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On the enigmatic *Heterostomus curvipalpis* Bigot, 1857, with a description of the pupa (Diptera, Brachycera)

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Abstract

The previously unknown pupa of *Heterostomus curvipalpis* Bigot is described. The morphology of the pupa of *Heterostomus* is compared with the pupae of Xylophagomorpha, Tabanomorpha and Stratiomyomorpha families, based on five characters, and its phylogenetic position is discussed. Currently placed in Xylophagidae, we conclude that the pupa of *Heterostomus* shares most characters with the pupae of Pelecorhynchidae.

Key words: Insecta, lower Brachycera, Systematics, Neotropical Region, Chile, Tabanomorpha, Xylophagomorpha, Stratiomyomorpha

Introduction

Heterostomus curvipalpis Bigot, 1857 is a peculiar species from central Chile with an enigmatic systematic position. The placement of *Heterostomus* has been contentious among authors. Most included the genus in Xylophagomorpha (Mik 1890; Hunter 1900; James 1975; Nagatomi 1977, 1981, 1984, 1985, 1992; Woodley 1989; Sinclair *et al*. 1994; Mazzarolo & Amorim 2000; Jarzembowski & Mostovski 2000; Palmer & Yeates 2000; Stuckenberg 2001; Yeates 2002; Kerr 2010). Others included it in Tabanomorpha: Kröber (1930) placed it into Tabanidae; Malloch (1932) included it in Rhagionidae; and Hennig (1972) placed it close to Pelecorhynchidae. However, up to now only adults of *Heterostomus* were known, and to consider the systematic position of a brachyceran without knowing the immature stages is very difficult (Woodley 1989).

In this contribution we describe the pupa of *Heterostomus curvipalpis* for the first time, and its morphology is compared with the pupae of Xylophagomorpha, Tabanomorpha and Stratiomyiomorpha.

Material and methods

The materials examined belong to the Instituto de Entomología of Universidad Metropolitana de Ciencias de la Educación (UMCE), Santiago, Chile, and to the National Museum of Natural History (USNM), Washington DC, USA. External morphology and ornamentation were studied using a stereomicroscope. The terminalia were dissected, cleared using potassium hydroxide and phenol, and mounted using Canada balsam onto microslides; these were observed with a compound microscope. The morphological terminology is based on Coscarón and Coscarón (1995) and McAlpine (1981).

Examined material: From UMCE. CHILE, **Valparaíso**, Quilque, Los Penales;20-X-68; Solervicens collector: 2 females, 1 pupa (collected in sawdust found in the soil of the forest, and maintained in the same substrate in the laboratory, where later a female emerged on 31-X-68). Limache, Piedras Blancas;15-I-68; Solervicens collector: 1 male. **Santiago**, El Manzano;11-XI-78; Rivas-Elgueta collector: 1 female. Maipu, Quebrada de la Plata;4-XI-60; C. Vivas collector: 2 males. Talagante; 25-IX-58; G. Pino collector: 1 male. El

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Canelo;X-67; Etcheverry collector: 1 male. San Cristóbal;Etcheverry collector: 1 male. Petorca, Colchagua Quebrada El Tigre; 15-XI-89; González collector: 1 male. Bosque Relicto, Quinteno; 24-X-66; C. Vivas collector: 1 male.

From USNM. CHILE, **Santiago**, #182; Inardi Lasalle collector): 1 female. **Biobío**, Concepción; XII-1926; Shannon collector: 1 male. **Araucanía**, Galvarino; 28-I-27; determined as *Heterostomus curvipalpis* by J.R.Malloch: 1 female; 12-XI-30: 2 females. Angol; 28-I-40, G.R.D.B. collector: 1 male. 6-XII-40, Eduardo Barga collector: 1 female.

Description

Heterostomus curvipalpis Bigot, 1857

(Figs. 1–23)

Heterostomus curvipalpis Bigot, 1857: 285; Malloch, 1932: 204; Nagatomi, 1984:115; 1985: 699.

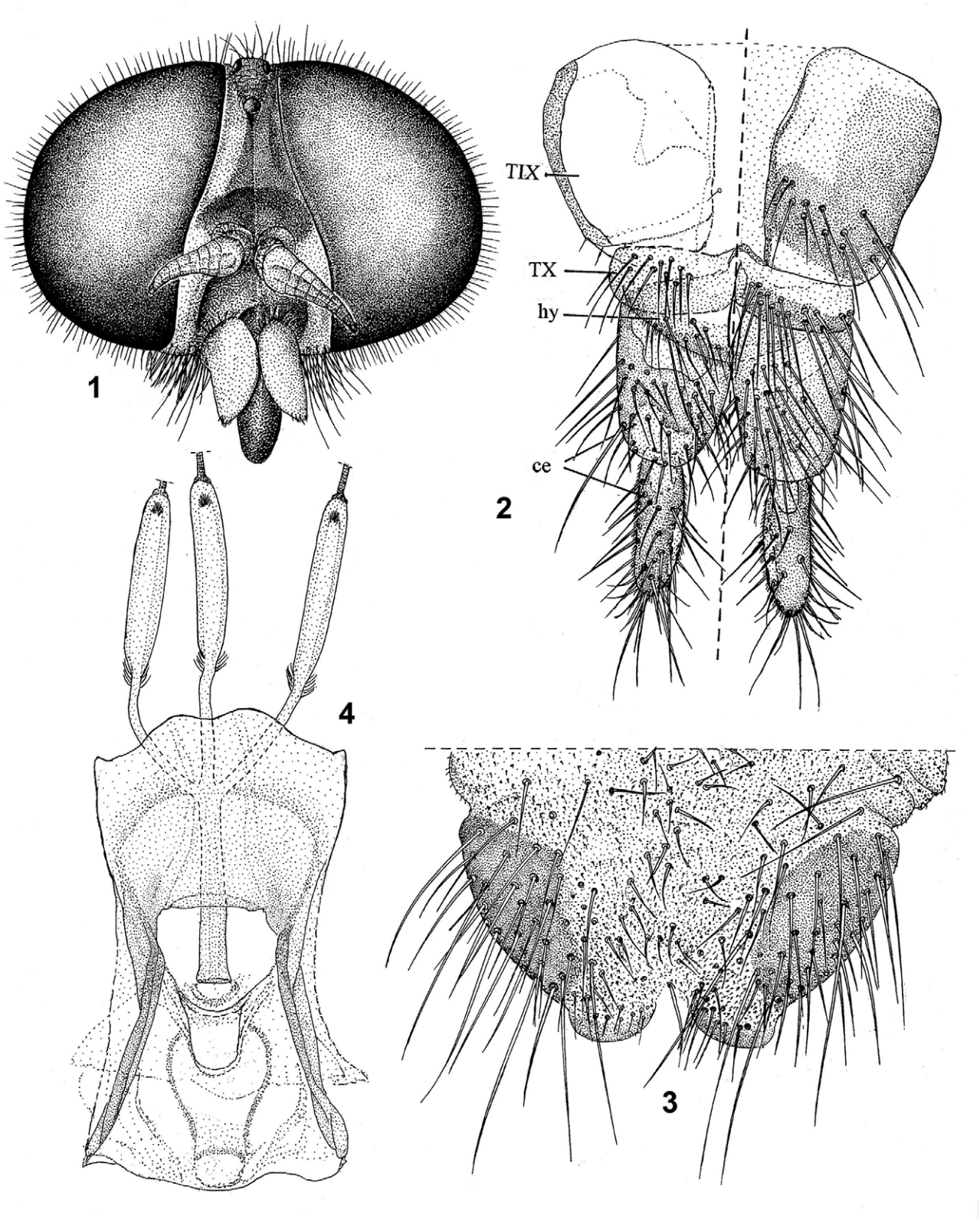
Adult (Figs. 1–14): Large species, wing length 13.0–18.0 mm, eyes bare; face with upper and mid lower part scarcely produced anteriorly; conspicuous ocelli; antennal flagellum with eight flagellomeres, palpus with two flattened articles, proboscis fleshy and surpassing palpus length (Figs. 1, 5, 12, 14); male holoptic. Scutum flat (Figs. 9, 10); postmesonotum and postscutellum present; metathorax with postspiracular plate. Wing elongate (Figs. 8, 13), vein C reaching wing apex, vein R_1 setose, R_{2+3} anteriorly curved from medial portion and ending very close to R_1 apex; basal radial cell elongate, its apex surpassing the middle of discal cell; R_4 arising from anterior third of R_5, which ends just at the wing apex; M_1 ending posterior to the wing apex, vein M_3 curved but not fusing with Cu–A_1, thus cell m_3 open at wing margin, CuA_1 arises from the apex of basal medial cell, posterior cubital cell closed; alula scarcely developed and lower calypter well developed, with a tuft of long pubescence. Tibial spurs 1:2:2. Abdomen elongate and flattened, gradually narrowed beyond VII segment (Fig. 11).

Female genitalia: tergite IX membranous at middle, tergite X divided; cerci with two segments (Fig. 2), with a few developed subapical sensorial pits on internal side; genital fork wide basally, with thick spermathecal ducts at base (Fig. 4).

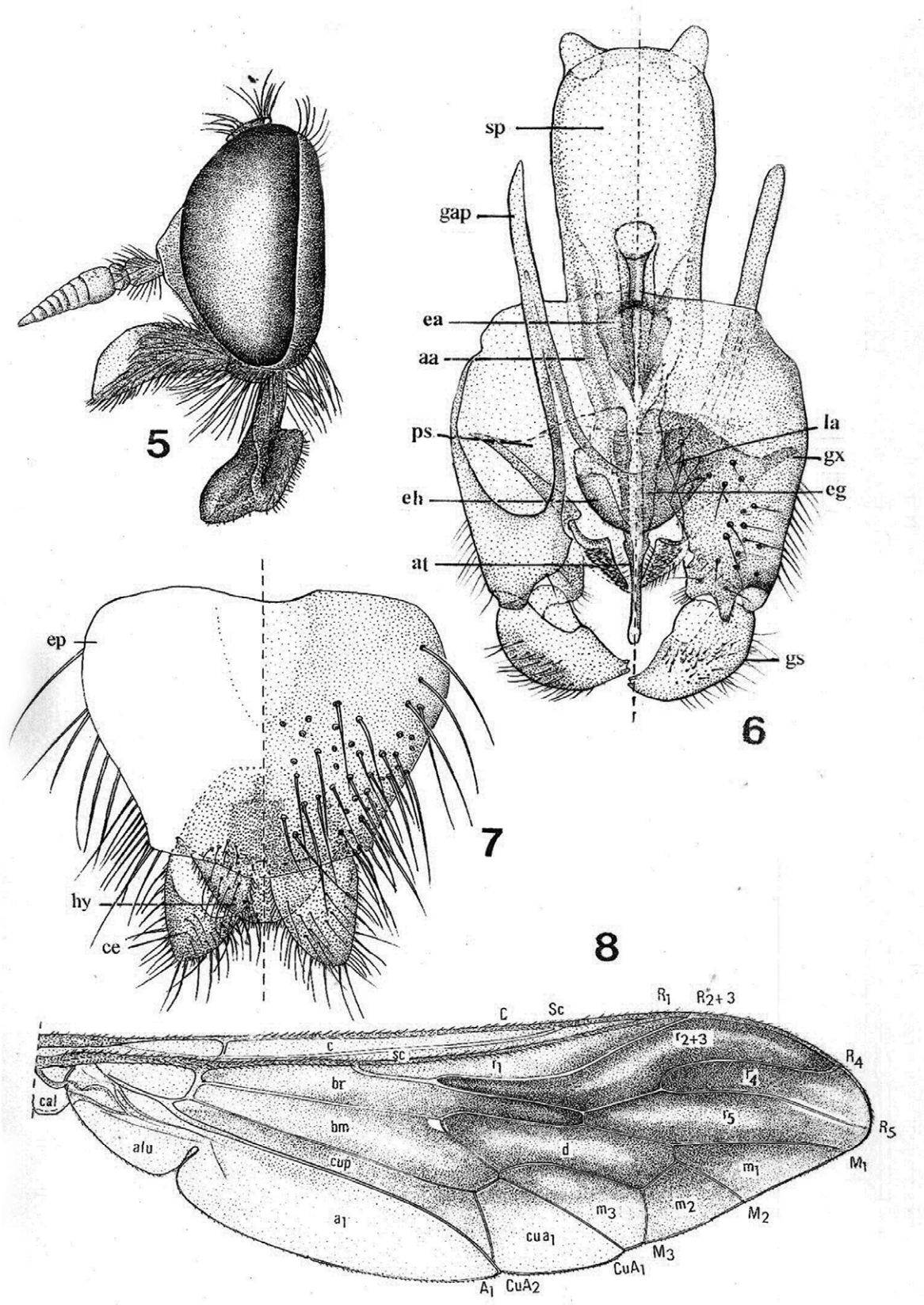
Male genitalia (Fig. 6): gonocoxites fused dorsally, gonostylus subtriangular, short and externally curved; parameral sheath surrounding the aedeagus; tip of the aedeagus well developed; ejaculatory apodeme extended posteriorly by endoaedeagal guide, lateral aedeagal apodeme large; spermatic pump subcylindric and enlarged; gonocoxal apodemes relatively thick and greatly projected anteriorly. Tergites IX and X fused (Fig.7) (= epandrium), cerci subquadrangular; sternite IX expanded (= hypoproct).

Pupa (female, emerged in the laboratory) (Figs. 15–23): Exuvial coloration reddish brown, uniformly glossy, slightly darker on thoracic and abdominal spiracles, and with blackish spines forming abdominal rings on each segment. Length 30.0 mm.

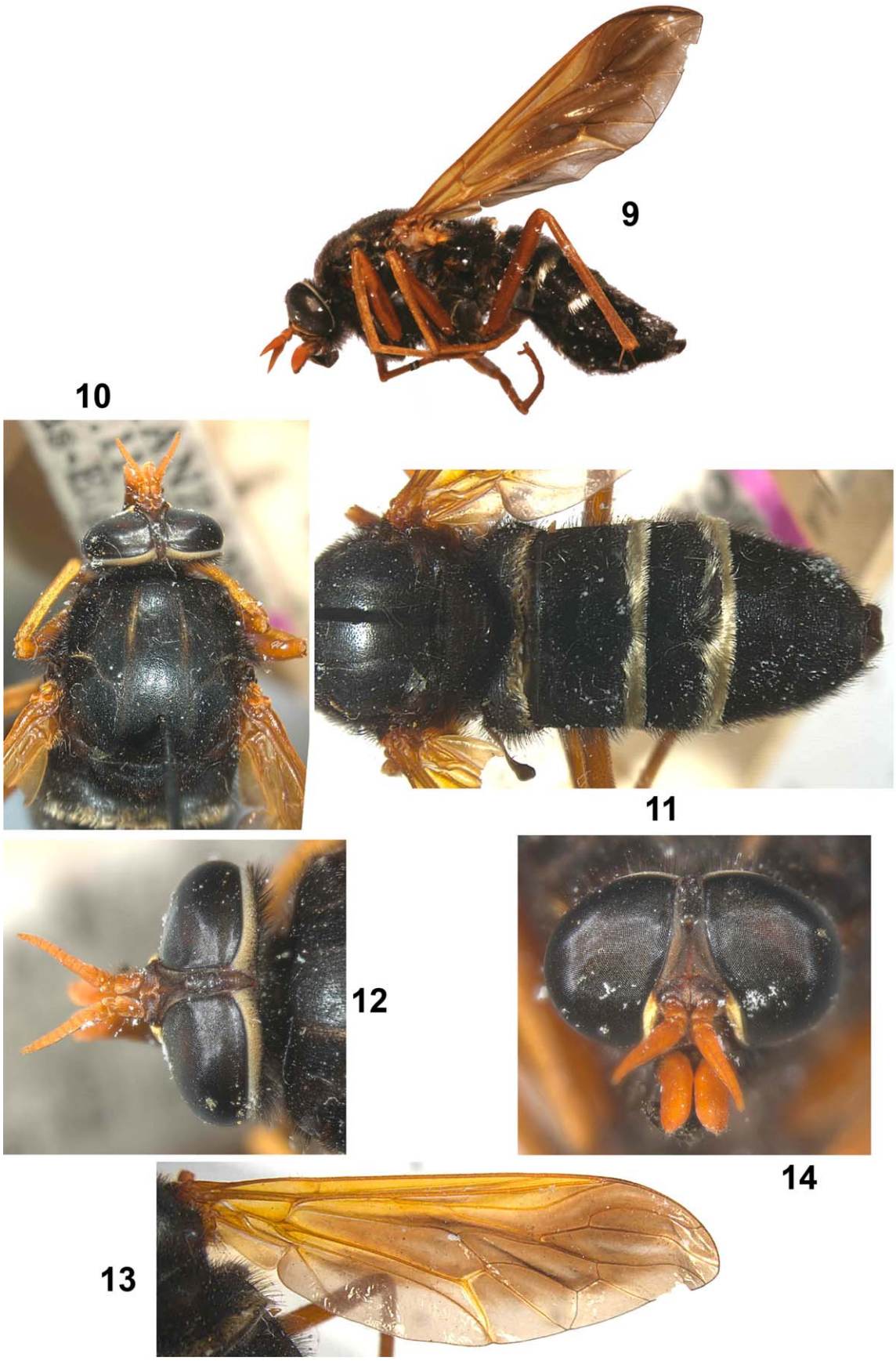
Frontal and cephalic sclerites unknown (lost during the emergence). Thorax dorsally with transverse sulcus (Fig. 16, 17) on anterior 3/4 and small lateral rugosities (wrinkled areas). Mesothoracic spiracle prominences slightly elevated (0.8 mm) (Figs. 16, 17, 18, 19). Spiracle slit placed transversely on the apex of the prominence, is arched and elongated, showing curved like a semicircle on both extremes and without projection. Wing and leg sheaths of equal length, extended surpassing a little the first abdominal segment border. Mesonotum with three separated spines on each side: one anterolateral, one mediodorsal and one submediandorsal. Abdominal spines appear seta-like,stout at base and thinly prolonged distally. First abdominal tergum with 9+9 stout spines approximately equidistant, five of them more dorsal in position; the following four spines on pleura are closer to each other. Subsequent abdominal segments II–VII with two uniseriate and continuous rows of spines and without setae, and delimiting, in combination with the intersegmental sutures, three annular stripes, all around each segment and of approximately same length (Figs. 15, 16, 20, 21). Middle stripes between spine rings smoother and glossier. First rows of spines smaller than the second, and absent ventrally between the respiratory spiracles area. The second rows of spines are complete around the ring segment; the spines are longer dorsally and in the VII segment some grouped forming a spur (Fig. 22). Segments II –VII with the first rows of spines with 46, 52, 50, 62,



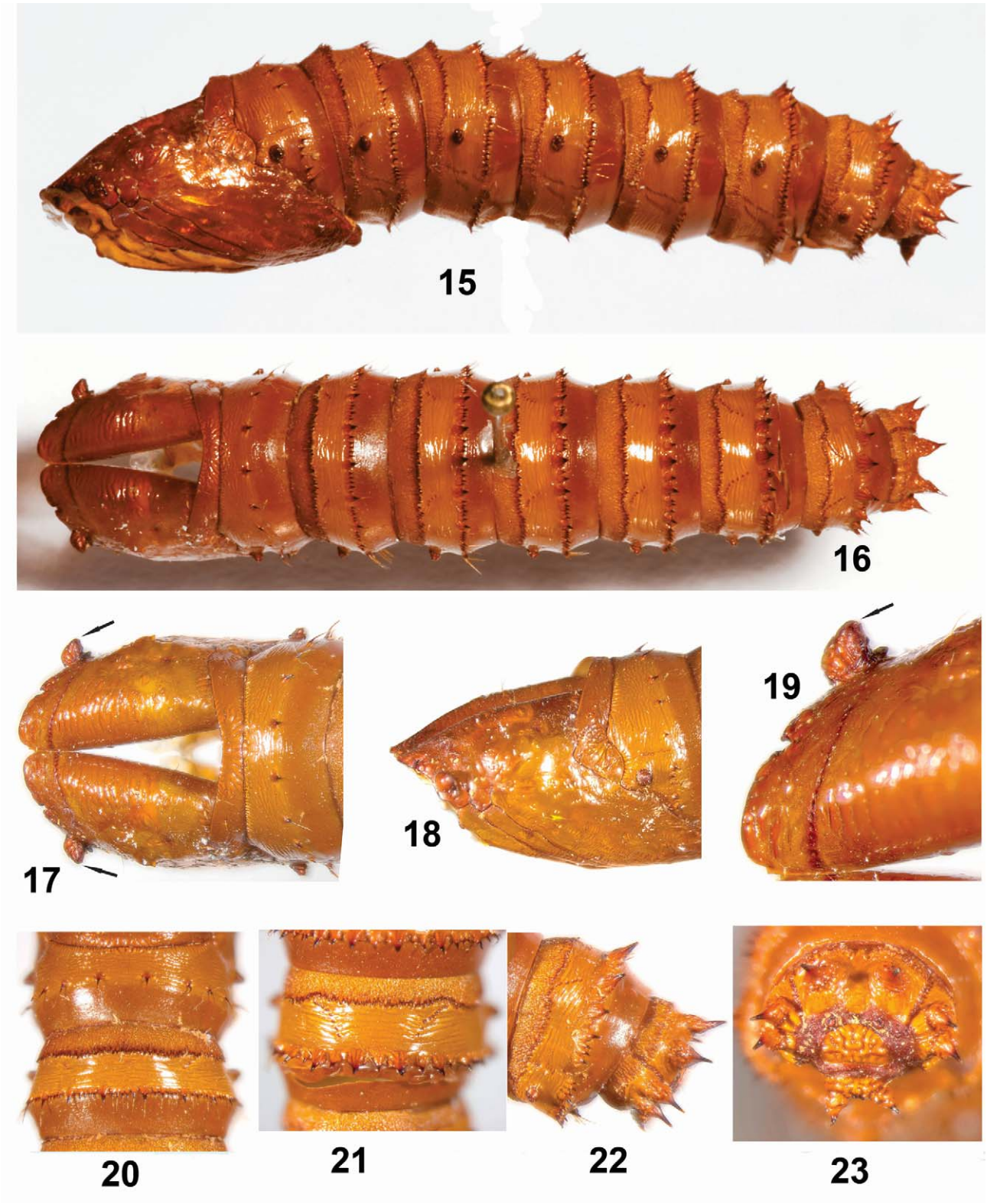
FIGURES 1–4. *Heterostomus* female. 1: head, frontal view. 2: terminal abdominal segments (epigynium), shown on left side the ventral view, and on right side dorsal view. ce: cerci, hy: hypoproct, TIX and X: ninth and tenth tergites. 3: distal portion of hypogynium (eighth sternite and gonapophysis). 4: genital fork with basal parts of spermathecal ducts.



FIGURES 5–8. *Heterostomus* male. 5: head, lateral view. 6: hypopygium, shown on left side the ventral view, and on right side dorsal view. gs: gonostyle, gx: gonocoxite, aa: aedeagal apodeme, pa: parameral sheath, at: aedeagus tip, ea: ejaculatory apodeme, eg: endoaedeagal guide, eh: endophalic hilt, ea: ejaculatory apodeme, gap: gonocoxal apodeme, la: lateral apodeme, sp: sperm pump. 7: epandrium (ep) (tergites IX and X fused), shown on left side the ventral view, and on right side dorsal view. hy: hypoproct. 8: wing.



FIGURES 9–14. *Heterostomus* female. 9: lateral view. 10–13: dorsal view. 14: frontal view.



FIGURES 15–23. *Heterostomus* pupa. 15, 18, 19, 22: lateral view. 16, 17, 20, 21: dorsal view. 23: aster in posterior view. 17 and 19: arrows points spiracle.

50, 38 spines per segment, respectively; and the second rows of spine with 86, 96, 106, 94, 64, 50 spines per segment, respectively. Anal segment without spines, but with small rugose anterior stripe-like area in the preceding apical segments. VIII segment with eight large wrinkled and well sclerotized tubercles, forming the aster, arranged as following: 1+1 dorsal (1.2 mm), 2+2 lateral (1.1 mm), and ventral (0.7 mm); dorsally there is a comb of 11–12

small spines (Fig. 23), and internally on base of lateral spines, there are another two small acuminate tubercles (Figs. 22, 23). Seven subconical abdominal respiratory spiracles with similar shape (0.36 mm) (Fig. 15), and positioned lateroanteriorly on segments I–VII (Figs. 15–16).

Discussion

The pupa of *Heterostomus* can be distinguished from the other families of lower Brachycera by a combination of four characters, which can be tested in future cladistic analyses (Table 1). *Heterostomus* appears most similar to the pupae of Pelecorhynchidae, which differs from other lower Brachycera in that the thoracic spiracles are small and placed relatively low (middle height of the metathorax, ventrodorsally), with two rows of spines and three round ridges on each of segments II-VII (Mackerras & Fuller 1942; Teskey, 1970). Additionally, *Heterostomus* have abdominal segments undivided (a condition only shared with *Oreoleptis* Zloty, Sinclair & Pritchard, 2005). This set of characters differentiates it from Pelecorhynchidae, which have the abdominal segments clearly divided into dorsal, ventral and lateral areas (Table 1).

TABLE 1. Comparative morphology of pupae of lower Brachycera families[1]

Characters of pupae	Xylophagomorpha		**Stratiomyomorpha**[2]
	Heterostomus	Xylophagidae	
Thoracic spiracles	small and low (height about as long as the medium metathorax length)	very large and raised on a sub-conical tubercle	small and low
Abdominal segments	undivided	divided into dorsal, ventral and lateral areas	divided into dorsal, ventral and lateral areas
Rows of spines on abdominal segments II–VII	two continuous rows; anterior absent ventrally	Only one continuous rows	only one row, continuous or not
Two rows of spines forming three round ridges on each of the segments II–VII	present	absent	absent
Number of acuminante tubercles on anal aster	8	2	2–6

continued.

Characters of pupae	Tabanomorpha				
	Rhagionidae	Pelecorhynchidae	Athericidae	Tabanidae	Oreoleptidae
Thoracic spiracles	small and low	small and low	very large and raised on a sub-conical tubercle	variable	very large and raised on a sub-conical tubercle
Abdominal segments	divided into dorsal, ventral and lateral areas	divided into dorsal, ventral and lateral areas	divided into dorsal, ventral and lateral areas	divided into dorsal, ventral and lateral areas	undivided
Rows of spines on abdominal segments II–VII	two rows dorsally	two continuous rows	only one row, continuous or not	only one row, continuous or not	only one row, continuous or not
Two rows of spines forming three round ridges on each of the segments II–VII	absent	present	absent	absent	absent
Number of acuminante tubercles on anal aster	2	6	8	4–6	2

[1]Adapted from: Mackerras & Fuller (1942); Nagatomi (1961); Teskey (1970); Coscarón (2002); Yeates (2002); Zloty *et al.* (2005). [2]Stratiomyidae, Pantophthalmidae and Xylomyidae share the same features.

There is a divergence of opinions regarding the systematic position of *Heterostomus*. Most works position *Heterostomus* within the Xylophagidae, based on the flattened clypeus of the imago (Woodley 1989, Stuckenberg 2001), similarities with the male genitalia (Sinclair *et al*. 1994), or molecular data (Kerr 2010). We consider that the facial area of *Heterostomus* is more swollen than in the Xylophagidae genera, even if it does not reach the antennal base dorsally (Webb 1979). The facial area of *Heterostomus* is more similar to the condition occurring in the Rhagionidae (Kerr 2010) and Tabanidae (Coscarón & Papavero 2009). Also, the pupa of *Heterostomus* resembles a Tabanomorpha pupa more, mainly Pelecorhynchidae (Mackerras & Fuller 1942, Teskey 1970) than a Xylophagidae pupa (Webb 1979). Yet Pelecorhynchidae shows notorious differences in the imagoes, as the more globose head, and the prominent face, thinner and elongated distal abdominal segments, female with first cerci segment postero-laterally produced, and male gonostyle narrower and thinner distally (Mackerras & Fuller 1942). The classification scheme of lower Brachycera proposed by Woodley (1989) is based mainly on larval characters. Unfortunately the larva of *Heterostomus* remains unknown, and this substantial lack of data is needed to understand the position of the genus among the lower Brachycera.

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