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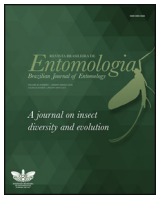

A new species of *Nectopsyche* Müller, 1879 (Trichoptera: Leptoceridae) and notes on the adults of *Nectopsyche splendida* (Navás, 1917)

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ABSTRACT

The male and female of a new species in the long-horned caddisfly genus *Nectopsyche* Müller, 1879 are described from southeastern Brazil. The new species has male genitalia similar to species of the *candida-group*, but has several endothecal spines in the phallic apparatus similar to those of *gemma-group* species. The color pattern of the scales and hairs on the head, thorax and forewings is similar to that of *Nectopsyche splendida* (Navás, 1917), as both species have bands of metallic silver-iridescent scales interleaved with black areas on the forewings. Additionally, we present illustrations of the male and female genitalia of *N. splendida* and expand the knowledge of its distribution.

Introduction

The genus *Nectopsyche* Müller, 1879 is a member of the long-horned caddisfly family Leptoceridae. The genus is known for the unique swimming habit of the larvae and the colored hairs and shiny scales on the forewings, thorax, and head of the adults of many species (Müller, 1879). Currently, 104 species are known within the genus, all restricted in distribution restricted to the New World (Holzenthal and Rios-Touma, 2018; Morse, 2022).

The genus is traditionally divided into groups of species that do not necessarily represent monophyletic clusters of species (Flint, 1983; Holzenthal, 1995). Species are grouped by distinct differences in color pattern, forewing length, eye size, and major differences in male genitalia (Flint, 1983). The genus has a high intraspecific variability of the genitalic structures, even within the same population, and with subtle differences in the genitalia among the species of a group (Holzenthal, 1995). The most currently important feature in the determination of the species of *Nectopsyche* is the color pattern of hairs and scales on forewings, thorax, and head, which hampers any attempt to identify individuals stored in alcohol or even pinned material with denuded forewings (Holzenthal, 1995; Oláh, 2016). Nevertheless, six groups of species were determined based only on structures of the male genitalia, without reference to color pattern of the forewings, by Oláh and Oláh Junior (2017), allowing some studies with material preserved in alcohol.

Nectopyche splendida (Navás, 1917) was described based on material (♂, unspecified number of specimens) from Santa Fe, Argentina, and as for many species described by Navás, the type material is lost (Schmid, 1950; Muñoz-Quesada, 2000; Holzenthal and Calor, 2017). The species was redescribed by Flint (1982) based on material (one ♀ and possibly ♂) from Buenos Aires, San Miguel, Argentina. Both the description by Navás (1917) and the redescription by Flint (1982) do not describe or illustrate the male genitalia. Currently, this species has a wide distribution in the Neotropics, with occurrences extending from northern Venezuela to the central region of Argentina (Holzenthal and Calor, 2017).

Recently, based on material collected predominantly in the Rio Doce basin, southeastern Brazil, we found a new species apparently related to *N. splendida*. Herein we describe the male and female adults of the new species, as well as the different eversible states of male genital structures. Additionally, we present illustrations of the male and female genitalia of *N. splendida* and expand the knowledge of its distribution in southeastern Brazil.

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Material and methods

Specimens were collected sporadically at low altitude sites (15 m–585 m) in two hydrographic basins in southeastern Brazil: the Rio Doce basin, in the main river and its large tributaries, including Rio São José, Rio Manhuaçu, Rio Santana and in an associated lake, Lagoa Nova; and the São Mateus river basin, including Rio São Mateus and Rio Cricaré. Both basins are located in the Atlantic Forest biome in the southeast of Minas Gerais state and north of Espírito Santo state (Fig. 5).

Adults were collected by attracting them to white or black light fluorescent tube lamps placed in front of white bed sheets as well as with Pennsylvania light traps (Frost, 1957; Upton and Mantle, 2010). Most of the material was preserved in 80% ethanol and a few specimens were pinned. To observe genitalic structures, the abdomen was removed and cleared using potassium hydroxide solution (KOH 10%) at room temperature; for eversion of the genitalic structures, lactic acid (85%) method was used (Blahnik and Holzenthal, 2004; Blahnik et al., 2007). After clearing, the abdomen was placed on an excavated microscopic slide with alcohol gel and a coverslip was gently placed over the gel for viewing, photographing, and drawing the genitalia. For the illustration of the forewing and genitalia, a stereomicroscope (Olympus SZ61), a compound microscope (Olympus CX31) and an attached camera (Motic A5) were used. The focus montage of the individual digital photographs and editing of the images were done in Adobe Photoshop®. Drawings of the genitalia were done in Adobe Illustrator®. The morphological terminology follows that of Schmid (1998) and for genitalia Holzenthal (1995).

The distributional map was created in the QGIS® software, using geographic coordinates of the material analyzed in this paper, published literature records and data available at the Global Biodiversity Information Facility (GBIF). "Terrestrial Ecosystems of the World" layers used in the map are available from the World Wildlife Fund (WWF) (Olson et al., 2001). For literature records without detailed locality of georeference information, with only occurrence information for the country, we provide their respective central points, to demonstrate the occurrence recorded in the literature for these countries. Material examined, including types of the new species, is deposited in the Museu de Entomologia, Universidade Federal de Viçosa (UFVB) and the Museu Nacional do Rio de Janeiro (MNRJ).

Results

Nectopsyche aymore, new species

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(Fig. 1A-F, 2A-C & 3A-C)

Diagnosis. This new species has male genitalia similar to the species of the *candida-group* (Flint, 1968) based on the following characteristics: simple, elongated preanal appendages (Fig. 1B, C); slender, straight inferior appendages (Fig. 1A, B); basoventral process of the inferior appendages digitate (Fig. 1A, B). On the other hand, this species has several endothecal spines in the phallic apparatus (Fig. 1D-F), as in species included in the *gemma-group*. The color pattern of the scales and hairs on the head, thorax, and forewings (Fig. 2A) is similar to those of *N. splendida*, as both species have bands of metallic silver-iridescent scales interleaved with black hairs or scales on the forewings. In the new species, however, the black coloration is formed only by dark hairs between the bands of scales, and the scales in the bands as well as the bands themselves are not as densely distributed or defined as they are in *N. splendida* (compare Figs. 2A and D). Furthermore, the forewing of *N. splendida* has a patch of golden scales over the stigma (Fig. 2D), which is absent in the new species. In addition, the new species differs from *N. splendida* by having wider abdominal segment IX in lateral view (Fig. 1B); narrower and smaller ovoid tergum IX acrotergites (Fig. 1B, C); smaller, more robust preanal appendage (Fig. 1B, C); segment X lateral process thin with acute apex (Fig. 1B); inferior appendage with apicomesal lobe with small spines at the apex (Fig. 1A); periphalic process without an enlarged apex (Fig. 1D-F); phallobase strongly curved and flexible (Fig. 1D-F); and endothecal membranes with small spines (Fig. 1D-F).

Description. Adult male. Length of forewing 6.3 – 6.7 mm, (6.5 mm, n = 10). Head dark brown (Fig. 2B, C), with metallic silver-iridescent scales on dorsum; antennae brown to dark, scape dark brown (Fig. 2B, C); labial and maxillary palps dark brown; eyes small, width approximately 0.4 times interocular distance (Fig. 2B). Thorax black to dark brown (Fig. 2B, C) covered with metallic silver-iridescent scales, mesothorax with 4, 5 or 6 pairs of setal warts, metathorax with 1 pair of setal warts (Fig. 2B); legs brown to light brown; forewings dark brown with 3 vertical irregular bands of metallic silver-iridescent scales interleaved with dark hairs, and 1 horizontal band of metallic silver-iridescent scales in the anal region extending to apical region (Fig. 2A). Male genitalia. Abdominal segment IX, in lateral view, trapezoidal (Fig. 1B); tergum sub-rectangular with a pair of mid-dorsal protuberance, with pair of small oval acrotergites (Fig. 1C); sternum IX absent. Preanal appendage approximately same length as segment IX, narrow, setose, rounded apically (Fig. 1B, C). Segment X lateral process approximately 0.5x the length of preanal appendage, thin, very narrow, apex acute with 2 apical setae (Fig. 1B). Inferior appendage slender straight with apex acute in lateral view (Fig. 1B), with long setae; apicomesal lobe rounded apically, with few setae and many small spines at apex (Fig. 1A); basoventral process long, approximately 0.3x length of inferior appendage, narrow, with several long setae (Fig. 1A, B). Phallic apparatus with periphallic processes thin, long, slightly curved s-shaped, apex acute, smooth (Fig. 1D-F); phallic apodeme enlarged, bulbous, semi-membranous (Fig. 1D-F); phallobase sclerotized and flexible, in relaxed state (clarified with KOH 10% method) the basal median ventral area is strongly curved into a closed c-shape (Fig. 1D), in semi-everted state (minutes after clarification with lactic acid 85% method) phallobase protruding from inside the phallic apparatus (Fig. 1E), in full-everted (immediately after classification by the lactic acid 85% method) its median basal area is flexed and slightly curved (Fig. 1F); endothecal membranes highly eversible with many small spines (Fig. 1D-F); phallotremal sclerite small, U-shaped in dorsal view.

Adult Female. Length of forewing 4.4 – 4.8 mm, (4.5 mm, n = 10). Color as in male. Female genitalia. Abdominal segment IX trapezoidal (Fig. 3A, C); tergum with pair of small oval acrotergites (Fig. 3A, C); sternum IX absent. Appendages of segment X short, subtriangular, setose (Fig. 3A-C); digitate process setose, short, with at right angles present midlaterally, below appendages of X (Fig. 3B, C); valves short, narrow, setose (Fig. 3C). Vaginal apparatus (spermathecal sclerite complex) with narrow and slightly arcuate posterior vertical sclerite connected to sclerite on the side extremities (Fig. 3B); mid-ventral longitudinal sclerite with narrow elliptical shape connected to U-shaped dorsal sclerite (Fig. 3B); vaginal apparatus connected to terminal membranes by narrow, partially sclerotized neck (Fig. 3B, C).

Holotype. Male. BRAZIL: Espírito Santo: São Mateus, Santa Maria, Sítio Santa Maria, Rio São Mateus, S 18°39'17.1" W 39°59'36", 17 m, 07-08.ix.2012, CEUNES col. (UFVB) (UFVBTR00072) [illustrated]. **Paratypes:** Same data as holotype, 1 male, 3 females (UFVB) (UFVBTR00073); same, except 13-14.vi.2012, 11 males, 9 females (UFVB) (UFVBTR00074); same, except 13-14.vi.2012, 11 males, 8 females (MNRJ).

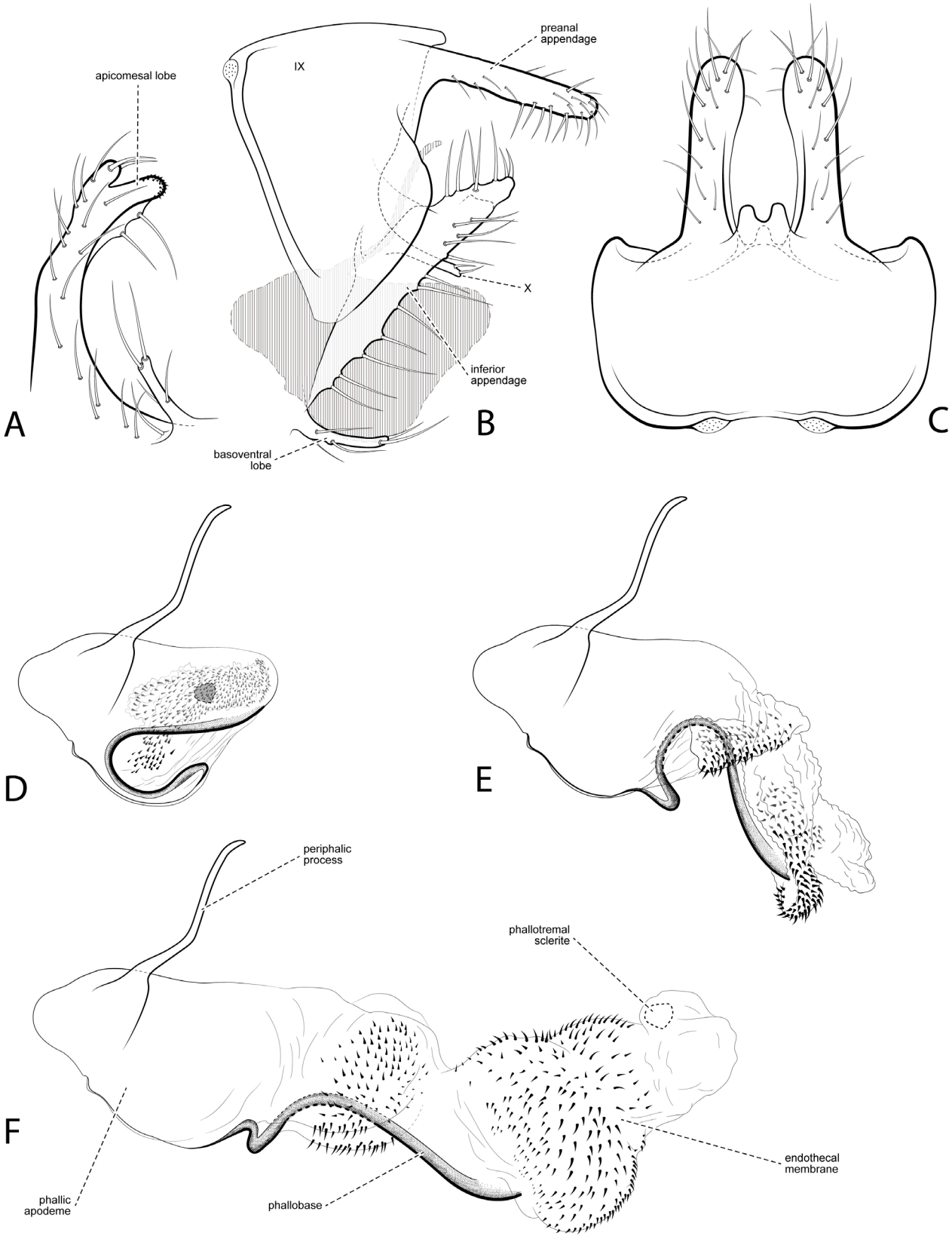

Figure 1 *Nectopsyche aymore* new species. Male. A, inferior appendage, ventral; B, segment IX – X, lateral; C, segment IX, dorsal; D, phallic apparatus in relaxed state, lateral; E, phallic apparatus in semi-everted state, lateral; F, phallic apparatus in full-everted state, lateral.

Figure 2 *Nectopsyche* species. *Nectopsyche aymore* new species. A, forewing; B, head and thorax, dorsal; C, head and thorax, lateral. *Nectopsyche splendida*. D, forewing; E, head and thorax, dorsal; F, head and thorax, lateral.

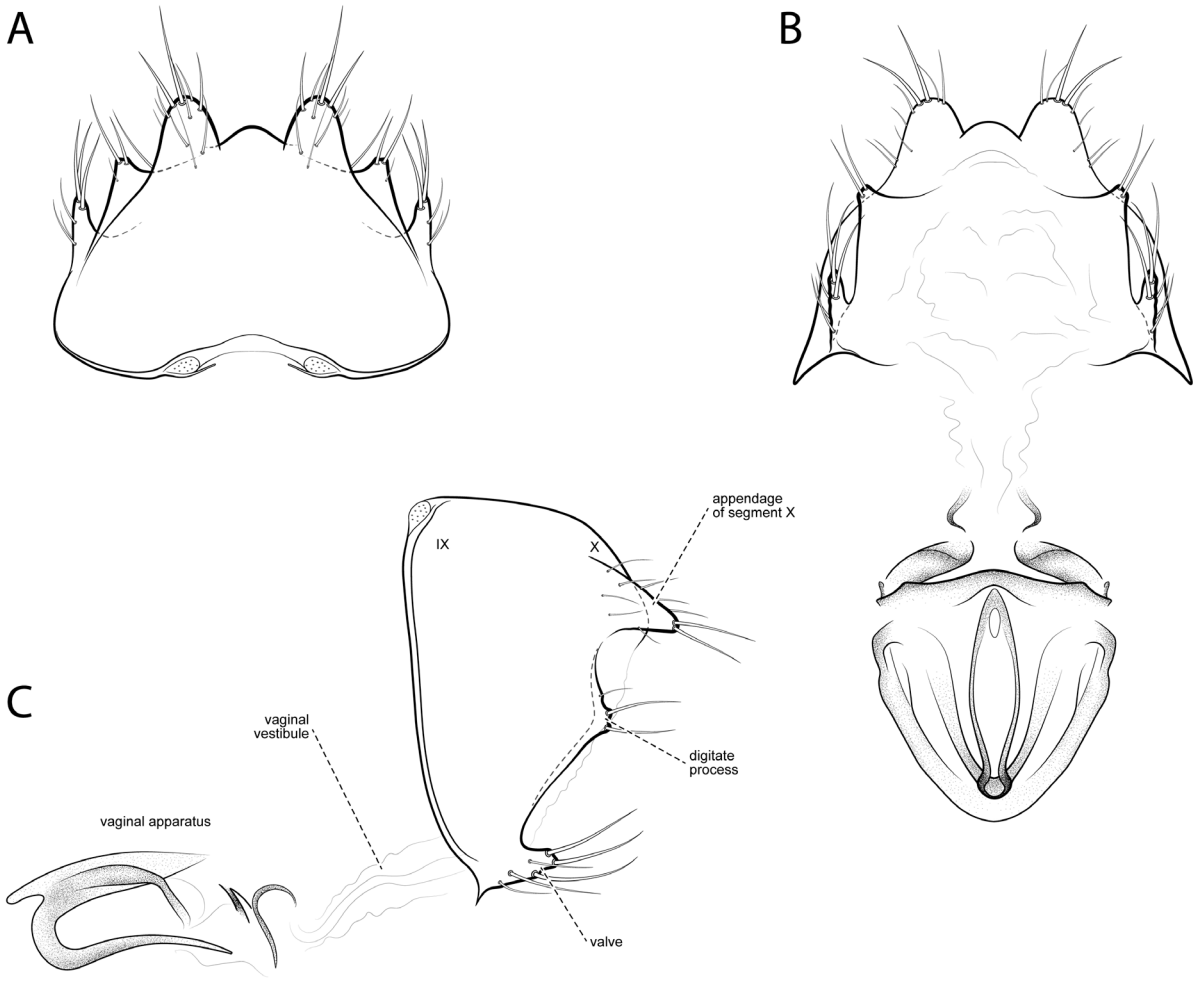

Figure 3 *Nectopsyche aymore* new species. Female. A, segment IX- X, dorsal; B, segment IX – X, vaginal apparatus, ventral; C, segment IX – X, vaginal apparatus, lateral.

Additional material examined. BRAZIL: Espírito Santo: Nova Venécia, Santa Rita do Pip Nuck, Rio Cricaré, S 18°39'51.4" W 40°30'44.9", 74 m, 18-19.iv.2012, CEUNES col., 1 female (UFVB) (UFVBTR00075); Colatina, Rio Doce, S 19°32'14.0" W 40°38'23.5", 75 m, 05-06.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col., 2 males, 4 females (UFVB) (UFVBTR00076); Linhares, Lagoa Nova, S 19°19'49.0" W 40°10'12.3", 16 m, 12-13.ix.2022, Viana, Bonfá & Ataide col., 43 females (UFVB) (UFVBTR00077); Linhares, Rio Doce, S 19°26'06.4" W 39°57'04.8", 20 m, 13-14.ix.2022, Viana, Bonfá & Ataide col., 6 males, 9 females (UFVB) (UFVBTR00078).

Etymology. The specific epithet is a name of Tupi origin given to the indigenous people who inhabited the south of Bahia state, north of Espírito Santo state and also in Minas Gerais state. They are also known as Botocudos and Krenak.

Nectopsyche splendida (Navás, 1917)

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(Fig. 2D-F & 4A-H)

Literature records:

Navás (1917) [Argentina]; Navás (1923) [Argentina]; Flint (1972) [Argentina and Colombia]; Flint (1982) [Bolivia, Paraguay, Peru and Venezuela]; Flint (1991) [Roraima, Brazil, Ecuador and Guyana]; Flint (1996) [Peru]; Almeida and Marinoni (2000) [Paraná, Brazil]; Paprocki et al. (2004) [checklist]; Paprocki and França (2014) [checklist]; Quinteiro et al. (2014) [Bahia, Piauí, Brazil]; Ríos-Touma et al. (2017) [Ecuador]; Desidério et al. (2017) [Maranhão, Brazil]; Henriques-Oliveira et al. (2018) [Minas Gerais, Brazil].

Many of the literature records of *N. splendida* listed by Flint (1972, 1982, 1991), such as Bolivia, Colombia, Paraguay, Ecuador, Peru, and Venezuela, did not include specific locality data. For some of these countries, additional information was provided in other papers (Flint, 1996; Ríos-Touma et al., 2017) or are available from the Global Biodiversity Information Facility (GBIF, database). For others countries, such as Colombia, Guyana, and Paraguay, no specific locality data are known. The species is frequently captured near larger rivers (Flint, 1991) and at lower altitudes (10 m–800 m), but it has been recorded at 1200m (Henriques-Oliveira et al., 2018; GBIF, 2022).

According to the characteristics of the male genitalia, *N. splendida* belongs to the *candida-group* species [i.e., simple elongated preanal appendages (Fig. 4B and 4C), slender straight inferior appendages (Fig. 4B), and basoventral process of the inferior appendages digitate (Fig. 4A and 4B)].

Material examined. BRAZIL: Espírito Santo: Sooretama, Rio São José, 19°07'33.1"S 40°14'26.1"W, 25 m, 20.i.2015, CEUNES col. (UFVB); same, except 13.i.2015 (UFVB); São Mateus, Santa Maria, Sítio Santa

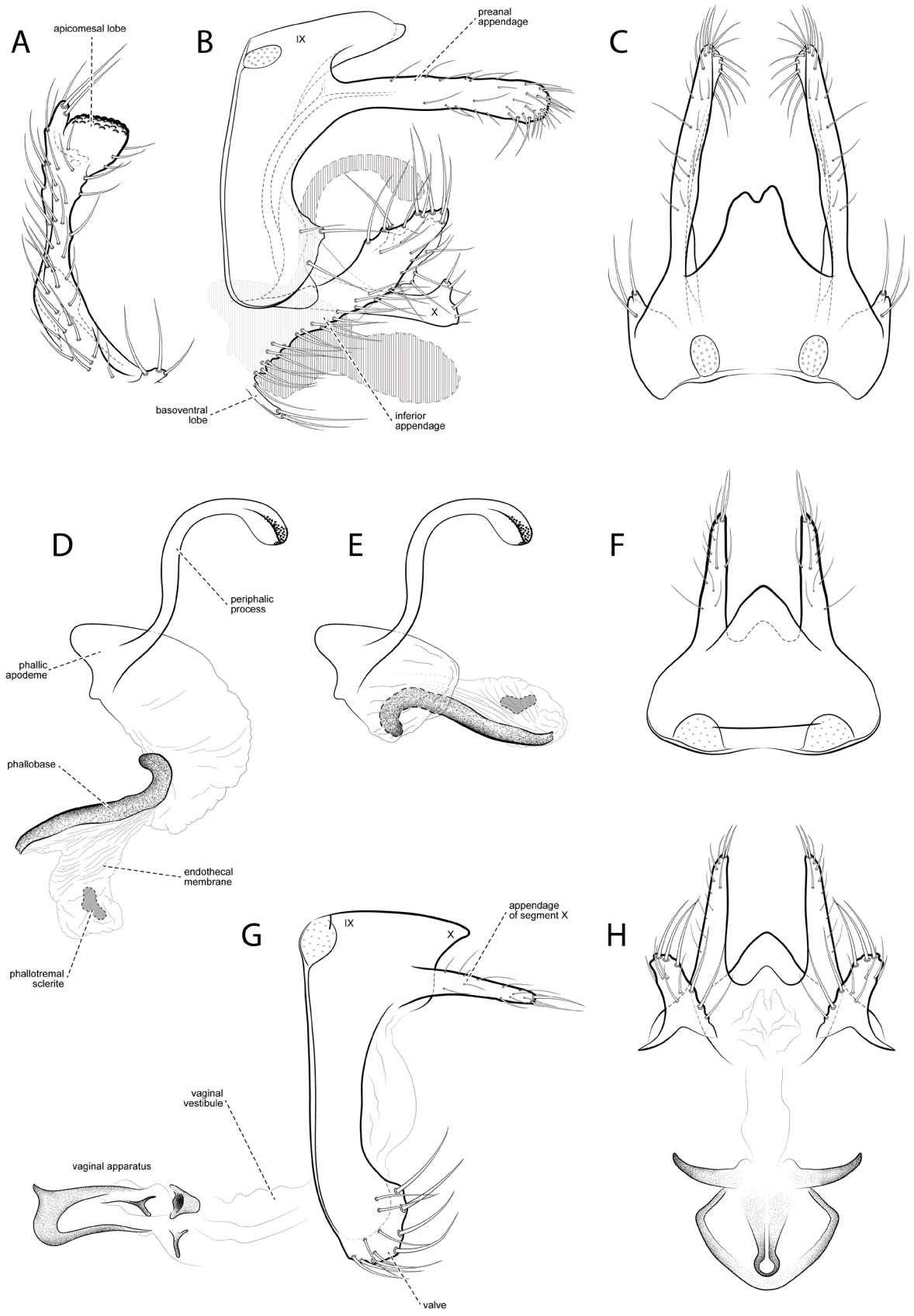

Figure 4 *Nectopsyche splendida* (Navás, 1917). Male. A, inferior appendage, ventral; B, segment IX – X, lateral; C, segment IX, dorsal; D, phallic apparatus in full-erected state, lateral; E, phallic apparatus in relaxed state, lateral. Female. F, segment IX- X, dorsal; G, segment IX – X, vaginal apparatus, ventral; H, segment IX – X, vaginal apparatus, lateral.

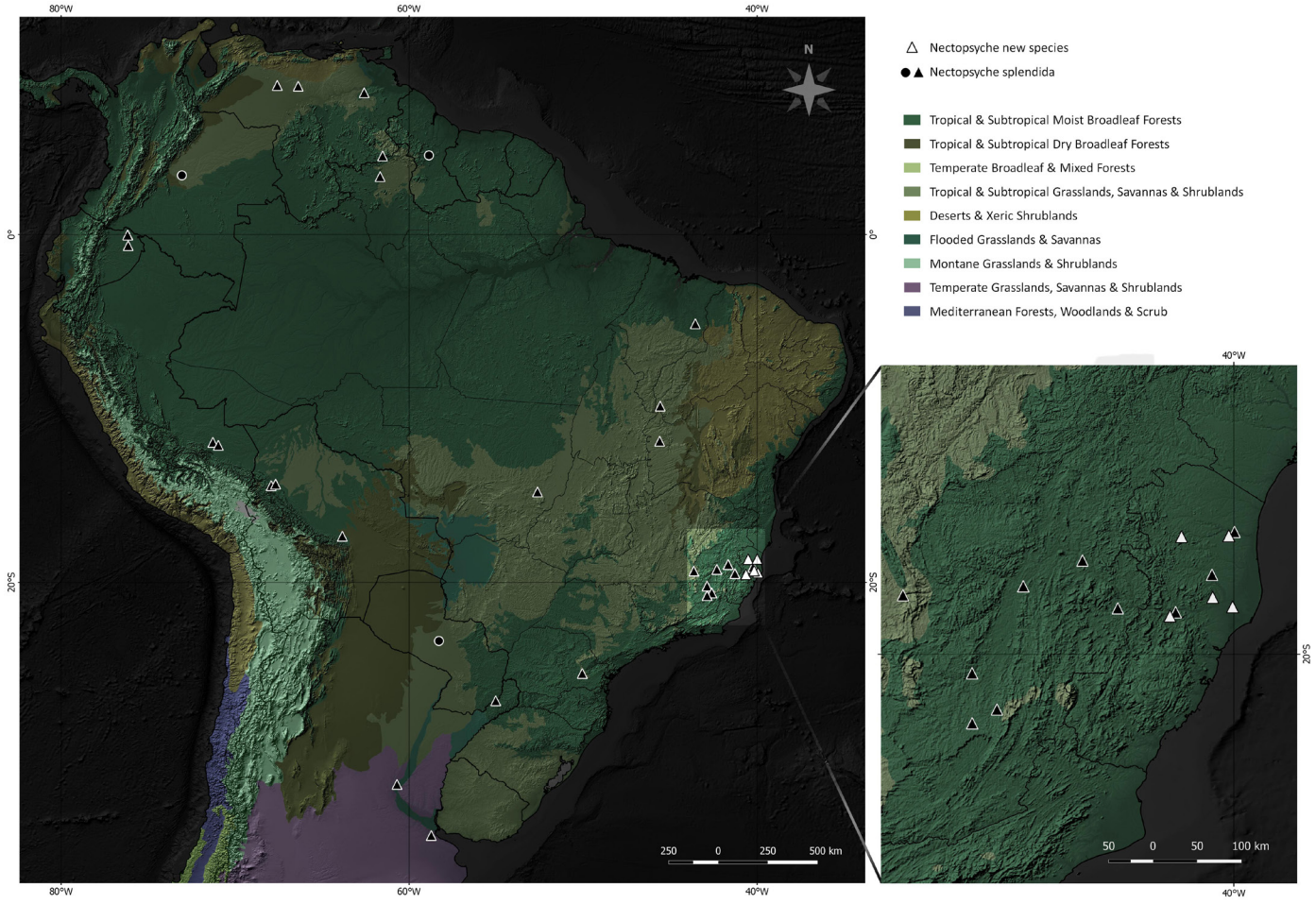

Figure 5 Distribution maps. Highlighted in Southeastern Brazil. White triangle: *Nectopsyche aymore* new species; black triangle and black circle: *Nectopsyche splendida* (Navás, 1917). Black circle: central points, records without detailed location information.

Maria, Rio São Mateus, S 18°39'17.1" W 39°59'36", 17 m, 07-08.ix.2012, CEUNES col. (UFVB); Colatina, Rio Doce, S 19°26'06.4" W 39°57'04.8", 75 m, 05-06.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col. (UFVB). **Minas Gerais:** Aimorés, Rio Manhuaçu, 19°29'38.1"S 41°16'31.7"W, 124 m, 06-07.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col. (UFVB); Tumiritinga, Rio Doce, 18°58'07.6"S 41°39'49.4"W, 130 m, 07-08.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col. (UFVB); Rio Doce, UHE Risoleta Neves, Rio Doce, 20°12'28.7"S 42°52'34.8"W, 315 m, 12.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col. (UFVB); Naque, Rio Doce, 19°15'05.6"S 42°18'50.5"W, 190 m, 08-09.i.2022, Viana, Bonfá, Rodrigues & Rothe-Neves col. (UFVB); Cannã, Rio Santana, Cachoeira Grande, 20°36'19.0"S 42°36'13.0"W, 585 m, 27.x.2020, Salles, Bonfá & Gonçalves col. (UFVB); Viçosa, without a specific location, 13.i.1988, Fiuza col. (UFVB).

Distribution (Fig. 5**).** Argentina, Bolivia, Brazil (BA, ES, MA, MG, PI, PR, RR), Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

PBN Conceptualization, Data curation, Investigation, Methodology, Software, Writing – original draft. FFS Conceptualization, Data curation, Investigation, Methodology, Project administration, Supervision, Writing – review & editing.

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