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Taxonomic and Behavioural Notes on Patagonian Xeromelissinae with the Description of a New Species (Hymenoptera: Colletidae)

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ABSTRACT: The male and female of ***Chilicola* (*Chilicola*) *venticola*, Packer, new species** are described based upon material from Santa Cruz Province in Patagonian Argentina. The previously unknown females of *C.* (*Chilioediscelis*) *araucana* Toro and Moldenke and *Chilimelissa australis* Toro and Moldenke are also described. Notes on the nesting biology and adult behaviour of the species are given. *Chilimelissa australis* is the second xeromelissine known to nest in the ground and the possibility that other congeners nest in similar substrates is discussed. SEM analyses of brood cell lining materials are made for all three species and suggest the presence of some fibrous components, possibly silk, as in some other colletids. The ichneumonid *Grotea* sp. is recorded parasitizing brood cells of *C. venticola.*

KEY WORDS: *Chilicola*, *Chilimelissa*, Xeromelissinae, Colletidae, taxonomy, nesting biology, Patagonia, *Grotea*

While on a field trip to Santa Cruz Province in Argentinian Patagonia, I discovered the nests of three species of Xeromelissinae (Hymenoptera: Colletidae). This subfamily of bees is known from the southern tip of South America to central Mexico (Michener, 2000). The purpose of this paper is to describe the nesting behaviour and cell lining materials of three species from Argentinian Patagonia: ***Chilicola* (*Chilicola*) *venticola* Packer new species**, *Chilicola* (*Chilioediscelis*) *araucana* Toro and Moldenke and *Chilimelissa australis* Toro and Moldenke. The new species is described as are the females of *C. araucana* and *Ch. australis*, previously known only from the male holotypes. Because there are additional species of *Chilimelissa* and both subgenera of *Chilicola* referred to in this paper awaiting description, presentation of keys would be premature, but diagnoses are somewhat extensive and should permit identification of the newly described forms.

Methods

Nests in the ground were excavated using a small trowel aided by pushing a thin grass stem down the entrance to detect the direction of the burrow. Ground-nest contents were stored in absolute alcohol. Specimens of all species except *C. venticola* Packer were collected both using a hand net and pan traps partially filled with propyl glycol. White bowls and those painted with fluorescent yellow or blue paint were all attractive to the bees. Stem nests were partially opened in the field, stored in Ziploc® bags within a large plastic container and brought back to York University (under Agriculture Canada's Import Permit number P-2003-04794) until the bees eclosed or the nests were destructively sampled to observe cell linings and/or obtain other information.

Descriptions generally follow the format of Toro and Moldenke (1979) who described most of the Xeromelissinae currently known from southern South America. The following abbreviations are used: particular metasomal terga or sterna and antennal flagellomeres are denoted by the letters T, S and F respectively followed by the appropriate number; IOC – interocellar distance, OOC – ocellocular distance, UOD – upper interocular distance,

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LOD – lower interocular distance, i – interspace, d – puncture diameter; the last two abbreviations are used together to give an indication of the relative density of punctures, and OD to refer to the diameter of the median ocellus. The relative size or shape of some body parts are given as ratios in which the units are eyepiece graticule units at the magnification used (which varies among parts). Translating these to fractions of standard units would have resulted in many rather unwieldy numbers being listed.

SEM photographs were taken using a Hitachi™ S520 at 20 kV. Bees and/or cell linings of *Chilimelissa australis* and *Chilicola venticola* were not treated prior to coating with Osmium tetroxide whereas the provision mass-containing cells of *C. araucana* were critical point dried before coating. Figure 14 was taken with a coolsnap digital camera attached to a Leica™ M5A stereomicroscope. Pictures were processed with Photoshop™ software and turned into figures with QuarkXpress™.

Results

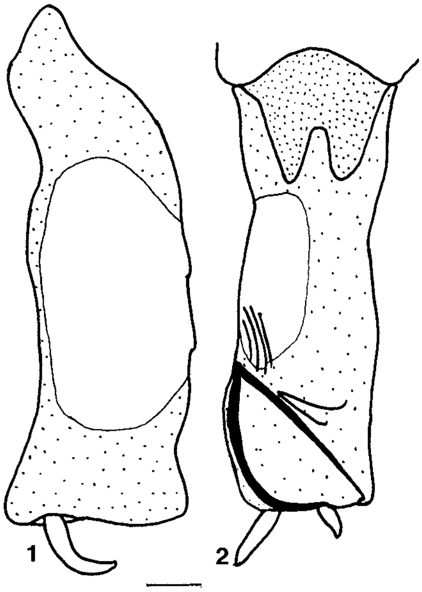
Chilicola (*Chilicola*) *venticola* Packer, new species

(Figs. 1–7)

DIAGNOSIS: The somewhat concave face, strongly curved and robust hind tibial spurs and presence of the episternal groove extending well below the level of the scrobal groove serve to identify this species as a member of the subgenus *Chilicola s. str.* Additionally, a new synapomorphy for the subgenus is the spinose apical process to the S6 in females. The males are readily separated from all other species of the subgenus on the basis of the comparatively unmodified hind tibia (Figs. 1, 2) which is almost parallel-sided and cylindrical, albeit more robust than in most bees and bearing some specialized features on its ventral surface. Other species in the subgenus (other than those of *C. colliguay* Toro and Moldenke) have a marked convexity on the ventral surface of the hind tibia (although not always as strongly marked as shown in Fig. 14). Males of the new species are readily differentiated from *C. colliguay* by the entirely dark coloration of the hind tibia in the latter species. The color pattern of the female metasoma in *C. venticola* is unique among the known females of the subgenus (this sex is unknown for *C. pangue* Toro and Moldenke, and *C. aisenensis* Toro and Moldenke): T2–T4 are orange-red turning to dark brown towards the lateral portions of the terga such that the ventrally reflexed portions are entirely dark. In *C. colliguay* the metasoma is entirely dark and in *C. rubriventris* Spinola T1–T5 are red except for small marks near the base of T1 and the foveae of T2 and T3 which are dark. Additionally, the other two species have the vertex slightly convex whereas in the new species it is slightly concave when seen from the front (Fig. 7).

DESCRIPTION: **Male.** Length 5.5 mm, forewing length 4.0 mm, head width 1.5 mm.

Colouration: Black-brown with following parts yellow: labrum, basal half of mandible (rest testaceous tending to red-brown), large T-shaped mark on clypeus, lower paraocular area to just beneath antennal socket, spot anteriorly on tegula (rest translucent pale straw), small spot on apico-ventral margin of hind coxa, small spot on flat posterior portion of hind trochanter, apical rings on all femora, foretibia except for posterior brown blotch, midtibia except for broad medial brown ring which is narrowly incomplete on anterior surface, hind tibia except for broad medial brown ring which is narrowly incomplete on ventral surface (Figs. 1, 2), all basitarsi except brown dorsal surface at apex of hind basitarsus; spot at apex of ventral surface of scape, ventral surfaces of pedicel and flagellum orange-brown; apically impressed areas of T1–T7 testaceous; wing veins dark brown except first sectors of M+Cu and V pale testaceous.

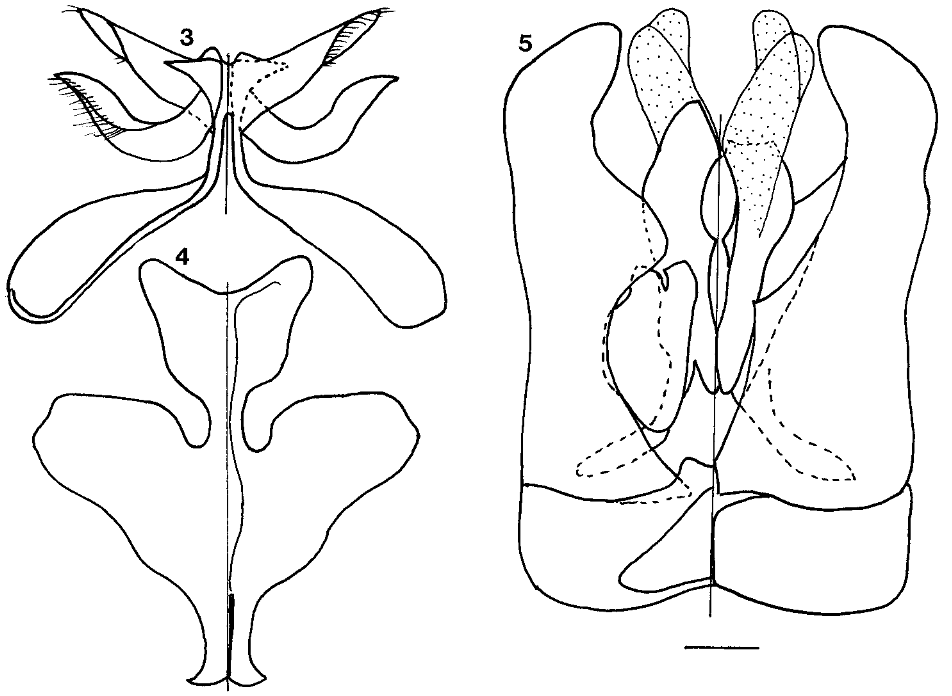


Figs. 1, 2. Hind tibia of male *Chilicola* (*Chilicola*) *venticola* Packer, new species. 1. Outer surface, 2. Ventral surface. The inner hind tibial spur in Fig. 1 is hidden behind the basitarsus (not shown). Sparse stippling represents areas of pale colouration, dense stippling denotes membranous area between tibia and femur, the relative sizes of carinae and carinulae are denoted by the thickness of the black lines in Fig. 2. Scale = 0.1 mm.

Surface sculpture: Microsculpture granular, dense, surface moderately dull except on face below antennae; punctures distinct and of moderate size throughout, sparse on clypeus and supraclypeal area $(i > 2d)$, somewhat denser on lower paraocular area $(i \sim d)$, dense almost crowded on upper frons; mesoscutum and mesoscutellum unevenly punctate $(i = 1 - 4d)$, metanotum with dense rough microsculpture, mesopleura more densely and evenly punctate $(i = 1 - 2d)$; dorsal surface of propodeum irregularly reticulate; metasomal terga with strong microsculpture, very dull, punctures deep, dense and distinct $(i = 1 - 2d)$; apical impressed areas devoid of punctures and microsculpture on T1–T4, microreticulate on T5–T7.

Pubescence: Face, gena, posterior surface of forefemur, lateral surface of mesothorax and propodeum, dorsal portion of outer surface of hind femur and apical impressed areas of T1–T5 with moderately dense, somewhat woolly, white hairs up to 3OD in length, except up to 2OD on hind femur and metasoma; posterior band of short, appressed white scale-like hairs on posterior margin of dorsal surface of pronotum, similar hairs on lateral portion of mesoscutum; vertex, mesoscutum, mesoscutellum and metanotum with fine, long hairs very sparse except on vertex (3OD); very small hair tufts on postero-lateral corners of S2 and S3.

Structure: Head broader than long (48:43), IOC one and one-half OOC (9:6), eyes convergent below UOD:LOD (29:23); clypeus broader than long (19:14), extending one-third of its length beyond lower ocular tangent; face below antennae flat with median longitudinal depression on clypeus; antenna with scape long and narrow, ratio of lengths (ventral surface) of pedicel: F1–F3 - 6:7.5:9:11; antenna lacking any conspicuous modifications other than an obtuse angulation on ventral surface of FI; upper paraocular area distinctly and broadly depressed above antenna; vertex slightly concave in frontal

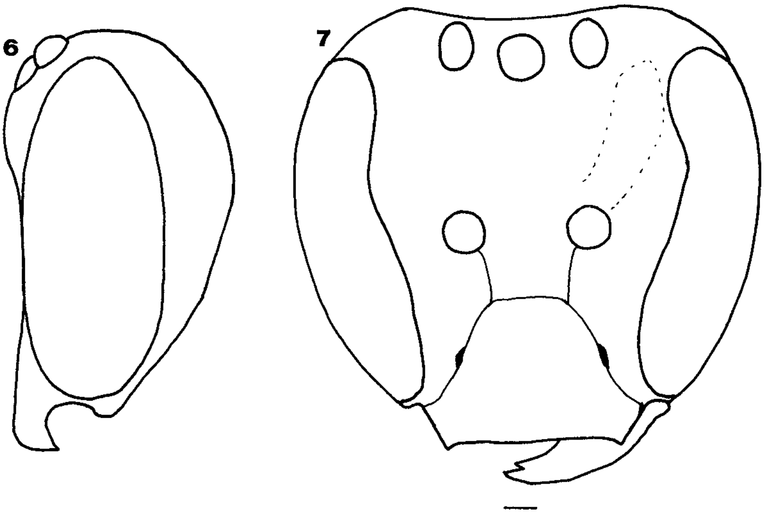


Figs. 3–5. Terminalia of male *C. venticola*, ventral views to left, dorsal to right. 3. S7, 4. S8, 5. Genitalia, stippling represents membranous lobes to penis valves. Scale = 0.1 mm.

view; gena less than half as wide as eye (12:32); dorsal area of propodeum intermediate in length to metanotum and scutellum (16:13:24); posteroventral surface of hind trochanter flat, forming a slightly acute angle with mesal surface and continuous with concave ventral surface of hind femur; hind femur considerably expanded, greatest height to greatest length 42:72; hind tibia (Figs. 1, 2) robust, subcylindrical with ventral surface somewhat flattened and apex slightly expanded dorsally and ventrally, with strong carina on inner ventral margin starting at midlength and extending along medial margin to apex and then across apex towards outer hind tibial spur, weaker carina extending from base of stronger one to outer posterior extremity of tibia, the two carinae delimiting an approximately semi-circular flat area, weak carinulae somewhat parallel and basal to weaker carina with more longitudinal carinulae just basal to junction between the two stronger ones; T1 slightly broader than long (64:60); S1 somewhat swollen apically, other sterna lacking modifications; terminalia as in Figs. 3–5, S7 with two pairs of lateral lobes; apex of S8 broadly concave, anterior margin of spiculum biconvex; gonoforceps elongate with slightly acute angle on inner dorsal surface, penis valves with two large membranous appendages.

Female. Length 5.0 mm, forewing length 4.0 mm, head width 1.4 mm.

Colouration: Black with following parts dark yellow: dorsal half of basal third of mandible (apical portions testaceous to dark red-brown apically), spot on apex of forefemur, basal spot and narrow apical ring on all tibiae, dorsal surface of foretibia; following parts testaceous: foretarsi, ventral surface of midtarsus and narrow apical ring on each hindtarsomere; ventral surface of antennal flagellum dusky yellow; wing veins dark brown except for basal portions of M+Cu and V pale yellow; metasomal terga dusky



Figs. 6, 7. Head of female *C. venticola*. 6. Lateral view, 7. Frontal view, dotted line shows extent of depressed area dorsal to antennal sockets. Scale = 0.1 mm.

orange except vertical portion of T1, lateral one-quarter on each side of T2–T4, most of T5 and all of T6 brownish-black.

Surface sculpture: Microsculpture granular, surface moderately dull except on face, paraocular areas particularly shiny, region between antennae and ocelli longitudinally striate; punctures fine and sparse throughout ($i > d$) except on frons, anterior margin of mesoscutum and anterior and posterior margins of mesoscutellum ($i = d$); metanotum with rougher microsculpture, dull; dorsal surface of propodeum with irregular longitudinal striae, only the median stria attaining the posterior margin; metasomal terga shiny despite moderately dense microsculpture, with very sparse punctures.

Pubescence: Face with moderately sparse erect hairs of highly variable length up to 3OD, denser on lower paraocular area; band of dense plumose pubescence on posterior margin of pronotoum; mesoscutum with sparse short hairs ($<$0.5OD, very few hairs 1OD), with dense plumose hairs on posterolateral corners; mesoscutellum with short sparse hairs, longer and denser laterally and with a few anteriorly directed long hairs along posterior margin (2.5OD); lateral surface of propodeum with long somewhat woolly hairs ($\leq$3OD), decreasing in size ventrally; scopa on hind femur and tibia with hairs ($\leq$2OD); T1–T4 with apical patches of somewhat woolly white pubescence ($\leq$1OD) forming broadly interrupted bands on T2–T4, bands on T2 and T3 continue onto the ventrally curved portions of terga; patches on T1–T3 particularly dense and conspicuous; scopa on S2 weak, absent from central portion, hairs with few branches ($\leq$1OD).

Structure: Head (Figs. 6, 7) broader than long (47:41), trapezoidal in shape with vertex slightly concave, IOC subequal to OOC (8:7); eyes converging below, UOD:LOD 29:23; clypeus broader than long (21:14) extending for approximately one third of its length beyond lower ocular tangent, flat with slight longitudinal median depression; malar space linear; area above antennal base broadly depressed to level of medial extremity of compound eye; gena narrow, ratio of width of compound eye to gena 13:9 (7. 6); propodeum much shorter than scutellum (15:25).

MATERIAL STUDIED: Holotype male, allotype female, one male paratype and three female paratypes: ARGENTINA, Santa Cruz, Hwy 26 E. of Valle Hermosa, S45°46′789″ W068°14′636″, 657 m, 27.xi. 2003, L. Packer, all ex dead stems of *Sisymbrium altissimum* L. An additional pupa of each sex was damaged as the nest was opened; these were both fully developed and in the process of eclosion, these have been partially disarticulated and are stored in glycerine. An additional female is stored frozen and will be used for DNA extraction. The holotype and allotype are housed in the Museo Nacional de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina. The paratypes are housed in the author's collection at York University, Toronto, Canada.

COMMENTS: All individuals known were found in a single stem nest, described in the section below. All individuals were callow adults when the nest was collected other than one male and one female, noted above, which were pupae when collected. Most bees were kept alive for several days before being killed so that their wings could harden.

ETYMOLOGY: The specific epithet is a reference to the windy nature of the area in which the species was found, being based upon the Latin word for windy – *ventoso* and *cola* – dweller.

Notes on the Nest Architecture of *C.* (*Chilicola*) *venticola* Packer

A nest of this species was discovered at the type locality in a dried stem of tumble mustard, *Sisymbrium altissimum* L. (Cruciferae), a Eurasian plant that is an invasive species in many other parts of the world (USDA, NRCS, 2004). The stem, like those in which nests of *C. araucana* were found (see below), had been uprooted and apparently blown across the road where it had lodged in spinose bushes of *Adesmia* spp. (Fabaceae) [at least four different species of this genus occurred at this site (M. Arbo, pers. comm.)]. The stem in which *C. venticola* nested had its broken base uppermost. The nest entrance was in the base of the stem.

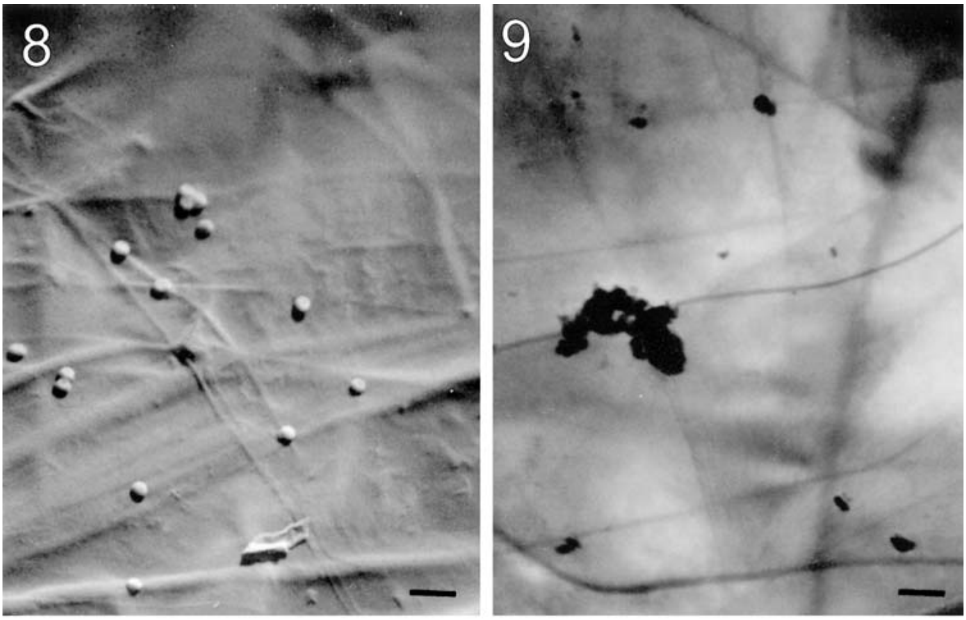
The nest must have contained at least 12 cells as seven females, two males and one large ichneumonid (*Grotea* sp.) taking up the space of two cells, emerged from it and there was one cell which seems to have been filled in with old nesting material and dried pollen. Measured cell dimensions were 6.1 mm and 6.5 mm in length and 3.8 mm and 4.0 mm in diameter respectively for the two cells.

The inner surface of the burrow, after removal of the brood cells, looked as if another layer of secretion had been applied to, and absorbed by, the pithy material.

SEM micrographs of the cell lining show a comparatively smooth surface with some evidence of marks perhaps associated with the application of the lining materials (Fig. 8). These marking are, however, somewhat ill-defined, suggesting that the lining materials are applied in a fairly liquid form and that "brush" marks from the tongue are largely effaced as the liquid spreads and dries. Examination of the broken edges of cell linings failed to reveal evidence of their being more than one layer of cellophane-like material, although the material absorbed by the inner surface of the pithy stem should be considered as a second layer. The small granules in Fig. 8 may be bacteria; they are too small to be pollen grains.

The Female of *Chilicola* (*Chilioediscelis*) *araucana* Toro and Moldenke
(Fig. 10)

DIAGNOSIS: This species is readily identified as a member of the subgenus *Chilioediscelis* by the strongly curved hind tibial spurs (shared with the nominate subgenus), considerably reduced tooth on the claws of the hind pretarsus and the absence of the episternal groove below the scrobal groove. Among the Xeromelissinae, the last two features are synapomorphies for *Chilioediscelis* species. Females can be separated from the other two known species of the subgenus by their metasomal colouration. The metasoma of *C. andina*



Figs. 8, 9. SEM micrographs of brood cell linings. 8. *C. venticola* showing weak markings perhaps resulting from the application of the cell lining materials; the small granules may be bacteria, they are too small to be pollen grains. Scale = 5 µm. 9. *Ch. australis*, the black blotches are extraneous material. Note the absence of three-dimensional effects associated with the dark lines in the brood cell lining in contrast to those visible in Fig. 8, suggesting a chemically heterogeneous mixture of materials. Scale = 5 µm.

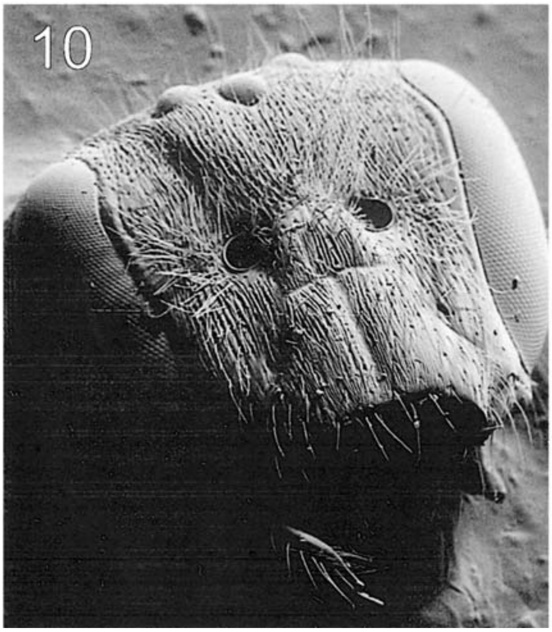


Fig. 10. SEM micrograph of face of female *Chilicola* (*Chilioediscelis*) *araucana* Toro and Moldenke to show striate sculpture, depression above antennal socket and longitudinal median depression of the clypeus.

Toro and Moldenke is entirely dark, whereas that of *C. patagonica* Toro and Moldenke is largely orange-red with most of T1, the basal two-thirds of T2 and lateral markings on T3 and T4 dark brown. Females of *C. araucana* have T1–T3 entirely dark except for the testaceous apical impressed margins, T4 is either entirely dark or dark for the basal two-thirds with the rest bright orange, T5 is bright orange and T6 is orange but dark apicomedially. The colouration of the metasoma in *C. araucana* changes abruptly from black to orange, whereas in *C. patagonica* the markings are less discrete. Additional differences between *C. patagonica* and *C. araucana* include the larger size of the latter (over 5.5 mm versus less than 5 mm), the longer malar space in *C. araucana* (almost as long as the greatest width of the scape whereas in *C. patagonica* the malar space is much shorter) and the more extensive pale colouration on the dorsal surface of the foretibia: such marks are restricted to the basal half of the tibia in *C. patagonica* but extend almost the entire length of the tibia in *C. araucana*. Males can readily be distinguished on the basis of the same size and malar space differences as in females and also by the more robust hind tibia of *C. araucana* and differences in the genitalia, these features were figured by Toro and Moldenke (1979; Figs. 33–58). *C. andina* is known from Santiago to Coquimbo province in Central Chile, whereas both the other species are from Patagonian Argentina and can be found almost sympatrically near Los Antiguos, Santa Cruz Province (Packer, pers. obs.).

DESCRIPTION: Length 5.5–6.5 mm, wing length 4.5–5 mm, head width 1.9–2.1 mm.

Colouration: Black with following parts dark yellow: spot on pronotal lobe, small apical spot on fore and mid femur, most of dorsal surface of foretibia, small basal spot on mid tibia, small anterior spot on tegula (rest translucent amber); following parts testaceous: base of wing veins, apical impressed areas of metasomal terga, hind tibial spur; T5 and usually apical portion of T4 and basal and lateral portions of T6 bright orange.

Surface sculpture: Head longitudinally striate throughout except on vertex (Fig. 10), punctures indistinct among striae except on upper paraocular area and vertex ($i \sim d$); thorax with fine, distinct punctures on a granulose microsculptured background, punctures irregular on mesoscutum ($i = 1 - 6d$), especially sparse just mesad of parapsidal line, punctures of mesoscutellum and mesopleura more evenly spaced ($i = 1 - 3d$); metanotum with deeper microsculpture and denser punctation ($i = d$); dorsal area of propodeum with fine longitudinal striae attaining posterior margin, somewhat reticulate towards base; punctures of metasomal terga finer than on thorax, microsculpture somewhat granulose, strongest on T1.

Pubescence: Erect hairs on face and thorax yellowish ($\leq$2OD), on pleura and propodeum white ($\leq$2OD), white appressed tomentum forming a band across posterior margin of pronotum and lateral patches on T1–T3.

Structure: Head broader than long (61:53), trapezoidal in shape with vertex slightly concave in facial view (not detectable from oblique view in Fig. 10), IOC greater than OOC (10.5:9); eyes slightly converging below UOD:LOD 37:34; clypeus much broader than long (30:20) extending for almost one half of its length beyond lower ocular tangent, convex with longitudinal median depression; malar space subequal in length to apical breadth of scape; area above antennal base flat, appearing depressed in comparison to somewhat swollen mesal portion of frons; gena narrow, ratio of widths of compound eye and gena 15:9; propodeum much shorter than scutellum, subequal to length of metanotum, (9:14:8).

COMMENTS: This species varies somewhat in the strength of the mesoscutal punctures, strength of the microsculpture on the meso and metasoma and in the extent of orange on the midfemur of males and T4 of females, the demarcation of the latter is, however, always discrete. For comments on behaviour and nest structure see following section. John Ascher kindly compared one of my male specimens with the holotype male of *C. araucana* and notes that the only differences are slightly less yellow on the clypeus and slightly more yellow on the hind femur in the holotype.

MATERIAL STUDIED: All from ARGENTINA, Santa Cruz Province: Hwy 26 E. of Valle Hermosa, S45°46′789″ W068°14′636″, 657 m above sea level, 27.xi. 2003, L. Packer, one male and six females, females from nests in dead stems of *S. altissimum*; 23 km W. of Las Heras, S46°36′827″ W069°38′394″, 382 m, 16.xi.03, L. Packer, two males and one female ex pan trap, one of the males in alcohol; same locality but 17–27.xi.2003, pan traps, four males and seven females; 20 km E. of Los Antiguos, S46°36′595″ W071°21′472″, 237 m, one male and six females plus two males and one female in alcohol, 17.xi.03 L. Packer, one male two females same data except 17–21.xi.03, pan trap; 25 km E. of Los Antiguos, S46°37′187″ W071°18′322″ 250 m, 22.xi.03, L. Packer, one male and one female; 35 km E. of Los Antiguos, S46°36′118″ W071°11′845″, 234 m, one male and six females on 18.xi.03, L. Packer, one male and one female pan traps 17–23.xi.03, L. Packer. All specimens remain in the Packer collection at York University except for one pair at each of the following institutions: Museo Nacional de Ciencias Naturales, Buenos Aires, Argentina; Entomology Division, Natural History Museum, University of Kansas and American Museum of Natural History, New York.

Notes on the Biology of *Chilicola* (*Chilioediscelis*) *araucana*

Males and females of this species were found moderately commonly almost throughout the area encompassed by my field work in Santa Cruz Province, from 23 km West of Las Heras S46°37′W069°38′ 382 m in the East to 20 km E of Los Antiguos, S46°36′595″ W071°21′472″, 237 m, in the West. The latter location is very close to the type locality for *C. patagonica*; however, the two species are quite different and the author collected a short series of *C. patagonica* to the south of Los Antiguos. The bees were most commonly seen sitting on the flat soil surface immediately adjacent to an *Adesmia* bush to the leeward side in relation to the winds, which are persistently ferocious throughout the species' flight season in this part of the world. Several males and females could often be seen "resting" in this manner in an area of 0.25 m^2, but even in the comparative protection afforded by the *Adesmia* bushes, both males and females were often seen to be "blown off their feet" for a distance of several centimeters (the same thing happened to the author, although over somewhat larger distances). Females were observed moving from the ground to *Adesmia* flowers and back again, though rarely to exactly the same spot. Observations of three females demonstrated that they spent almost twice as much time stationary on the ground as they did actively foraging on flowers with stationary periods lasting from 7 to 20 sec (mean $= 12$, $n = 16$) and foraging bouts lasting from 3 to 20 sec (mean $= 7.5$, $n = 6$). Females visited from one to three individual *Adesmia* flowers per foraging trip, forcing entry into the somewhat tight and small flowers by pushing upwards with their heads as they curled over the lower petal of the flower. While on the ground females were occasionally observed "nectar whipping", a process whereby a drop of nectar is continuously manipulated by movements of the mouthparts and likely concentrated as a result.

There are 52 species of *Adesmia* in Patagonian Argentina and fruits are required for species level identification (M. Arbo, pers. comm.). In the Los Antiguos area, all *C. araucana* seemed to be associated with one moderately large (~1 m tall) species.

Nests of *C. araucana* were found at the same location as that of *C. venticola*, but were more numerous and were being actively provisioned, suggesting that the former species is active earlier in the season than the latter. The complete contents of two nests have been studied, one (Fig. 11) contained two cells, one with a small larva the other being actively

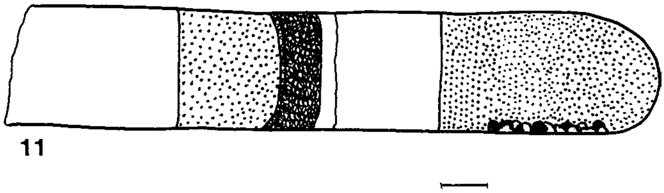


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Fig. 11. Diagram of two cells of *C. araucana* Toro and Moldenke. Sand grains are shown at the bottom of the brood cell on the right. Pith fragments are shown by dark webbing at the base of the brood cell on the left and the provision masses are indicated by stippling. Scale = 0.1 mm.

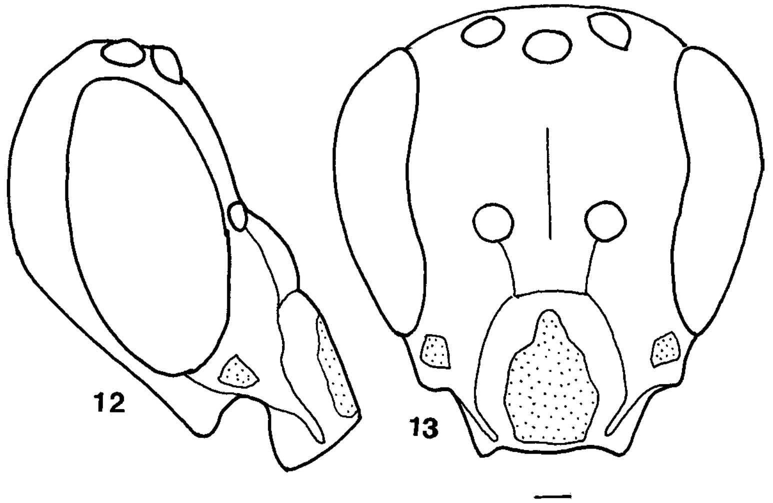
provisioned. The other nest contained one brood cell being actively provisioned. Provision masses were sticky and somewhat liquid but nonetheless the surface remained vertical when the cells were in a horizontal position. The cell with a complete provision mass contained a moderate number of sand grains at the bottom. This cell was 6.7 mm in length and 2.4 mm in depth. There was 0.3 mm of overlapping cell lining where the two cells met followed by 1.0 mm of pith fragments forming a plug at the base of the second cell. The length of the provision mass in the first cell was 4.5 mm, whereas that of the second was only 2.0 mm, further evidence that pollen and nectar were still being collected for this cell.

The cellophane-like cell lining material of *C. araucana* was identical in nature to that of *C. venticola* (Fig. 8). However, the absorbed layer on the inner surface of the burrow was more readily observed in this species and the brood cell lining adhered to it in places. When a cell was pried away from the stem, small strips of material could be seen joining the cell to the absorbed layer.

All adults had emerged from several additional nests (although it is possible that some, or all, of these might have belonged to *C. venticola*). The absorbed material on the inner walls of these stems resulted in the surface layer of pith becoming somewhat separable from the less superficial portions. In these vacated nests the faecal masses of the larval bees could be detected, although they were no longer adhering to the brood cell lining as they had been dislodged, presumably by the nest-vacating activities of the adults. All faecal masses were blackish in coloration, at the bases of the cells and most (9 out of 12 observed) were in the shape of a ring, the outer surface of which matched the shape of the base of the intact brood cells described above. The remaining three formed complete discs, although the centres were notably thinner that the edges.

The Female of *Chilimelissa australis* Toro and Moldenke
(Figs. 12, 13)

DIAGNOSIS: The genus *Chilimelissa* is readily identified by the yellow banding pattern on the metasoma, unusual modifications of the maxillary palps and greatly extended epistomal lobe (Michener, 2000). *Chilimelissa australis* is a member of the *Ch. chillan* species group which is typified, in the males, by an angular projection to the ventral margin of the forefemur and in both sexes by a strongly oblique malar suture (Fig. 12). Males of *Ch. australis* can be separated from all other species in the group by the unique concave ventral surface of the hind femur and F1 which is longer than broad (ratio 7.5:6, shorter than broad in the remaining species – ratio 5:6). Females can be differentiated from the other species of the *Ch. chillan* species group by the combination of the clypeus not sinuate in profile, the malar space and lateral clypeal flange mostly dark and the length and width of the malar space subequal. *Chilimelissa farellones* Toro and Moldenke has the clypeus sinuate in



Figs. 12, 13. Head of female *Chilimelissa australis* Toro and Moldenke. 12. Lateral view, 13. Frontal view. Stippling represents areas of yellow colouration. Scale = 0.1 mm.

profile, *Ch. chillan* Toro and Moldenke has the malar area and lateral clypeal flange yellow or orange and *Ch. machi* Toro has the malar space almost twice as long as wide.

DESCRIPTION: Length 4.0 mm, forewing length 2.7 mm, head width 1.3 mm.

Colouration: Black with following parts yellow: basal spot on mandible (rest testaceous other than red-brown apical one third), triangular mark on clypeus, spot on malar area above malar suture, ventral surface of antennal flagellomeres, apical rings on all femora, most of ventral surface of forefemur, basal and apical rings on all tibiae, inner and dorsal surfaces of foretibia, inner surface of midtibia, pronotal lobe, anterior spot on tegula (rest translucent amber), subapical bands on T1–T5 (margined anteriorly with orange and extreme apices of terga transparent, colourless); T6 entirely orange; labrum, metasomal sterna and wing veins dark brown except basal portions of M+Cu and V pale yellow.

Surface sculpture: Microsculpture granular and dense, surface moderately dull except supraclypeal and hypostomal areas and mesothoracic venter shiny; punctures sparse on clypeus, denser on supraclypeal area and dense, but not crowded, on frons ($i < d$); disk of mesoscutum and mesoscutellum with irregular punctures ($i = 2 - 5d$) denser anteriorly on mesoscutum and axillae $i \sim d$; sides of thorax almost impunctate, thoracic venter with weak, sparse punctures ($i = 2d$); metanotum minutely roughened; dorsal surface of propodeum with irregular longitudinal striae attaining the upper margin of declivous posterior surface; metasomal terga shiny, chagreened, with sparse minute punctures.

Pubescence: Face and mesoscutum with sparse erect hairs ($\leq$1OD); following parts with dense somewhat appressed whitish-yellow tomentum: lower paraocular area, genal area, dorsal surface of pronotum, anterior and posterior surfaces of mesoscutum, metanotum, upper half of mesopleura, dorsal portions of lateral surface of propodeum; band of dense plumose pubescence on posterior margin of pronotum; scopa on hind femur and tibia weak with hairs ($\leq$1.5OD); scopa on S2 with hairs longer anteriorly (2OD) decreasing posteriorly (to 1OD), hairs with few branches.

Structure: Head (Figs. 12, 13) breadth subequal to length (78:81); vertex flat in facial view, IOC 1.5 times OOC (8:12); eyes not convergent below UOD:LOD 42:42; clypeus broader than long (39:28), extending for approximately three-quarters of its length beyond lower ocular tangent; clypeus and supraclypeal area protuberant; malar space two-thirds basal width of mandible (9:14); malar suture clearly evident; gena much narrower than width of compound eye (10:25); dorsal surface of propodeum much shorter than scutellum and shorter than metanotum (5:16:7).

MATERIAL STUDIED: Almost all specimens, including the male holotype (Toro and Moldenke, 1979), were found on one sand dune approximately 2.8 km E. of the Los Antiguos town centre. Specimens collected by the author at this site are labeled ARGENTINA, Santa Cruz, 0.5 km E. of Los Antiguos, S46°33′500″ W071°35′507″, 235 m, with dates varying from 17–22.xi.03 L. Packer, 174 males and 73 females, most were collected in pan traps. Additional samples are all from Santa Cruz Province as follows: 10 km E. of Los Antiguos, S46°36′432″ W071°27′096″, 17.xi.03, L. Packer, one male; 20 km E. of Los Antiguos, S46°36′595″ W071°21′472″, 17.xi.03, L. Packer, four males (three in alcohol) and one female; 25 km E. of Los Antiguos, S46°37′187″ W071°18′322″, 250 m. 22.xi.03, L. Packer, eight males and one female. Some specimens of this species will be sent to the American Museum of Natural History, New York; Museo Nacional de Ciencias Naturales, Buenos Aires, Argentina; Entomology Division, Museum of Natural History, University of Kansas; Instituto Miguel Lillo, Tucuman; Universidad Católica de Valparaiso and the Zoological Institute of St. Petersburg. The remainder will be housed in the author's collection. The holotype male is the property of the American Museum of Natural History.

Notes on the Biology of *Chilimelissa australis*

This species was found abundantly on the sloping and horizontal surfaces of a sand dune at the type locality. The type label includes the following information "2.8 km E. of Los Antiguos" and "river dune". Although the species was found in four locations between Los Antiguos and 25 km E of the town, it was by far most abundant approximately 2.8 km from the town centre (0.5 km east of the edge of the town), on the first dune system reached when traveling east out of town along Hwy 43, on the south side. Males and females were observed darting from place to place on the sand surface, or from the sand to flowers of *Polygala sabuletorum* Skottsberg (Polygalaceae), a plant upon which it may be monolectic. The sand surface was sufficiently loose that males in particular were often seen "sliding" down the surface of the substrate for up to a centimeter before coming to rest. Movements were extremely frequent with males rarely staying stationary for more than one second.

Two small entrance holes in the sand were seen being entered by female *Ch. australis*. The entrances were in the slightly more compacted sand around the bases of the stems of *Adesmia* sp. The friability of the sand surface resulted in the entrances being uneven, but they were from 2.5 to 3 mm across and somewhat less deep. Only one nest could be completely excavated. The burrow extended almost horizontally for approximately 15 mm before curving downward where it ended in one empty brood cell at a depth of approximately 65 mm. Beneath the more normal sand at the very surface of the soil the substrate was noticeably gray, undoubtedly from the ash that resulted from the eruption of the Hudson Volcano in Chile in 1991, which deposited 80 cm of ash in the region. The brood cell was beneath this layer, in normal, clearly damper and less friable sand.

The brood cell lining was approximately 5 mm in length, parallel sided with a diameter of 3 mm. No pollen or faeces were found in the cell suggesting that it had been newly constructed. A few sand grains were on the inside of the cell lining perhaps resulting from my nest excavation activities, but a larger number were attached to the outer surface around the entrance of the cell suggesting that they were adhering to the outside.

Under the light microscope, the inner surface of the cell had a clearly fibrous component that extended along its length for only a small portion of its circumference. When the same surface was observed under the SEM these fibers were largely undetectable (Fig. 9) suggesting that they were not on the inner surface of the brood cell but had been covered over by less fibrous material. The SEM micrograph does, however, reveal the presence of "strands" of more electron absorbing material in a comparatively smooth matrix. Although these lines appear superficially similar to those found in the *Chilicola* nests (Fig. 8), they differ in that they clearly do not give three-dimensional relief but are on the same plane as the general matrix.

Discussion

In this paper I have described aspects of the nesting biology of three species of xeromelissine bee including a new species. Although the diversity of flowering plants observed in the field was generally low, and bee collecting under the cold and extremely windy conditions was slow and unusually difficult, it would appear that a large proportion of the bee fauna of this region may be unknown. In addition to the new species described here, at least six additional new species of *Chilicola* were found, suggesting the utility of additional collecting in different parts of southern Patagonia and/or during different times of the spring and summer. The ready discovery of fairly large numbers of *C.* (*Chilioediscelis*) *araucana*, a member of a subgenus that is generally considered to be very rare (Michener, 2000), further supports the suggestion that the apifauna of southern Patagonia should be further explored.

The *Grotea* (Ichneumonidae) parasite represents the first record of this genus parasitizing a stem-nesting colletid bee, although the genus has been recorded in nests of other stem nesting bees such as *Ceratina*, *Manuelia* (Apidae) and *Megachile* (Megachilidae) (Gauld, 2000). It would be of interest to discover how the parasite larva consumes two host larvae: the emerged adult certainly filled the space occupied by two host cells.

The subgenera *Chilicola* and *Chilioediscelis* are both known for their comparatively flat faces, indeed, those of the former subgenus are somewhat concave (Fig. 6), a highly unusual condition among the bees. Another unusual feature of both subgenera is that most individuals in collections have the head oriented forwards such that the face is on the same plane as the dorsal surface of the mesoscutum (Fig. 14). The same death posture was also observed in all individuals that were collected in pan traps. Observations of foraging bees suggests a functional explanation for this could be that the females have to push upwards with their heads to obtain entry to their floral hosts as noted above for *C. araucana*. Similarly, females of *C. rubriventris* have been seen foraging on *Adesmia* near Vallenar, Huasco Province, Chile (Packer, pers. obs.). These flower-entry movements presumably require stronger muscles for the upward movement of the head than are possessed by most bees which may explain the bees' posture in death and may favour a comparatively flattened face. A similar death posture was observed in females of *Leioproctus* (*Perditomorpha*) sp., a similar sized bee foraging on the same flowers.

The cell linings of bees of the family Colletidae have received some attention. They are made of secretions of the Dufours gland and/or salivary glands (Hefetz, *et al.*, 1979; Cane, 1983; Espelie *et al.*, 1992). The bee's tongue spreads the cell lining materials around, thereby explaining its bilobed nature in all but the males of a few species in the subfamily Hylaeinae (Michener, 2000). The waterproof nature of the cell linings is important for

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Fig. 14. Photograph of lateral view of male *Chilicola* (*Chilicola*) *rubriventris* Spinola, to show flattened face and death posture with head rotated upwards (both features thought to be associated with aiding flower entry) and shape of hind tibia of male.

preventing escape of the generally comparatively liquid provision mass in bees of this family (Torchio, 1984, for exceptions see Michener, 2000, p. 127). The number of layers of this lining varies among taxa: one was recorded in the ground nests of *Scrapter longula* (Friese) (Rozen and Michener, 1968), two in *Colletes ciliatoides* Stephen and *Co. compactus* Cresson (Torchio, 1965; Rozen and Favreau, 1968) and three in *Ptiloglossa arizonensis* Timberlake (Rozen, 1984).

The chemical nature of the lining also seems to vary. In *Hylaeus* it is made up of lipid and a silk-like protein (Espelie *et al.*, 1992) whereas it is mostly a type of polyester in *Colletes* (Hefetz *et al.*, 1979). Torchio (1984) gave a detailed account of the process of brood cell lining in *Hylaeus*. No similar chemical or behavioural observations are available for any species of Xeromelissinae. However, the ridges observed in the SEMs of *Chilicola* and the darker lines seen in *Ch. australis* suggest the presence of some fibrous components, possibly silk. Hefetz *et al.* (1979) showed that the outer cell lining of *Colletes* caused grains of soil to adhere to the surface and they also mention the presence of fibres that join the inner and outer layers of the cell lining (see also Rozen and Favreau, 1968). The material found absorbed by the inner surface of the pithy stem and the strips that joined the inner lining to the stem may be homologous features in *Chilicola*.

Xeromelissine bees are generally thought to nest in stems (or perhaps also abandoned beetle burrows in wood) as is well known for various subgenera of *Chilicola* such as *Anoediscelis* (Eickwort, 1967; Gonzalez and Michener, 2004; Michener, 2000; Packer, pers. obs. of *C. mailen* Toro and Moldenke), *Chilicola s. str.* (Packer, herein), *Chilioediscelis* (Packer, herein), *Oediscelis* [A. Zayed and J. Grixti, pers. comm. for *C. vernalis* (Philippi)] and *Oroediscelis* (Michener, 2002). *Chilimelissa* has also been thought to be a twig nester based upon observations of *Ch. rozeni* Toro and Moldenke, whose larva was described (as Xeromelissinae sp. A) by McGinley (1981) and *Ch. sielfeldi* Toro and Moldenke (Packer, pers. obs.). Exclusive woody substrate nesting for the subfamily was disproved by Michener and Rozen (1999) who found nests of *Geodiscelis megacephala* Michener and Rozen in sandy soil in San Juan Province, Argentina.

The finding of a species of *Chilimelissa* that nests in the ground suggests the possibility that other species of this genus might do the same. Observations of a large number of additional species indicate that the habit of alighting on the ground, where these white, black and yellow bees are remarkably well camouflaged, is common (Packer, pers. obs. of *Ch. irwini* Toro and Moldenke, *Ch. xanthorhina* Toro, *Ch. rosie* Toro and Packer and *Ch. laureli* Toro and Packer). Indeed, in bees of this genus, only *Ch. rozeni* (see above) and *Ch. sielfeldi* Toro and Moldenke (Packer, pers. obs.) are known to nest in stems. Although the observations of *C.* (*Chilioediscelis*) *araucana* above demonstrate that sitting on the ground and nesting in stems are certainly not mutually exclusive, a morphological character serves to suggest the possibility that perhaps most *Chilimelissa* species nest in the ground. Females of all species in this genus except *Ch. rozeni* and the species group that includes *Ch. sielfeldi* (i.e., those taxa known to nest in stems) possess rather long hairs on the foretarsi, and among these there are several hairs (usually at least one towards the apex of each of the first two tarsomeres) that are approximately twice the length of the others. It seems possible that this setation serves as a rake, in a manner more commonly associated with sand wasps (Evans, 1966; Bohart and Menke, 1976).

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Literature Cited

Bohart, R. M., and A. S. Menke. 1976. The Sphecid Wasps of the World: A Generic Revision. University of California Press, Berkeley, California.

Cane, J. H. 1983. Chemical evolution and chemosystematics of the Dufour's gland secretions of the lactone-producing bees (Hymenoptera: Colletidae, Halictidae and Oxaeidae). Evolution 37:657–674.

Eickwort, G. C. 1967. Aspects of the biology of *Chilicola ashmeadi* in Costa Rica. Journal of the Kansas Entomological Society 40:42–73.

Espelie, K. E., J. H. Cane, and D. S. Himmelbach. 1992. Nest cell lining of the solitary bee *Hylaeus bisinuatus*. Experientia 48:414–416.

Evans, H. E. 1966. The Comparative Ethology and Evolution of the Sand Wasps. Harvard University Press, Cambridge, Massachussetts.

Gauld, I. D. 2000. The Ichneumonidae of Costa Rica, 3. Memoirs of the American Entomological Institute 63:1–453.

Gonzalez, V. H., and C. D. Michener. 2004. A new *Chilicola* from Colombian Páramo (Hymenoptera: Colletidae: Xeromelissinae). Journal of the Kansas Entomological Society (In press).

Hefetz, A., H. M. Fales, and S. W. T. Batra. 1979. Natural polyesters: Dufour's gland macrocyclic lactones form brood cell laminesters in *Colletes* bees. Science 204:415–417.

McGinley, R. J. 1981. Systematics of the Colletidae based upon mature larvae with phenetic analysis of apoid larvae. University of California Publications in Entomology 91:i–xvi,1–307.

Michener, C. D. 2000. The Bees of the World. Johns Hopkins University Press, Baltimore, Maryland. xiv + [1] + 913 pp.

Michener, C. D. 2002. The bee genus *Chilicola* in the tropical Andes, with observations on nesting biology and a phylogenetic analysis of the subgenera (Hymenoptera: Colletidae, Xeromelissinae). Scientific Papers of the Natural History Museum, University of Kansas 26:1–47.

Michener, C. D., and J. G. Rozen, Jr. 1999. A new ground nesting genus of xeromelissine bees from Argentina and the tribal classification of the subfamily (Hymenoptera: Colletidae). American Museum Novitates. 3281: 10 pp.

Rozen, J. G., Jr. 1984. Nesting biology of diphaglossine bees (Hymenoptera, Colletidae). American Museum Novitates 2786: 33 pp.

Rozen, J. G., Jr., and M. S. Favreau. 1968. Biological notes on *Colletes compactus compactus* and its cuckoo bee, *Epeolus pusillus* (Hymenoptera: Colletidae and Anthophoridae). Journal of the New York Entomological Society 76:106–111.

Rozen, J. G., Jr., and C. D. Michener. 1968. The biology of *Scrapter* and its cuckoo bee *Pseudodichroa* (Hymenoptera: Colletidae and Anthophoridae). American Museum Novitates 2335: 13 pp.

Torchio, P. F. 1965. Observations on the nesting biology of *Colletes ciliatoides*. Journal of the Kansas Entomological Society 38:182–187.

Torchio, P. F. 1984. The nesting biology of *Hylaeus bisinuatus* Forster and development of its immature forms. Journal of the Kansas Entomological Society 48:257–279.

Toro, H., and Moldenke. 1979. Revision de los Xeromelissinae Chilenos (Hymenoptera – Colletidae). Annales del Museo de Historia Natural de Valparaiso 12:95–182.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490, USA.