Zoologischer Anzeiger 262 (2016) 29–42

Contents lists available at ScienceDirect

Zoologischer Anzeiger

journal homepage: www.elsevier.com/locate/jcz

Zoologischer Anzeiger

Antennal sensilla analyses as useful tools in the revision of the sweat-bee subgenus *Corynura* (*Callistochlora*) Michener (Hymenoptera: Halictidae)

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ARTICLE INFO

Article history:
Received 5 August 2015
Received in revised form 22 January 2016
Accepted 13 March 2016
Available online 16 March 2016

Keywords:
Augochlorini
Taxonomy
Flagellum
Wild bees

ABSTRACT

Although many studies have analyzed the physiology of the antennal sensilla, only a few have used them for systematics. If the abundance and distribution of the different types of sensilla are constant within species, these characters may be used as additional tools in wild bee systematics, especially for the identification of cryptic species. To assess this, we studied the antennal sensilla of the subgenus *Corynura* (*Callistochlora*) Michener, which comprises species frequently collected in Chile and the Argentinean Patagonia. Although the species of *C.* (*Callistochlora*) play an important role in the pollination of wild and cultivated plants, there are no useful keys to identify them. Here we provide a comparative study of antennal sensilla, as well as a detailed morphological revision of the species, including characters of the genital capsule and the hidden sterna. The sensilla have been important in the resolution of the subgenus, especially in the delimitation of male species. Three valid species are recognized: *Corynura aureoviridis* Friese, revalidated name, *C. chloris* Spinola and *C. prothysteres* Vachal. The male of *C. aureoviridis* and the female of *C. prothysteres* are described for the first time. Lectotypes are designated for four names. Synonyms, notes on variation within species, images, distributional data and a key to the species are provided. The study of the antennal sensilla as a potential tool in wild bee systematics is discussed.

1. Introduction

The family Halictidae comprises mostly small- to medium-sized species, which are globally distributed and represent the most frequently collected bees in surveys, when the honey bee is not considered (Michener, 2007). The tribe Augochlorini, restricted to the Western Hemisphere, includes very speciose genera such as *Augochlora* Smith and *Augochloropsis* Cockerell, broadly distributed in the tropical areas of South America, with some species reaching southern Canada, or the south of Chile and Argentina. *Corynura* Spinola 1851, the most species-rich augochlorine genus in Chile (19 species: Montalva and Ruz, 2010), is endemic to both Chile and the Andean *Nothofagus*-dominated forests of north-west Patagonia in Argentina. *Corynura* is a basal genus, closely related to *Halictillus* Moure, in the phylogenies proposed for the tribe (Danforth and Eickwort, 1997; Danforth et al., 2008; Engel, 2000; Gonçalves, 2016).

Corynura is composed by two subgenera, very different in appearance, but similar in many morphological characters. The subgenus *Corynura* (18 species: Moure, 2007) comprises dark-coloured species, with bluish or greenish highlights or a dull cuticle, the sculpture of the metapostnotum of the females is tessellate, sometimes with very short striae on its base, and the males have a petiolated metasoma. *Corynura* subgenus *Callistochlora* Michener is composed by bright green or red species, the females having long, well-defined striae on the metapostnotum and the males have an elongated metasoma, but not petiolated (Michener, 2007). Moure (1964, under the synonym Callochlora Moure) presented a key to the two species of *C.* (*Callistochlora*) that he recognized, the only species that were considered before the present contribution. This key is not useful as it mentions characters that are very difficult to interpret without figures, many of them variable within a given species. For this reason, most of the specimens housed at the collections are identified only at the subgenus level, or under the name of *C. chloris* (Spinola 1851), one of the most common species of Halictidae in Chile.

The species of *Corynura* (*Callistochlora*) are very abundant in all their range of distribution, and may be key components of the southern South America ecosystems. They play an important

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http://dx.doi.org/10.1016/j.jcz.2016.03.006
0044-5231/

role in the pollination of wild and cultivated plants. Several studies support the importance of *C. chloris* for Chilean agriculture, being among the major pollinators of some crops, such as the Chilean hazel (*Gevuina avellana* Molina: Miranda Villalón, 2002; Tapia Sáez, 2000), raspberry (*Rubus idaeus* L.: Viscarra Torrico, 1996) and buckwheat (*Fagopyrum esculentum* Moench: De Ugarte Serra, 1991). This species may also pollinate the orchid *Chloraea lamellata* Lindl. (Lehnebach and Riveros, 2003), the Chilean firetree (*Embothrium coccineum* J.R.Forst. & G.Forst.: Mendoza Contreras, 2012) and some herbs like *Loasa tricolor* Ker Gawl. (Cares-Suárez et al., 2011) and *Viola portalesia* Gay (Espinoza et al., 2012). In Argentina, *C. aureoviridis* (Friese 1910) is a frequent visitor of the native plants *Escallonia virgata* Ruiz & Pav. and *Discaria chacaye* G. Don (Gravel, 2010; R.A. González-Vaquero, pers. comm. 2015). *Corynura* (*Callistochlora*) species were frequently mentioned in historical field surveys (Gazulla and Ruiz, 1928; Jaffuel and Pirion, 1921; Ruiz, 1923, 1936; Ruiz and Stuardo, 1935) as in recent ecological studies of pollinator-plant interactions both in Chile (Aizen et al., 2002; Montalva et al., 2010; Smith-Ramírez et al., 2005, 2014) and Argentina (Devoto et al., 2009; Gravel, 2010; Vázquez, 2002), some of them including an ecological network approach (González-Vaquero et al., 2014; Rezende et al., 2007). Large nidification areas of *C. chloris* have been reported for some localities of the Metropolitan Region (Chile) early in the last century (Claude-Joseph, 1926), and nests of this species are found in the Quinta Normal Park, where the Museo Nacional de Historia Natural is located in Santiago, every season continuously since the mid '60s (Rojas, 2012; Vera Sánchez, 2002). This is evidence of the abundance of *C.* (*Callistochlora*), especially *C. chloris* in central Chile. As these bees are potential pollinators of many crops and native plants, the proper identification of the species is important for future ecological studies.

Examination of antennal sensilla may be a useful tool for wild bee systematics if different patterns of distribution and abundance are detectable. Insect sensilla are the basic structural and functional units of cuticle receptors, serving mainly mechano- and chemoreceptor functions (Chapman, 1998). The antennae are important sensory organs, which bear many types of sensilla that differ in structure and sensory modality. In recent decades, the development and optimization of scanning electron microscopy have allowed the study of antennal sensilla in arthropod taxonomy (Fleminger, 1973; Notario-Muñoz et al., 1997). The pioneer study about the inner and outer morphological structure of the antennal sensilla of *Apis mellifera* L. (Esslen and Kaissling, 1976) allowed subsequent comparative studies in other species of bees (Ågren, 1977, 1978; Ågren and Svensson, 1982; Galvani et al., 2008; Gupta, 1992; Wcislo, 1995).

Hymenoptera have a diversity of antennal sensilla, including placodea, trichodea, basiconica, coeloconica, ampulacea, coelocapitular and setae (Basibuyuk and Quicke, 1999; Fleminger, 1973; Hashimoto, 1991; Polidori et al., 2012; Walther, 1983). Electrophysiological evidence suggests that sensilla placodea are important olfactory receptors in bees (Getz and Akers, 1993), ants (Sheridan et al., 1996) and parasitoid wasps (Ochieng et al., 2000; Pettersson et al., 2001), while sensilla trichodea and basiconica have been described as chemoreceptors or mechanoreceptors in several hymenopteran species (Anderbrant et al., 1995; Bénédet et al., 2002; Hallberg, 1979; Ozaki et al., 2005). On the other hand, sensilla coeloconica, ampulacea and coelocapitular are known to respond to humidity and thermal stimuli (Ruchty et al., 2009; Yokohari et al., 1982). Since there is a high variation in gross morphology in some types of sensilla, any comparison in their physiological role must be done with caution (Altner and Prillinger, 1980). The study of the sensilla may shed light in the systematics of some groups. For example, the distribution and density of the different sensilla types have been suggested as valuable characters for phylogenetic studies in ants (Walther, 1983). The variation between the length and the aperture of the pore of sensilla placodea may be useful to support evolutionary relationships in braconid wasps (Barlin and Vinson, 1981).

The amount of each type of sensilla and its distribution vary between taxa, sexes, and life styles (Galvani et al., 2012; Streinzer et al., 2013). For instance, drones of *Apis mellifera* have a higher number of olfactory sensilla than workers allowing the drones to locate the queen (Esslen and Kaissling, 1976). In some species such extreme dimorphism is not present, mate recognition not being necessarily linked to the gross morphology of the sensilla since the difference in odorant reception may be given at the molecular level (chemosensory genes; Brand et al., 2015). In some cases morphological differences can be detected among species, as in the halictid genus *Sphecodes* Latreille. Ågren and Svensson (1982) analyzed the different patterns of sensilla, proposing a key to identify the males based only on the presence and distribution of the different types of sensilla. This kind of studies shows that the analyses of the antennal sensilla may be useful in wild bee systematics, for example, as additional tools to identify cryptic species.

The aim of this contribution is to study the pattern of the antennal sensilla of the species of *Corynura* (*Callistochlora*), as well as to revise the subgenus. The sensilla have been important in the resolution of the subgenus, especially in the delimitation of male species, as well as the analyses of diagnostic structures commonly used in wild bee systematics. The potential use of antennal morphology as a tool in wild bee systematics is discussed. The revision includes diagnoses, notes on the variation observed within species, comments on the type specimens, flower records, images of diagnostic structures, distributional data and a key to the species.

2. Material and methods

We examined 3231 specimens, which belong to 17 collections (see Appendix in Supplementary material), and type specimens from the following collections, acronyms following Arnett et al. (1993) when possible: American Museum of Natural History, New York, U.S.A. (AMNH); Colección Nacional de Entomología, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina (MACN); Muséum National d'Histoire Naturelle, Paris, France (MNHN); Hope Entomological Collections, Oxford University Museum of Natural History, Oxford, England (OUMNH); Museum für Naturkunde der Humboldt Universität, Berlin, Germany (ZMB).

Higher-level classification of Halictidae and terminology for structures follow Michener (2007), except that *metapostnotum* (Brothers, 1976) is used instead of *basal area of propodeum*, and features of the genital capsule of the male follow Eickwort (1969). We consider the gonostylus of the genital capsule of the male as a single structure in *C.* (*Callistochlora*), with a hairy ventral area and a usually glabrous, more sclerotized and reduced dorsal area. Terminology for surface sculpture follows Harris (1979). The hairs on the pleura measured are those on the mesepisternum, below the hypoepimeral area. Measurements of head were made following Michener (2007: Fig. 10 –3 b). Ratios based on measurements of body parts were taken from five specimens from distant localities. Flower records were taken from the specimen labels, many of them collected in recent field trips made by R.A. González-Vaquero to Neuquén and Río Negro (Argentina). Synonymies are restricted to original citations; for complete lists of citations refer to Moure (2007).

The following abbreviations are used in the text: MOD—median ocellar diameter (it is used to give a relative measure of hair length); PD—puncture diameter (it is used to give a relative measure of puncture density); F—flagellomere, T—tergum and S—sternum (followed by the appropriate number); *sPa*—sensilla

placodea; *stA*—sensilla trichodea type A; *stB*—sensilla trichodea type B; *stC-D*—sensilla trichodea type C-D; *sCoe*—sensilla coeloconica; *sAmp*—sensilla ampullacea; *sCap*—sensilla coelocapitular.

The male genital capsule and hidden sterna were dissected and immersed in a solution of potassium hydroxide 10% for 24 hs before observation. Images from scanning electron microscopy (SEM) were taken of diagnostic structures. Antennae were detached from the head and rinsed overnight in a commercial detergent; after dehydration in graded ethanol: distilled water series of 50, 70, 96% (v/v) to absolute ethanol for 30 min each, antennae were air dried (Settembrini, 1984). Antennae and diagnostic structures were coated with gold palladium and examined in a Philips XL30 SEM microscope. We analyzed only the flagellum sensilla of the right antenna. To assess differences among the females, we calculated the density of sensilla and setae of the ventral side of the F9 (n = 6), counting the units inside an area as defined in Galvani et al. (2008). The mean number of units is given in mm^2, with its respective standard error (SE). Data were analyzed using the GraphPad Prisma Software. Interespecific comparisons were performed using a Kruskal-Wallis test followed by post hoc comparison using Dunn's test to reveal significant differences between species.

A distribution map was performed in DIVA-GIS 7.5 (www.diva-gis.org), taking into consideration the localities from the labels of the specimens examined. The De Martonne aridity index (De Martonne, 1927) is shown on the map, providing an idea of the different environments the species inhabit.

3. Results

3.1. *Corynura* (Callistochlora) Michener, 1997

Callochlora Moure, 1964: 269. Type species: *Halictus chloris* Spinola, 1851, by original designation. Preocc. *Callochlora* Packard, 1864

Callistochlora Michener, 1997: 12. *Nom. nov.* for *Callochlora* Moure, 1964.

The genus *Corynura* is defined among the genera of Augochlorini by the following combination of characters: galeal comb strong; pronotal lateral angle not produced; lack of paraocular lobe; propodeal pit surrounded by triangular recess; female with one or two metatibial spines; male labrum truncate; male S6 with a mid cleft; male S8 with broad spiculum (Engel, 2000). *Corynura* (*Callistochlora*) contains species metallic green or red, sometimes with a bluish tint, in contrast to *Corynura s. str.*, whose species have a black integument, usually with weak bluish or greenish highlights on head and mesosoma. In addition, the species of *C.* (*Callistochlora*) can be identified by the following characters: integument smooth or very weakly tessellate on mesoscutum, scutellum, supraclypeal area and clypeus; metapostnotum with strong, long striae, almost reaching the apical margin; compound eyes bearing hairs which are longer than an ommatidium; inner metatibial spur of female pectinate, teeth long, and basitibial plate with anterior border obsolete. In contrast, *Corynura s. str.* has the following characters: integument strongly tessellate, metapostnotum with short striae if any, compound eyes glabrous, inner metatibial spur of female serrate, or pectinate with short teeth bent towards the axis, and basitibial plate rimmed on all borders. In addition, in *Corynura* (*Callistochlora*) the metasoma of the male is elongate, with the apical width of T1 similar to the following terga, while in most *Corynura s. str.* the metasoma is petiolate, with T1 clearly narrower than the following terga.

Moure (1964) described the subgenus *Corynura* (*Callistochlora*) (as *Callochlora*) to include two species: *Halictus chloris* Spinola and *H. prothysteres* Vachal. He failed to recognize *Augochlora aureoviridis* Friese as a valid species of the subgenus. His key can be used to separate the males of *C. chloris*, but it is not useful to separate females, since the characters he mentioned are variable within species. Moure and Hurd (1987) synonymized *A. aureoviridis* under *H. chloris*, based on the female, since the male was unknown. Moure and Hurd (1987) also included in *C.* (*Callistochlora*) two further species, *Halictus cercops* Vachal and *Halictus joannisi* Vachal, later transferred by Engel (1996) to *Neocorynura* Schrottky and *Andinaugochlora* Eickwort, respectively. Eickwort (1969) in his generic study of the Augochlorini mentioned males with plate areas in the antennae, which he mistakenly attributed to *C. prothysteres.* The species C. *chloris* and C. *prothysteres* are the only two species currently recognized in the subgenus (Moure, 2007; Montalva and Ruz, 2010). The characters mentioned in the diagnoses and in the key below, in addition to DNA barcoding (González-Vaquero et al., in preperation) suggest that three species should be recognized. *Corynura aureoviridis* is considered a valid species. The identity of *C. prothysteres* is clarified, since all specimens from Argentina misidentified as *C. prothysteres* correspond to *C. aureoviridis*, and specimens of *C. prothysteres* from Chile are usually misidentified as *C. chloris*.

3.2. Morphology and distribution of flagellar sensilla

The following types of sensilla are recognized in species of *Corynura* (*Callistochlora*): *sPa*, *stA*, *stB*, *stC-D*, *sCoe*, *sAmp* and *sCap* (Figs. 1–3). The only type of sensilla not found in the subgenus is the basiconica, known to be present in females of other bees. Sensilla are more diverse and abundant on the dorsal side of the antennae, but scarce on the ventral side, where setae are plentiful. The ventral surface of the last flagellomere (F10 in females, F11 in males) shows a smooth area at the distal end without setae or sensilla (Fig. 3B). The *sPa*, *stA* and *stB* are more abundant on the distal flagellomeres, scarce on F2–3, and on F1 only *stC-D* and setae were observed. The sensilla known as "pit organs", *sCoe* and *sAmp*, are usually in groups (Fig. 1C,E). This pattern has been observed in other taxa of bees.

Corynura (*Callistochlora*) has sexual dimorfism not only in the relative length of the flagellomeres (Figs. 1 A; 3 A), as it happens in many halictid bees, but also in the distribution of the sensilla. In males, the ventral surface of the flagellum bears many setae and a small number of *stC-D* (Fig. 1F). The sculpture of the cuticle and the difference in the types of the sensilla allow a clear distinction between the dorsal and the ventral sides of the flagellum (Fig. 1D,F). The distribution of the dorsal sensilla shows different patterns among the species of *C.* (*Callistochlora*). The most striking feature, easily seen through a stereo microscope at 20 x magnification, is the presence of a median area composed only by *sPa* in the F2–11 of the males of *C. aureoviridis* (Fig. 8C). Through the SEM images we observed that these *sPa* zones have one or two rings of not continuous, long *stC-D*. These sensilla form a circle around the mid part of each flagellomere (Figs. 1 B; 2 B). In addition, the proximal and distal area of each flagellomere have zones composed mainly by sensilla trichodea, and very few *sPa* scattered in the center of these areas (Fig. 1F); the *sPa* are rare on the lateral sides of the flagellomeres. In contrast, in the other species the *sPa* are intermingled with other types of sensilla all throughout the flagellomeres (Figs. 1 D,E; 2 A), and are not easily detectable through the stereo microscope (Fig. 8F,I). In *C. chloris* and *C. prothysteres*, there is only one ring of *stC-D*, which is easier to observe in *C. prothysteres* as it is on a small elevation (Fig. 1D). The subtype of *stC-D* that form these rings consist in straight, long and coarse trichodea, which bear longitudinal grooves in the three species. In contrast, the other subtypes of *stC-D* found elsewhere on the flagellomeres, are slightly curved trichodea, and either short and coarse (Fig. 1E), or long and slender (Fig. 1F).

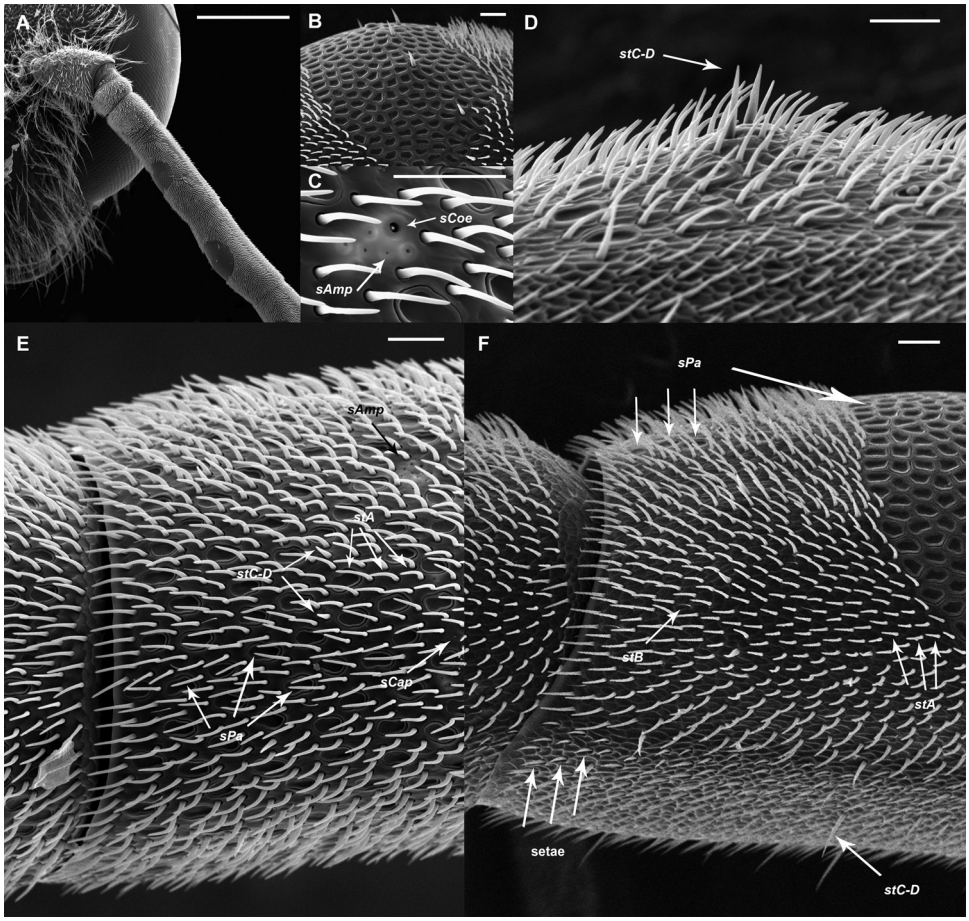

Fig. 1. Antennal sensilla of the males of *Corynura* (*Callistochlora*). Setae and sensilla trichodea types A and B apically oriented. (A) *C. aureoviridis*. (B) *C. aureoviridis*, F10, dorsal view. (C) *C. chloris*, F10, dorsal view. (D) *C. prothysteres*, F10, lateral view. (E) *C. chloris*, apical half of F10, dorsal view. (F) *C. aureoviridis*, apical half of F10, lateral view. Abbreviations: *sPa*, placodea; *stA*, trichodea type A; *stB*, trichodea type B; *stC-D*, trichodea type C–D; *sCoe*, coeloconica; *sAmp*, ampullacea; *sCap*, coelocapitular. Scale bars = (A) 500 μm; (B–F) 25 μm.

In females, *sPa*, *stB* and *stC-D* are scattered on both surfaces of F6–10, being less abundant and more dispersed on the proximal flagellomeres. Compared to males, females have a greater diversity of sensilla on the ventral side of the flagellomeres, although *stA* are absent (Fig. 3C). The limits between dorsal and ventral sides of the flagellum are less defined in females. We have found no significant differences among the species according to the density of sensilla on the ventral surface of F9. However, the density of setae in *C. aureoviridis* (7437 ± 288) was lower than those of *C. prothysteres* (9145 ± 374) and *C. chloris* (9283 ± 283) ($p < 0.005$, Kruskall-Wallis test; $p < 0.05$, Dunn's test).

3.3. Genital capsule and hidden sterna

The shape of the genital capsule has some differences among the species of *C.* (*Callistochlora*) (Fig. 4). In *C. chloris* the width of the gonobase is equal or shorter than the length of the gonocoxite (Fig. 4C-D), while in the other species the width of the gonobase is longer than the length of the gonocoxite (Fig. 4A-B,E-F). In *C. aureoviridis* the gonocoxite is slightly concave on the sides (arrow on Fig. 4A), being straight or barely convex in *C. chloris* and *C. prothysteres*. The gonocoxite has some simple setae near the apex. The volsella is short, its inner apical margin truncate. The gonostylus has a ventral area (Fig. 4A: *vag*) bearing short, coarse, and bent setae in *C. aureoviridis* and *C. prothysteres* (see detail in Fig. 4F), or long, slender and straight setae in *C. chloris* (see detail in Fig. 4D), and a dorsal area more sclerotized, reduced to the base of the gonostylus (Fig. 4A: *dag*). The zone between the ventral and the dorsal areas of the gonostylus has slender setae, which are longer than those of the ventral area. In caudal view the ventral gonostylus ends in a small projection directed mesally. The basal process of the gonostylus (Fig. 4B: *bpg*) is barely developed and hairless in *C.* (*Callistochlora*), although in some *C. aureoviridis* it can bear one or two setae. The genital capsule of *C. chloris* was illustrated by Moure (1964: Fig. 2), mistakenly labeled as *Ruizanthedella mutabilis* Spinola (as *Ruizantheda*, as pointed out by Eickwort, 1969: page 393), and by Eickwort (1969: Figs. 329–330) although the setae of the ventral area of the gonostylus are short and bent, more similar to those of the remaining species.

The S7 and S8 (Fig. 5) are laterally fused by the apodemes, but they can be easily separated with a pin. The posterior margin of S7 is bilobed in *C. aureoviridis* (Fig. 5A), and curved, simple in the remaining two species. The posterior margin of S8 is medially produced, and it usually bears one or two setae, although in some specimens of *C. prothysteres* it can bear a group of up to eight setae (Fig. 5F). In *C. aureoviridis* the broad projection has three small apical lobes (Fig. 5D). The S7–8 illustrated by Eickwort (1969: Figs. 271 –273) probably belong to *C. prothysteres* instead of *C. chloris*, as suggested by the bunch of setae on the S8.

3.4. Distribution

Corynura (*Callistochlora*) is distributed from Atacama to Aysén in Chile, and in the provinces of Neuquén, Río Negro and Chubut, near

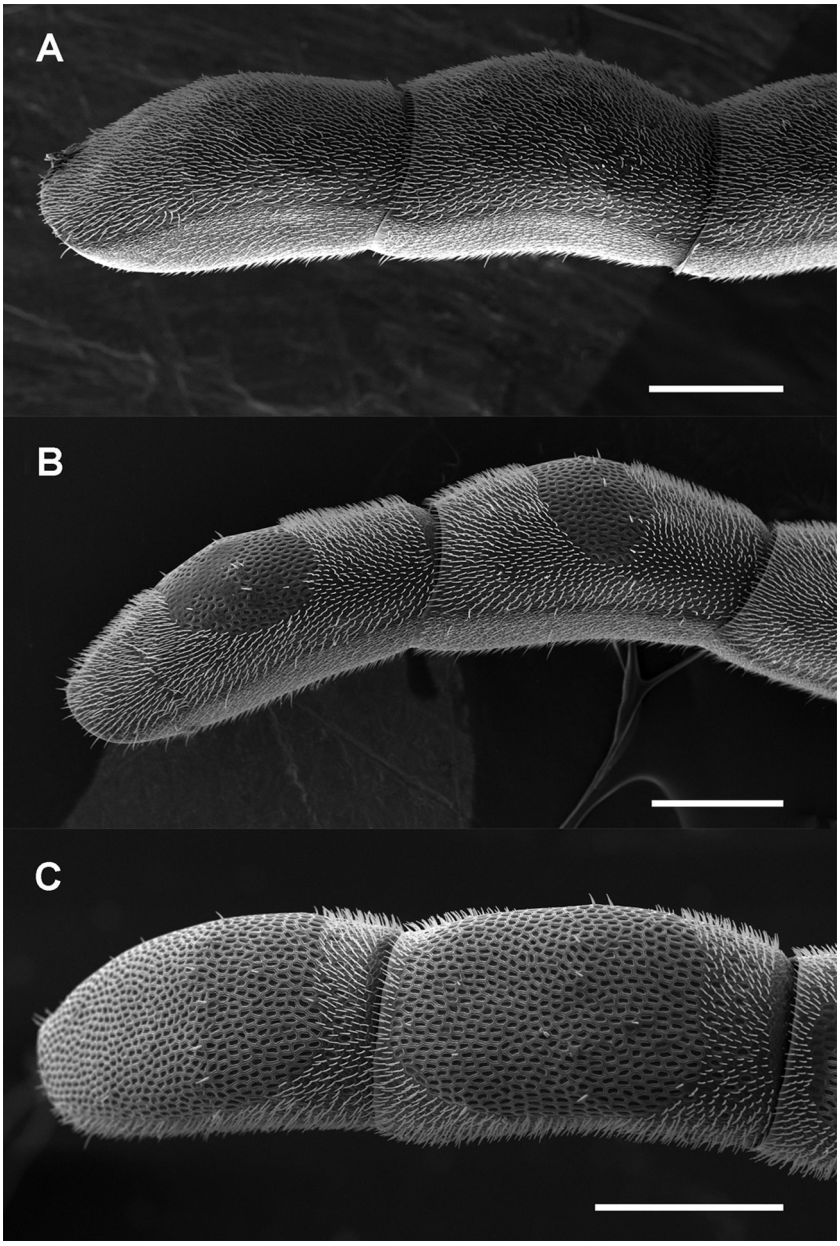

Fig. 2. Antennae (F10–11) of the males of the genus *Corynura*. Setae and sensilla apically oriented. (A) *C.* (*Callistochlora*) *prothysteres*, sensilla placodea (*sPa*) intermingled with other types of sensilla, absence of areas composed only by *sPa*. (B) *C.* (*Callistochlora*) *aureoviridis*, *sPa* areas covering 1/3-1/2 of the dorsal side of each flagellomere. (C) *C.* (*Corynura*) *ampliata*, practically all (4/5) the dorsal area of each flagellomere covered by *sPa*. Scale bars = 200 μm.

the Andes, in Argentina (Fig. 9). Its species tolerate a wide range of precipitation and temperatures, and they inhabit from above 3000 m in some parts of the Andes to the sea level. Despite this, each species has its particular distribution. *Corynura chloris* presents the largest distribution, reaching the desert areas of Coquimbo, with a few records from the Atacama region (latitude −26.5°). In central Chile also occurs *C. prothysteres*; this region is distinguished by its bushlands and sclerophyllous forests, comprised by vegetation adapted to the arid climate. The three species of *C.* (*Callistochlora*) co-occur in the areas near the Andes of Bío-Bío and La Araucanía, where the climate is temperate and humid, with rainfalls all year round; the dominant vegetation is the *Nothofagus* forest, although there are also prairies and large areas of peatlands. *Corynura prothysteres* reaches Chiloé and the north of Aysén, in the perhumid and cold south of Chile (latitude −44.5°). In contrast, *Corynura aureoviridis* occurs only in humid and perhumid areas in the southwest of Argentina and in the south of Chile. This area consists of plateaus and valleys with a cold-temperate and dry climate, and strong winds; the dominant vegetation is the bushland steppe, with abundant "cushion plants".

3.5. Key to species

3.5.1. Females

(1) Disk of mesoscutum with punctures sparser medially (Fig. 6D), separated by 2.0–3.0 PD; punctures of similar size. Mesoscutum with whitish, plumose hairs of different lengths. Clypeus with black transverse apical band as long as 0.3–0.4 times clypeus length (Fig. 8D). . . ***chloris*** (Spinola, 1851)

- Disk of mesoscutum with punctures evenly distributed (Fig. 6C), separated by 0.5–1.0 PD; punctures of two sizes. Mesoscutum with dense, plumose, short, dark hairs, and

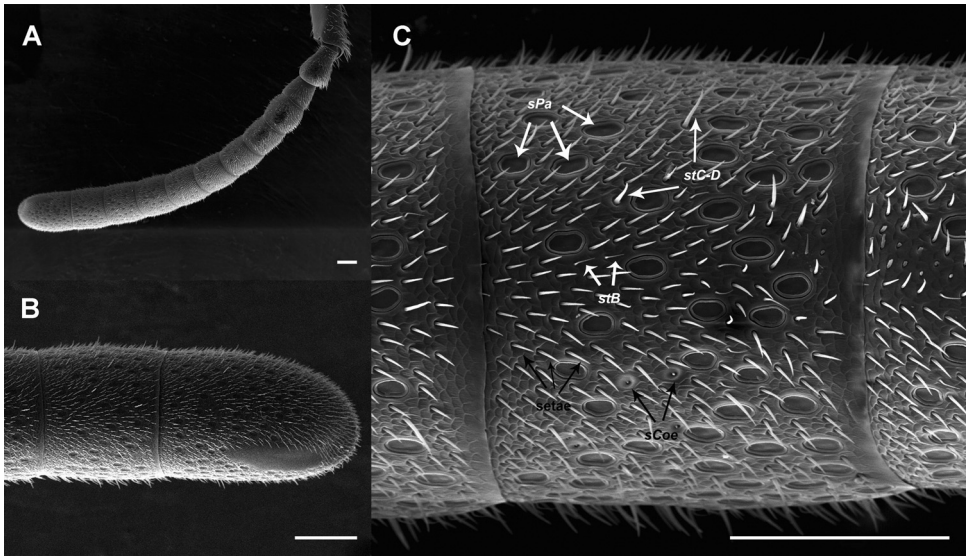

Fig. 3. Antennal sesilla of the females of *Corynura* (*Callistochlora*). Setae and sensilla trichodea type B apically oriented. (A) *C. prothysteres*. (B) *C. prothysteres*, F9–10, ventral view. (C) *C. aureoviridis*, F9, ventral view. Abbreviations: *sPa*, placodea; *stB*, trichodea type B; *stC-D*, trichodea type C–D; *sCoe*, coeloconica. Scale bars = 100 μm.

longer, whitish, plumose hairs intermixed (Fig. 6A,B). Clypeus with black transverse apical band as long as 0.1–0.2 times clypeus length (Fig. 8A,G). . .2

(2) Metapostnotum with radial striae all over its breath (Fig. 7A). Cuticle red (Fig. 8A) or green with reddish highlights on the mesoscutum. Compound eyes with hairs as long as 2.0–2.5 times the diameter of an ommatidium. Apical process of labrum with keel slightly flattened apically (Fig. 7D). Tibiae and tarsi II and III dark brown. . . ***aureoviridis*** (Friese, 1910)
- Metapostnotum with striae radially arranged on sides, and finer striae, usually transversely arranged in median area (Fig. 7C). Cuticle green (Fig. 8G), sometimes the metasoma blue. Compound eyes with hairs as long as 3.0–3.5 times the diameter of an ommatidium. Apical process of labrum with keel broadly flattened apically (Fig. 7F). Tibiae II and III dark brown, tarsi light brown. . . ***prothysteres*** (Vachal, 1904)

3.5.2. Males

1. Terga metallic green. Mesoscutum, scutellum and metanotum with whitish plumose hairs of different sizes. Sterna mainly with plumose hairs, as long as 2.7 times MOD. Ventral area of gonostylus with long, slender and straight setae (detail in Fig. 4D). Length 6.5–7.5 mm. . . ***chloris*** (Spinola, 1851)
   - Disk of terga dull black. Mesoscutum, scutellum and metanotum with dense, simple, short, dark hairs, and longer, whitish, plumose hairs intermixed. Sterna mainly with simple hairs, as long as 0.6 times MOD. Ventral area of gonostylus with short, coarse and bent setae (detail in Fig. 4F). Length 7.5–9.0 mm. . . 2
2. Flagellomeres with a median area composed only by sensilla placodea (Fig. 8C). Marginal zones of terga with simple hairs. Posterior margin of S7 bilobed (Fig. 5A). Posterior margin of S8 with one or two setae (Fig. 5D). Tibiae III entirely dark brown, tarsi dark brown. . . ***aureoviridis*** (Friese, 1910)
   - Flagellomeres with sensilla placodea scattered all over the dorsal surface (Fig. 8I). Marginal zones of terga bearing plumose and simple hairs. Posterior margin of S7 curved, simple (Fig. 5C). Posterior margin of S8 usually with three to eight setae (Fig. 5F). Tibiae III dark brown with light brown apex, tarsi light brown. . . ***prothysteres*** (Vachal, 1904)

3.6. *Corynura* (Callistochlora) aureoviridis *(Friese, 1910)*

(Figs. 1 A,B,F; 2 B; 3 C; 4 A,B; 5 A,D; 6 A,B; 7 A,D; 8 A-C; 9)

Augochlora aureoviridis Friese, 1910: 643, 654. Lectotype: Female, Argentina: Neuquén. Museum für Naturkunde der Humboldt Universität, Berlin. Examined, **present designation**.

3.6.1. Diagnosis

Corynura (*Callistochlora*) *aureoviridis* is easily distinguished by its shiny red color, although some specimens are green with reddish highlights only on the mesoscutum. This species is similar to *C. prothysteres*. It is very common in Argentina, where *C. prothysteres* does not occur; the distribution of both species overlaps in the south of Chile. The female can be distinguished by the following combination of characters: metapostnotum with radial striae all over its breath, usually surpassing half the length of the dorsal surface in the median area (Fig. 7A); apical process of labrum with keel slightly flattened apically (Fig. 7D); compound eyes with hairs no longer than 2.5 times the diameter of an ommatidium; tarsi dark brown. The male can be easily identified by the distribution of the sensilla placodea: each flagellomere has a dorsal area composed only by this type of sensilla, which covers 1/3–1/2 of the surface, and it is clearly visible under stereo microscope at low magnification (20×) (Fig. 8C). In addition, this is the only *C.* (*Callistochlora*) species whose males have the posterior margin of S7 bilobed (Fig. 5A), and the marginal zones of terga bear simple hairs.

3.6.2. Description of the male

Length 7.4–7.9 mm. Forewing length 5.9–6.9 mm.

Color. Body metallic red, or green with a reddish or golden tint on head and dorsum of mesosoma. Following parts black: labrum, malar area, mandible, pedicel, posterior surface of flagellum, disks of terga. Following parts dark brown: apex of mandible, anterior surface of flagellum, tibiae, tarsi, posterior half of tegula. Sometimes tibiae with reddish or greenish highlights. Wings hyaline, with dark brown veins and pterostigma, radial vein dark brown to black.

Pubescence. Light brown. Head with erect, plumose hairs, those on paraocular area up to 1.6 times MOD, on vertex as long as 1.7–2.4 times MOD. Lower part of gena with hairs as long as 2.5–2.9 times MOD. Upper paraocular area, mesoscutum, scutellum and metanotum with dense, simple, dark brown, short hairs (0.3–0.4 times MOD). Mesoscutum with plumose hairs (1.7–2.0 times MOD),

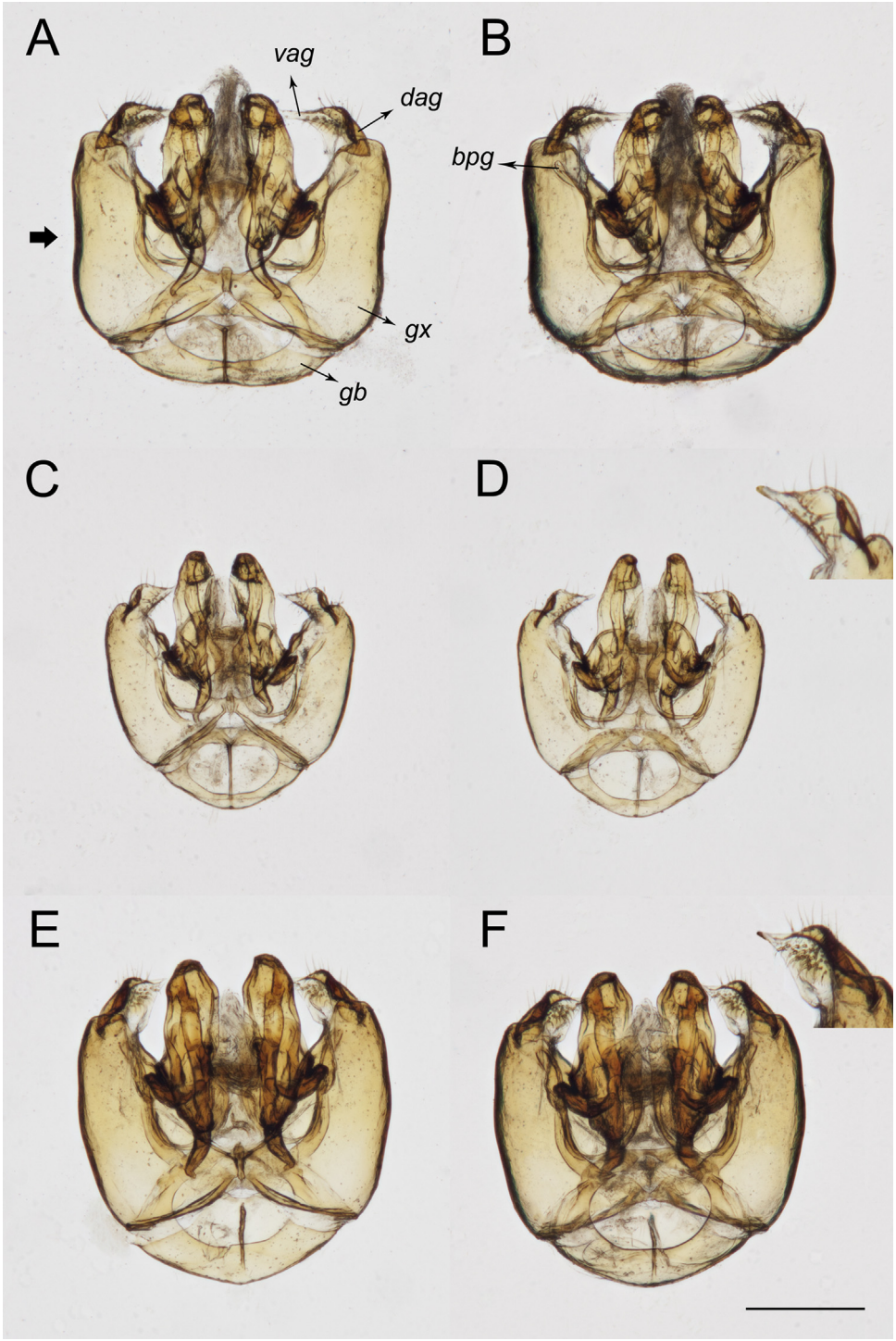

Fig. 4. Genital capsule of the males of *Corynura* (*Callistochlora*). (A, C, E) dorsal view, (B, D, F) ventral view. (A–B) *C. aureoviridis*. (C–D) *C. chloris*. (E-F) *C. prothysteres*. Abbreviations: *vag*, ventral area of gonostylus; *dag*, dorsal area of gonostylus; *gx*, gonocoxite; *gb*, gonobase; *bpg*, basal process of gonostylus. Scale bar = 500 μm.

longer on pleura and metanotum (up to 2.3 times MOD). Terga with simple, dark brown, short hairs (0.1 times MOD), with scattered longer, light brown, simple and plumose hairs (0.6–0.8 times MOD); marginal zones with simple hairs only. T1 with plumose hairs, longer on sides (up to 0.9 times MOD), and slightly longer than those of following terga. Sterna mostly with simple hairs, as long as 0.7 times MOD.

Sculpture. Labrum short and truncate. Clypeus with punctures separated by 0.7–1.0 PD, supraclypeal area with sparser punctures, separated by 2.0–3.0 PD. Lower paraocular area with punctures separated by 0.5–1.0 PD; upper paraocular area with punctures separated by 0.4–0.5 PD. Mesoscutum and scutellum with punctures separated by 1.0–2.0 PD, denser on sides of mesoscutum and metanotum. Metapostnotum with radial striae all over its breath, reaching apical margin. Terga with punctures separated by 1.0–2.0 PD, sparser towards apex. Surface between punctures weakly tessellate throughout body, except: legs clearly tessellate; pleura finely rugose; apical margin of terga, and metasomal sterna substrigulate.

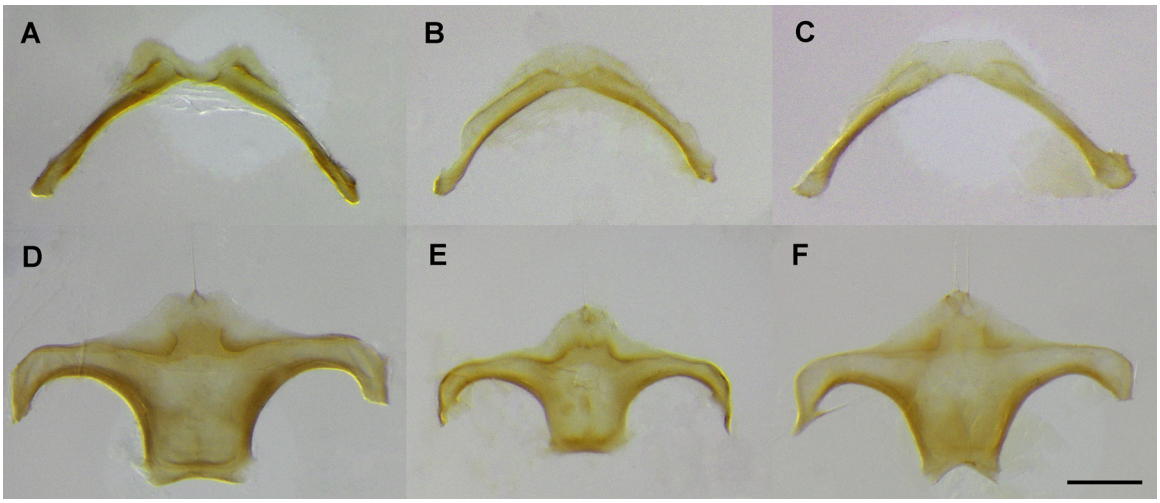

Fig. 5. Hidden sterna of the males of *Corynura* (*Callistochlora*). (A–C) S7, (D–F) S8. (A, D) *C. aureoviridis*. (B, E) *C. chloris*. (C, F) *C. prothysteres*. Scale bar = 200 μm.

Structure. Head broader than long, 1.14–1.19:1. Proportion of lower to upper interocular distance 0.65–0.70:1. Clypeus broader than long, 1.43–1.55:1. Proportion of interantennal to antennocular distance, 1.58–1.95:1. Proportion of posterior interocelar to ocelo-ocular distance, 0.95–0.96:1. Proportion of length of scape, pedicel and first two flagellomeres, 0.90–1.01:0.26–0.30:0.33–0.41:1. *Flagellar sensilla*: F2–11 with median area composed only by *sPa*, encircled by one or two rings of *stC-D* (Figs. 1 B; 2 B). *Hidden*

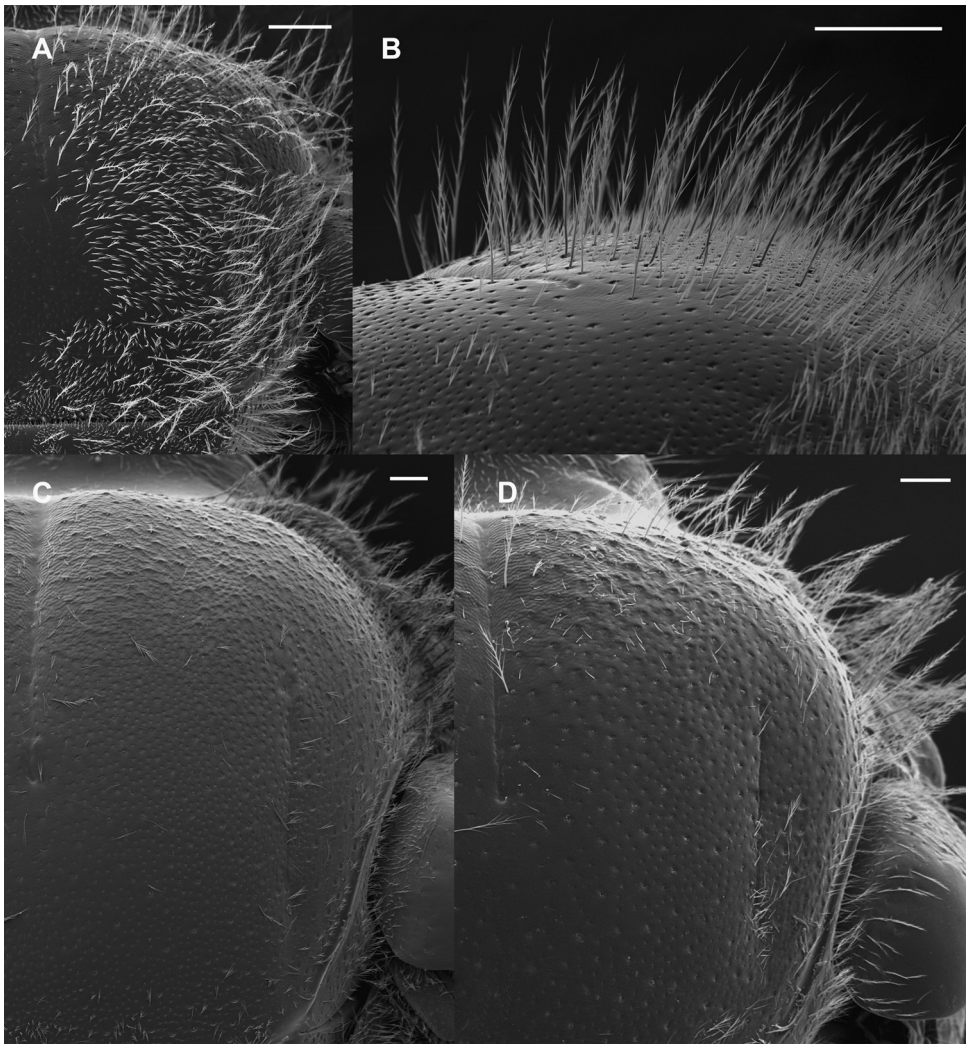

Fig. 6. Mesoscutum of the females of *Corynura* (*Callistochlora*). (A–B) hairs, (C–D) sculpture. (A–B) *C. aureoviridis*. (C) *C. prothysteres*. (D) *C. chloris*. Scale bars = 200 μm.

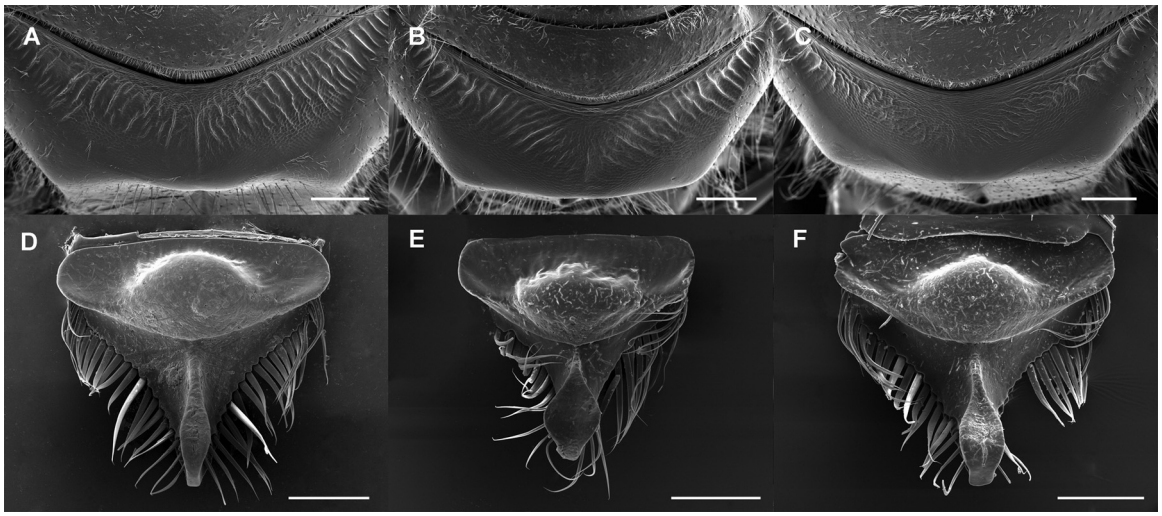

Fig. 7. Metapostnotum and labrum of the females of *Corynura* (*Callistochlora*). (A–C) metapostnotum, (D–F) labrum. (A, D) *C. aureoviridis*. (B, E) *C. chloris*. (C, F) *C. prothysteres*. Scale bars = 200 μm.

sterna: S7 with bilobed posterior margin (Fig. 5A). S8 with medially produced posterior margin with three small apical lobes, median lobe bearing one or two setae (Fig. 5D). *Genital capsule* (Fig. 4A,B): Gonobase width longer than gonocoxite length. Gonocoxite slightly concave on sides, with few simple hairs near apex. Volsella short, inner apical margin truncate. Ventral area of gonostylus with short, coarse, bent setae; it ends in a small projection directed mesally in caudal view. Dorsal area of gonostylus more sclerotized than ventral area, reduced to the base of gonostylus. Basal process of gonostylus barely developed, sometimes with one or two setae.

3.6.3. Variation

As many species of Augochlorini, *C. aureoviridis* varies in color. The color of a few specimens was metallic green instead of the typical metallic red, and the reddish highligths of these specimens were restricted to the mesoscutum; this is the case of a female of this species found among the type series of *C. chloris*. Two females from Las Trancas (Bío-Bío) had bluish instead of reddish highlights all over the body, which are more intense on the metasoma. One male from Chiloé (Los Lagos) had the tarsi light brown, and the basal process of the gonostylus bore one or two setae.

3.6.4. Type material

A female syntype from the ZMB and two female syntypes housed at the AMNH were examined. The specimens agree with the description of Friese, where he mentions three females collected in Neuquén by Lendl. The female from the ZMB is in very good condition, except by the mesoscutum which was dented by the pin, and the naturally faded margins of the wings. We designate this specimen as the lectotype. It has the following labels: "Argentina/Salta 1200/Neoquen/3.1905" printed, but Neoquen (*sic*) handwritten; "*Augochlora*/*aureoviridis*/♀ Fr." handwritten and "1909 Friese det." printed; "Coll./Friese" printed; a printed orange label "Typus"; "Zool. Mus./Berlin" printed.

The paralectotypes housed at the AMNH have similar labels which say "Argentina/Salta 1200/Neoquen/3.1905" printed, but Neoquen (*sic*) handwritten, and there is a "7" handwritten corresponding to the year, over the "5" printed. Both specimens have the following labels: "*Augochlora*/*aureoviridis*/♀ Fr." handwritten and "1909 Friese det." printed. One of the specimens has an orange label which says "Typus" printed, and it is in good condition like the designated lectotype, it only has the two apical tarsomeres of the right hind leg missing. The other specimen has the metasoma glued to the identification label, and an additional label which says "*Corynura*/(*Callochlora*)/sp. det. G.C. Eickwort".

3.6.5. Plants visited

Alstroemeriaceae: *Alstroemeria aurea*; Anacardiaceae: *Schinus patagonicus*; Apiaceae: *Daucus pusillus*, *Mulinum spinosum*; Asteraceae: *Baccharis obovata*, *B. rhetinoides*, *B. umbelliformis*, *Baccharis* sp., *Chrysanthemum* sp., *Hypochaeris radicata*, *Matricaria inodora*, *Senecio filaginoides*, *Solidago chilensis*, *Taraxacum officinale*; Boraginaceae: *Phacelia secunda*; Buddlejaceae: *Buddleja globosa*; Caryophyllaceae: *Cerastium arvense*; Elaeocarpaceae: *Aristotelia chilensis*; Escalloniaceae: *Escallonia virgata*; Fabaceae: *Cytisus scoparius*, *Lathyrus magellanicus*, *Lupinus arboreus*, *L. polyphyllus*, *Trifolium repens*; Grossulariaceae: *Ribes magellanicus*; Malvaceae: *Tilia moltkei*; Onagraceae: *Oenothera odorata*; Plantaginaceae: *Plantago lanceolata*; Proteaceae: *Embothrium coccineum*, *Lomatia hirsuta*; Ranunculaceae: *Anemone multifida*; Rhamnaceae: *Discaria articulata*, *D. chacaye*, *Ochetophila trinervis*; Rosaceae: *Rosa rubiginosa*; Verbenaceae: *Diostea juncea*.

3.6.6. Nesting biology

Unknown.

3.6.7. Distribution

Argentina: Neuquén, Río Negro and Chubut. Chile: From Bío-Bío to Los Lagos.

3.7. *Corynura* (Callistochlora) chloris *(Spinola, 1851)*

(Figs. 1 C,E; 4 C,D; 5 B,E; 6 D; 7 B,E; 8 D-F; 9)

Halictus chloris Spinola, 1851: 202. Lectotype: Male, Chile. Gay Collection, Muséum National d'Histoire Naturelle, Paris. Designated by Moure and Hurd, 1987: 213. Examined.

Auglochlora floralia Smith (1853): 78. Lectotype: Female, South America. Hope Entomological Collections, Oxford University Museum of Natural History, Oxford. Synonimized by Moure and Hurd, 1987: 213. Examined through photographs, **present designation**.

Augochlora (*Tetrachlora*) *porteri* Brèthes, 1910: 143. Lectotype: Female, Chile. Museo Nacional de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires. Synonimized by Herbst (1921): 111. Examined, **present designation**.

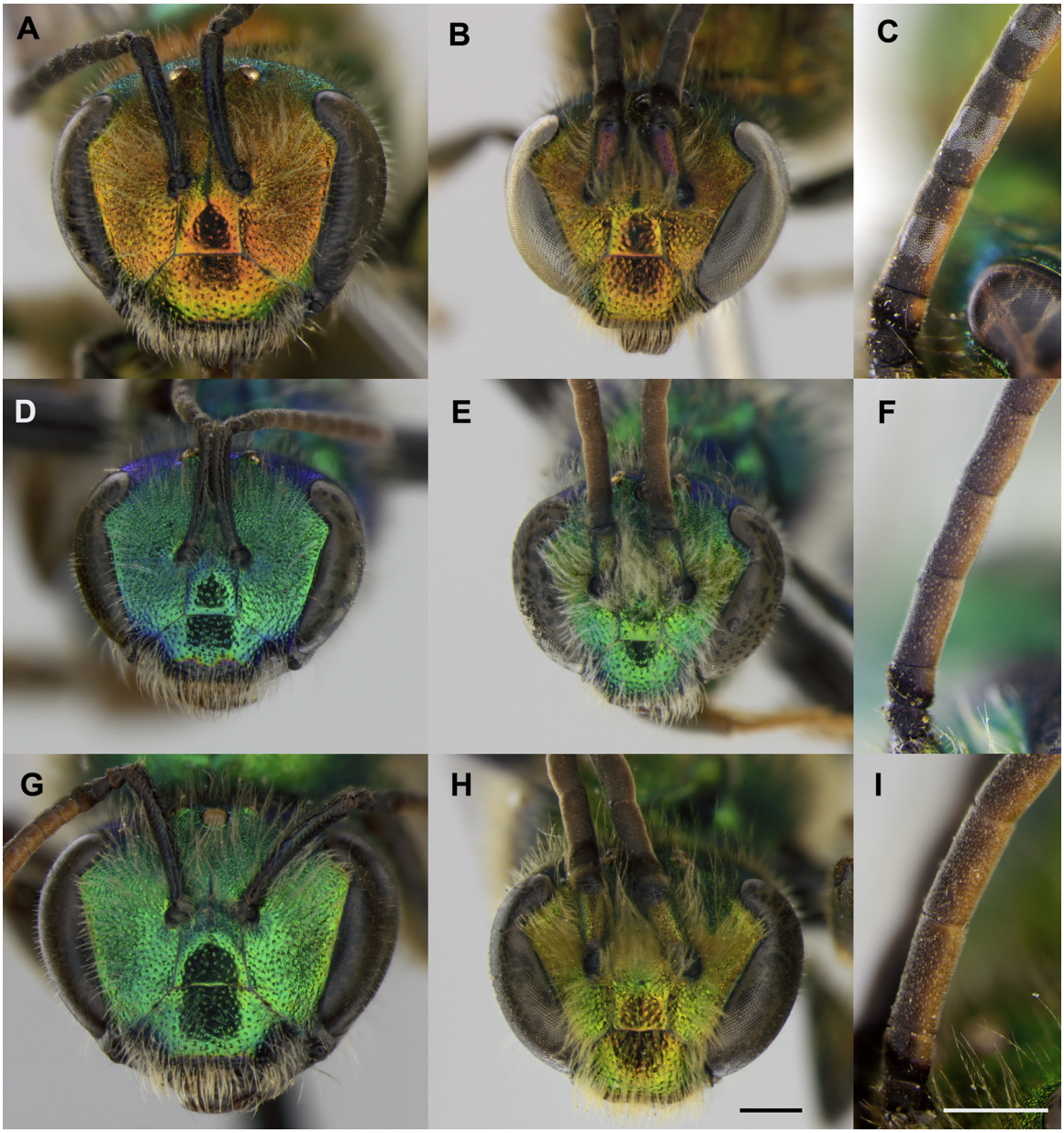

Fig. 8. Heads of *Corynura* (*Callistochlora*) and antennae of the male. (A, D, G) head of female, (B, E, H) head of male, (C, F, I) antenna of the male, dorsal view. (A–C) *C. aureoviridis*. (D–F) *C. chloris*. (G–I) *C. prothysteres*. Scale bars = 500 μm.

3.7.1. Diagnosis

Corynura (*Callistochlora*) *chloris* is a very common species in Chile, and can be separated from other *C.* (*Callistochlora*) by its smaller size (6.5–8.0 mm), among other features. The female can be identified by the sculpture of the mesoscutum, which has punctures of different sizes, sparser on the disk (Fig. 6D), by the long, black apical band of the clypeus (0.3–0.4 times of clypeus total length) (Fig. 8D), and by the upper paraocular area and mesoscutum bearing only plumose, whitish hairs. The male can be distinguished by the color of the terga, totally metallic green, by the hairs of the sterna, mostly plumose and as long as 2.7 times MOD, much longer than in the other species, by the distribution of the *sPa*, which are intermingled with other types of sensilla, and by some characters of the genital capsule: gonobase width equal or shorter than gonocoxite length, and ventral area of gonostylus only with thin setae (Fig. 4C,D).

3.7.2. Variation

Although most of the specimens are metallic green, a few specimens had reddish highlights on the mesoscutum (six females from Termas de Río Blanco, La Araucanía) or on the metasoma (one female from Huintil, Coquimbo). Some females from Valparaíso had dark brown hairs on the outer surface of tibiae, and mid and hind tarsi.

3.7.3. Type material

The following type series housed at the MNHN was studied: one male and eight females from Gay Collection, one male and 18 females from Sichel Collection, and one female with no Collection label. The male from Gay Collection was designated lectotype by Moure and Hurd (1987), but it does not have any labels that indicate its status. This specimen has the following labels: "*chloris*/♂ Spin." handwritten, "Museum Paris/Chili/Gay 1833" printed, and a green rounded label folded in the middle, pinned. This specimen has some dirt on the hairs, but the main characters can be seen and it clearly

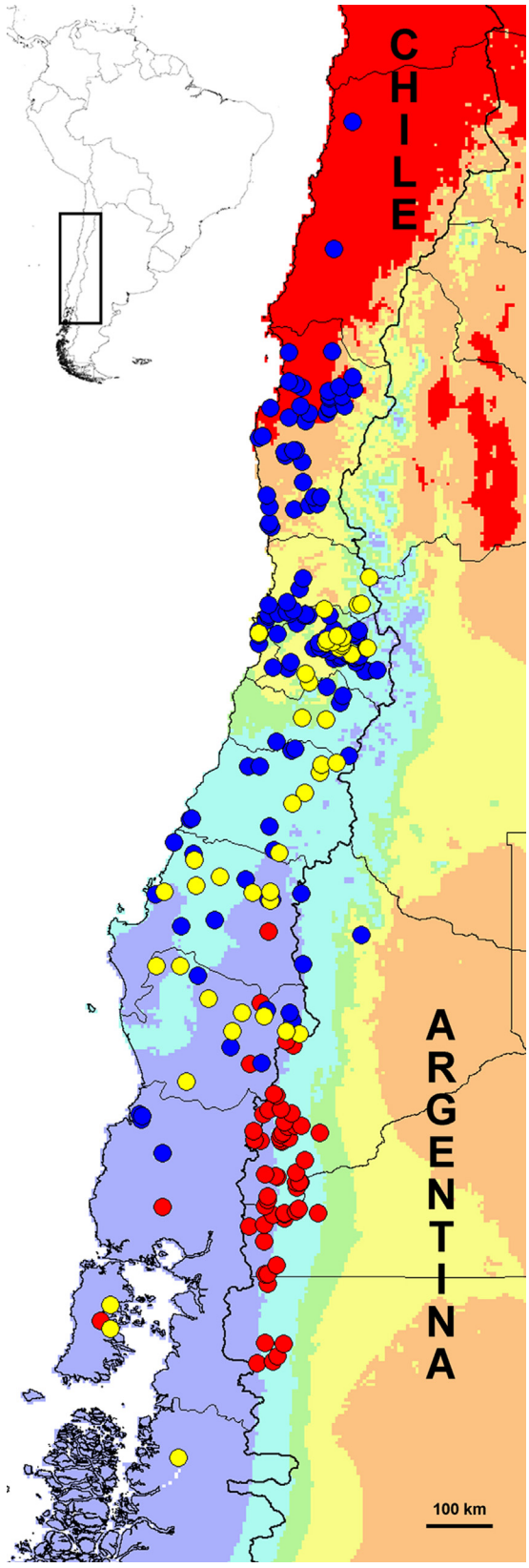

Fig. 9. Distribution map of *Corynura* (*Callistochlora*) species. Color patterns follow De Martonne aridity index: red (0–5), hiperarid; orange (5–10), arid; yellow (10–20), semiarid; green (20–30), subhumid; light blue (30–60), humid; purple (60–500), perhumid. Blue circles, *C. chloris*; red circles, *C. aureoviridis*; yellow circles, *C. prothysteres*. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

agrees with Spinola's description. It is in good condition though, and only has the left hind tarsus missing. Except by two females (identified as *C. aureoviridis* and *C. prothysteres*), all the specimens agree with the diagnostic characters of *C. chloris*. The only difference found between the specimens and Spinola's description is that the wing venation and the antennae of the females are light brown instead of black, as Spinola described them. All the specimens have a label which says "Chili" or "Chili 63", a female has an identification label which says "*floralia* Sm.", and another female has one that says "*Hal.* ♀/*chloris*/Spin." handwritten.

The type of *Augochlora floralia* was examined through photographs kindly sent by Dr. James E. Hogan (OUMNH). The mesoscutum sculpture, with punctures sparser medially on the disk, the striae of the metapostnotum and the lenght of the apical band of the clypeus suggest that the specimen belongs to the species *C. chloris*. This type is in good condition, although it has the right antenna, the right front leg from the tibia and the right hind leg from the femur missing. The specimen has the following labels: an illegible handwritten label, "*Floralia*/S. Am. Sm" handwritten, " = *chloris* Spin/HOLOTYPE/*Caenohalictus*/*floralia* (Sm)/J.S. Moure 1957" handwritten, "*Augochlora floralia*/Smith 1853/SYNTYPE/Ex W.W.Saunders Cooln./OX.UNI.MUS.NAT./HIST. (OUMNH)" printed. Smith (1853) did not specify how many specimens he studied. The single specimen in OUMNH was clearly labeled by Moure, and later mentioned as "holotype" in Moure (2007: 795). According to Article 74.7 of the *International Code of Zoological Nomenclature* this act cannot be taken as a valid lectotype designation. The specimen is here designated as the lectotype, for nomenclatural stability.

Even though the two syntypes of *Augochlora* (*Tetrachlora*) *porteri* Brèthes are not in good condition, they clearly belong to *C. chloris*. The first specimen has the mesoscutum broken around the pin, and it misses from F3 of the right and F2 of the left antena on, the left forewing, from the right mid and hind tibiae on, the apical two tarsomeres of the left front tarsus and the last one of the left hind tarsus. This specimen has the following labels: "Nos (Chile)/Videla/XI.1909" handwritten, "*Augochlora*/(*Tetrachlora*)/*Porteri* Brèthes" handwritten, "Colección/J. Brèthes" printed, and an additional label which says "MACN-En/12795" printed. The second specimen, from which only the mesosoma remains, bears the same labels, except "MACN-En/13763" printed. Brèthes (1910) did not specify how many specimens he studied, but clearly, both specimens belong to the type series. Although Moure (2007: 795) mentioned "holotype" in the type data of the species, none of these specimens have an identification label made by him. According to Article 74.7 of the *International Code of Zoological Nomenclature* this act cannot be taken as a valid lectotype designation. The first specimen is here designated as the lectotype.

3.7.4. Plants visited

Asteraceae: *Baccharis rosmarinifolia*; Fabaceae: *Phaceolus vulgarii*; Rhamnaceae: *Retanilla trinervia*. These asociations were taken from the labels of the specimes, but according to Moure and Hurd (1987), over 30 plant species from many different families are visited by *C. chloris* (data taken from previous published articles, ex. Herbst, 1922). Although *C. chloris* seems to be the most abundant *C.* (*Callistochlora*) species in Chile, the validity of these records might not be ensured given the difficulty to identify correctly this species with Moure's (1964) key.

3.7.5. Nesting biology

The nesting biology of *C. chloris* was described by Herbst (1917), Claude-Joseph (1926) and Vera Sánchez (2002), the latest including further biology aspects of the species. The nests of *C. chloris* are vertical burrows in flat ground, which can reach to 50 cm in depth. The cells are horizontally oriented, grouped in clusters, and surrounded

by a cavity. The cluster is typically 12 cm below the entrance of the nest, and it may be followed by a second, third or fourth cluster depending on how old the nest is. Vera Sánchez (2002) found up to four females in some of the nests, inferring a communal behavior for the species, since he found no evidence of a social division of tasks. However, behavioral observations using the circle tube apparatus showed high levels of aggression among specimens of *C. chloris*, suggesting a semisocial behavior for the species (Packer, 2005, 2006). Unfortunately we were able to confirm only the identification of the specimens studied by Claude-Joseph (1926), which are housed at the National Museum of Natural History (Smithsonian Institution, Washington D.C.).

3.7.6. Distribution

Argentina: Neuquén. Chile: From Atacama to Los Ríos.

3.8. *Corynura (*Callistochlora*)* prothysteres *(Vachal, 1904)*

(Figs. 1 D; 2 A; 3 A,B; 4 E,F; 5 C,F; 6 C; 7 C,F; 8 G-I; 9)

Halictus prothysteres Vachal, 1904: 23. Lectotype: Male, Chile. Sichel Collection, Muséum National d'Histoire Naturelle, Paris. Examined, **present designation**.

3.8.1. Diagnosis

Corynura (*Callistochlora*) *prothysteres* shares many characters with *C. aureoviridis*, such as the upper paraocular area and mesoscutum bearing dark, short hairs (as in Fig. 6A,B), the black apical band of the clypeus of the females short (0.1–0.2 times of clypeus total length) (Fig. 8G), and the disks of terga of the male black. The females can be identified by the sculpture of the metapostnotum, which bears short striae, radially arranged on the sides, and finer striae, disorderly arranged in the median area (Fig. 7C). In the male, the *sPa* of the flagellomeres are intermingled with other types of sensilla (Fig. 2A), and a small elevation with a ring of *stC-D* can be seen in lateral view (Fig. 1D). Both sexes have the tarsi light brown.

3.8.2. Description of the female

Length 8.3–8.9 mm. Forewing length 6.5–6.9 mm.

Color. Body metallic green, with bluish highlights on metasoma. Apical band of clypeus black, as long as 0.15–0.20 times clypeus length. Following parts black: labrum, malar area, mandible, scape. Following parts dark brown: apex of mandible, pedicel, posterior surface of flagellum, tibiae, posterior half of tegula, median area of T5. Anterior surface of flagellum, and mid and hind tarsi light brown, front tarsi sometimes darker. Wings hyaline, with dark brown veins and pterostigma, radial vein dark brown to black.

Pubescence. Light brown, with dark brown hairs on outer surface of mid and hind tibiae and tarsi. Compound eyes with hairs as long as 3.0–3.5 times MOD. Head with erect, plumose hairs, those on paraocular area and vertex as long as 1.3–1.7 times MOD. Lower part of gena with hairs up to 2.7 times MOD. Upper paraocular area, mesoscutum, scutellum and metanotum with dense, simple and plumose, short hairs (0.1–0.2 times MOD) (as in Fig. 6A,B), those on upper paraocular area and mesoscutum dark brown. Mesoscutum with scattered, plumose, long hairs (1.0–1.6 times MOD), longer on pleura (2.4–3.0 times MOD) and metanotum (up to 1.3 times MOD). Lateral area of propodeum with simple and plumose hairs as long as 2.1–2.5 times MOD. Anterior part of T1 with plumose hairs (0.9–1.4 times MOD), shorter and sparser on disk; marginal zone hairless. T2–4 with simple and plumose hairs, short (0.2 times MOD), and some scattered, plumose longer hairs (0.6–1.0 times MOD), directed posteriorly; marginal zones with simple, short hairs only. T5 with plumose hairs only. Sterna with very short, scattered hairs basally, and longer, mostly simple hairs on posterior half, those on S2–3 with their apices bent down.

Sculpture. Labrum with verrucose, median, basal elevation (Fig. 7F). Clypeus with punctures separated by 1.0–2.0 PD, supraclypeal area with sparser punctures, separated by 3.0 PD. Lower paraocular area with punctures separated by 1.0–2.0 PD; upper paraocular area with punctures separated by 0.3–0.5 PD. Mesoscutum, scutellum and metanotum with small punctures, separated by 1.0 PD, intermixed with larger punctures separated by 3.0–4.0 PD; punctures evenly distributed (Fig. 6C). Hypoepimeral area with punctures separated by 2.0–3.0 PD, those on lateral area of propodeum separated by 4.0–5.0 PD. Metapostnotum with striae not surpassing half of length of dorsal surface, short and radially arranged on sides, finer and disorderly arranged in median area (Fig. 7C); apical margin tessellate. T2–4 with punctures separated by 2.0 PD, sparser on sides and on disk of T1 (punctures separated by 4.0–6.0 PD). Surface between punctures tessellate throughout body, except: clypeus and disk of mesoscutum weakly tessellate, almost smooth; supraclypeal area and scutellum smooth; mesopleura finely rugose; T1 and metasomal sterna substrigulate.

Structure. Head broader than long, 1.24–1.27:1. Proportion of lower to upper interocular distance 0.94–0.97:1. Clypeus broader than long, 1.72–1.81:1. Proportion of interantennal to antennocular distance, 0.41–0.49:1. Proportion of posterior interocelar to ocelo-ocular distance, 0.82–0.92:1. Inner hind tibial spur pectinate, with three to five teeth directed to apex of spur.

3.8.3. Variation

In the type series of *Halictus chloris*, one of us (R.A. González-Vaquero) found a female of *C. prothysteres*, which had some golden highlights on the mesoscutum. All the other examined females of *C. prothysteres* had the mesoscutum totally green. A few specimens from Til-Til (Metropolitan Region) had the wing venation light brown.

3.8.4. Type material

The four males of the type series of *Corynura* (*Callistochlora*) *prothysteres* from the Sichel Collection (MNHN) have been studied. Although Moure and Hurd (1987) report that a specimen was labeled as the "lectoholotype" by Moure, in March 1958, none of the specimens have a label with such information. The specimen in the best condition has a red label "TYPE;" as there is no certainty regarding which specimen Moure and Hurd (1987) made reference to, we designate this specimen as the lectotype. In addition, this specimen has the following labels: "*prothysteres*/♂ Vach" handwritten, "Chili/63" handwritten, "Museum Paris/Chili/Coll. O. Sichel 1867" printed, and a label "*H. pro-*/*thysteres*/Vach" handwritten. The lectotype is in excellent condition except for the left antenna which is broken from F6 on. Two of the other specimens have the metasoma glued to a card, and the head is missing from the fourth one. Although the specimens of the type series are slightly smaller than the rest of the examined material, they do agree in sculpture, the black disks of terga, the ring of stC-D on a small elevation in the dorsal surface of each flagellomere, and the light brown color of the tarsi, antenna and wing venation. The T6–7 are brown instead of red as reported in Vachal's description of the species.

3.8.5. Plants visited

Unknown.

3.8.6. Nesting biology

Unknown.

3.8.7. Distribution

Chile: From Valparaíso to La Araucanía, with a few records from Los Lagos and Aysén.

4. Discussion

The patterns of the flagellar sensilla observed in *Corynura* (*Callistochlora*) agree in part to those observed in other bees. The great amount of setae (and few sensilla) in the proximal flagellomeres (F1–3) is a regular pattern reported in bees of different families (Ågren, 1977, 1978; Ågren and Svensson, 1982; Galvani et al., 2008, 2012; Gupta, 1992; Wcislo, 1995). The presence of areas composed only by *sPa* was reported for the males of several genera, aside from some species of *Corynura s. str.* This character is known to be present in *Halictillus*, *Neocorynura*, *Andinaugochlora, Chlerogas* Vachal, *Pseudaugochlora* Michener and *Megommation* Moure (Eickwort, 1969), as well as in some species of *Augochlora* (Michener, 2007). The only species of *Corynura* that do not bear this character, easily detectable under stereo microscope, are *C. chloris, C. prothysteres* (Fig. 2A) and *C. chilensis* (Spinola). The remaining species have practically all the dorsal area of the antennae covered only by *sPa* (Fig. 2C), although in *C. aureoviridis* (Fig. 2B) and *C. chloromelas* (Alfken) these areas occupy approximately the mid third or half of the dorsal side of each flagellomere.

The SEM images allowed the observation of the other types of sensilla, and two particularities of the subgenus were found. Firstly, we observed that in the males of *C. aureoviridis* there are one or two rings of *stC-D* encircling the areas composed only by *sPa* (Fig. 1B), which are hardly seen under stereo microscope. The straight and long *stC-D* that form these rings differ in morphology from the ones found elsewhere in the flagellomere. These rings are not mentioned by Ågren and Svensson (1982) in their study about *Sphecodes*, but some *stC-D* arranged in rows can be observed in their images. *Corynura aureoviridis* also has areas with practically no *sPa* on the laterals of the flagellomeres (Fig. 1F), a character not previously registered in bees. Secondly, and probably a more significant result of this contribution, is the absence of sensilla basiconica in the females of *C.* (*Callistochlora*). The lack of this type of sensilla, which are known to be present in the distal part of the dorsal flagellomeres in species of Apidae, Halictidae, Andrenidae and Colletidae (Ågren, 1977, 1978; Ågren and Svensson, 1982; Esslen and Kaissling, 1976; Galvani et al., 2012; Wcislo, 1995), was observed only in cleptoparasitic bees of the subfamily Nomadinae (G.L. Galvani, unpublished results). Further studies focused on the sensilla basiconica may shed light about the function of this type of sensilla, and its absence in some groups of bees.

The results of our analyses suggest that the study of the sensilla may be an additional tool to delimit species, as the presence or absence of areas composed only by sensilla placodea as well as its size relative to flagellomere length have proved to be constant among specimens in the species studied. This was previously suggested by Ågren and Svensson (1982) for the halictid bee genus *Sphecodes*. In addition to the presence/absence of different types of sensilla, a detailed study is needed to assess abundance and distribution patterns, including a large number of specimens from different localities to assess intraespecific diversity. Given the new technologies available every year, we believe that the analyses of the sensilla may be helpful, especially for taxonomists who work with species that are very hard to tell apart under classical morphological methodologies, as it occurs with males of *C. aureoviridis* and *C. prothysteres*.

Acknowledgements

We thank Arturo Roig Alsina, Beatriz Settembrini and an anonymous reviewer for their helpful comments on the manuscript, Fabián Tricárico for technical assistance and Juan Pablo Torretta for his help with plant identifications. R.A. González-Vaquero thanks Gustavo Giovinazzo and José Mondaca for their assistance in field trips. We thank Administración de Parques Nacionales, Dirección General de Control de los Recursos Faunísticos (Province of Neuquén) and Dirección de Fauna Silvestre of the Secretaría de Ambiente y Desarrollo Sustentable de la Nación for the permits granted. This research was funded by scholarships from CONICET to R.A. González-Vaquero and G.L. Galvani. Field trips and MEB images were funded by grants of the Fondo iBOL Argentina-CONICET, and the Agencia Nacional de Promoción Científica y Técnológica, PICT 2007-1238, préstamo BID.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jcz.2016.03.006.

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