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## Research article

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# Taxonomy of the New World bee genus *Agapostemon* Guérin-Méneville – new names and synonymies (Hymenoptera: Halictidae)

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**Abstract.** Many early taxonomic works on North American bees were published by Europeans using specimens collected in the New World, some with type locations so imprecise that uncertainty on the nomenclatural status remains to this day. Two examples come from Fabricius (1745–1808) who described *Andrena virescens* Fabricius, 1775 and *Apis viridula* Fabricius, 1793 from “America” and “Boreal America”, respectively. The former species of *Agapostemon* Guérin-Méneville, 1844 occurs across most of the United States and southern Canada, the latter presumed an endemic to Cuba. The type materials of these two taxa have never been compared to each other, though a morphology-based phylogenetic analysis placed both in distinct species groups. Here we synonymize *Apis viridula* under *Ag. virescens*, thereby making *Ag. femoralis* (Guérin-Méneville, 1844) available as the name for the Cuban species. A lectotype for *Ag. femoralis* (the type species for the genus *Agapostemon*) is hereby designated to stabilize this taxonomy. We also synonymize *Ag. obscuratus* Cresson, 1869 under *Ag. femoralis*, suggesting that it represents a dark colour polymorphism. As *Ag. cubensis* Roberts, 1972 is a junior secondary homonym of *Ag. cubensis* (Spinola, 1851), we offer *Ag. robertsi* as a replacement name for the former.

**Keywords.** Bees, lectotype, North America, the Antilles.

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## Introduction

Much past confusion has surrounded the nomenclatural status of the North American sweat bee *Agapostemon virescens* (Fabricius, 1775) (Hymenoptera: Halictidae) largely due to the fact that, pre-1900, many taxonomists naming material from the New World were from Europe (e.g., Fabricius 1775, 1793; Lepeletier 1841; Smith 1853; Dalla Torre 1896) and vague or imprecise collection information was recorded for much of this material, including the type localities. *Andrena virescens* Fabricius, 1775 was named from material collected in “America” (Fabricius 1775); this species is widespread across most of the United States and southern Canada (Roberts 1972), but seemingly is not found in Mexico or Mesoamerica (Roberts 1972; Roberts & Brooks 1987; Ramírez-Freire *et al.* 2012); the few specimens identified from Mexico, Honduras (det. by W.E. LaBerge), and Cuba (St. Clara) (see Ascher & Pickering 2020) may represent misidentifications. The latter is especially interesting as it likely represents a specimen of *Ag. viridulus* (Fabricius, 1793), a species now considered to be a Cuban endemic (Moure 1960; Roberts 1972; Moure *et al.* 2007).

Cresson (1887) was the first North American to apply a name currently associated with *Ag. virescens* to this taxon, recognizing *Ag. nigricornis* (Fabricius, 1793) as a valid species, likely following the classification of Smith (1853); a more specific type locality of Georgia was provided for this taxon by Fabricius (1793), though Cresson (1887) also indicated that this species may be a synonym of *Ag. sericeus* (Forster, 1771). Soon after, several works on North American bees applied the name *Ag. viridulus*, and not the older *Ag. virescens*, to material collected in the United States and Canada, including Robertson (1895, 1897), Titus (1900), Crawford (1901, 1906 (in Viereck *et al.* 1906), 1912), Vachal (1903), Cockerell (1902, 1904, 1909, 1911), Shelford (1913, 1937), Stevens (1920), and Tucker (1909). Cockerell (1917a) later described *Ag. tyleri* Cockerell, 1917 from Mexico, but indicated that it was almost exactly like *Ag. viridulus*.

The name *Ag. viridulus* was likely applied to North American material because Robertson (1897) stated that “it is an absurd affection of authority to give this name [i.e., *Ag. viridulus*] to the Cuban species, before it is shown that Fabricius did not mean that his species came from the continent of North America, that he did not know where it came from, or that the description of *Apis viridula* does not apply to the North American species”. In his study of Cuban bees, Baker (1906) expressed sentiments similar to those of Robertson (1897) on *Ag. viridulus* as a valid species in Cuba. Fabricius (1793) did not provide a type locality for *Ag. viridulus* in his original work, but in 1804 indicated that the species (as *Megilla viridula*) was from “Habitat in America boreali” (Fabricius 1804) which Robertson (1897) considered to mean North America. Robertson (1897) also indicated that Provancher (1882) likely misidentified *Ag. viridulus* (= *Ag. virescens*) as *Augochlora radiata* (= *Ag. sericeus* (Forster, 1771)) based on the black metasoma (this misidentification was confirmed by Sheffield & Perron 2014), though in that same work he (i.e., Provancher 1882) recognized *Ag. tricolor* Lepeletier, 1841 (= *Ag. virescens*) as a distinct species. Crawford (1912) later used *Ag. viridulus* for specimens from Medicine Hat, Alberta, and the name *Ag. virescens* did not appear in his earlier revision of North American species (Crawford 1901), though again the morphology and geography fit the current concept for this species (i.e., Roberts 1972). Though *Ag. virescens* is the oldest name for this taxon, Robertson (1897) and later authors did not consider *Ag. viridulus* a synonym of *Ag. virescens* presumably because Fabricius (1804) provided more precise type location information. However, *Ag. virescens* is now widely recognized as the only member of the genus occurring in eastern North America and all of Canada in which the female has the combination of a black metasoma (Sandhouse 1936; Roberts 1972; Packer *et al.* 2007) and dark-tipped clypeus.

Ashmead (1900) was among the first American entomologists to consider *Ag. viridulus* a Cuban species, likely based on the earlier opinion of Dalla Torre (1896), in contrast to the earlier opinion of Robertson (1897) quoted above. Dalla Torre’s (1896) concept was subsequently followed by Friese (1902), with

both considering *Ag. femoralis* Guérin-Méneville, 1844 a synonym of *Ag. viridulus*. The lectotype for *Ag. viridulus* was designated by Moure (1960) from two female specimens at the Sehested – Tønder Lund collection at the Zoologisk Museum in Copenhagen; Moure (1960) indicated that the species was apparently limited to Cuba, and provided a brief description but offered no diagnosis to separate this material from the more common and widespread North American species *Ag. virescens* despite the past controversy. Roberts (1972) accepted the treatment of Moure (1960), but indicated that due to the inadequacy of the original description, many authors believed that *Ag. viridulus* was a synonym of *Ag. virescens*. Almost 50 years later, *Ag. viridulus* is still considered an endemic to Cuba (e.g., Roberts 1972; Janjic & Packer 2003; Engel 2004; Genaro 2008). The male specimen of *Ag. femoralis* that Ashmead (1896, and subsequently Krombein 1953) recorded from Eleuthera, Bahamas was presumably misidentified; however, several other species are known from the Bahamas (Roberts 1972; Janjic & Packer 2003).

Another Cuban endemic, *Ag. obscuratus* Cresson, 1869 has also contributed to the confusion. At the time of describing *Ag. obscuratus*, Cresson (1869) first thought it was likely only a variety of *Ag. femoralis* (= *Ag. viridulus*), but later indicated it was a distinct species, supporting the opinion of J.C. Gundlach (as cited in Cresson 1869); subsequently, Gundlach (1896) still considered it a distinct Cuban species. In fact, Cresson (1865) indicated that two of the 40 male specimens identified as *Ag. femoralis* that he examined had the head and thorax dull black with very faint obscure blue colouration, matching what he would later (i.e., Cresson 1869) call *Ag. obscuratus*. Oddly, Cresson (1869) compared what he indicated as a female to the male of *Ag. femoralis*; Roberts (1972) correctly pointed out that the type materials of both taxa are male. Cockerell (1917b) seemingly made the same mistake for his *Ag. obscuratus* var. *abjectus* Cockerell, 1917, and also indicated that it was close to *Ag. femoralis*, but larger with the head and thorax coloured differently (i.e., obscurely dark green head and thorax in *Ag. obscuratus abjectus*) from Cresson's taxon that had the head and thorax black, with a more or less purple tinge. Since the last comprehensive revision (i.e., Roberts 1972), *Ag. obscuratus* has been considered a valid taxon.

Though the genus *Agapostemon* Guérin-Méneville, 1844 has received taxonomic treatment several times (e.g., Crawford 1901; Sandhouse 1936; Fischer 1950; Roberts 1972, 1973), only Roberts (1972) provided a comprehensive review of the genus throughout its entire range. Unfortunately, Roberts (1972) treated the species in a series of regional keys, and no comparisons were made that included both *Ag. virescens* and *Ag. viridulus*. However, Janjic & Packer (2003) produced a morphology-based phylogeny in which all species were included, including material from Cuba identified as *Ag. viridulus* and *Ag. obscuratus*. Although *Ag. virescens* and *Ag. viridulus* are seemingly very similar (Roberts 1972), the results of Janjic & Packer (2003) clearly separated the two species, enough that they were placed in two different species groups, the latter belonging to a species group restricted to the Antilles which also contained *Ag. obscuratus*. Unfortunately, type material for all species was not compared and/or used in that phylogenetic analysis, so they (i.e., Janjic & Packer 2003) used the taxonomic concepts of Roberts (1972; with some exceptions). Our purpose here is to clarify the taxonomy of *Ag. virescens* and *Ag. viridulus*.

## Material and methods

Using the morphology-based matrix of Janjic & Packer (2003) as a guide, female specimens of *Ag. virescens* from throughout North America were examined for morphological consistency with the holotype (Fig. 1) and compared with the lectotype of *Ag. viridulus* (Fig. 2). The phylogeny of Janjic & Packer (2003) placed these two species into two morphologically unique species groups; those characters considered most useful (i.e., unique species specific character states) for distinguishing *Ag. virescens* from *Ag. viridulus* albeit chosen so not to damage Fabricius's types (i.e., not requiring dissection or relaxation of the specimens to permit movement of body parts) were compared, in addition to more

general morphological features discussed below. The type material of *Ag. femoralis* (Fig. 3) and photos of the type material of *Ag. semiviridis* Cresson, 1865 (Fig. 4), *Ag. obscuratus* (Fig. 5), and *Ag. obscuratus* var. *abjectus* Cockerell, 1917 (synonymized under *Ag. obscuratus* by Roberts 1972) (Fig. 6) were also examined; *Ag. femoralis* and *Ag. semiviridis* were previously synonymized under *Ag. viridulus* by Dalla Torre (1896) and Baker (1906), respectively, though the latter is the only taxon currently synonymized under *Ag. viridulus* that is from Cuba that has a female type specimen.

Morphological terminology generally follows that of Michener (2007), with some specific terms from Roberts (1972); surface sculpture terminology follows Harris (1979). Face length to width (L:W) ratios were calculated using the following: L = distance from lower edge of median ocellus to the basal edge of clypeus; W = greatest distance between the inner edges of the compound eyes, measured at apex of angulation.

DNA barcodes (Hebert *et al.* 2003) were also compared, using Cytochrome Oxidase I (COI) sequences previously published by Sheffield *et al.* (2009, 2017), and for material identified as or sharing a Barcode Index Number (BIN, after Ratnasingham & Hebert 2013) with *Ag. viridulus* from Cuba in the Barcodes of Life Data (BOLD) system (Ratnasingham & Hebert 2007), this included a single specimen of *Ag. obscuratus*. Sequences were analyzed using the Barcode Gap Analysis tool on BOLD, using the Kimura 2 Parameter distance model with sequence alignment using MUSCLE. Using the same distance model and alignment parameters, nucleotides from sequences of a representative member of each BIN with a full DNA barcode were examined and compared.

The following acronyms are used for collections:

- AMNH = American Museum of Natural History, New York, USA
- ANSP = Academy of Natural Sciences, Philadelphia, USA
- BMNH = Natural History Museum, London, United Kingdom
- INHS = Illinois Natural History Survey, Champaign, USA
- MSNT = Museo Regionale di Science Naturali, Turin, Italy
- NHMD = Natural History Museum of Denmark (formerly ZMUC), Copenhagen, Denmark
- RMNH = Naturalis Biodiversity Center, Leiden, Netherlands (formerly Rijksmuseum van Natuurlijke Historie)
- USNM = United States National Museum, Smithsonian, Washington, USA

## Results

Morphologically, the lectotype of *Ag. viridulus* (Fig. 2) clearly matches *Ag. virescens* (in the *splendens* group of Moure & Hurd 1987) and not Cuban material in the the *viridulus* group seemingly confined to the Antilles (Moure & Hurd 1987; Janjic & Packer 2003). In fact, the females of *Ag. virescens*, including the type material of *Ag. viridulus* are quite different from material from Cuba, with specimens from the latter, including *Ag. obscuratus*, having a longer face (L:W = 0.78, versus 0.72 in *Ag. virescens*) (Fig. 7C, E; Roberts 1972: figs 33–34, 53–54), with prominent horizontal striations across most of the clypeus and supraclypeal area (Fig. 7C, E), while those of *Ag. virescens* and the type material of *Ag. viridulus* are coarsely and closely punctate, with striations limited to the medial area of supraclypeal area (Fig. 7A). Other morphological differences include the propodeal surface of *Ag. virescens* and the type material of *Ag. viridulus*, which is coarsely rugose, with the posterior surface of the propodeum encircled by a strong carina (Fig. 8A), while the surface is costulate to costate in Cuban material, including *Ag. obscuratus*, with the carina much less distinct, especially laterally (Fig. 8C).

Though males of *Ag. virescens* and Cuban material identified as *Ag. viridulus* were also not compared or keyed by Roberts (1972), they are distinctive. Males of *Ag. virescens* have extensive yellow maculations,

including a more pronounced triangular mark on the clypeus apically that extends basad medially (Fig. 7B), while the clypeal maculation on Cuban material (Fig. 7D), including *Ag. obscuratus* (Fig. 7F) is linear. Most of the legs in male *Ag. virescens* are extensively yellow, with dark markings restricted to the outer basal area of the fore and mid femur, an elongate basal mark basally on the inner front tibia, two elongate marks on the inner and outer basally on the mid tibia, and the hind leg with dark spot at the apex of femur, a small basal spot and an elongate spot in the outer basal half of the tibia; the legs of Cuban males, including *Ag. obscuratus* are primarily dark with yellow areas restricted to the inner surfaces, and the basal half of hind femur; *Ag. virescens* have the metasoma with a submedian yellow band on tergum 1, and extensive basal bands on terga 2–5 (Fig. 9A), while the metasoma of Cuban material is entirely dark (Fig. 9B–C). Structurally, the males of *Ag. virescens* also have a shorter face (L:W = 0.72) (Fig. 7B) than material from Cuba (L:W = 0.8) (Fig. 7D, F). In addition, the hind tibia and femur of *Ag. virescens* are relatively narrow, less than half as wide as long, while more robust in Cuban material including *Ag. obscuratus*, the femur less than twice as long as wide (Figs 3C, 5A, 6A); the hind tarsi of *Ag. virescens* are unmodified (Fig. 10A) while the hind basitarsus of Cuban material has a prominent basal ridge and an apical groove (Fig. 10B; Roberts 1972: figs 150, 158). The propodeum of *Ag. virescens* is coarsely rugose over its dorsal and lateral surfaces, with the posterior surface encircled by a strong carina (Fig. 8B), while males of Cuban material have a less distinctive carina (entirely lacking laterally), with the propodeal surfaces striate (Fig. 8D).

Based on our comparison of the type material of *Ag. viridulus* (Fig. 2) to female specimens of *Ag. virescens* from North America, including the holotype (Fig. 1), we conclude that the former is a synonym of the latter. As such, *Ag. femoralis*, with a type locality of Cuba (Fig. 3) would be the oldest name available for the Cuban species. We also rename the *viridulus* species group of Moure & Hurd (1987) the *femoralis* species group to reflect this. We conclude that, though Robertson (1897) felt that *Ag. viridulus* was the priority name for the North American taxon, the type specimen of *Ag. virescens* matches North American material, and we assume that the type locality “America” referred to North America (the type material has previously even been labelled as such, see Fig. 1), as this specimen does not match other species outside of the continent (i.e., Central or South America, or the Antilles). This also stabilizes the taxonomy of a species that has been subject to many ecological and taxonomic studies (e.g., LaBerge & Ribble 1966; Roberts 1972; Abrams & Eickwort 1980, 1981; Eickwort & Abrams 1980; Eickwort 1981).

The BIN for *Ag. virescens* is AAB2708, and currently in BOLD there are 90 sequences from across Canada and the eastern United States; within this BIN the mean distance is 0.36%, with a maximum distance of 1.48%. There are two sequences (BOLD Process IDs BEECB084-07 and BEECB087-07) available for *Ag. femoralis* from Cuba (AAJ7225; the former of these identified as *Ag. obscuratus* Cresson, 1869), differing from that of *Ag. virescens* by 12.1%, with 86 nucleotide differences, and supporting that though these species are considered morphologically very similar (i.e., Roberts 1972), there is enough genetic and morphological divergence to distinguish these species. Though only a single specimen of each taxon was sequenced, barcoded material of *Ag. obscuratus*, also from Cuba, is genetically almost identical to the sequence of *Ag. femoralis*, differing in only one nucleotide at position 494 (A to C, respectively). In addition, apart from colour, the morphology of both taxa are identical, *Ag. obscuratus abjectus* (synonymized under *Ag. obscuratus* by Roberts 1972) representing an intermediate coloured form.

Lastly, *Ag. cubensis* Roberts, 1972 became a junior secondary homonym of *Ag. cubensis* (Spinola, 1851) when Engel (2004) designated a lectotype for the latter taxon and recognized it as a synonym of *Ag. viridulus* [= *Ag. femoralis*]. Roberts’ taxon is known only from the male holotype (Roberts 1972), and since it was described the name has only been used in a handful of other publications (i.e., Alayo 1973, 1976; Janjic & Packer 2003). Therefore, we offer *Ag. robertsi* as a replacement name for *Ag. cubensis*

Roberts, named for the late Radclyffe Burnand Roberts (1938–1988) for his work on *Agapostemon* and other bees.

### **Taxonomy**

Class Insecta Linnaeus, 1758  
Order Hymenoptera Linnaeus, 1758  
Family Halictidae Latreille, 1804  
Subfamily Halictinae Latreille, 1804  
Tribe Halictini Latreille, 1804  
Subtribe Caenohalictina Cameron, 1903

Genus *Agapostemon* Guérin-Ménéville, 1844

*Andrena* (*Agapostemon*) Guérin-Ménéville, 1844a: 448. Type species: *Apis femoralis* Guérin-Ménéville, 1844, monobasic.

*Agapostemon virescens* (Fabricius, 1775)  
Figs 1, 7A–B, 8A–B, 9A

*Andrena virescens* Fabricius, 1775: 378 [♀].

*Andrena nigricornis* Fabricius, 1793: 313 [♂] [synonymy by Smith 1853: 86, though of *Ag. virescens* under *Ag. nigricornis*; synonymy of *Ag. virescens* by Dalla Torre 1896: 98].

*Apis viridula* Fabricius, 1793: 3742 [♀]. **syn. nov.**

*Halictus dimidiatus* Lepeletier, 1841: 283 [♀] [synonymy of *Ag. virescens* by Dalla Torre 1896: 98; of *Ag. viridulus* by Robertson 1897: 326].

*Halictus tricolor* Lepeletier, 1841: 289 [♂] [synonymy of *Ag. nigricornis* by Cresson 1887: 293; synonymy of *Ag. virescens* by Dalla Torre 1896: 98].

*Agapostemon bicolor* Robertson, 1893: 148 [♀, ♂] [synonymy of *Ag. viridula* by Robertson 1895: 118; of *Ag. virescens* by Moure 1960: 103].

### **Material examined**

#### **Holotype**

COUNTRY UNKNOWN • 1 ♀; “America”; BMNH(E) 668675.

See <https://data.nhm.ac.uk/object/4dece8b7-ab26-4233-86c9-de79d6a80a91>.

#### **Additional material**

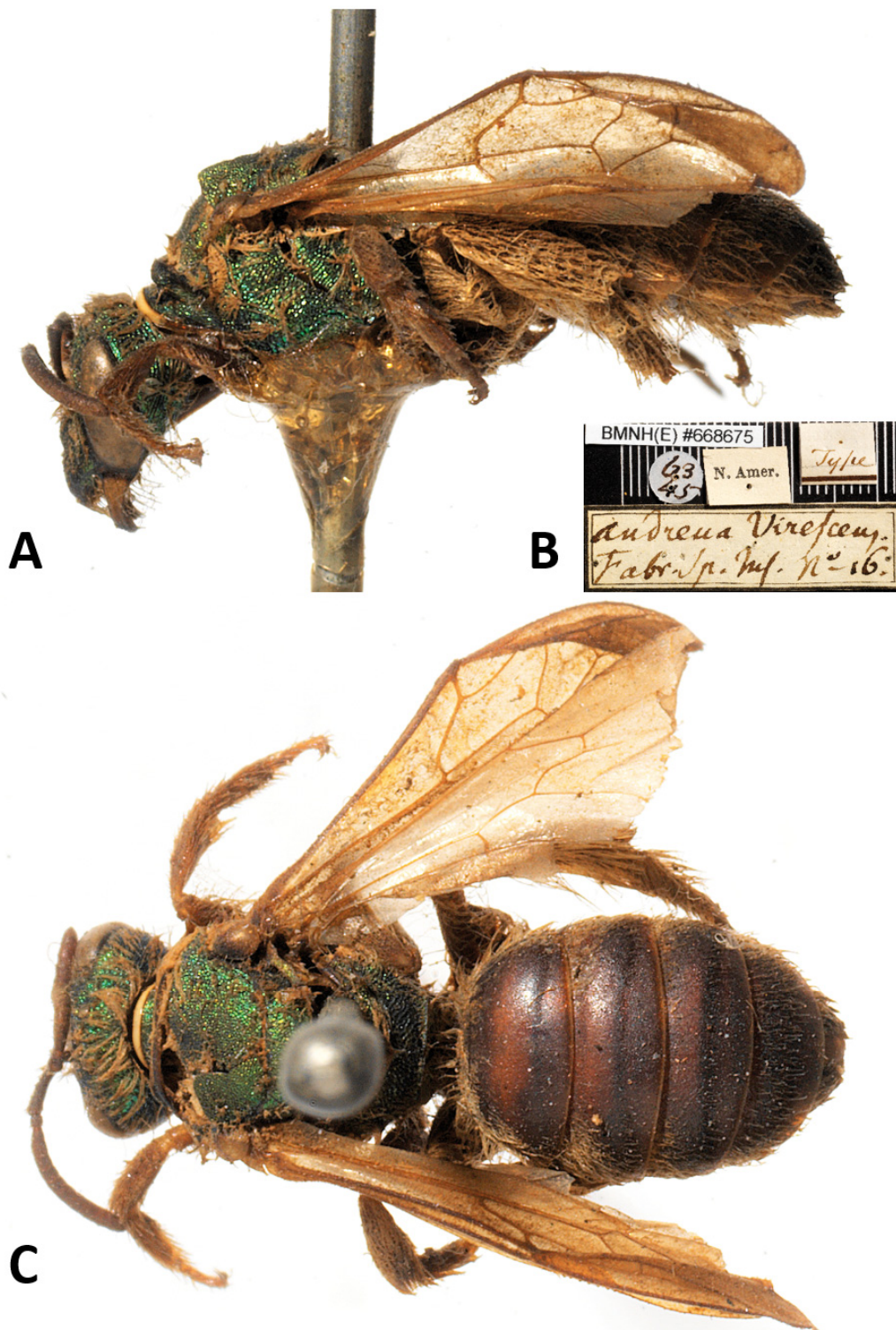
COUNTRY UNKNOWN • 1 ♀ (lectotype of *Apis viridula* Fabricius, 1793, designated by Moure 1960: 104); [Type locality not indicated in original work; “Habitat in America boreali” was indicated by Fabricius (1804)]; NHMD ZMUC00241490 (Fig. 2).

#### **Notes**

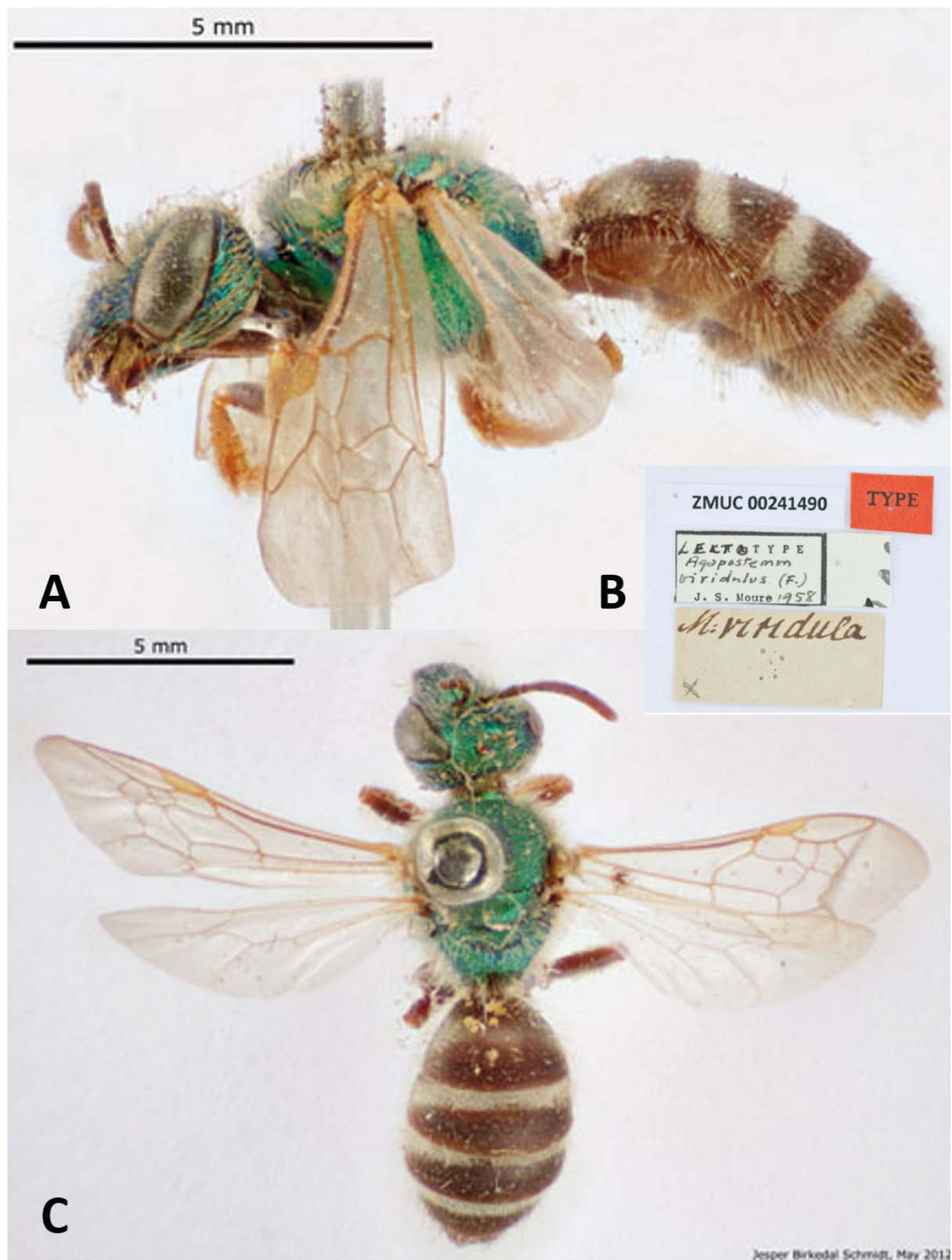
The location of the syntype ♂ of *Andrena nigricornis* Fabricius, 1793, from Georgia, is unknown, as per Sandhouse 1936: 77 and Moure 1960: 104. The same is true with the ♀ type of *Halictus dimidiatus* Lepeletier, 1841: “probablement de l’Amérique septentrionale” [Musée de M. Serville was indicated], and with the ♂ type of *Halictus tricolor* Lepeletier, 1841: “Amérique septentrionale” [Musée de M. Serville was indicated, Roberts (1972) indicated Instituto e Musco de Zoologia, Università di Torino, Italy].

The lectotype ♀ of *Agapostemon bicolor* Robertson, 1893 (designated by W.E. LaBerge in Webb 1980: 115) from USA, Illinois, Carlinville, 22 Sep. 1886, C.A. Robertson leg., INHS 3306, was not examined as the synonymy was not questioned.





**Fig. 1.** *Andrena virescens* Fabricius, 1775. Holotype, ♀ (BMNH(E) 668675). **A.** Lateral view. **B.** Associated labels. **C.** Dorsal view. Photo credit: Natural History Museum, London (2020). Data Portal Query on “Specimens” <https://doi.org/10.5519/qd.7pgn1j4u>. Subset of “Collection specimens” (dataset) <https://doi.org/10.5519/0002965>. Layout modified from original.



**Fig. 2.** *Apis viridula* Fabricius, 1793. Lectotype, ♀ (NHMDZMUC00241490). **A.** Lateral view. **B.** Associated labels. **C.** Dorsal view. Photos by Jesper Birkedal Schmidt, Natural History Museum of Denmark [digitized assets <http://daim.snm.ku.dk/digitized-type-collection-details-simple?catno=z muc00241490>].



**Remarks**

Under his discussion of *Ag. virescens*, Cockerell (1921) included a brief mention of *Apis vitreus*, originally named and described from the male (with a colour illustration) by Harris (1782: pl 39 fig. 17); in the figure caption, Harris (1782) mentioned the brilliant green head and thorax, with yellow mouthparts, antennae, legs and abdomen, the latter with six black bands, which is consistent with most male *Agapostemon* in North America (e.g., Roberts 1972). Cockerell (1921) felt that this name should be considered valid, and presumably a synonym of *Ag. virescens*. As Harris's (1782) work was focused on the insects of England, Warncke (1973) considered it (as *Apis vitreus* Harris, 1776, from England) a synonym of *Halictus tumulorum* (Linnaeus, 1758). However, Ebmer (1974) considered Harris's taxon nomen dubium, indicating that the synonymy of Warncke (1973) was incorrect, and suggested that the large size of 11.5–12.5 mm (from Ebmer (1974), based on Harris's (1782) mention of "five lines and a half") and description supported that it was likely a male of *Agapostemon*, partially supporting Cockerell's (1921) opinion. Ebmer (1974) also indicated that it was likely that at the time of collection (i.e., pre-1776), the New England states (where it was presumably collected) were regarded as belonging to the "motherland" (i.e., England), though by the time of publication of Harris's works (i.e., 1776–1782) the United States was independent. However, as four species of *Agapostemon* with males generally matching that described by Harris (1782) are found in the New England states, we follow Ebmer's (1974) recommendation and consider Harris's species nomen dubium until the type material can be located.

"America" was indicated as the type locality for *Ag. virescens* by Fabricius (1775), but the type specimen has seemingly been re-labelled after the fact (i.e., post Cresson 1887) with N[orth]. Amer[ica]. (Fig. 1); the specimen was previously examined by Cockerell (1921) and later by Charles D. Michener (as per Roberts 1972) who both considered it a valid representation of this taxon. Smith (1853) considered *Apis virescens* Fabricius 1793 (not 1775) a synonym of *Ag. nigricornis*, presumably not realizing that the species had been named 18 years previous (though he attributed it to the Banks Collection, as is the type material).

*Agapostemon femoralis* (Guérin-Méneville, 1844) stat. nov.

Figs 3, 7D, 8D, 9B, 10B

*Andrena (Agapostemon) femoralis* Guérin-Méneville, 1844a: 447 [♂].

*Halictus cubensis* Spinola, 1851: 203 [♂, not ♀] [synonymy of *Ag. viridula* by Engel 2004: 170].

*Agapostemon semiviridis* Cresson, 1865: 172 [♀] [synonymy of *Ag. viridulus* by Baker 1906: 274].

*Agapostemon obscurata* Cresson, 1869: 295 [♂, not ♀ as indicated]. **syn. nov.**

*Agapostemon obscuratus* var. *abjectus* Cockerell, 1917b: 436 [♂, not ♀ as indicated] [synonymy of *Ag. obscuratus* by Roberts 1972: 513].

*Agapostemon viridualus* –Janjic & Packer, 2003: 109. Lapsus calami.

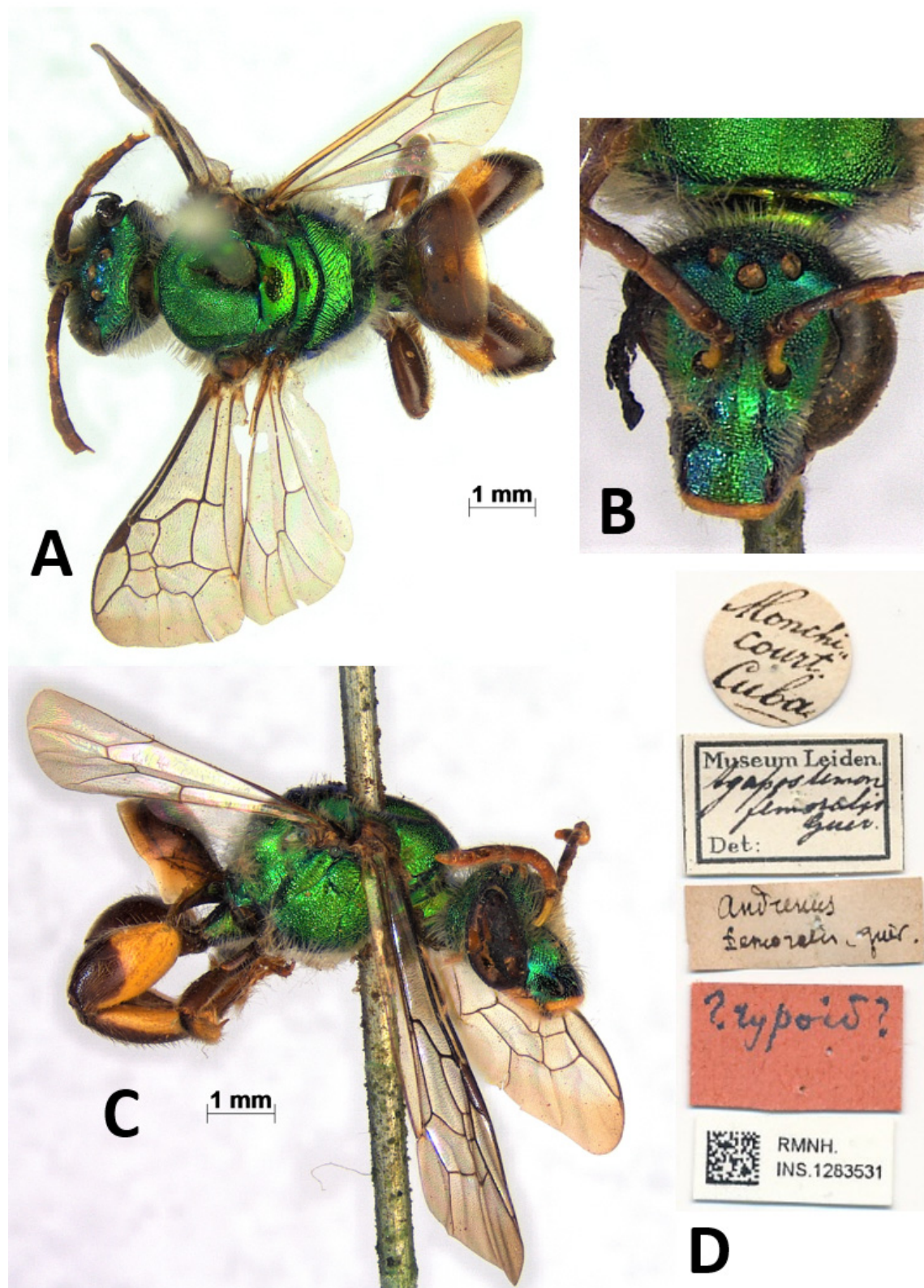
**Material examined**

**Lectotype** (designated here, Fig. 3)

CUBA • ♂; Monchicourt leg.; RMNH.INS.1283531.

**Additional material**

CUBA • 1 ♀ (lectotype of *Agapostemon semiviridis* Cresson, 1865, designated by Cresson 1916: 109); ANSP 2788 (Fig. 4) • 1 ♂ (lectotype of *Agapostemon obscurata* Cresson, 1869, designated by Cresson 1916: 108); ANSP 2790 (Fig. 5) • 1 ♂ (holotype of *Agapostemon obscuratus* var. *abjectus* Cockerell, 1917); Cabanas [Cabañas]; 28 May [no year provided]; Palmer and Riley leg.; USNM 22938 (Fig. 6).



**Fig. 3.** *Agapostemon femoralis* Guérin-Méneville, 1844, the type species for the genus *Agapostemon* Guérin-Méneville, 1844. Lectotype (designated here), ♂ (RMNH.INS.1283531). **A.** Dorsal view. **B.** Face. **C.** Lateral view. **D.** Associated labels. Photos by F. Bakker, Naturalis Biodiversity Center.

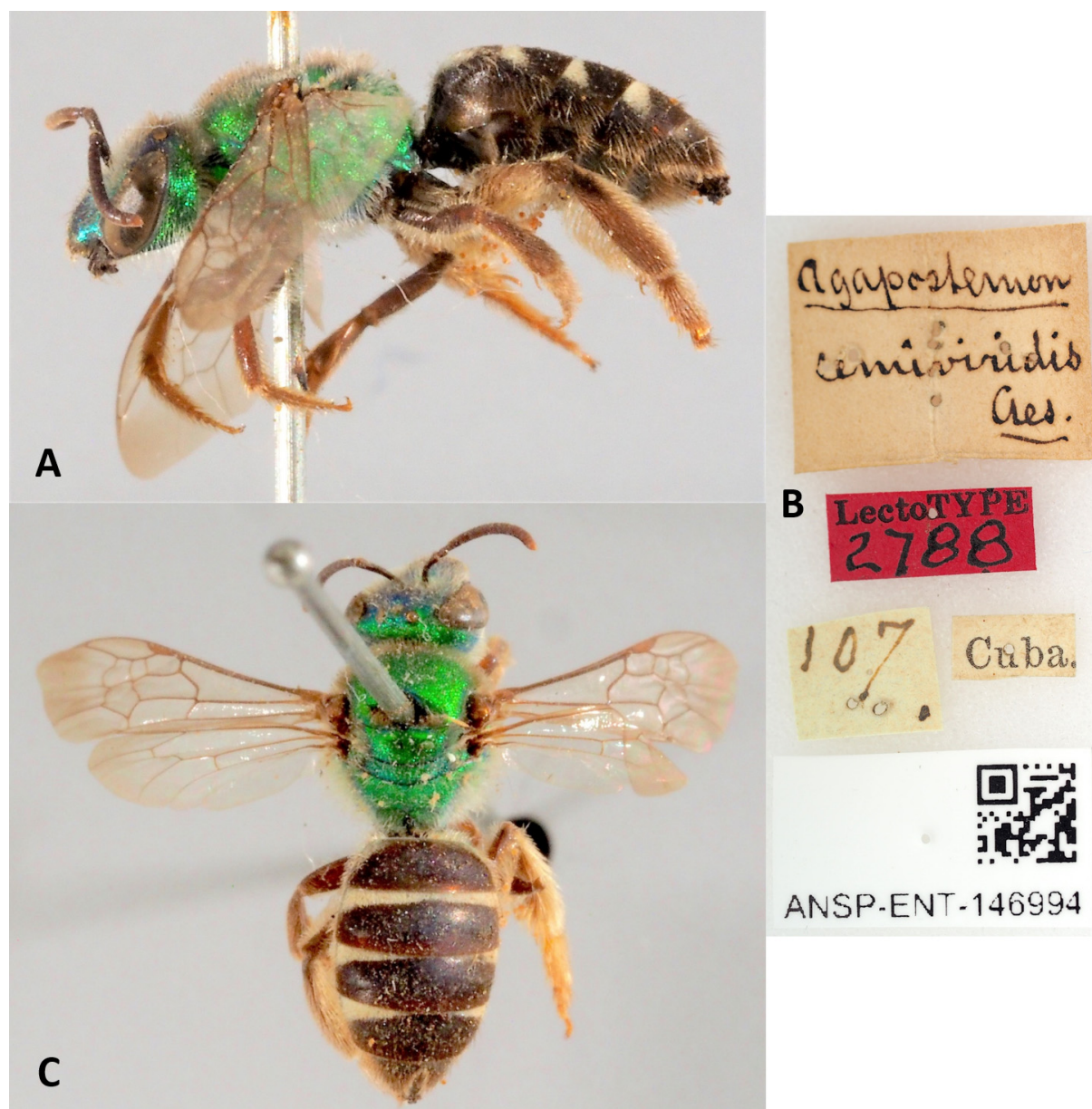


**Notes**

The lectotype ♂ of *Halictus cubensis* Spinola, 1851 (designated by Engel 2004: 170), from Cuba, Havana, Spinola Collection, MSNT, was not examined as the synonymy was not questioned.

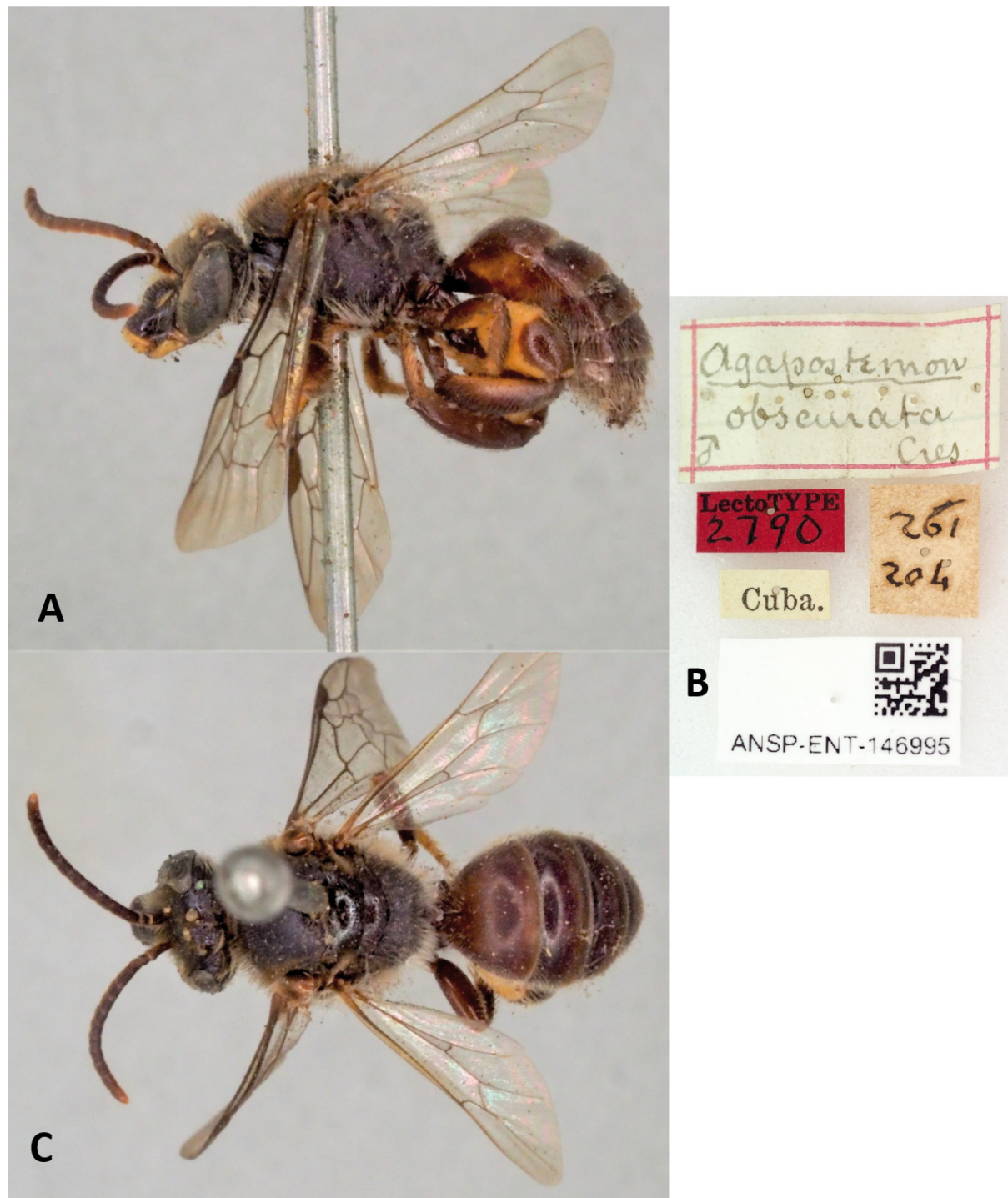
**Remarks**

The name and description of *Andrena femoralis* is attributed to Guérin-Méneville (1844a), though the name (i.e., *Andrena femoralis* Guer.), type locality (i.e., Cuba) and first illustration appear on plate 83, figure 1 (incorrectly recorded as plate 73 by Van der Vecht 1957) for Cuvier's (1836) work published in 1837 (Cuvier 1837). These images were later duplicated in Guérin-Méneville (1844b) as "Insectès, Pl[ate]. 73, Figure 1". Banks (1909) commented on the dates of Guérin-Méneville's *Iconographie du Regne Animal*,



**Fig. 4.** *Agapostemon semiviridis* Cresson, 1865. Lectotype, ♀ (ANSP 2788). A. Lateral view. B. Associated labels. C. Dorsal view. Photos by J.D. Weintraub/ANSP Entomology.

indicating that the volume dedicated to insects (i.e., Guérin-Méneville 1844a) is dated 1829–1838 with many references to other dates within the text, including 1844, the year most researchers have used in citing this work (e.g., Roberts 1972; Michener 2000, 2007, though Moure (1960) indicated 1845). However, as Cuvier's original plates were published in 1837 (Cuvier 1837), Banks (1909) felt that those of the opinion

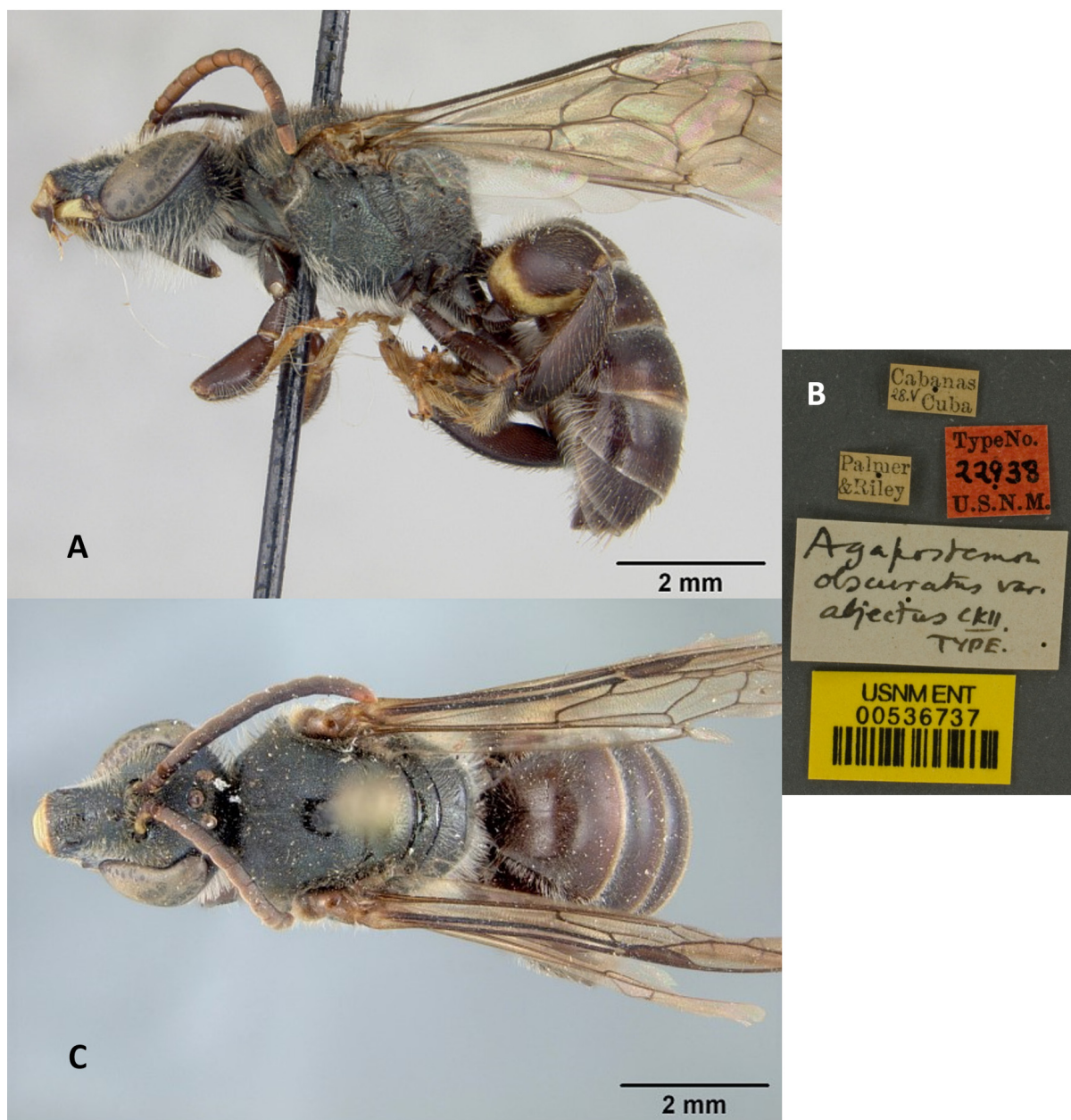


**Fig. 5.** *Agapostemon obscuratus* Cresson, 1869. Lectotype, ♂ (ANSP 2790). A. Lateral view. B. Associated labels. C. Dorsal view. Photos by J.D. Weintraub/ANSP Entomology.



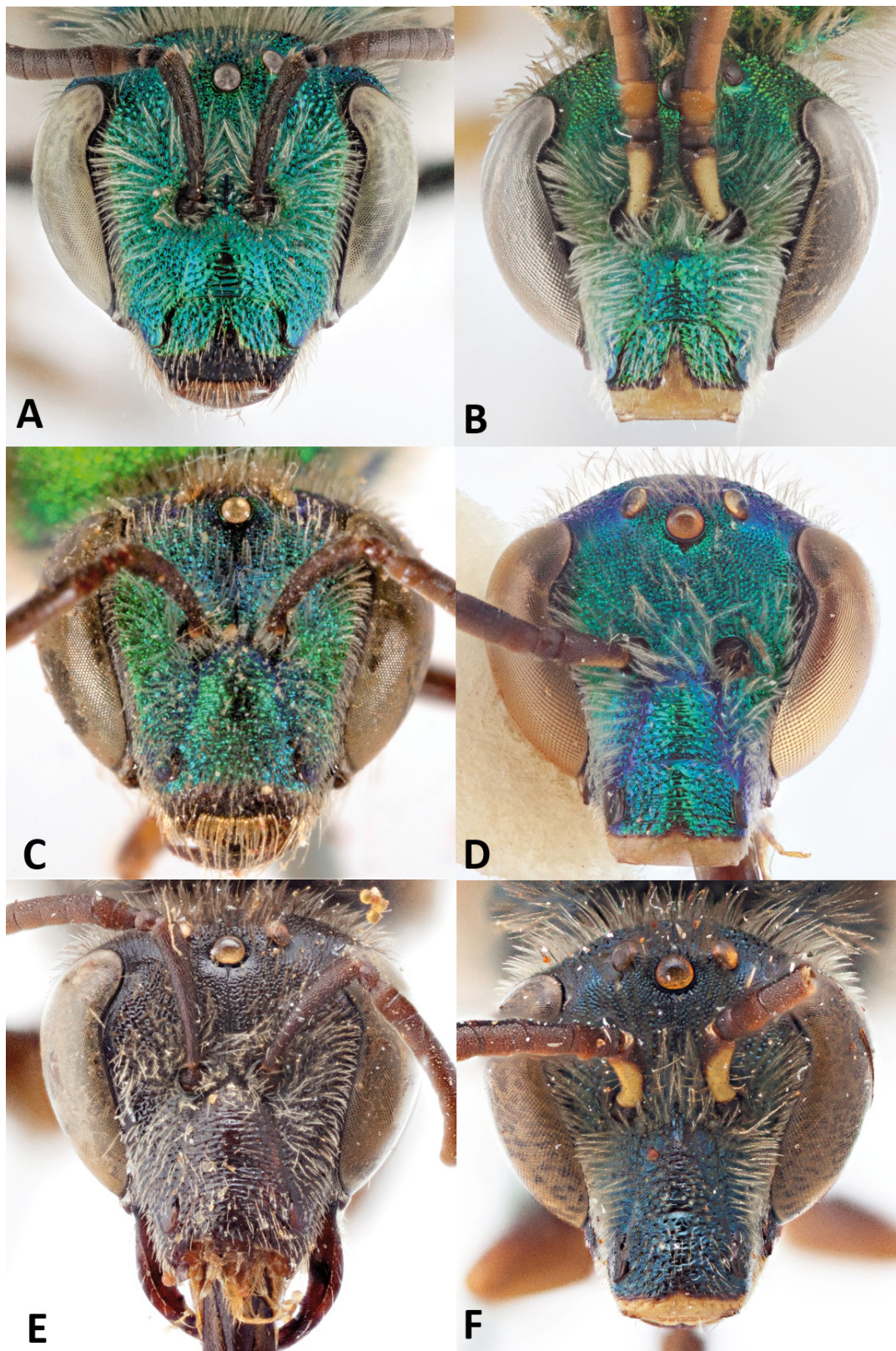
“that a named figure is valid without [accompanying] text must credit such names” with the dates of the plate publication. However, Cowan (1971) more recently reviewed the issue of Guérin-Méneville’s works and concluded that the date relevant to the insects is 1844, and this decision is followed here.

Van der Vecht (1957) examined material that he assumed was part of the type material for *Ag. femoralis* at the Rijksmuseum van Natuurlijke Historie, Leiden (now Naturalis Biodiversity Center, Leiden), though he also indicated the possibility of syntypes existing at other institutions; other specimens with the same collection information exist at Naturalis Biodiversity Center. Thus, to stabilize *Ag. femoralis* as the valid name of this Cuban taxon, the specimen Van der Vecht (1957) provided details on (i.e., fig. 3) is hereby selected as the lectotype. Incidentally, *Ag. femoralis* is the type species for the genus *Agapostemon*



**Fig. 6.** *Agapostemon obscuratus* var. *abjectus* Cockerell, 1917. Holotype, ♂ (USNM 22938). **A.** Lateral view. **B.** Associated labels. **C.** Dorsal view. Photos by USNM.





**Fig. 7.** Face of females (left column) and males (right column). **A–B.** *Agapostemon virescens* (Fabricius, 1775). **C.** *Ag. semiviridis* Cresson, 1865, lectotype [= *Ag. femoralis* (Guérin-Méneville, 1844)]. **D.** *Ag. femoralis*. **E–F.** *Ag. obscuratus* Cresson, 1869; note, the apex of clypeus of female is damaged.



(Sandhouse 1936, 1943; Michener 1997). Dalla Torre (1896) was the first to treat *Ag. femoralis* as a synonym of *Ag. viridulus* (later followed by Friese 1902), though the assumption that the type material of *Ag. viridulus* was collected in Cuba was baseless.

The female type material of *Halictus cubensis* Spinola was not an *Agapostemon*, but rather *Augochlora regina* Smith, 1853 (Augochlorini) (Engel 2004), so Engel (2004) designated the male as a lectotype, and placed it into synonymy with *Ag. femoralis*. However, as a result of this designation, *Ag. cubensis* Roberts became a junior secondary homonym of *Ag. cubensis* (Spinola), thus requiring the replacement name provided below.

Though Roberts (1972) records the synonymy of *Ag. semiviridis* Cresson under *Ag. viridulus* as new, Baker (1906) had already treated it as a synonym. When described, Cresson (1865) indicated that it was potentially the female of *Ag. viridulus*.

***Agapostemon (Agapostemon) robertsi* nom. nov.**

*Agapostemon cubensis* Roberts, 1972: 478 [♂] [preoccupied, not *Ag. cubensis* (Spinola) = *Ag. femoralis* (Guérin-Ménéville, 1844)].

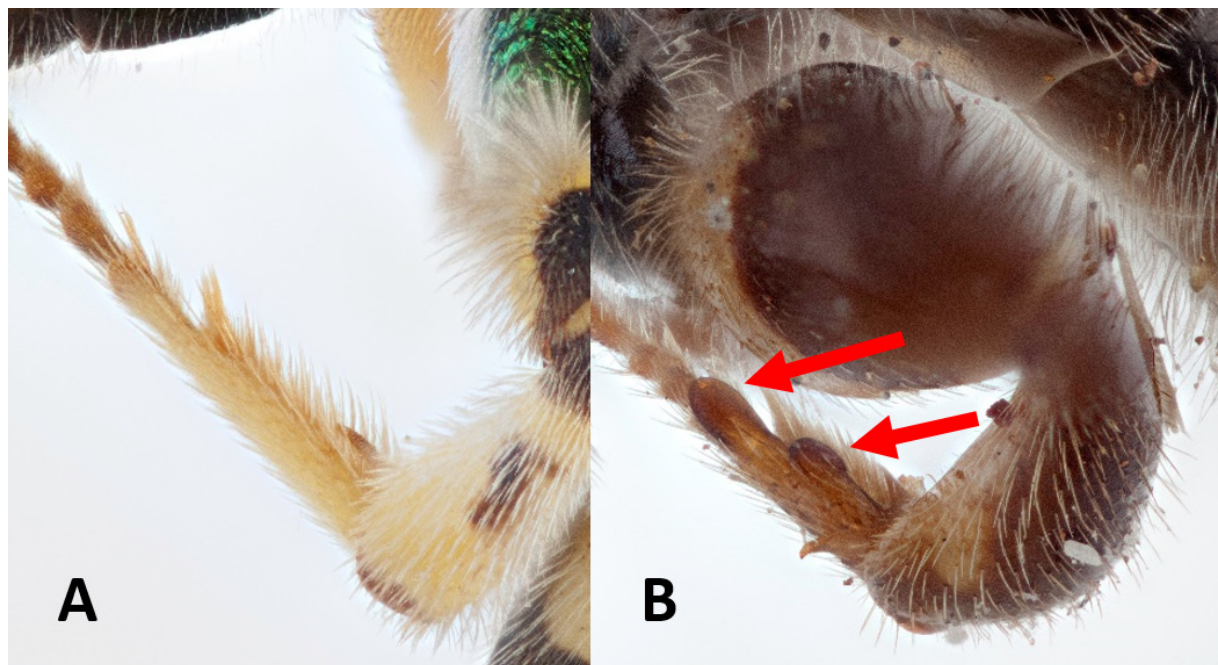


**Fig. 8.** Propodeum. **A–B.** *Agapostemon virescens* (Fabricius, 1775), ♀ (A) and ♂ (B), showing distinctive carina encircling posterior surface. **C.** *Ag. obscuratus* Cresson, 1869, ♀ [= *Ag. femoralis* (Guérin-Ménéville, 1844)]. **D.** *Ag. femoralis*, ♂, with weak carina that does not encircle posterior surface.





**Fig. 9.** Dorsal view of the metasoma of male. **A.** *Agapostemon virescens* (Fabricius, 1775). **B.** *Ag. femoralis* (Guérin-Ménéville, 1844). **C.** *Ag. obscuratus* Cresson, 1869 [= *Ag. femoralis*].



**Fig. 10.** Hind basitarsus of male. **A.** *Agapostemon virescens* (Fabricius, 1775), which is unmodified. **B.** *Ag. femoralis* (Guérin-Ménéville, 1844), with upper arrow showing the prominent apical groove, and the lower arrow showing the prominent basal ridge.

### Notes

The holotype ♂ of *Ag. robertsi*, from Cuba, “5.K. S. of Pinar Rio” [Pinar del Río], “12-23 September ’13”, AMNH, did not need to be examined.

### Discussion

Though previous workers assumed that the type material of *Ag. viridulus* was from, and presumably endemic to Cuba (e.g., Dalla Torre 1896; Ashmead 1900; Cockerell 1910; Moure 1960; Roberts 1972), there is no evidence that this is true. In fact, in Fabricius’s collected works there is only one bee species that was described with a type locality from Cuba, *Coelioxys tridentata* (Fabricius, 1775) [described as *Apis tridentata*] (Genaro 2006). As indicated by Genaro (2006), most early works on bees in the area are generally identified as coming from “Americae Meridionalis Insulis” (includes Cuba and/or another Caribbean island). Thus, it is hard to believe that Fabricius would have provided a specific locality for a species from Cuba in an earlier work (Fabricius 1775), though not for a species described in 1793 for which no locality was recorded until done so in 1804 (Fabricius 1804). However, it is also likely that detailed information was lacking for many of the specimens that Fabricius received from the Western Hemisphere.

Within the BIN to which *Ag. virescens* belongs, there is little genetic variation, though members differ by over 12% from *Ag. femoralis*, suggesting that although these species were considered morphologically very similar by Roberts (1972), there is enough genetic and morphological divergence to distinguish the species. The COI sequence of *Ag. obscuratus*, also from Cuba, is genetically identical to material now recognized as *Ag. femoralis*. The phylogeny of Janjic & Packer (2003) recovered *Ag. femoralis* [as *Ag. viridulus*] and *Ag. obscuratus* as separate taxa, albeit within the same species group, suggesting that a new phylogenetic analysis is warranted, though this was likely due in large part to colour differences between the material examined. Based on genetic similarity, shared geography, and past opinions of Cresson (1869) and Roberts (1972), we consider the taxon *Ag. obscuratus* to represent a colour polymorphic form of *Ag. femoralis*, and place it into synonymy. As Roberts (1972) synonymized Cockerell’s (1917b) obscurely dark green (i.e., intermediate in colour; Fig. 6) taxon under Cresson’s (1869), we assume he was also of the opinion that colour polymorphisms existed in *Agapostemon*. Though Roberts (1972) also considered the specific rank of *Ag. obscuratus* questionable, he did not synonymize it under *Ag. viridulus* despite noting only differences in colour between the two taxa. Such variation within a metallic bee species, ranging from metallic green or blue to black is uncommon, but not unheard of in bees. For instance, *Osmia (Melanosmia) tersula* Cockerell, 1912 (Megachilidae) is typically metallic blue in most of its range (Sandhouse 1939; Mitchell 1962), though black specimens lacking metallic colouration do occur (Rightmyer *et al.* 2010). Many metallic halictid bees show extensive congeneric (e.g., Gibbs 2010, 2011; Engel 2013, 2014a, 2014b) and conspecific (e.g., Ordway 1966) variation in body colouration; Ordway (1966) and Gibbs (2009) indicated that killing agents and other chemicals can alter metallic colouration to some extent. Combining molecular methods such as DNA barcoding to studies of bee taxonomy has proven very useful for recognizing colour variable species (e.g., Sheffield *et al.* 2011; Sheffield *et al.* 2020).

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## References

- Abrams J. & Eickwort G.C. 1980. Biology of the communal sweat bee *Agapostemon virescens* (Hymenoptera: Halictidae) in New York State. *Search Agriculture* 1: 1–20.
- Abrams J. & Eickwort G.C. 1981. Nest switching and guarding by the communal sweat bee *Agapostemon virescens* (Hymenoptera, Halictidae). *Insectes Sociaux* 28: 105–116. <https://doi.org/10.1007/BF02223699>
- Alayo P. 1973. *Catálogo de los Himenópteros de Cuba*. Pueblo y Educación, La Habana.
- Alayo P. 1976. Introducción al estudio de los himenópteros de Cuba. IX- Superfamilia Apoidea. *Serie Biológica, Instituto de Zoología, Cuba* 68: 1–35.
- Ascher J.S. & Pickering J. 2020. Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila). Available from [http://www.discoverlife.org/mp/20q?guide=Apoidea\\_species](http://www.discoverlife.org/mp/20q?guide=Apoidea_species) [accessed 21 Aug. 2020].
- Ashmead W.H. 1896. Notes of the Hymenoptera. Collected by the Bahama Expedition from the State University of Iowa. *Bulletin from the Laboratories of Natural History of the State University of Iowa* 4: 28–32.
- Ashmead W.H. 1900. VI. Report upon the aculeate Hymenoptera of the Islands of St. Vincent and Grenada, with additions to the parasitic Hymenoptera and a list of the described Hymenoptera of the West Indies. *Transactions of the Entomological Society of London* 2: 207–367. <https://doi.org/10.1111/j.1365-2311.1900.tb02379.x>
- Baker C.F. 1906. Halictinae de Cuba. In: Earle F.S. (ed.) *Primer Informe Anual de la Estación Central Agronómica de Cuba*: 253–274. La Universal de Ruiz y Hermano, Havana.
- Banks N. 1909. Dates of Guérin's *Iconographie du Regne Animal*. *Entomological News* 20: 396–397.
- Cockerell T.D.A. 1902. Flowers and insects in New Mexico. *The American Naturalist* 36: 809–817. <https://doi.org/10.1086/278219>
- Cockerell T.D.A. 1904. IV.—Descriptions and records of bees. *Annals and Magazine of Natural History Series* 7 14 (79): 21–30. <https://doi.org/10.1080/03745480409442962>
- Cockerell T.D.A. 1909. II.—Descriptions and records of bees.—XXI. *Annals and Magazine of Natural History Series* 8 4 (19): 25–31. <https://doi.org/10.1080/00222930908692634>
- Cockerell T.D.A. 1910. Some neotropical bees. *Psyche* 17: 142–144. <https://doi.org/10.1155/1910/35751>
- Cockerell T.D.A. 1911. Records of bees. *The Canadian Entomologist* 43: 389–391. <https://doi.org/10.4039/Ent43389-11>
- Cockerell T.D.A. 1917a. XXV.—Descriptions and records of bees.—LXXVI. *Annals and Magazine of Natural History Series* 8 20 (117): 235–241. <https://doi.org/10.1080/00222931709486998>
- Cockerell T.D.A. 1917b. LIV.—Descriptions and records of bees.—LXXVIII. *Annals and Magazine of Natural History Series* 8 20 (120): 436–441. <https://doi.org/10.1080/00222931709487033>
- Cockerell T.D.A. 1921. XXXV.—Descriptions and records of bees.—XCI. *Annals and Magazine of Natural History Series* 9 8 (45): 359–368. <https://doi.org/10.1080/00222932108632595>
- Cowan C.F. 1971. On Guérin's *Iconographie*: particularly the insects. *Journal of the Society for the Bibliography of Natural History* 6: 18–29. <https://doi.org/10.3366/jsbnh.1971.6.1.18>



- Crawford J.C. 1901. North American bees of the genus *Agapostemon* Guérin. *Proceedings of the Nebraska Academy of Sciences* 7: 156–165.
- Crawford J.C. 1912. Notes on some Canadian bees. *The Canadian Entomologist* 44: 359–360.  
<https://doi.org/10.4039/Ent44359-12>
- Cresson E.T. 1865. On the Hymenoptera of Cuba. *Proceedings of the Entomological Society of Philadelphia* 4: 1–200.
- Cresson E.T. 1869. Notes on Cuban Hymenoptera, with descriptions of new species. *Transactions of the American Entomological Society* 2: 293–298. <https://www.jstor.org/stable/25076211>
- Cresson E.T. 1887. Synopsis of the families and genera of the Hymenoptera of America, north of Mexico, together with a catalogue of the described species, and bibliography. *Transactions of the American Entomological Society* Supplementary Volume: i, iii–vi, 1–350. <https://doi.org/10.5962/bhl.title.38716>
- Cresson E.T. 1916. The Cresson types of Hymenoptera. *Memoirs of the American Entomological Society* 1: 1–141. <https://doi.org/10.5281/zenodo.26375>
- Cuvier G. 1836. *The Animal Kingdom, Arranged According to its Organization, Serving as a Foundation for the Natural History of Animals, and an Introduction to Comparative Anatomy. Vol. IV.* G. Henderson, London. [text].
- Cuvier G. 1837. *The Animal Kingdom, Arranged According to its Organization, Serving as a Foundation for the Natural History of Animals, and an Introduction to Comparative Anatomy. Vol. IV. Insecta-Zoophytes.* G. Henderson, London. [plates].
- Dalla Torre C.G. 1896. *Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus. Vol. 10.* Guilelmi Engelmann, Leipzig [Lipsiae]. <https://doi.org/10.5962/bhl.title.10348>
- Ebmer A.W. 1974. Von Linné bis Fabricius beschriebene westpaläarktische Arten der Genera *Halictus* und *Lasioglossum* (Halictidae, Apoidea). *Nachrichtenblatt der Bayerischen Entomologen* 23: 111–127.
- Eickwort G.C. 1981. Aspects of the nesting biology of five Nearctic species of *Agapostemon* (Hymenoptera: Halictidae). *Journal of the Kansas Entomological Society* 54: 337–351.  
<https://www.jstor.org/stable/25084166>
- Eickwort G.C. & Abrams H. 1980. Parasitism of sweat bees in the genus *Agapostemon* by cuckoo bees in the genus *Nomada* (Hymenoptera, Halictidae, Anthorhoridae). *The Pan-Pacific Entomologist* 56: 144–152.
- Engel M.S. 2004. On the identity of *Halictus cubensis* Spinola, 1851 (Hymenoptera: Halictidae). *Entomological News* 115: 169–170.
- Engel M.S. 2013. The bee genus *Ischnomelissa* in Peru, with a key to the species (Hymenoptera: Halictidae). *Journal of Melittology* 23: 1–5. <https://doi.org/10.17161/jom.v0i23.4641>
- Engel M.S. 2014a. The bee genus *Caenaugochlora* in Venezuela (Hymenoptera: Halictidae). *Journal of Melittology* 33: 1–10. <https://doi.org/10.17161/jom.v0i33.4725>
- Engel M.S. 2014b. Three new species of the genus *Caenaugocholora* from Central America and Columbia (Hymenoptera: Halictidae). *Journal of Melittology* 41: 1–15.  
<https://doi.org/10.17161/jom.v0i41.4810>
- Fabricius J.C. 1775. *Systema Entomologiae*. Libraria Kortii, Flensburg and Leipzig [Flensbergi et Lipsiae]. <https://doi.org/10.5962/bhl.title.36510>
- Fabricius J.C. 1793. *Entomologia Systematica*, 2. Copenhagen [Hafniae].  
<https://doi.org/10.5962/bhl.title.122153>

- Fabricius J.C. 1804. *Systema Piezatorum*. Brunswick [Brunsvigae].  
<https://doi.org/10.5962/bhl.title.10490>
- Fischer R.L. 1950. Kansas bees of the genus *Agapostemon* Guerin (Hymenoptera, Halictidae). *Journal of the Kansas Entomological Society* 23: 76–78. <https://www.jstor.org/stable/25081922>
- Friese H. 1902. Beitrag zur Apidenfauna der grossen Antillen. *Zeitschrift für systematische hymenopterologie und dipterologie* 2: 196–201.
- Genaro J.A. 2006. A history of systematic studies of the bees of Cuba (Insecta: Hymenoptera, Anthophila). *Zootaxa* 1195: 39–60. <https://doi.org/10.11646/zootaxa.1195.1.3>
- Genaro J.A. 2008. Origins, composition and distribution of the bees of Cuba (Hymenoptera: Apoidea: Anthophila). *Insecta Mundi* 52:1–16.
- Gibbs J. 2009. New species in the *Lasioglossum petrellum* species group identified through an integrative taxonomic approach. *The Canadian Entomologist* 141: 371–396. <https://doi.org/10.4039/n09-020>
- Gibbs J. 2010. Revision of the metallic species of *Lasioglossum* (*Dialictus*) in Canada (Hymenoptera, Halictidae, Halictini). *Zootaxa* 2591: 1–382. <https://doi.org/10.11646/zootaxa.2591.1.1>
- Gibbs J. 2011. Revision of the metallic *Lasioglossum* (*Dialictus*) of eastern North America (Hymenoptera: Halictidae: Halictini). *Zootaxa* 3073: 1–216. <https://doi.org/10.11646/zootaxa.3073.1.1>
- Guérin-Méneville F.E. 1844a. *Iconographie du Règne Animal de G. Cuvier, ou représentation d'après nature de l'une des espèces les plus remarquables, et souvent non encore figurées de chaque genre d'animaux*. *Insectes*. [1829–1838]. J.B. Baillière, Paris. [text]. <https://doi.org/10.5962/bhl.title.10331>
- Guérin-Méneville F.E. 1844b. *Iconographie du Règne Animal de G. Cuvier, ou représentation d'après nature de l'une des espèces les plus remarquables, et souvent non encore figurées de chaque genre d'animaux*. Tome II. *Planches des Animaux invertébrés*. [1829–1844]. J.B. Baillière, Paris. [plates].
- Gundlach J.C. 1896. *Contribución a la Entomología Cubana*. Tomo II. G. Montiel, Habana.  
<https://doi.org/10.5962/bhl.title.49760>
- Harris M. 1782. *An Exposition of English Insects*. London. <https://doi.org/10.5962/bhl.title.168994>
- Harris R.A. 1979. A glossary of surface sculpturing. *Occasional Papers in Entomology* 28: 1–31.
- Hebert P.D.N., Cywinska A., Ball S.L. & deWaard J.R. 2003. Biological identifications through DNA barcodes. *Proceedings of the Royal Society B: Biological Sciences* 270 (1512): 313–322.  
<https://doi.org/10.1098/rspb.2002.2218>
- Janjic J. & Packer L. 2003. Phylogeny of the bee genus *Agapostemon* (Hymenoptera: Halictidae). *Systematic Entomology* 28: 101–123. <https://doi.org/10.1046/j.1365-3113.2003.00204.x>
- Krombein K.V. 1953. The wasps and bees of the Bimini island group, Bahamas, British West Indies (Hymenoptera, Aculeata). *American Museum Novitates* 1633: 1–29. Available from <http://hdl.handle.net/2246/4931> [accessed 29 Apr. 2021].
- LaBerge W.E. & Ribble D.W. 1966. The nests and larvae of two species of *Agapostemon* (Hymenoptera: Halictidae). *Journal of the Kansas Entomological Society* 39: 467–472.  
<https://www.jstor.org/stable/25083542>
- Lepelletier A.L.M. 1841. *Histoire Naturelle des Insectes — Hyménoptères*. II. Roret, Paris.  
<https://doi.org/10.5962/bhl.title.9005>
- Michener C.D. 1997. Genus-group names of bees and supplemental family-group names. *Scientific Papers of the Natural History Museum, The University of Kansas* 1: 1–81.  
<https://doi.org/10.5962/bhl.title.4052>

- Michener C.D. 2000. *The Bees of the World*. Johns Hopkins University Press, Baltimore.
- Michener C.D. 2007. *The Bees of the World. Second Edition*. Johns Hopkins University Press, Baltimore.
- Mitchell T.B. 1962. Bees of the eastern United States, Volume 2. *North Carolina Agricultural Experiment Station Technical Bulletin* 152: 1–557.
- Moure J.S. 1960. Notes on the types of Neotropical bees described by Fabricius (Hymenoptera: Apoidea). *Studia Entomologica* 3: 97–160.
- Moure J.S. & Hurd P.D. 1987. *An Annotated Catalog of the Halictid Bees of the Western Hemisphere (Hymenoptera: Halictidae)*. Smithsonian Institution Press, Washington.
- Moure J.S., Urban D. & Melo G.A.R. (eds) 2007. *Catalogue of bees (Hymenoptera, Apoidea) in the Neotropical Region*. Sociedade Brasileira de Entomologia, Curitiba.
- Ordway E. 1966. Systematics of the genus *Augochlorella* (Hymenoptera, Halictidae) north of Mexico. *The University of Kansas Science Bulletin* 46: 509–624. <https://doi.org/10.5962/bhl.part.20079>
- Packer L., Genaro J.A. & Sheffield C.S. 2007. The bee genera of eastern Canada. *Canadian Journal of Arthropod Identification* 3: 1–32. <https://doi.org/10.3752/cjai.2007.03>
- Provancher L. 1882. Faune Canadienne. Les Insectes Hyménoptères. *Naturaliste canadien* 13: 193–209.
- Ramírez-Freire L., Alanís-Flores G.J., Ayala-Barajas R., Quiroz-Martínez H. & Velasco-Macías C.J. 2012. Las abejas del género *Agapostemon* (Hymenoptera: Halictidae) del estado de Nuevo León, México. *Revista Mexicana de Biodiversidad* 83: 63–72. <https://doi.org/10.22201/ib.20078706e.2012.1.1143>
- Ratnasingham S. & Hebert P.D.N. 2007. BOLD: The Barcode of Life Data System ([www.barcodinglife.org](http://www.barcodinglife.org)). *Molecular Ecology Notes* 7: 355–364. <https://doi.org/10.1111/j.1471-8286.2007.01678.x>
- Ratnasingham S. & Hebert P.D.N. 2013. A DNA-based registry for all animal species: the barcode index number (BIN) system. *PLoS ONE* 8 (7): e66213. <https://doi.org/10.1371/journal.pone.0066213>
- Rightmyer M.G., Griswold T. & Arduser M.S. 2010. A review of the non-metallic *Osmia* (*Melanosmia*) found in North America, with additional notes on palearctic *Melanosmia* (Hymenoptera, Megachilidae). *ZooKeys* 60: 37–77. <https://doi.org/10.3897/zookeys.60.484>
- Roberts R.B. 1972. Revision of the bee genus *Agapostemon* (Hymenoptera: Halictidae). *The University of Kansas Science Bulletin* 49: 437–590.
- Roberts R.B. 1973. *Bees of Northwestern America: Agapostemon (Hymenoptera: Halictidae)*. Agricultural Experiment Station, Oregon State University, Corvallis.
- Roberts R.B. & Brooks R.W. 1987. Agapostemonine bees of Mesoamerica (Hymenoptera: Halictidae). *The University of Kansas Science Bulletin* 53: 357–392.
- Robertson C. 1893. Notes on bees, with descriptions of new species. *Transactions of the American Entomological Society* 20: 145–149. <http://www.jstor.org/stable/25076604>
- Robertson C. 1895. Notes on bees, with descriptions of new species. *Transactions of the American Entomological Society* 22: 115–128. <https://www.jstor.org/stable/25076640>
- Robertson C. 1897. North American bees — descriptions and synonyms. *Transactions of the Academy of Science of St. Louis* 7: 315–356.
- Sandhouse G.A. 1936. The bees of the genus *Agapostemon* (Hymenoptera: Apoidea) occurring in the United States. *Journal of the Washington Academy of Sciences* 26: 70–83.
- Sandhouse G.A. 1939. The North American bees of the genus *Osmia*. *Memoirs of the Entomological Society of Washington* 1: 1–167.

- Sandhouse G.A. 1943. The type species of the genera and subgenera of bees. *Proceedings of the United States National Museum* 92: 519–619. <https://doi.org/10.5479/si.00963801.3156.519>
- Sheffield C.S. & Perron J.-M. 2014. Annotated catalogue of the bees described by Léon Provancher (Hymenoptera: Apoidea). *The Canadian Entomologist* 146: 117–169. <https://doi.org/10.4039/tce.2013.64>
- Sheffield C.S., Hebert P.D.N., Kevan P.G. & Packer L. 2009. DNA barcoding a regional bee (Hymenoptera: Apoidea) fauna and its potential for ecological studies. *Molecular Ecology Resources* 9: 196–207. <https://doi.org/10.1111/j.1755-0998.2009.02645.x>
- Sheffield C.S., Ratti C., Packer L. & Griswold T. 2011. Leafcutter and mason bees of the genus *Megachile* Latreille (Hymenoptera: Megachilidae) in Canada and Alaska. *Canadian Journal of Arthropod Identification* 18: 1–107.
- Sheffield C.S., Heron J., Gibbs J., Onuferko T.M., Oram R., Best L., deSilva N., Dumesh S., Pindar A. & Rowe G. 2017. Contribution of DNA barcoding to the study of the bees (Hymenoptera: Apoidea) of Canada: progress to date. *The Canadian Entomologist* 149: 736–754. <https://doi.org/10.4039/tce.2017.49>
- Sheffield C.S., Oram R. & Heron J.M. 2020. *Bombus* (*Pyrobombus*) *johanseni* Sladen, 1919, a valid North American bumble bee species, with a new synonymy and comparisons to other “red-banded” bumble bee species in North America (Hymenoptera, Apidae, Bombini). *ZooKeys* 984: 59–81. <https://doi.org/10.3897/zookeys.984.55816>
- Shelford V.E. 1913. *Animal Communities in Temperate America as Illustrated in the Chicago Region*. The Geographic Society of Chicago by the University of Chicago Press, Chicago. <https://doi.org/10.5962/bhl.title.34437>
- Shelford V.E. 1937. *Animal Communities in Temperate America as Illustrated in the Chicago Region. Second Edition*. The Geographic Society of Chicago by the University of Chicago Press, Chicago. <https://doi.org/10.5962/bhl.title.7231>
- Smith F. 1853. *Catalogue of Hymenopterous Insects in the Collection of the British Museum*. British Museum, London. <https://doi.org/10.5962/bhl.title.20858>
- Spinola M. 1851. Himenópteros. In: Gay C. (ed.) *Historia Física y Política de Chile, Zoología* [volumen 6]: 153–569. Maulde et Renou. <https://doi.org/10.5962/bhl.title.16172>
- Stevens O.A. 1920. Further notes on evening flowers, panurgine and halictine bees. *The Canadian Entomologist* 53: 65–69. <https://doi.org/10.4039/Ent5365-3>
- Titus E.S.C. 1900. Notes on Colorado bees. *The Canadian Entomologist* 32: 303–305. <https://doi.org/10.4039/Ent32303-10>
- Tucker E.S. 1909. Additional results of collecting insects in Kansas and Colorado. *Transactions of the Kansas Academy of Science* 22: 276–304.
- Vachal J. 1903. Étude sur les *Halictus* d’Amérique (Hym.). *Miscellanea Entomologica* 11: 89–104.
- Van der Vecht J. 1957. On some Hymenoptera from the collection of Guérin-Méneville in the Leiden Museum. *Zoologische Mededelingen* 35: 21–31. Available from <https://repository.naturalis.nl/pub/317915> [accessed 28 Apr. 2021].
- Viereck H.L., Cockerell T.D.A., Titus E.S.G., Crawford J.C. & Swenk M.H. 1906. Synopsis of bees of Oregon, Washington, British Columbia and Vancouver. —V. *The Canadian Entomologist* 38: 297–304. <https://doi.org/10.4039/Ent38297-9>
- Warneke K. 1973. Die unter dem Gattungsnamen *Apis* beschriebenen Bienen der Gattung *Halictus* (Apoidea, Hymenoptera) und Fixierung von Lectotypen weiterer von Fabricius beschriebener *Halictus*-Arten. *Nachrichtenblatt der Bayerischen Entomologen* 22: 23–26.

Webb D.W. 1980. Primary insect types in the Illinois Natural History Survey Collection, exclusive of the Collembola and Thysanoptera. *Bulletin of the Illinois Natural History Survey* 32: 55–191. Available from <https://www.biodiversitylibrary.org/part/79302> [accessed 14 May 2021].

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