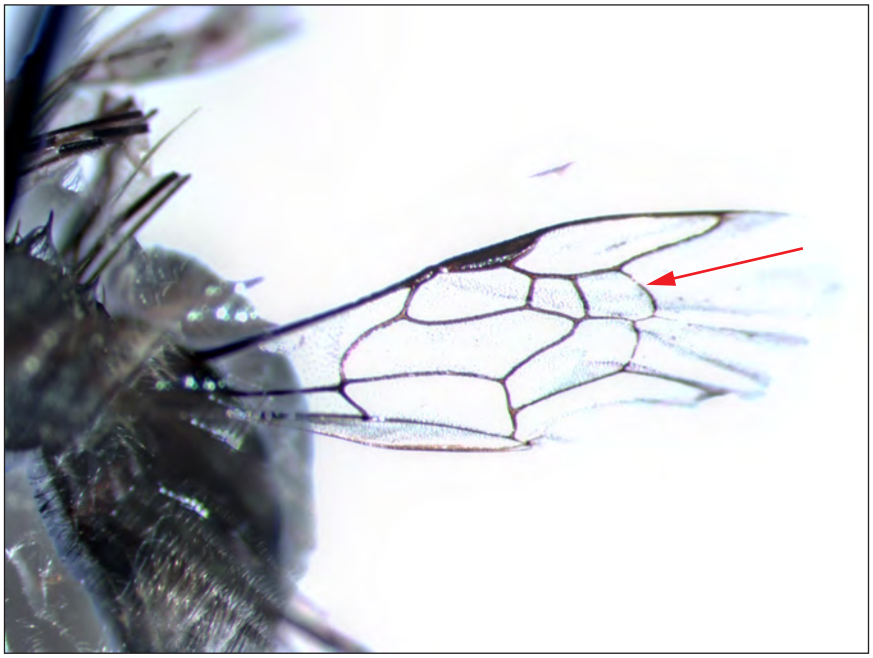


Figure 95. A female *Lasioglossum* wing, with the distal veins thinner than others. A strong enough magnification will show the thin veins are one vein thick, whereas the robust veins are two veins thick.

4. Life history information:

   a. Nesting habits: Mostly ground nesters, but some nest in rotting wood, include solitary, communal, semisocial, and primitively eusocial nesting species (Wilson and Messinger Carril, 2016).

   b. Diet: Mostly generalists, but some specialists (Wilson and Messinger Carril, 2016).

Sphecodes

1. Female:

Figure 96. A female *Sphecodes*.

2. Male:

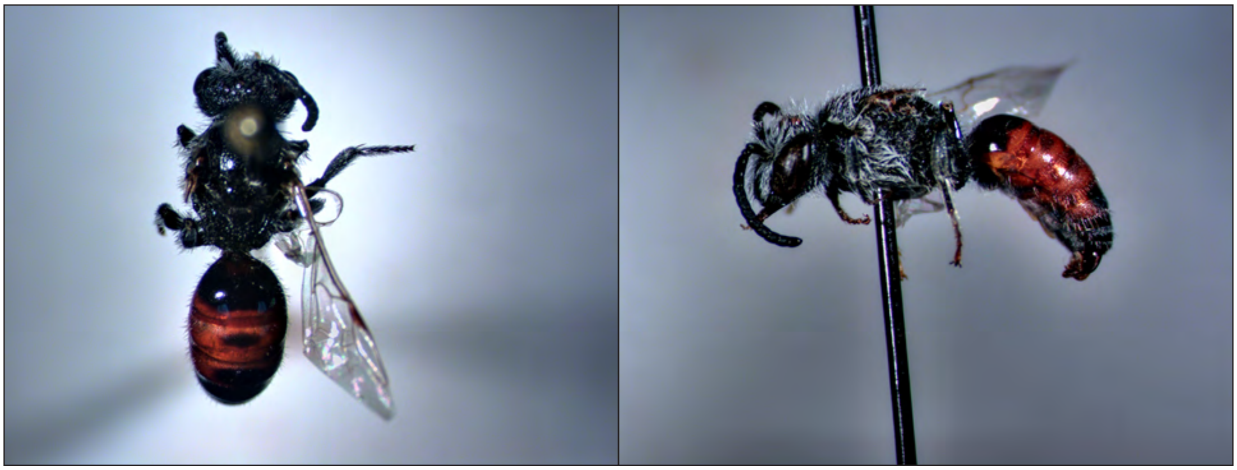


Figure 97. A male *Sphecodes*.

3. General identification criteria:

    a. Red or reddish-brown abdomen (figs. 96 and 97; Wilson and Messinger Carril, 2016).

    b. Lack scopa (Wilson and Messinger Carril, 2016).

4. Life history information:

    a. Nesting habits: Parasitize nests of other halictids (Wilson and Messinger Carril, 2016).

    b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Megachilidae

Anthidium

1. Female:

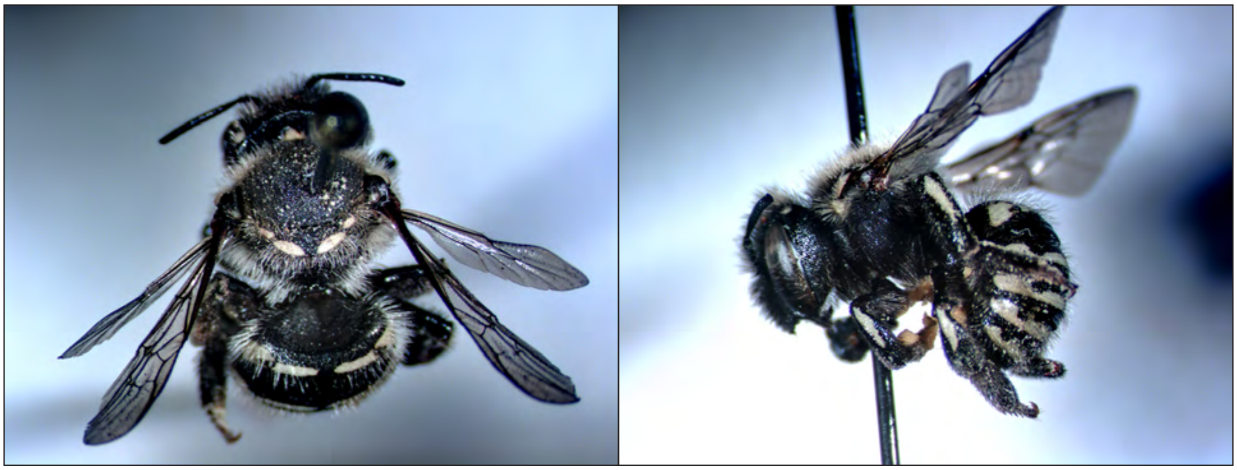


Figure 98. A female *Anthidium.*

2. Male:

Figure 99. A male *Anthidium*.

3. General identification criteria:

   a. Typically black, non-metallic bees with bright yellow integument markings (figs. 98 and 99).

   b. Lack arolia (pads in between the tarsal claws) on the front tarsi (fig. 100).

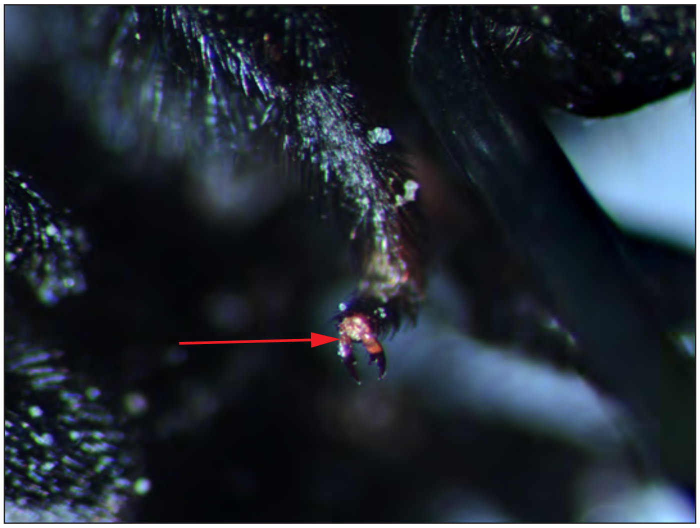


Figure 100. Front tarsus of an *Anthidium* bee with no arolium.

4. Life history information:

   a. Nesting habits: Solitary twig and cavity nesters (Wilson and Messinger Carril, 2016).

   b. Diet: Mostly generalists on pollen and nectar, but some with known strong preferences for Asteraceae, Fabaceae, *Phacelia*, or *Astragalus* (Wilson and Messinger Carril, 2016).

Coelioxys

1. Female:

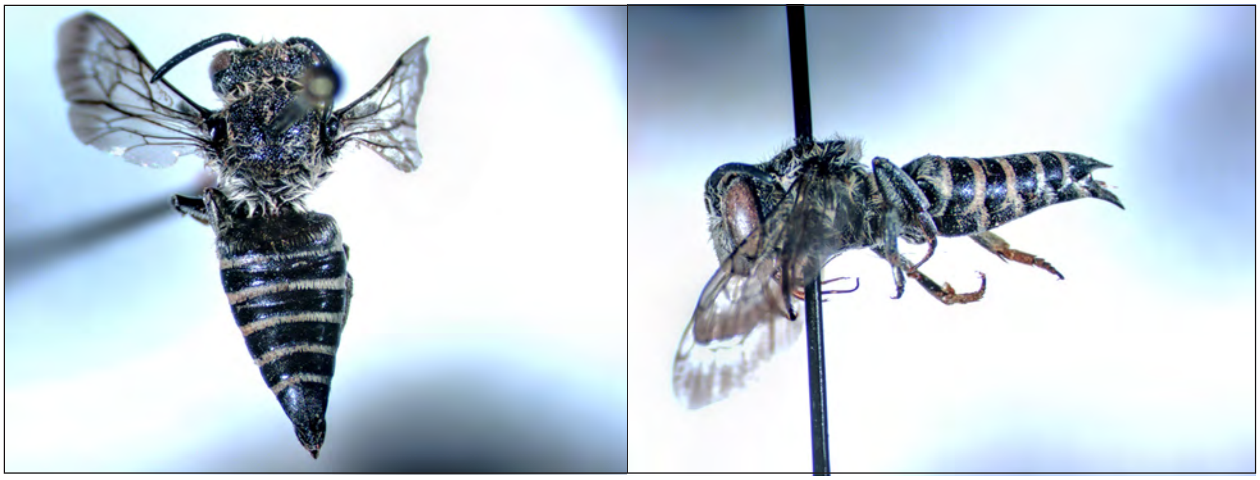


Figure 101. A female *Coelioxys*.

2. Male:

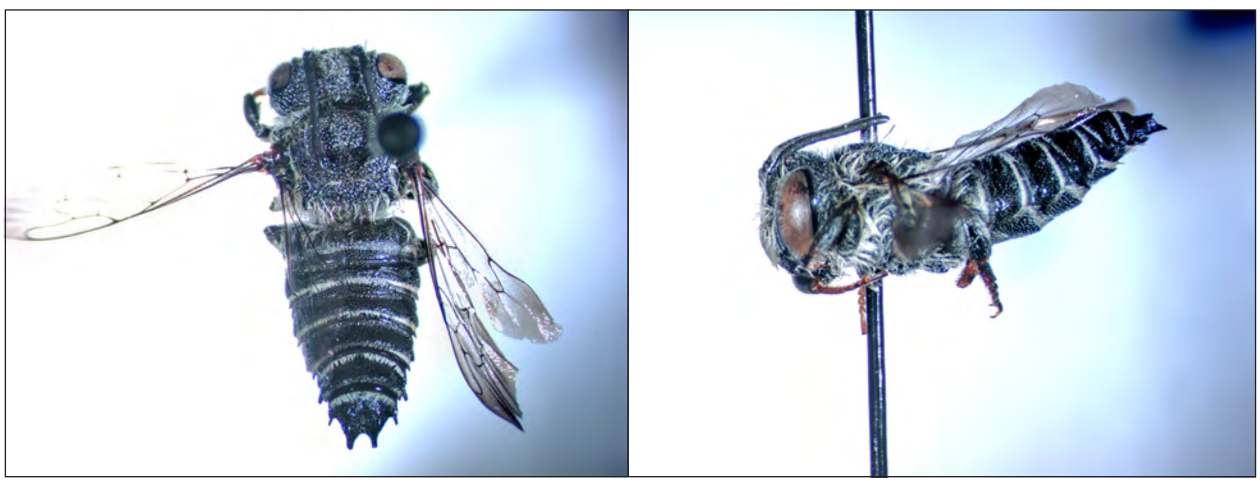


Figure 102. A male *Coelioxys*.

3. General identification criteria:

   a. No scopa (fig. 101).

   b. Females have distinctive tapering of abdominal segments; males have pointy spikes at the end of the abdomen (figs. 101 and 102).

4. Life history information:

   a. Nesting habits: Parasitize mostly other Megachilidae nest cells (Wilson and Messinger Carril, 2016).

   b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Dianthidium

1. Female:

Figure 103. A female *Dianthidium*.

2. General identification criteria:

    a. Small (typically less than 10 mm), bright-yellow and black bees, look very similar to *Anthidium* and other Anthindiini (fig. 103).

    b. Female mandible has fewer than four teeth (fig. 104).

    c. Pronotal lobe (a lobe located in front of the tegula) edges are nearly translucent (fig. 105).

    d. Arolia between the front tarsal claws.

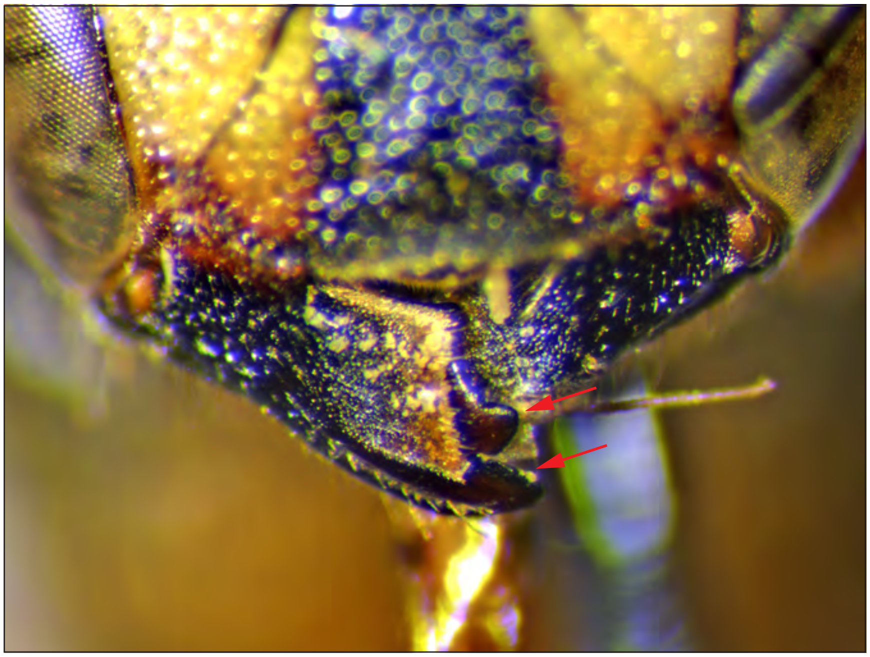


Figure 104. The mandible of a female *Dianthidium*—usually has fewer than four teeth. This specimen has two obvious teeth, pointed to with arrows.

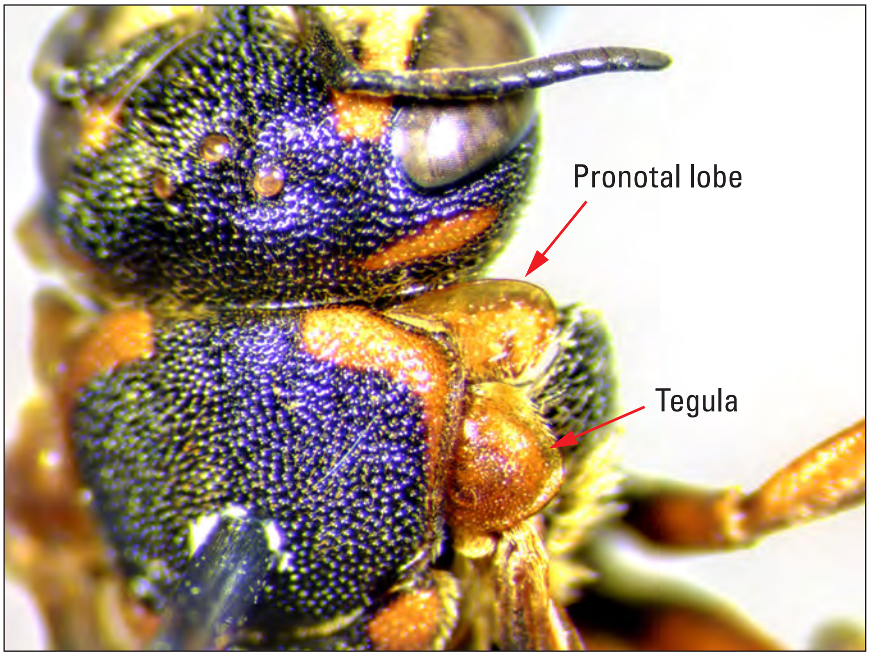


Figure 105. The pronotal ("pronotal" is derived from the term "pronotum," which refers to the anterior part of the bee's thorax) lobe.

3. Life history information:

   a. Nesting habits: Solitary ground or stem nesters (Wilson and Messinger Carril, 2016).

   b. Diet: Generalists, but prefer Asteraceae (Wilson and Messinger Carril, 2016).

Hoplitis

1. Female:

Figure 106. A female *Hoplitis*.

2. Male:

Figure 107. A male *Hoplitis*.

3. General identification criteria:

   a. Sometimes small (5–7 mm minimum size) and can be mistaken for other bees like Osmia (figs. 106 and 107).

   b. Parapsidal lines are linear, not punctuate dots as in *Osmia* (fig. 108; Wilson and Messinger Carril, 2016).

   c. Some species have antennae which taper to hooks at the end (fig. 109; this characteristic is found only in *Hoplitis*; Wilson and Messinger Carril, 2016).

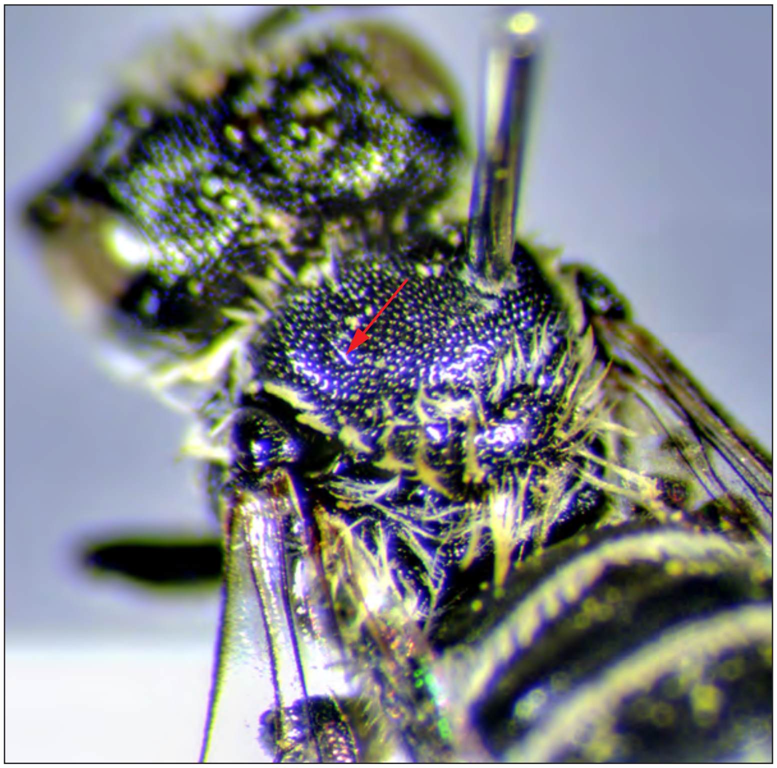


Figure 108. Linear parapsidal lines of a *Hoplitis*.

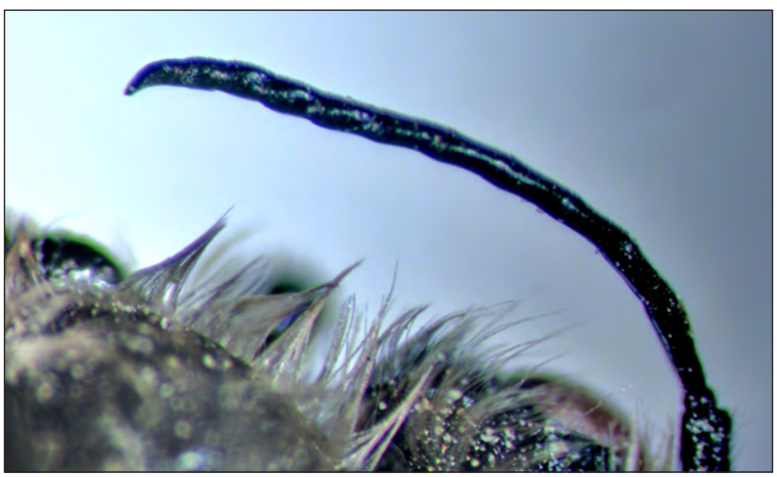


Figure 109. Hooked antenna ends, a characteristic only of *Hoplitis*.

4. Life history information:

   a. Nesting habits: Nest in various types of cavities, including soil burrows, plant stems and beetle burrows in wood (Wilson and Messinger Carril, 2016).

   b. Diet: Both generalists and specialists (Wilson and Messinger Carril, 2016).

Megachile

1. Female:

Figure 110. A female *Megachile.*

2. Male:

Figure 111. A male *Megachile*.

3. General identification criteria:

    a. Often have hair bands on the abdomen (figs. 111 and 112).

    b. No arolia between front tarsal claws (fig. 113; Wilson and Messinger Carril, 2016).

    c. Many males have dense yellow patches of hair (manes) on their forelimbs (fig. 114; Wilson and Messinger Carril, 2016).

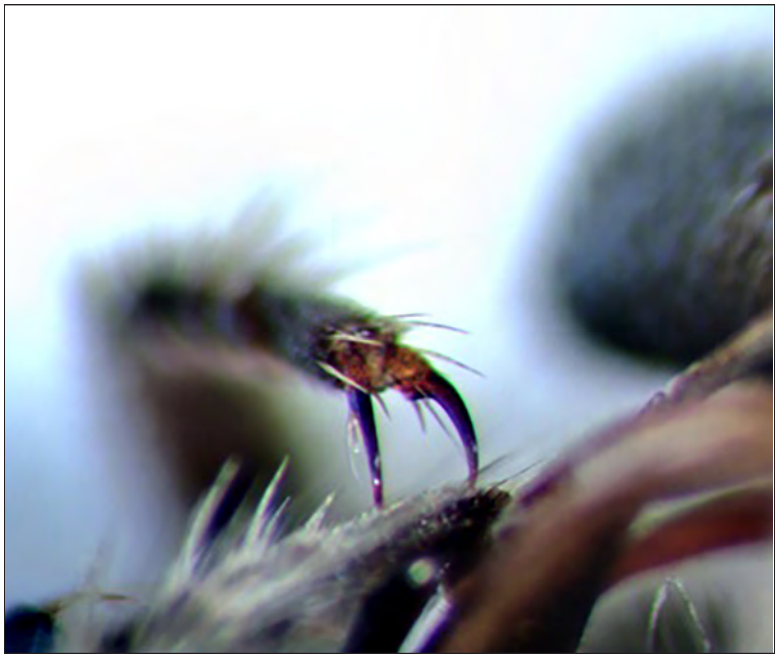


Figure 112. A *Megachile*'s front tarsal claws, with no arolium (see fig. 15 for comparison).

Figure 113. A male *Megachile* with distinctive forelimbs: cream or yellow colored hair manes on the fore tibia (arrows).

4. Life history information:

   a. Nesting habits: Solitary cavity nesters, occasionally arranged in aggregations. Nests are lined with leaf or petal pieces (Wilson and Messinger Carril, 2016).

   b. Diet: Mostly generalists, some specialists (Wilson and Messinger Carril, 2016).

Osmia

1. Female:

Figure 114. A female *Osmia*.

2. Male:

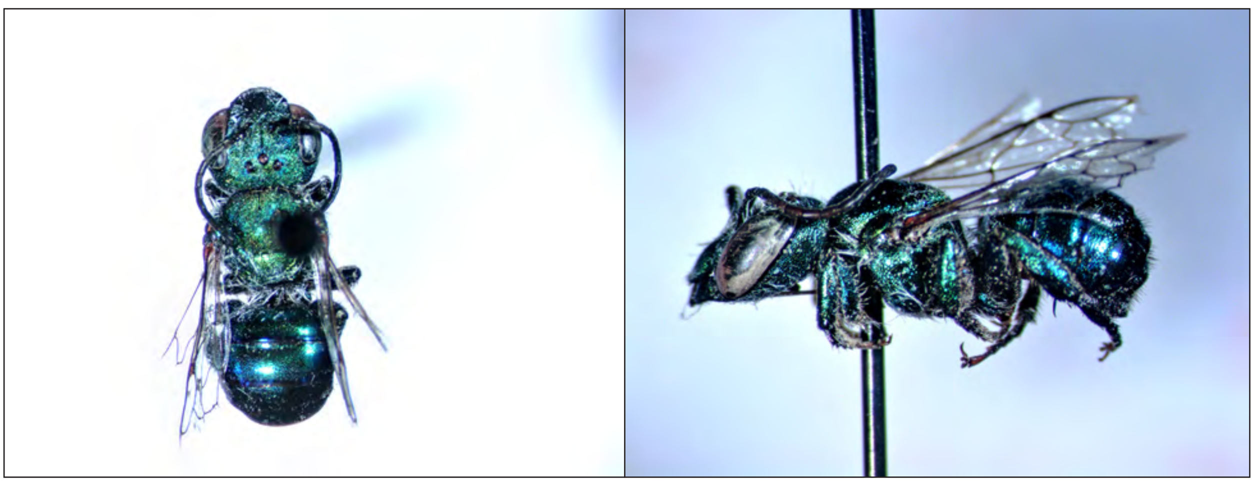


Figure 115. A male *Osmia*.

3. General identification criteria:

   a. Small-to-medium (typically 5–15 mm) sized bees, often black, dull metallic green, and sometimes bright metallic green or greenish-blue (figs. 115 and 116; Wilson and Messinger Carril, 2016).

   b. Have arolia on the front pretarsal claws (fig. 117; Wilson and Messinger Carril, 2016).

   c. Parapsidal lines are punctuate (that is, dots, fig. 118; Wilson and Messinger Carril, 2016).

   d. No pygidial plate (fig. 119; Wilson and Messinger Carril, 2016).

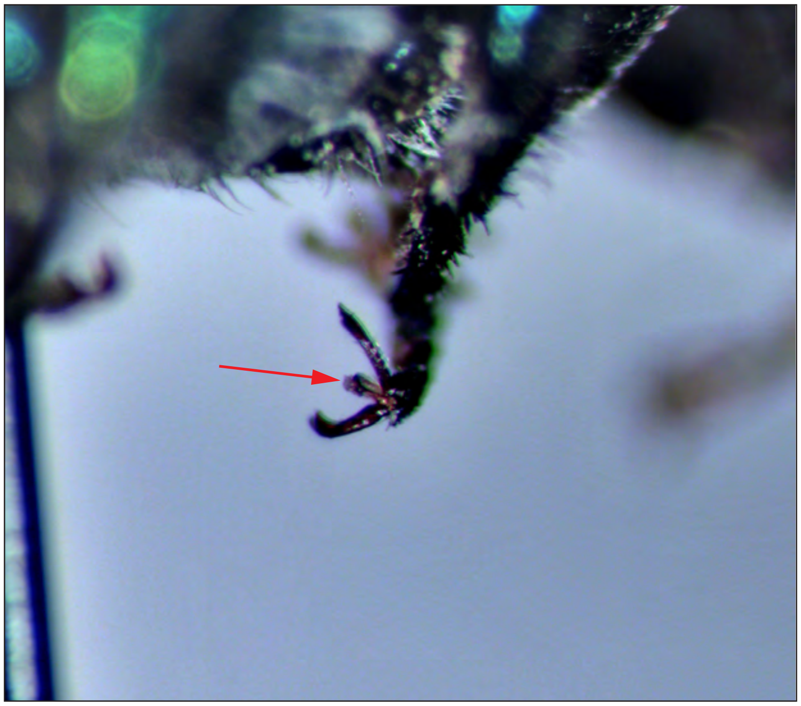


Figure 116. Arolium between the front tarsal claws.

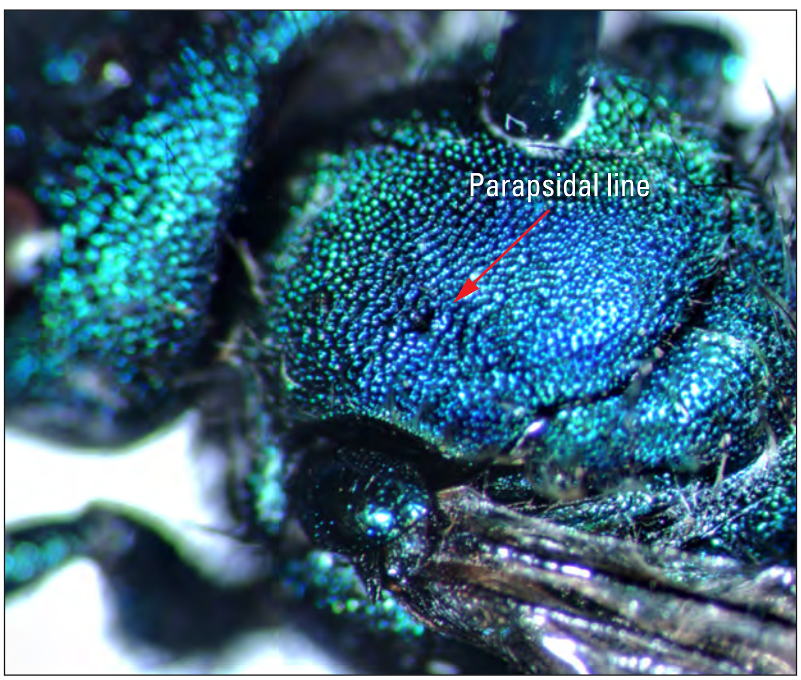


Figure 117. *Osmia* with a punctuate parapsidal line. Parapsidal lines are the terminology for this feature, but can appear as dots as dots as opposed to lines.

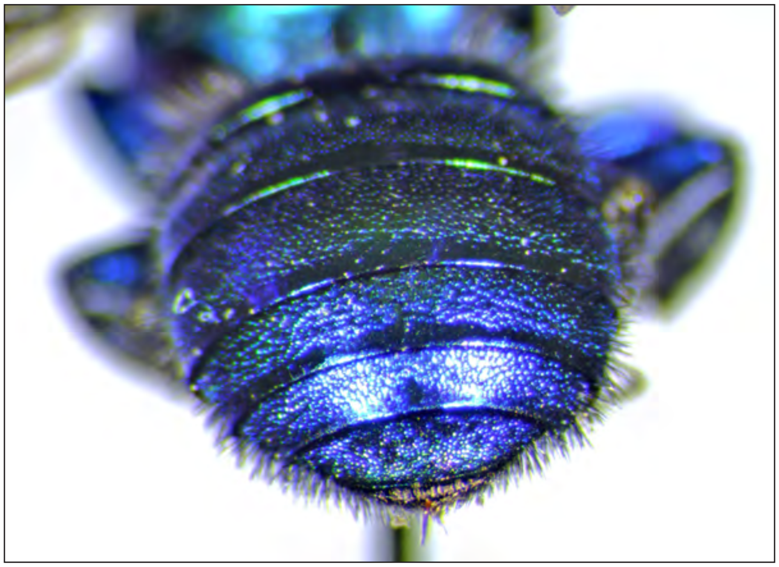


Figure 118. *Osmia* have no pygidial plate (dorsal side of T6/T7).

4. Life history information:

   a. Nesting habits: Nest in empty cavities, some cobble together nests of mud and pebbles, some line nests with leaves (Wilson and Messinger Carril, 2016).

   b. Diet: Mostly generalist, but some specialists (Wilson and Messinger Carril, 2016).

Stelis

1. Female:

Figure 119. A female *Stelis*.

2. Male:

Figure 120. A male *Stelis*.

3. General identification criteria:

   a. Look superficially like *Osmia* (figs. 119 and 120).

   b. Have linear parapsidal lines, not punctuate dots (fig. 121; Wilson and Messinger Carril, 2016).

   c. Lack scopa.

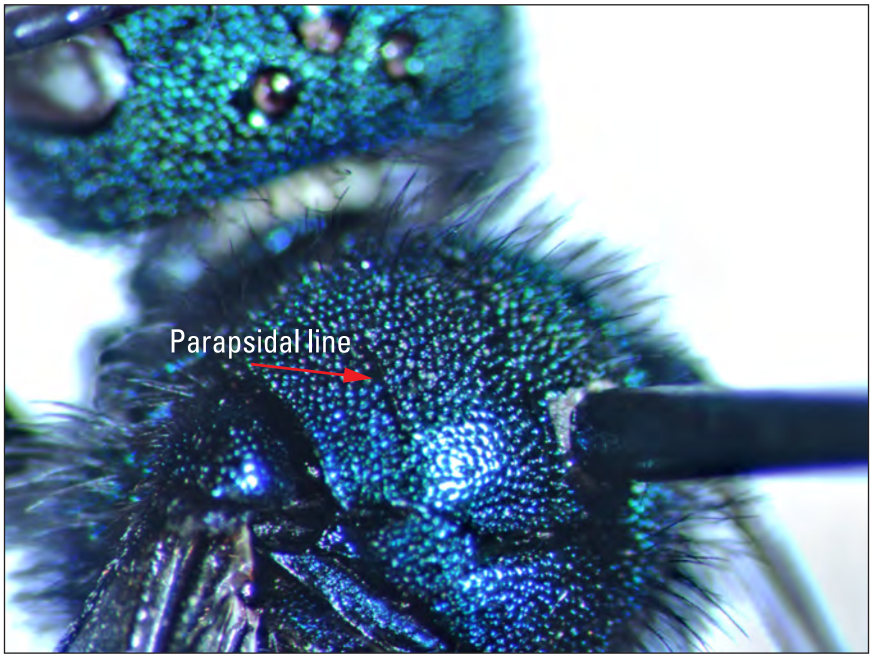


Figure 121. The parapsidal lines of *Stelis* are linear.

4. Life history information:
   a. Nesting habits: Parasitize nests of mostly other Megachilidae (Wilson and Messinger Carril, 2016).
   b. Diet: Visit flowers for nectar only, not pollen (Wilson and Messinger Carril, 2016).

Melittidae

Hesperapis

1. Female:

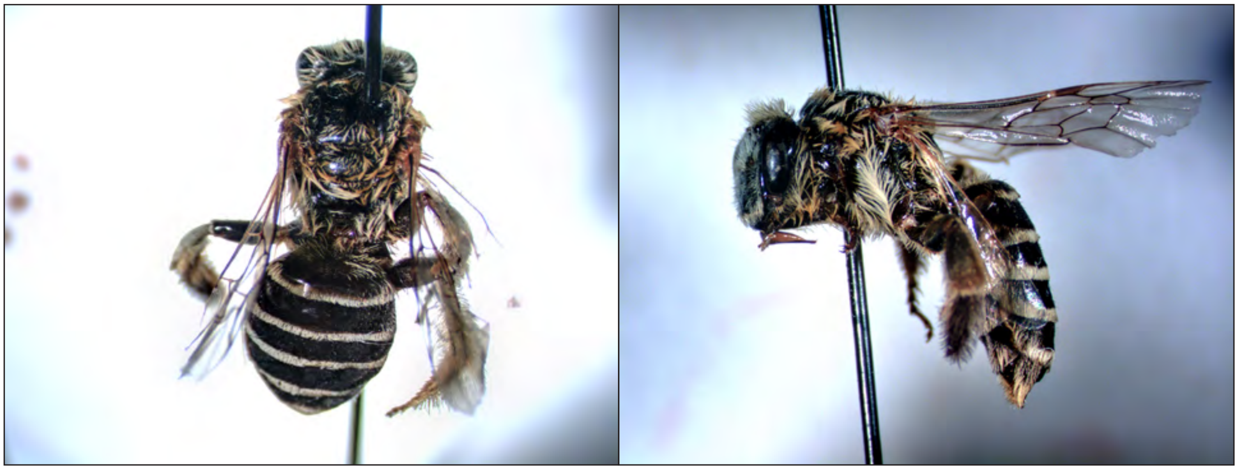


Figure 122. A female *Hesperapis*.

2. General identification criteria:

    a. Small to medium bees, typically look like *Andrena*, but unlike *Andrena*, *Hesperapis*. have (1) no facial fovea and (2) females have no scopa on the trochanter (fig. 122).

    b. Pygidial plate of female is very large and sometimes smooth (fig. 123).

    c. Two submarginal cells (fig. 124; Wilson and Carril, 2016).

    d. Basitarsus is long and slender (fig. 124; Wilson and Carril, 2016).

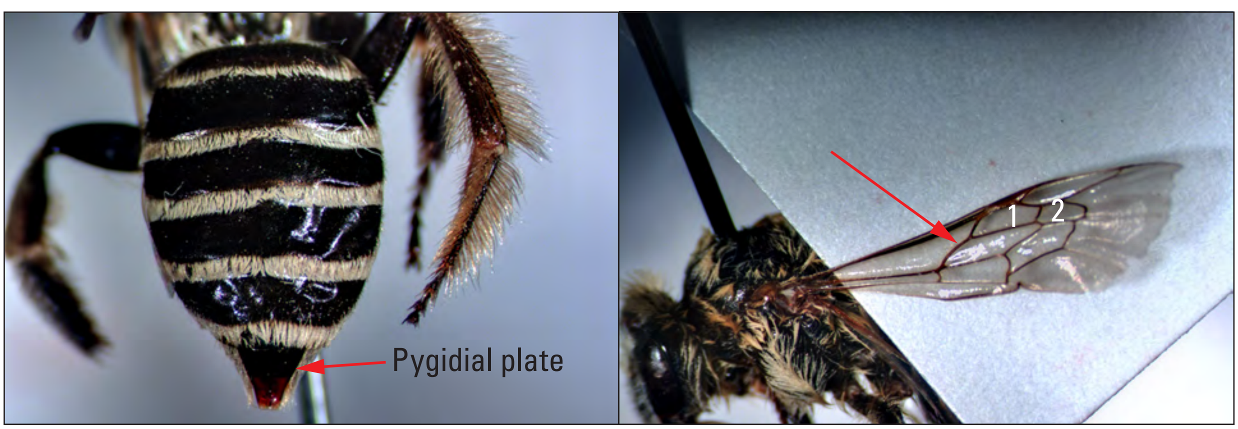


Figure 123. *Hesperapis* features. On the left, the long basitarsus and large pygidial plate are visible. On the right the forewing is visible, with two submarginal cells (labeled) and only a gently arcuate basal vein (arrow).

3. Life history information:

    a. Nesting habits: Ground nesters (Wilson and Carril, 2016).

    b. Diet: Specialists (Wilson and Carril, 2016).

Recommended Resources

- The Bee Genera of North and Central America (Hymenoptera: Apoidea)
  - Authors: Michener, C.D., McGinley, R.J., and Danforth, B.N.
  - Date: 1994
  - Publisher: Smithsonian Institution Press, Washington, D.C., USA
  - **Comments:** This is a popular text to use for genus identification of North American bees. However, this text is no longer in print and may be hard to find; check your local university library. This text is also somewhat outdated, as many of the classifications have changed over time—for example this text will list Anthophoridae and Apidae as separate families, but they have been combined into the single family Apidae since publication.
- The Bees in Your Backyard: A Guide to North America's Bees
  - Authors: Wilson J.S. and Carril, O.M.
  - Date: 2016
  - Publisher: Princeton University Press: Princeton, NJ, USA
  - **Comments:** This recent text has a wealth of interesting life history information, great color photographs, and tips on creating a bee-friendly garden at home. However, the book is not a traditional dichotomous key, and only lists some of the general characters of each bee genus.
- Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila)
  - Authors: Ascher, J.S. and Pickering, J.
  - Date: 2016
  - Online: http://www.discoverlife.org/mp/20q?search=Apoidea
  - **Comments:** This is a good resource that is often updated. Identification to species is possible and the site provides some life history information, location data, and host plant data. The key on this website can be hard to use at first, and pictures are not always available for all species, as some are only described in text.
- Bug Guide
  - Authors: Hosted by the Iowa State University Entomology Department
  - Date: 2017
  - Online: http://bugguide.net/node/view/15740
  - **Comments:** Volunteer amateurs and a few experts will identify your photographs of various insects, spiders, mites, centipedes, and millipedes. It contains a great variety of bee photographs identified to species, in many cases. Other information is also available, such as distribution, host plant, and some helpful identification tips. Links to other resources are provided. This not a traditional identification key, however, and sometimes identification to species cannot be accomplished with only a photograph.
- Bumble Bees of the Western United States
  - Authors: Koch, J., Strange, J., and Williams, P.
  - Date: 2012
  - Online: https://www.ars.usda.gov/ARSUserFiles/20800500/BumbleBeeGuideWestern2012.pdf
  - **Comments:** This is a great online resource. Identification of bumblebees to species is possible, and color photographs, location, and general life history information is available. Only useful for bumblebees and no other types of bees.
- The Very Handy Manual: How to Catch and Identify Bees and Manage a Collection
  - Authors: Sam Droege and others
  - Date: 2015
  - Online: https://www.pwrc.usgs.gov/nativebees/Handy%20Bee%20Manual/The%20Very%20Handy%20Manual%20-%202015.pdf
  - **Comments:** This resource has good information and helpful tips from bee experts around the United States. Proper catching, pinning, and storing of bee specimens are emphasized. Instructions are provided to make various equipment for bee curation also is described in detail. Does not contain any identification keys, but does have links to other keys.

Acknowledgments

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