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## Second species of *Augochlorodes* (Hymenoptera: Halictidae: Augochlorini) with known males and first record for the genus in Argentina

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### Abstract

The bee genus *Augochlorodes* Moure, up to now only known from Brazil, is recorded for the first time for Argentina. *Augochlorodes politus* Gonçalves & Melo was found in the south of the province of Buenos Aires, mideastern Argentina, being the southernmost record for the genus. The female of *A. politus* is redescribed and the male described for the first time, being the second male known for this genus. The phylogenetic position of *Augochlorodes* among Augochlorini is briefly discussed.

**Key words:** Province of Buenos Aires, South America, sweat bees, taxonomy

### Introduction

*Augochlorodes* Moure are small, bright-green bees of the tribe Augochlorini. The genus was described by Moure (1958) based on the single species *Augochlorodes turrifaciens* Moure. Recently, five species were added to the genus: *A. clementis* Gonçalves & Melo, *A. incomitatus* Gonçalves & Melo, *A. politus* Gonçalves & Melo, *A. rostratus* Gonçalves & Melo and *A. vachali* Gonçalves & Melo (Gonçalves & Melo 2008). Both sexes are known for *A. turrifaciens*, but only female specimens are known for all other described species.

Species of *Augochlorodes* resemble small *Augochlorella* Sandhouse and *Augochlora* Smith in appearance, although they can be differentiated by the noncarinate preoccipital ridge, the obtusely angled paraocular lobe, and the pectinate inner hind tibial spur of the female (Eickwort 1969; Engel 2000; Michener 2007). Nests were described for *A. turrifaciens* by Michener and Seabra (1959); they consist in short burrows in the soil, terminating in clusters of cells. This species was classified as having solitary and semisocial behavior by Danforth & Eickwort (1997), and it is the only one for which there is information about its biology.

*Augochlorodes* is known to occur from Minas Gerais to Rio Grande do Sul, Brazil, on the border with Uruguay (Michener 2007; Gonçalves & Melo 2008). One male and two females of *A. politus* from the province of Buenos Aires, Argentina, were recently added to the Entomology Collection of the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”. A fourth female specimen of the collection was identified as belonging to the same species. These specimens agree with *Augochlorodes* in the key to halictine genera of Michener (2007), and with previous diagnoses for the genus (Moure 1958; Eickwort 1969; Engel 2000, Gonçalves & Melo 2008). The aims of this contribution are to redescribe the female and describe the male of *A. politus*, reporting the southernmost record for the genus, and to discuss the phylogenetic position of *Augochlorodes* among Augochlorini.

### Material and methods

Higher-level classification of Halictidae and terminology for structures follow Michener (2007), except that *metapostnotum* is used instead of *basal area of propodeum* (Brothers 1976). Terminology for surface sculpture follows Harris (1979). The abbreviation MOD stands for median ocellar diameter, and it is used to give a relative

measure of hair length. The abbreviation PD stands for puncture diameter, and it is used to give a relative measure of puncture density. Individual flagellomeres, and metasomal terga and sterna are referred to by the letters F, T and S, respectively, followed by the appropriate number. Measurements were made following Michener (2007: figure 10–3 b). Examined specimens are housed at the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina (MACN). The holotype of *A. politus* was studied through photographs, thanks to the courtesy of Gabriel A.R. Melo (Departamento de Zoologia da Universidade Federal do Paraná, Curitiba, Brazil). To revise the relationship of *Augochlorodes* among other Augochlorini, the data matrix of Engel (2000) was modified, adding the information of *A. politus* male. *Augochlorodes* was coded with the same states present in *Augochloropsis* Cockerell for the apical margin of S4 (character 43 of Engel 2000), apical margin of S8 (char. 50 of Engel, 2000), and inner apical corner of the volsella (char. 55 of Engel 2000). Furthermore, we added a character to the matrix: lateral apical corners of S4 projected posteriorly and bearing modified setae, which was coded zero for outgroups and most Augochlorini, and one for *Augochlorodes*, *Augochloropsis*, *Paraugochloropsis* Schrottky, *Stilbochlora* Engel, Brooks & Yanega and *Thectochlora* Moure. This matrix was run under the same parameters used by Engel (2000: 63), with the same program used in that study: Nona v. 1.6 (Goloboff 1993). In addition, the matrix was run with the program TNT v. 1.1 (Goloboff *et al.* 2008) to explore possible changes with a more powerful program.

## Results

### *Augochlorodes* Moure

*Augochlorodes* Moure, 1958: 53–55. Type species: *Augochlorodes turrifaciens* Moure 1958, by original designation.

The diagnostic characters of *Augochlorodes* have been indicated by Moure (1958), Eickwort (1969), Engel (2000), Michener (2007) and Gonçalves & Melo (2008).

### *Augochlorodes politus* Gonçalves & Melo (2008)

(Figs. 1–8)

**Male description.** Length, 5.9 mm; forewing length, 4.1 mm.

**Color:** Body dark green with a metallic coppery tint on upper head area, mesoscutum, scutellum, metanotum and pleura. Apical fifth of clypeus dark purple with a black apical band. Hypostomal area dark coppery. Following parts dark brown to black: antenna, labrum, mandible, tegula, coxae, trochanters, femora near to apex, middle of mid and hind tibiae, sterna and apical margins of terga. Following parts light brown: apex of femora, tibiae, tarsi and apical margins of sterna. Wings light amber, with light brown veins and pterostigma, radial vein of forewing dark brown.

**Pubescence:** Whitish. Head with dense, plumose hairs on upper part of paraocular area and frons; erect hairs on gena as long as 1.4–2.5 times MOD; hairs on vertex as long as 2.1 times MOD. Thorax with plumose hairs on mesoscutum, scutellum and pleura (1.1–1.6 times MOD), longer on metanotum (up to 2.1 times MOD). Lateral side of propodeum with plumose hairs as long as 1.0–1.6 times MOD. Vestiture sparse on legs. Base of T1 with plumose hairs as long as 1.4–1.7 times MOD. Terga with hairless apical margins; disc of terga with simple hairs as long as 0.3 times MOD directed laterally, and with longer scattered simple hairs as long as 1 time MOD directed posteriorly; T2–T7 with some longer plumose hairs laterally, with their apices directed posteriorly. S1 with plumose hairs up to 1.9 times MOD, shorter and scattered on S2 and S3. Simple hairs as long as 0.4 times MOD on S2–S6, longer and thicker on apical part. S4 with plumose hairs on lateral apical part, with branches only on one side of the hair; the longest as long as 4 MOD, with branches restricted to the apical fourth (Fig. 5).

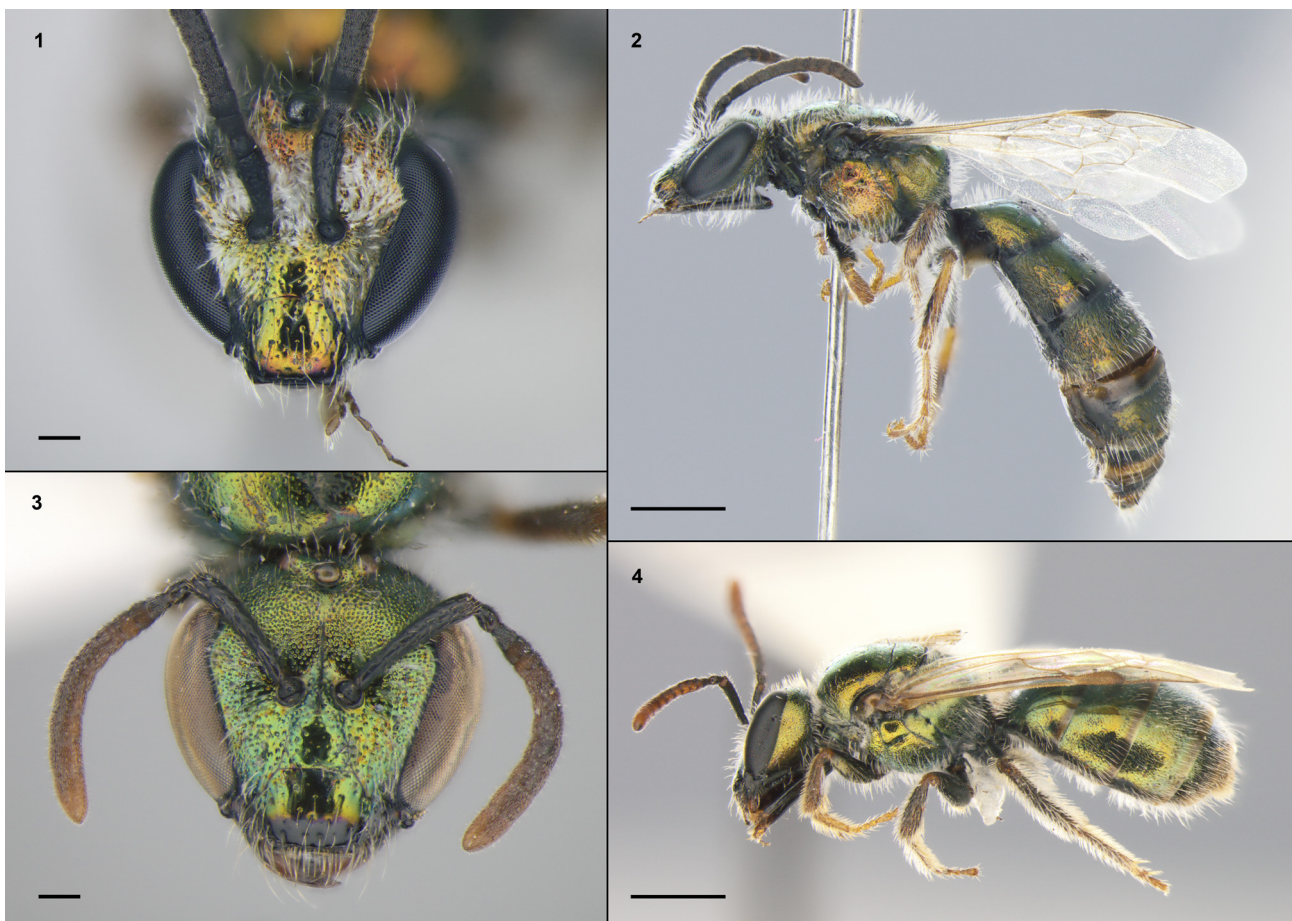
**Sculpture:** Labrum impunctate. Clypeus with punctures separated by 3–4 PD, punctures finer at sides. Lower paraocular area with punctures separated by 0.5–1 PD, sparser on supraclypeal area. Upper paraocular area with punctures separated by 0.5 PD. Punctures on disc of mesoscutum, scutellum and metanotum separated by 1–3 PD; those on pleura and propodeum separated by 0.5–1 PD. Dorsal surface of metapostnotum reticulate, with radiate

short striae on its base, smooth on its apex. Metasoma with fine punctures, disk of terga with punctures separated by 2–3 PD. Surface between punctures on head and mesosoma smooth, substrigulate on metasoma but smooth on disk of T1.

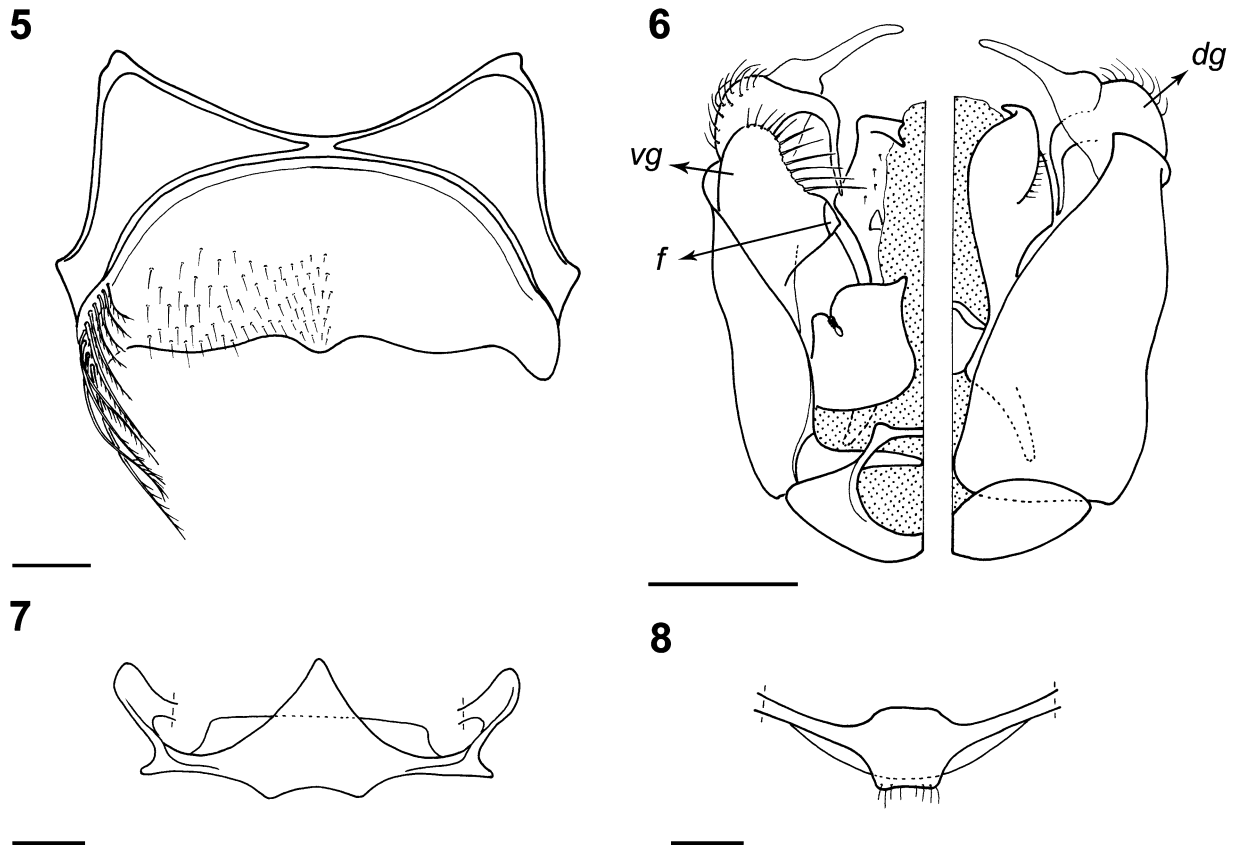
**Structure:** Head as broad as long, 1:1. Proportion of lower to upper interocular distance 0.7:1. Clypeus broader than long, 1.5:1. Proportion of interantennal to antennocular distance, 1:1. Proportion of posterior interocelar to ocello-ocular distance, 0.9:1. Proportion of length of scape, pedicel and first three flagellomeres 3.7:0.9:1:0.9:1. Third flagellomere 1.3 times as wide as its length. S1 with rounded apical median notch, following sterna with their apical margin straight. S3 and S4 with weak median apical angle; S4 with laterals produced (Fig. 5). S5 with margin straight. S6 with median apical notch. S7 with a truncate, setose median projection (Fig. 8). S8 weakly produced posteriorly into a bilobed median projection, spiculum broad (Fig. 7). Genital capsule (Fig. 6): Ventral gonostylus with slightly produced flap without hairs, a row of thick simple hairs along the apical margin. Dorsal gonostylus hairy basally, with two hairless projections directed inward: the ventral most one more sclerotized, with a filiform end, directed basally; the other one slender, flattened, tapering apically, directed medially. Volsella rounded basally, with concave inner margin; inner apical angle acute, projected. Penis valve with short setae bordering dorsal keel; ventrally with rudimentary prong.

**Female redescription.** Length, 4.8–5.0 mm; forewing length, 3.7–3.8 mm.

**Color:** Body dark green. Clypeus with black apical band (as long as 0.4–0.5 of clypeus total length). Hypostomal area dark coppery. Following parts dark brown to black: scape, pedicel, posterior surface of flagellum, labrum, mandible except reddish apex, tegula, most of legs, sterna and apical zone of terga. Following parts light brown: anterior surface of flagellum, front of foretibia and entire foretarsus. Tegula translucent. Wings light amber, with light brown veins and pterostigma, radial vein of forewing dark brown.



**FIGURES 1–4.** *Augochlorodes politus*. 1, 3 facial view; 2, 4 lateral habitus. 1, 2 male; 3, 4 female. Scale bars: 1, 3, 200  $\mu$ m; 2, 4, 1 mm.



**FIGURES 5–8.** *Augochlorodes politus*, male. 5, fourth sternum. 6, genital capsule, dorsal view (right) and ventral view (left). 7, eighth sternum. 8, seventh sternum. *dg*: dorsal gonostylus; *vg*: ventral gonostylus; *f*: flap. Scale bars: 5, 6, 200  $\mu\text{m}$ ; 7, 8, 100  $\mu\text{m}$ .

**Pubescence:** Whitish. Head with erect, plumose hairs; those on paraoocular area and vertex as long as 0.8–1.7 times MOD; hairs on lower part of genal area as long as 1.4–2.6 MOD. Thorax with plumose hairs on mesoscutum (0.5–0.9 times MOD), longer on pleura (1.2–1.9 times MOD) and metanotum (up to 1.5 times MOD). Lateral side of propodeum with very short, simple hairs (0.1–0.2 times MOD) and intermixed longer simple hairs (up to 1.9 times MOD). Vestiture rather dense on legs. Terga with hairless marginal zones, at most a few hairs scattered on the sides of T3–T4; disc of terga with very short, erect hairs (0.2–0.3 times MOD), laterally with some longer hairs with their apices directed latero-posteriorly. Posterior margin of S2–S3 with long, simple hairs, as well as rather long-barbed hairs with their apices directed posteriorly. Posterior margin of S4–S5 with plumose hairs, slightly shorter than those on previous sterna.

**Sculpture:** Labrum with median, basal elevation (as in Eickwort 1969: page 455: figure 150). Lower paraoocular area with strong punctures of different sizes, separated by approximately 0.5–1 PD. Clypeus and supraclipeal area with punctures separated by 3–4 PD. Upper paraoocular area and frons with punctures separated by 0.5 PD. Punctures on disc of mesoscutum and metanotum separated by 1–3 PD, those on pleura separated by 1–2 PD and those on propodeum separated by 0.5–1 PD. Dorsal surface of metapostnotum as in male, reticulate, with radiate short striae on its base, smooth on its apex. T2–T4 with punctures separated by 3–4 PD, sparser on T1. Surface between punctures smooth throughout the body, slightly reticulate on upper paraoocular area, frons, pleura and lateral side of propodeum; substrigulate on metasoma but smooth on disk of T1.

**Structure:** Head broader than long, 1.0–1.1:1. Proportion of lower to upper interocular distance 0.7–0.8:1. Clypeus broader than long, 1.4–1.7:1. Proportion of interantennal to antennocular distance, 0.6:1. Proportion of posterior interocelar to ocello-ocular distance, 0.8:1. Inner hind tibial spur pectinate, with two or three teeth.

**Variation.** The lateral surface of the propodeum is entirely microreticulated in the females from Sierra La Barrosa and Sierra La Chata, but it is smooth on its anterior part in the specimen from Sierra El Volcán. The specimen from Sierra La Barrosa has hairs on the vertex and lower part of the genal area slightly longer than in the other specimens, and the body has a metallic coppery tint on the upper head area, mesoscutum and scutellum.

**Material examined. ARGENTINA: Buenos Aires. Partido de Tandil:** 1 male (MACN-En 13517), Tandil, Cerro El Mate, -37.3644 -59.1419, 270–290 m a.s.l., 24–25-II-2011, C. Roig & A. Roig Alsina col. **Partido de Balcarce:** 1 female (MACN-En 13514), Sierra La Barrosa, -37.8899 -58.2651, 16–X–2007, M. Sabatino col.; 1 female (MACN-En 13515), Sierra La Chata, -37.8803 -58.3762, 7-XII-2007, M. Sabatino col.; 1 female (MACN-En 13516), Sierra El Volcán, Puerta del Abra, -37.8363 -58.0715, 19-XI-1962, Galiano col.

**Comments.** *Augochlorodes politus*, taking into account the female characters, is related to *A. incomitatus* by the small size, the rounded anterior border of the mesoscutum, the sparse punctation on the clypeus and supraclypeal area (Fig. 3), and the inconspicuous decumbent pubescence on the mesoscutum. In the key of Gonçalves & Melo (2008) our specimens run to couplet two, but do not entirely agree with any of the species in the key. They share with *A. politus* the polished, shiny mesoscutum, without microreticulations, and with *A. incomitatus* the long, erect, and mostly simple hairs on the lateral surface of the propodeum. In the specimens from Buenos Aires, the hairs surrounding the propodeal spiracle are plumose, those along the upper lateral margin of the propodeum have a few long branches, and the hairs on the lateral surface are simple. The description of *A. politus* also indicates punctures of uniform size in the lower paraocular area and thick simple hairs on the posterior margin of S4 and S5, whereas in our specimens the punctures of the lower paraocular area have different diameters and the hairs on S4 and S5 are plumose. The holotype of *A. politus* has plumose and not simple hairs in the posterior margin of S4 and S5 and a few simple setae on the lateral surface of the propodeum; other specimens of *A. politus* show variation in the size of the punctures of the lower paraocular area (G.A.R. Melo, personal communication). The specimens from Buenos Aires may represent a new species, but we decided to be conservative, and to adopt the name *A. politus* for these specimens until more evidence can be gathered.

The male differs in several ways from the description of *A. turrifaciens*. The apical third of the clypeus is yellowish white in *A. turrifaciens*, whereas there are no yellow markings in the head of *A. politus*, being the apical fifth of the clypeus dark purple with a black apical band (Fig. 1). The legs of *A. politus* are not green as in the type species; the coxae, trochanters and femora near the apex are black, the apex of the femora, the tibiae and the tarsi are light brown, except the middle of the mid and hind tibiae which are dark brown (Fig. 2). The proportion between length of compound eye: upper interocular distance: lower interocular distance is 2.4:1.7:1 in *A. turrifaciens*, and 1.6:1.4:1 in *A. politus*. In *A. politus* the posterior interocelar distance is shorter than the oculo-ocular distance, while it is longer in *A. turrifaciens*. The F1 and F3 are equal in length in *A. politus*, but F3 is longer (1.3 times) than F1 in *A. turrifaciens*. The S4 agrees with the description of Moure (1958). It differs from the illustration made by Eickwort (1969: page 469: figure 248) in the hairs, which are longer, with branches only on one side of the hair, and arranged in a row (Fig. 5), not scattered in the distal lateral end of the sternum. The S8, not produced posteriorly in *A. turrifaciens*, is weakly produced into a bilobed median projection in *A. politus* (Fig. 7). The genital capsule (Fig. 6) differs from that of *A. turrifaciens* (Eickwort 1969: page 490, figures 375–376) by the ventral gonostylus (*vg*), the flap (*f*) of which is considerably less produced in *A. politus*, and bears slender medially-directed hairs. The ventral gonostylus lacks the transverse median strip of short hairs observed in Eickwort (1969), and the apex of the gonostylus bears thick simple hairs in a row, whereas these long hairs are preapical in the gonostylus of *A. turrifaciens*. The dorsal gonostylus (*dg*) is hairy in *A. politus*, but glabrous in *A. turrifaciens*; it bears two hairless projections directed inward in both species, although of different shape. In *A. politus* the ventral projection has a filiform end directed basally. The penis valve is not as wide as in *A. turrifaciens*. The volsella is rounded basally, with concave inner margins, whereas in *A. turrifaciens* the volsella is truncate basally, with slightly convex inner margins.

**Distribution.** *Augochlorodes politus* was described from the state of Paraná in southern Brazil. The Argentine specimens of *A. politus* studied were collected in the Sistema Serrano de Tandilia, a range of low mountains (up to 500 m a.s.l.) that extends from Mar del Plata to Olavarría in the south of the province of Buenos Aires, Argentina. The Brazilian species of *Augochlorodes* inhabit all states from Minas Gerais to Rio Grande do Sul (Gonçalves & Melo 2008), the main upland area of the country. Many Brazilian bee species distributed below the parallel -24°, are absent in lowlands north of Paraná State but present at higher altitudes in the states of São Paulo, Rio de Janeiro and Minas Gerais (parallels 21–22°). Silveira & Cure (1993) described this pattern of distribution considering the correlation between temperature and altitude, which among other factors define the biogeography throughout the gradient of latitude. This can explain, at least in part, the distribution of the species of *Augochlorodes*. Most records for the Brazilian species of the genus are from highlands at 500–900 m a.s.l. (Gonçalves & Melo 2008) while the specimens of *A. politus* were collected in areas below 330 m a.s.l. (parallel -37°), where climatic conditions may be

equivalent to those of Brazil. This pattern of distribution with species in the temperate areas of Buenos Aires and the mountain ranges of the southeast of Brazil, is observed in other halictids, such as in the genus *Halictillus* Moure (González-Vaquero 2010), *Ruizantheda divaricata* Vachal (González-Vaquero & Roig-Alsina 2009) and *Pseudagapostemon hurdi* Cure (Cure 1989).

**Phylogenetical position.** The genus *Augochlorodes* does not belong to any of the genus-group clades that have been consistently recognized within the Augochlorini. The phylogenetic analyses of Danforth & Eickwort (1997) and Engel (2000) show different relationships for *Augochlorodes*, and Gonçalves & Melo (2008) qualified its relationships as uncertain. In the cladograms presented by Danforth & Eickwort (1997) *Augochlorodes* is a rather basal line in the phylogeny, branching after the basalmost *Corynura* Spinola and *Rhinocorynura* Schrottky groups, *Neocorynura* Schrottky, and *Thectochlora*, switching positions with *Paroxystoglossa* Moure depending on the cladograms, followed by the remaining genera of Augochlorini. In the consensus tree presented by Engel (2000) *Augochlorodes* belongs in a major clade, Engel's Augochloromorpha, basal to the *Augochlora* Smith and *Pseudaugochlora* Michener + *Megaloptidia* Cockerell groups. Engel (2000) placed *Augochlorodes* in a monotypic genus-group and listed four putative characters as synapomorphies for the genus. These four characters are homoplasious in his analysis and, interestingly, are all shared with *Augochloropsis*, as discussed below.

Eickwort (1969) pointed out the striking similarities of the male sterna and genitalia of *Augochlorodes turrifaciens* to species of *Augochloropsis*. These similarities also hold for *A. politus*, and are even more striking. The S4 has the gradulus and the antecosta meeting medially, the posterior margin has a median projection, and the lateral apical corners are produced bearing modified setae (Fig. 5). The S6 has a medially notched apex. The S7 has a truncate, setose median projection (Fig. 8). The S8 has a broad spiculum, and is weakly produced posteriorly into a bilobed median projection (Fig. 7). The ventral prong of the penis valve is rudimentary, and the inner apical angle of the volsella is digitiform (Fig. 6), although not as long as in species of *Augochloropsis*.

For two of the features just mentioned, our observations on *A. politus* are in disagreement with Eickwort's (1969) account on *Augochlorodes*. The apical margin of S4 is depicted as medially straight for *A. turrifaciens*, although Moure (1958) states that S4 is similar to S3, which is described as medially projected in this species. In *A. politus* both S3 and S4 have a median projection, rounded on S3 and pointed on S4. The apical median projection of S8, although weakly produced, is bilobed in *A. politus*, much as in several species of *Augochloropsis*. For *A. turrifaciens*, Eickwort (1969) describes and illustrates this sternum as apically straight and not produced posteriorly.

The matrix modified from Engel (2000) gives a consensus tree with the same topology to the one obtained in that study. Even though the position of *Augochlorodes* does not change, the remarkable similarities of the male structures of *Augochlorodes* and *Augochloropsis* remain as a challenge for future analyses, which might recover them as true synapomorphies of the two genera.

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