Journal *of* Melittology
Bee Biology, Ecology, Evolution, & Systematics *The latest buzz in bee biology*
No. 33, pp. 1–10 12 May 2014

The bee genus *Caenaugochlora* in Venezuela (Hymenoptera: Halictidae)

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Abstract. Two new species of the augochlorine bee genus *Caenaugochlora* Michener are described and figured. ***Caenaugochlora* (*Caenaugochlora*) *elpidia*** Engel, new species, and ***C.* (*C.*) *pantochlora*** Engel, new species, are the first formally described species of their genus from Venezuela. The new species, both from Aragua (north-central Venezuela), can be distinguished from other members of the subgenus by their coloration and pattern of integumental sculpturing.

INTRODUCTION

The bee genus *Caenaugochlora* Michener is one of several wide ranging genera in the New World tribe Augochlorini, extending from Mexico to at least Peru (Engel, 2000; Michener, 2007; Moure, 2007; Gonçalves & Engel, 2010), and likely even as far south as Bolivia based on one somewhat questionable record (Engel & Gonçalves, 2010). Unlike several other augochlorine genera with a similar or even larger distribution (*e.g.*, *Augochlora* Smith, *Augochloropsis* Cockerell, *Neocorynura* Schrottky), *Caenaugochlora* is not presently as species rich. While genera like *Augochlora* and *Augochloropsis* boast well over 100 described species and the diversity of *Neocorynura* is closing rapidly on the sixth Leyland number, *Caenaugochlora* remains manageable with only 23 species classified into two subgenera (Engel & Gonçalves, 2010; Gonçalves & Engel, 2010). Despite this, additional species of *Caenaugochlora* have been known for several years and some of those undescribed taxa expand the recorded distribution of the genus in significant ways. Although relatively few species of *Caenaugochlora* are recorded from South America, there is actually a much more diversified fauna. Presently there are four species of *Caenaugochlora s.str*. described from South America: *Caenaugochlora jeffreyi* Engel, *C. silvicola* Engel, *C. bennetti* Gonçalves & Engel, and *C. quichua* Gonçalves

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ISSN 2325-4467

& Engel (Gonçalves & Engel, 2010). Herein are presented two new species from Venezuela, formally extending the genus into the Cordillera de Mérida region. The new species belong to the nominate subgenus as evidenced by their setose compound eyes (Figs. 1–2), normally-pectinate inner metatibial spur, and propodeal sculpturing (Engel, 2000; Gonçalves & Engel, 2010), and can be readily distinguished from their congeners in terms of coloration and integumental patterning.

MATERIAL AND METHODS

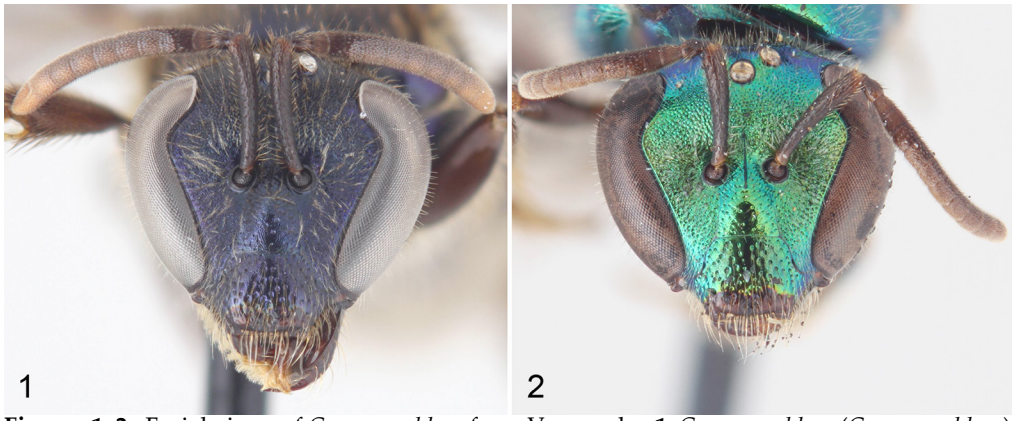
The specimens described herein were identified during a general sort of halictid bees in the Division of Entomology, University of Kansas Natural History Museum. Individuals were photographed using a Canon EOS 7D attached to an Infinity K-2 long-distance microscopic lens and then arranged in Adobe Photoshop®. The morphological terminology for the description is based on Eickwort (1969), Engel (2000, 2001, 2009b), and Michener (2007). The format for the description generally follows that used elsewhere in Caenaugochlora (*e.g.*, Engel, 1995, 1997a, 2007, 2009a). Measurements of specimens were made with an ocular micrometer attached to an Olympus SZX-12 stereomicroscope, those of the holotype are provided in the description while those from the paratype, where applicable, are in parentheses.

SYSTEMATICS

Genus *Caenaugochlora* Michener
Subgenus *Caenaugochlora* Michener
Caenaugochlora (Caenaugochlora) elpidia Engel, new species
ZooBank: urn:lsid:zoobank.org:act:E10617A6-E2D0-4D42-B344-60D62FFDD5CB
(Figs. 1, 3–5)

DIAGNOSIS: The new species can be recognized by the combination of its discolorous body coloration, with a deeply dark metallic purple-blue head and mesosoma contrasting with a metallic greenish golden metasoma (Figs. 3, 4); a weakly carinate preoccipital ridge; a strongly imbricate basal area of the propodeum with weak, short, basal rugae (Fig. 5); and a strongly imbricate mesoscutum with small, contiguous punctures over most of its surface.

DESCRIPTION: ♀: Total body length 7.6 mm (7.1 mm); forewing length 5.8 mm (5.6 mm). Head slightly wider than long, length 2.08 mm (1.97 mm), width 2.21 mm (2.13 mm). Mandible with weak subapical tooth. Labrum with low orbicular elevation, basally blending into remainder of surface. Malar space linear. Upper interorbital distance 1.15 mm (1.09 mm); lower interorbital distance 0.93 mm (0.88 mm). Compound eyes with fine, white ocular setae, individual setae much longer than an individual ommatidial diameter. Preoccipital ridge weakly carinate. Pronotal lateral angle slightly obtuse, dorsal ridge carinate, lateral ridge angled, not carinate. Mesoscutum with anterior border broadly rounded, with well-defined, narrow, anterior-facing surface but not projecting over pronotum; intertegular distance 1.68 mm (1.60 mm). Inner metatibial spur pectinate, with five long branches, not including apical portion of rachis. Forewing with basal vein distad 1cu-a by two times vein width; first submarginal cell slightly longer than combined lengths of second and third submarginal cells; second submarginal cell slightly narrowed anteriorly, anterior border along Rs about as a long as anterior border of third submarginal cell along same vein; 1rs-m confluent

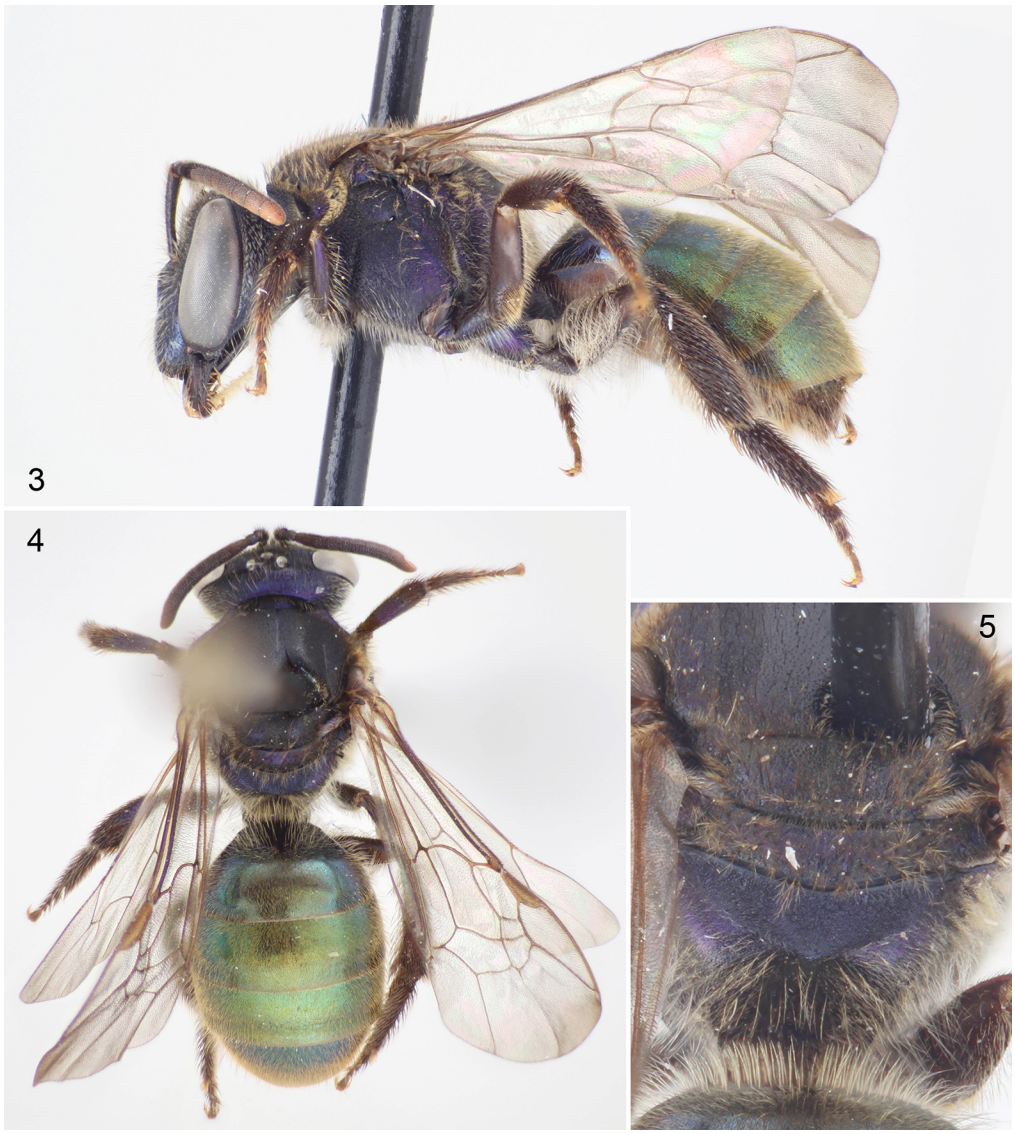


Figures 1–2. Facial views of *Caenaugochlora* from Venezuela. **1.** *Caenaugochlora* (*Caenaugochlora*) *elpidia*, new species. **2.** *C.* (*C.*) *pantochlora*, new species.

with 1m-cu; 2rs-m distinctly arched, distad 2m-cu by six times vein width. Metasoma broadly rounded, ovoid; terga not depressed; sterna unmodified.

Clypeus with coarse, shallow punctures separated by less than a puncture width except slightly more widely spaced basally, integument between punctures imbricate; supraclypeal area with small punctures separated by less than a puncture width along borders, more widely spaced centrally, integument between punctures imbricate; face with small, contiguous punctures, such punctures becoming weaker by ocellocular area such that surface appears strongly imbricate and roughened, similar integument on vertex and upper gena; gena with small punctures separated less than a puncture width, integument between finely imbricate, ventrally along border with postgena becoming longitudinally striate; postgena impunctate and longitudinally striate along outer portions blending to strongly imbricate integument toward inner border with hypostomal fossa. Pronotum imbricate. Mesoscutum imbricate with small contiguous punctures, such punctures becoming more spaced and shallower medially around median line; mesoscutellum imbricate with small contiguous punctures; metanotum imbricate with scattered small punctures; pleura with coarse, irregular, contiguous punctures giving surface a strongly roughened appearance; lateral and posterior surfaces of propodeum imbricate with scattered punctures, basal area of propodeum strongly imbricate, appearing almost granular, with weak, irregular, basal rugae. Metasomal terga imbricate with minute punctures, more finely imbricate on first tergum and apical margins; sterna finely imbricate with scattered course punctures in apical halves.

Mandible dark brown; labiomaxillary complex black, with yellow brown palpi; labrum black; clypeal apex dark brown, remainder of clypeus and head dark metallic blue-purple with blue and purple highlights; scape dark brown, nearly black; flagellum dark brown except lighter on venter, particularly on apicalmost flagellomeres where coloration is nearly yellowish brown. Mesosoma dark metallic purple-blue with bluish and purple highlights; tegula semi-translucent brown; wing membranes hyaline clear, venation brown; legs dark brown with metallic purple and blue highlights except tarsi without such highlights and pro- and metacoxae metallic entirely purple. Metasoma dark brown with strong metallic greenish-golden coloration; first tergum with noticeable metallic blue highlights, particularly laterally; succeeding terga without such blue highlights except along lateral extremities; sterna dark brown without metallic highlights.



Figures 3–5. Female of *Caenaugochlora* (*Caenaugochlora*) *elpidia*, new species. **3.** Lateral habitus. **4.** Dorsal habitus. **5.** Detail of propodeum.

Pubescence overall not obscuring integumental surfaces, color golden to white except more darkly golden to fuscous on dorsum of mesosoma and tarsi, tarsi also with distinctly black setae, particularly on outer surfaces; metasomal setae generally golden.

♂: Unknown.

HOLOTYPE: ♀, Venezuela: Aragua, Rancho Grande Biol. Stn., Portachuelo Pass, 10°21′0″N, 67°41′0″W, 1100 m, 4 Jun [June] 1998, J. Ashe, R. Brooks, R. Hanley; ex: insects moving thru [through] pass against wind-migration; deposited in the Division of Entomology, University of Kansas Natural History Museum, Lawrence, Kansas.

PARATYPE: ♀, same data and repository as holotype.

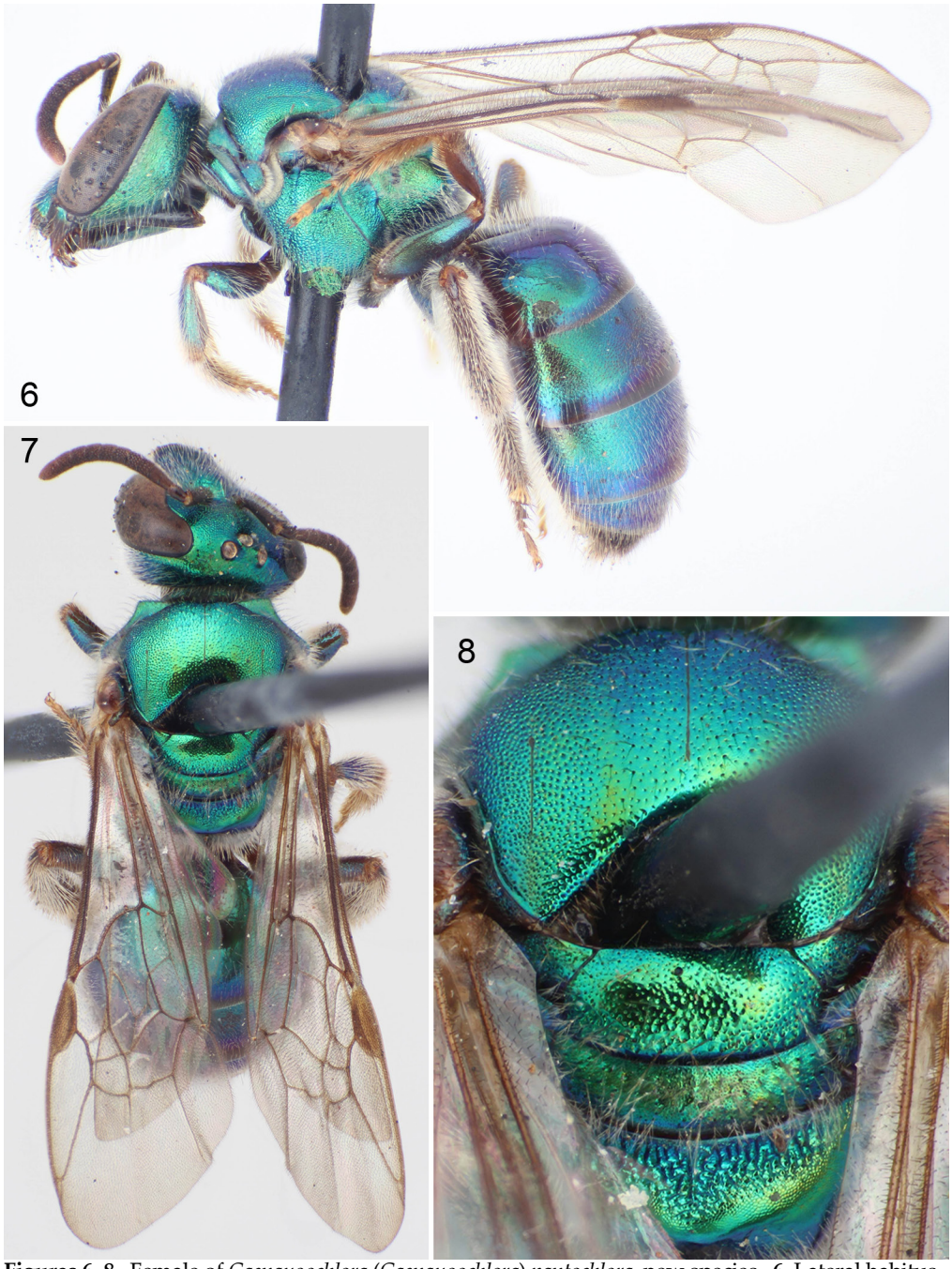
Etymology: The specific epithet is derived from the Greek term, *elpidos*, meaning, "hope".

Caenaugochlora* (*Caenaugochlora*) *pantochlora Engel, new species
ZooBank: urn:lsid:zoobank.org:act:E0277C82-F8CB-4B04-8583-C0B0882687A9
(Figs. 2, 7–8)

Diagnosis: The new species is quite similar to *C.* (*C.*) *gemmella* (Cockerell), as both are brilliant metallic green throughout (Figs. 6, 7) and have dense punctures on the mesoscutum laterally but more sparse medially (Fig. 8). However, *C. pantochlora* can readily be recognized by the sculpturing of the basal area of the propodeum and mesoscutum, and slightly larger body size (9.1 mm vs. 6.2–7.8 mm in *C. gemmella*). In *C. pantochlora* the basal area of the propodeum has irregular rugae that medially are more reticulate and not so rugoso-striate, then laterally more well-defined as rugoso-striate but relatively closely spaced and without well demarcated smooth areas between (Fig. 8), while in *C. gemmella* the pattern is one of more well-defined rugoso-striate integument, with the individual striae more spaced and with smoother areas between, medially the rugae are more well defined and not so reticulate. Also, while the overall pattern of puncture densities on the mesoscutum are similar between the two species, in *C. gemmella* the space between the punctures is shining and smooth, whereas in *C. pantochlora* there is under certain aspects of lighting (diffused lighting) a distinct imbricate pattern over the central disc.

Description: ♀: Total body length 9.1 mm; forewing length 6.1 mm. Head slightly wider than long, length 2.16 mm, width 2.27 mm. Mandible with weak subapical tooth. Labrum with low orbicular elevation, basally blending into remainder of surface. Malar space linear. Upper interorbital distance 1.10 mm; lower interorbital distance 0.96 mm. Compound eyes with fine, white ocular setae, individual setae much longer than an individual ommatidial diameter. Preoccipital ridge angled but not carinate. Pronotal lateral angle slightly obtuse, dorsal ridge carinate, lateral ridge angled but not carinate. Mesoscutum with anterior border broadly rounded, with well-defined, narrow, anterior-facing surface but not projecting over pronotum; intertegular distance 1.73 mm. Inner metatibial spur pectinate, with four long branches, not including apical portion of rachis. Forewing with basal vein distad 1cu-a by two times vein width; first submarginal cell about as long as combined lengths of second and third submarginal cells; second submarginal cell slightly narrowed anteriorly, anterior border along Rs only slightly shorter than anterior border of third submarginal cell along same vein; 1rs-m basad 1m-cu by vein width; 2rs-m distad 2m-cu by three times vein width, weakly arched. Metasoma broadly rounded, ovoid; terga not depressed; sterna unmodified.

Clypeus with coarse punctures separated by less than a puncture width except mediobasally more widely spaced, integument between smooth except laterally faintly and finely imbricate; supraclypeal area with smaller punctures than those of clypeus and separated by a puncture width or more medially, punctures separated by less than a puncture width laterally, integument between smooth except laterally finely imbricate; face with small punctures virutally contiguous; punctures becoming more widely spaced and fainter in ocellocular area, integument smooth to faintly imbricate; similar integument on vertex posterior to ocelli; gena generally smooth to faintly imbricate with small punctures separated by 1–3 times a puncture width, ventrally along border with postgena becoming longitudinally striate; postgena longitudinally striate



Figures 6–8. Female of *Caenaugochlora* (*Caenaugochlora*) *pantochlora*, new species. **6.** Lateral habitus. **7.** Dorsal habitus. **8.** Mesosomal dorsum (note that at the angle of the specimen the imbrication of the mesoscutum is washed out by the metallic coloration, but may be seen on the propodeum).

along outer portions blending to strongly imbricate integument toward inner border with hypostomal fossa. Pronotum imbricate. Mesoscutum with small contiguous to nearly contiguous punctures laterally, punctures gradually becoming more spaced medially until separated by 2.5 times a puncture width or less, especially sparse me-

dioapically, integument between punctures imbricate; tegula finely and faintly imbricate; mesoscutellum with minute punctures separated by 1.5 times a puncture width or less, integument between punctures smooth; metanotum imbricate with scattered punctures; pleura coarsely and contiguously punctured; propodeum with lateral surfaces anteriorly like that of pleura, blending posteriorly to more strongly and coarsely imbricate integument with scattered minute punctures, posterior surface faintly imbricate with scattered coarse punctures, basal area finely imbricate with irregular and closely-spaced rugae extending from base to near apex medially, such rugae clearly reticulate, laterally rugae more well defined, extending only to about two-thirds basal area length. Metasomal terga finely imbricate, with scattered minute punctures except in apical margins; sterna finely imbricate with scattered course punctures in apical halves to two-thirds.

Mandible dark brown basally, becoming lighter apically, with reddish brown apex; labiomaxillary complex dark brown, with palpi light brown; labrum black; clypeal apex dark brown, remainder of clypeus and head brilliant metallic green with some faint golden highlights on frons; antenna dark brown except venter of flagellum lighter, particularly toward apex. Mesosoma brilliant metallic green with faint golden or bluish highlights; tegula light brown, semi-translucent, with inner border brilliant metallic green; pro- and metacoxae brilliant metallic green, remaining podites dark brown with strong metallic highlights on more basal podites; wing membranes hyaline clear, venation brown. Metasomal terga metallic green with more prominent bluish highlights, apical margins of terga dark brown with metallic highlights; sterna dark brown with moderate metallic green and blue highlights.

Pubescence overall white except somewhat more golden toward apex of head, more tawny on tarsi, and progressively intermingled with fuscous setae on apicalmost metasomal terga; dark fuscous setae predominant on tergum V. Setae generally diffuse, not obscuring integumental surface.

♂: Unknown.

Holotype: ♀, Venezuela: Aragua, Rancho Grande Biol. Stn., Portachuelo Pass, 1100 m, 10°21′N, 67°41′W, 8.iii.1995 [8 March 1995], R. Brooks; deposited in the Division of Entomology, University of Kansas Natural History Museum, Lawrence, Kansas.

Etymology: The specific epithet is a combination of the Greek words *pantos* (meaning, "whole") and *chloros* (meaning, "green").

DISCUSSION

It is hoped that by continually documenting the diversity of this genus further material will become available for an eventual comprehensive evaluation of the group, particularly in terms of its morphological disparity. Extensive collecting is needed throughout the potential range of *Caenaugochlora* not only to identify further new species, but to discover presently unknown genders, elucidate their biology and floral relationships, and to refine our understanding of their biogeographic and ecological boundaries. Indeed, there are tantalizing patterns already observable among the species of *Caenaugochlora* that suggest it may not be as cohesive as once believed (*e.g.*, Gonçalves & Engel, 2010, and features mentioned below), either warranting the establishment of a third subgenus, or even removal of *Ctenaugochlora* into a separate generic group if the diversity of species cannot be conclusively resolved as forming a monophylum. For example, the variable presence or absence of long ocular setae, variable development of the preoccipital ridge, variable form of the malar space, shape of the

head, and variable form and sculpturing of the propodeum all tend to pull subset species of *Caenaugochlora* toward other genera. Although a formal relationship between *Caenaugochlora* and *Chlerogella* Michener or *Ischnomelissa* Engel has never been recovered (Engel, 2000), there are some striking similarities between the latter and species of the subgenus *Ctenaugochlora* Eickwort, particularly in the more elongate form of the propodeum, the shape of the head (at least for those non-rostrate species of *Chlerogella* and *Ischnomelissa*), and the densely pectinate inner metatibial spur (in *Ctenaugochlora* and *Ischnomelissa*) (Brooks & Engel, 1998; Engel, 1997b, 2010a, 2013; Engel & Brooks, 2002; Engel & Gonçalves, 2010; Engel & Rasmussen, 2013). Future work should explore the possibility that these groups are more closely related than presently hypothesized. For any clear resolution of the above matters, significantly larger numbers of individuals, particularly the unknown males of many taxa, are needed. Moreover, resolution of these issues may eventually reveal the number of origins of an elongate, rostrate head among these bees [*i.e.*, perhaps independently within *Chlerogella* and *Ischnomelissa*, and at least one *Caenaugochlora* has a minor prolongation to the malar space (Engel, 2007): note that the elongation in *Chlerogas* Vachal is certainly independent from the aforementioned groups (Brooks & Engel, 1999; Engel *et al*., 2006; Engel, 2009c, 2010b; Engel & Gonzalez, 2009), and itself is a single origin as the species definitely compose a monophyletic group (Engel, 2000), the same seems to be true for *Chlerogelloides* Engel *et al*. (Engel *et al*., 1997; Engel & Brooks, 1999; Oliveira *et al*., 2012)]. Collectively these bees afford an interesting opportunity to explore the genetic patterning necessary for extreme morphogenesis in rostrate bees, potentially providing a nice example of evolutionary developmental biology among Apoidea (Engel, 2011). While the elongation of the head likely a presumed adaptation for visiting flowers with tubular structures and comparative studies on foraging behavior among these bees are needed, these would not explain the underlying genetic mechanism that permits and produces such a phenotype. It would be interesting to look at differential gene expression between typical *Caenaugochlora* and non-rostrate *Ischnomelissa* and *Chlerogella*, and then against progressively more elongate-headed species within the latter two genera. Comparison between the genes responsible for head elongation among *Chlerogella* and *Ischnomelissa*, with those in *Chlerogas* might also reveal the degree to which identical or similar genetic pathways are coopted in the expression of convergent features. Before such a developmental pattern may be expounded upon, we require far greater clarity as to the diversity of these bees and the actual relationships involved, all of which emphasizes the necessity to undertake detailed systematic studies of *Caenaugochlora* and its putative relatives (Gonzalez *et al*., 2013).

ACKNOWLEDGEMENTS

The author is grateful to Mabel Alvarado for assistance with photography; to Kellie K. Magill Engel for support; and to two anonymous reviewers for their helpful input. This is a contribution of the Division of Entomology, University of Kansas Natural History Museum.

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ZooBank: urn:lsid:zoobank.org:pub:D7B1CC09-B623-4E2A-B35F-644ECEBBA136

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The *Journal of Melittology* was established at the University of Kansas through the efforts of Michael S. Engel, Victor H. Gonzalez, Ismael A. Hinojosa-Díaz, and Charles D. Michener in 2013 and each article is published as its own number, with issues appearing online as soon as they are ready. Papers are composed using Microsoft Word® and Adobe InDesign® in Lawrence, Kansas, USA.

Journal of Melittology is registered in ZooBank (www.zoobank.org), archived at the University of Kansas and in Portico (www.portico.org), and printed on demand by Southwestern Oklahoma State University Press.

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ISSN 2325-4467