

## Two new species and new records of the genus *Nectopsyche* Müller, 1879 (Trichoptera: Leptoceridae) from Pará state, Brazil

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### ABSTRACT

The genus *Nectopsyche* is widely recognized by its striking adults, with colored setae and scales, even metallic and/or iridescent. It is primarily distributed in the Neotropical region, with a few species found in the Nearctics. *Nectopsyche* has more than 100 described species, with 26 of them recorded in Brazil. In Pará state, one of the largest Brazilian states, only three species have been recorded. In contribution to the taxonomic knowledge about the Neotropical caddisflies, especially those of the Amazonian region, we propose two new species of *Nectopsyche* from Pará state based on male specimens: *Nectopsyche tridentata* n. sp. and *Nectopsyche froehlichii* n. sp. In addition, *Nectopsyche acutiloba*, *Nectopsyche adusta*, *Nectopsyche jenseni*, and *Nectopsyche quatuorguttata* are recorded for the first time in the state of Pará. Our results increase the number of *Nectopsyche* species recorded in Brazil to 28, and the number of recorded species in the state of Pará to eight.

### Introduction

In the caddisfly family Leptoceridae (Insecta: Trichoptera), the genus *Nectopsyche* Müller, 1879 has 105 described species (Bonfá Neto and Salles, 2023; Morse, 2023), and its distribution is restricted to the New World, with records ranging from Canada to South America, including the Greater Antilles and the Chilean sub-region (Flint, 1983; Holzenthal, 1995; Holzenthal and Calor, 2017). Adults of the genus are conspicuous, mostly characterized by their yellowish to brown bodies, but may also have colored setae and scales, often black, metallic, and iridescent (Holzenthal, 1995). Additionally, the adults may be diagnosed from the other leptocerid genera by the atrophied radial sector, M vein, and most of their branches on the hind wing (Haddock, 1977; Malm and Johanson, 2011).

The identification of the species within the genus is mostly based on the differences in the genital structures of the male, as well as the coloration pattern of the forewings (Flint, 1983; Holzenthal and Calor, 2017). Informal species groups are recognized in the genus by differences in color and genital characteristics, but these differences may be quite subtle (Holzenthal, 1995).

Most of the genus diversity occurs in the Neotropics, especially in the Brazilian tropical sub-region, the Andes, and the Amazon

rainforest (Holzenthal, 1995). In Brazil, 26 species of *Nectopsyche* are recorded, seven of them in the Northern region (Calor and Santos, 2023), which includes most of the Amazon biome. However, this diversity may be underestimated since there are many species in collections waiting to be described, and probably more are to be discovered in nature (Holzenthal and Calor, 2017; Holzenthal and Rios-Touma, 2018; Morse, 2023). In this study, we present two new species of *Nectopsyche* and four new species records of the genus for the state of Pará, in the Amazon biome. Such information helps to reduce the knowledge gap about the biodiversity of Brazilian Trichoptera, leading to a better understanding of the caddisfly fauna in the Neotropics.

### Material and methods

#### Study area

The sampled areas belong to three hydrographic basins of the Amazon biome in the state of Pará: the Caeté River, the Guamá River, and the Murucupi River (Figure 1). They are located in the northeastern region of the state (Figure 2), where temperatures range from 22° to 34°C and humidity ranges from 85% to 91% (Cordeiro et al., 2017). Dry and

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**Figure 1** Some of the sampled sites in the state of Pará. A, Bragança (01°04'42.22"S, 46°44'14.58"W); B and C, Comunidade do Itabocal, São Domingos do Capim (01°46'39"S, 47°44'28"W).

wet seasons are well-defined. The latter occurs from January to June, concentrating 80% of the annual rainfall volume (Martorano et al., 1993).

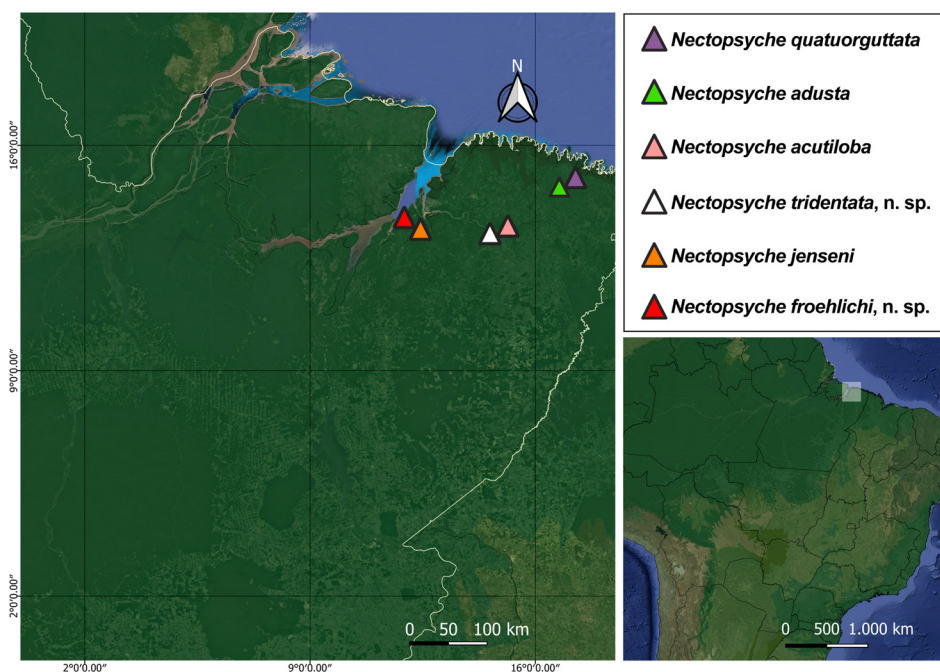
#### *Specimens' collection and preparation*

Specimens were collected using two different light traps: a white sheet associated with light bulbs, which provided specimens pinned in entomological drawers, and pan light traps filled with 80% alcohol and associated with LED lamps (Calor and Mariano, 2012; Price and Baker, 2016), which provided specimens kept in alcohol.

For species identification, the male specimens' genitalia and wings were carefully dissected and examined. Male genitalia clearing procedure was carried out using 85% Lactic Acid (Holzenthal and Andersen, 2004; Blahnik et al., 2007). Identifications were made using primary literature and morphological comparison with other specimens. The morphological terminology follows Holzenthal (1995). Type specimens are deposited in the Museu de Zoologia da Universidade de São Paulo (MZSP), Museu Paraense Emílio Goeldi (MPEG), and Museu de História Natural da Universidade Federal da Bahia (UFBA).

Illustrations were made in a Leica DM2500 microscope with an attached drawing tube. These images were used as templates for digital





**Figure 2** Distribution map of the new species of *Nectopsyche* and the new species records in the state of Pará.

image production using the software Adobe Illustrator® and Adobe® Photoshop®. Multifocus images were obtained in a Leica M205A stereomicroscope, using the Leica LAS Montage software.

## Results

### *Nectopsyche tridentata*, new species

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**Diagnosis.** This species is distinguished from all other congeners mainly by the presence of an inferior appendage with the apex divided into three processes (trilobed), in lateral view: two narrow and digitate lobes, and one stout, slightly sinuous lobe, with acute apex (Figs. 3F; 4A). In addition, its phallic apparatus has two horseshoe-shaped phallosclerites: one mesal sclerite and one lateral (Figs. 3H; 4A, 4C), being the mesal twice the size of the lateral one. *Nectopsyche acutiloba* Flint, 1974 is similar to *N. tridentata* n. sp., since they both have a thin and elongated inferior appendage, with an elongated apicomeral lobe originating near the base, bearing a sclerotized tip. In *N. tridentata* n. sp., however, the abdominal segment IX is about 2x wider laterally (Figs. 3F; 4A) than in *N. acutiloba*, and the pre-anal appendage is shorter, as is the tergum X.

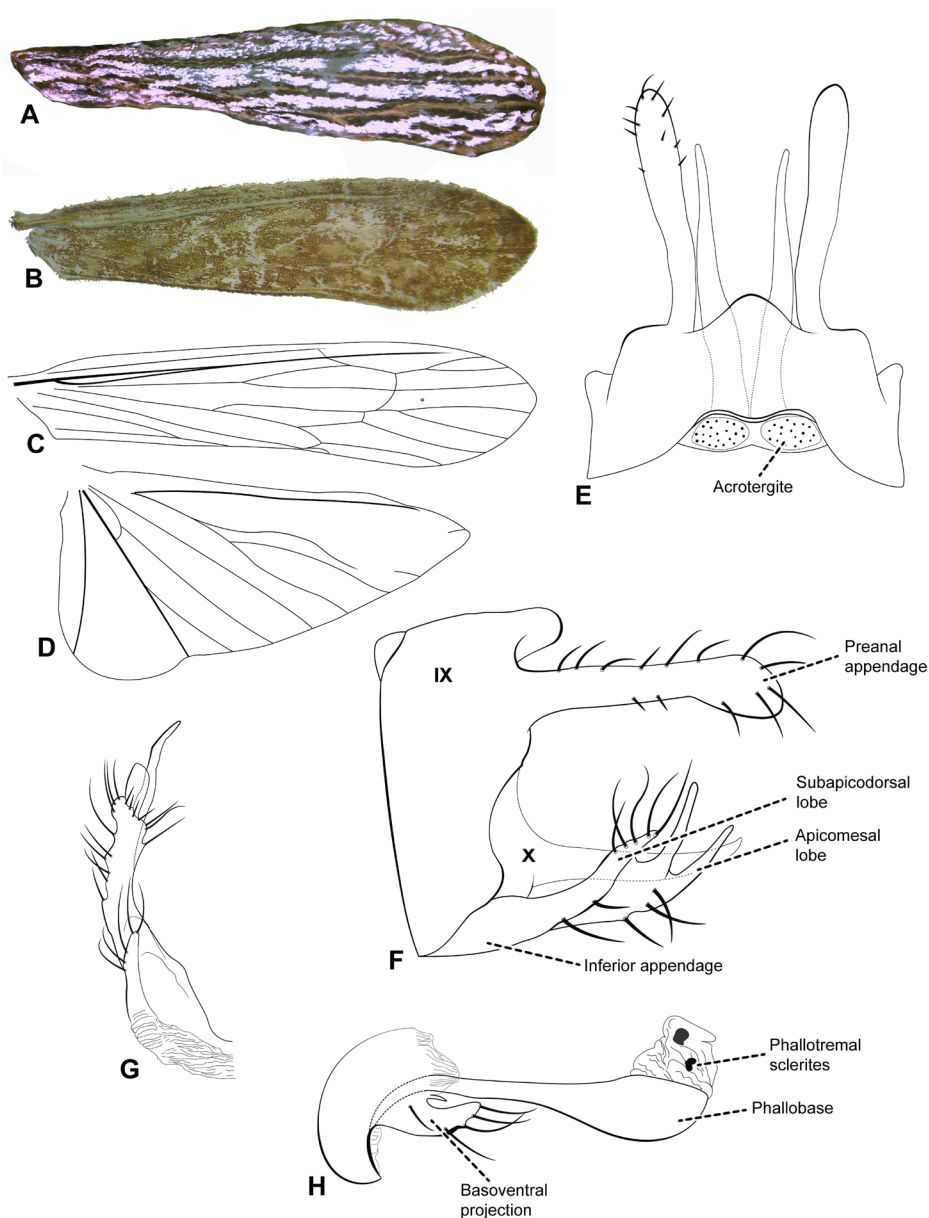
**Description.** Adult male. Length of forewing 6.0–7.0 mm (mean 6.5 mm, n = 5). Head brown, white setae in central area and near eyes; antenna pale yellow, scape brown, with white scales; maxillary and labial palps brown, dark brown setae on maxillary palp; eyes small, width around 0.4x interocular distance. Thorax brown, with small patches of white scales; legs light brown; forewing predominantly covered by white scales, with brown and light brown longitudinal setae bands; forewings and hind wing hyaline (Figs. 3A, 3B). *Male genitalia.* Segment abdominal IX, short, rectangular, about 2x as high as long, lateral view (Figs. 3F; 4A), with mesodorsal rounded protuberance pointed posteriorly; two anterior acrotergites, close to each other in mesodorsal region (Figs 3E; 4B). Preanal appendage, long, narrow, cylindrical, setose, apex enlarged (Figs 3E, 3F; 4A, 4B). Lateral process

of tergum X, narrow, slightly wider on base, acute apex, without apical setae (Fig. 3F). Inferior appendage setose, almost as long as preanal appendage, narrow at base, apex acuminate, lateral view, and spatulate, ventral view (Figs. 3F, 3G; 4A, 4C); subapicodorsal lobe shorter than others, pointed posterad, apex acuminate, setose, in lateral and ventral views (Figs 3F, 3G; 4A, 4C); apicomeral lobe cylindrical, apex acuminate, without setae, in lateral and ventral views (Figs. 3F, 3G; 4A, 4C). Phallic apparatus sclerotized; phallobase narrow and long, enlarged in distal half, with distinct basoventral projection spoon-shaped, sclerotized, with apical setae (Figs. 3H; 4A, 4C); endotheca membranous, slightly distended, projecting distally, two phallosclerites present, horseshoe-shaped, one lateral, one mesal (Figs. 3H; 4A, 4C); mesal sclerite two times larger than lateral; peripheral process absent.

**Holotype. Male:** Brazil: Pará: São Domingos do Capim, Sítio do Sr. Elsinho, próximo a comunidade Itabocal, 01°46'39"S, 47°44'28"W, alt 27 m, 03.vii.2022, luz, col. Assunção, O.T., Reis, R.T.G. (MZSP) [illustrated]. **Paratypes:** same data as holotype, except Bragança, Jiquiri, ramal Arauá, sítio Cururutuaia, Igapó, 01°04'42.22"S, 46°44'14.58"W, alt 19 m, 06.xii.2021, luz, col. Quinteiro, F.B., Costa, A.M., 1 male (MPEG); same, except São Domingos do Capim, Sítio do Sr. Elsinho, próximo a comunidade Itabocal, 01°46'39"S, 47°44'28"W, alt 27 m, 02.ii.2022, col. Assunção O.T. 3 males (pinned; MPEG); same, except 02.vii.2022, 1 male (UFBA).

**Etymology.** The species name is a reference to the genital inferior appendage with three processes, resembling a trident (Latin *tridentis* = fork with three tines).

**Taxonomic notes:** The forewing color pattern in *N. tridentata* n. sp. is similar to that in *N. taleola* (Flint, 1974), *N. acutiloba*, and *N. diminuta* (Banks, 1920). In the latter two, whitish scales are predominant on the wing with brown oblique and longitudinal setae bands, while *N. taleola* is described as having forewings mostly covered by white and brownish scales, producing an irregular pattern (Flint, 1974). However, on the forewings of the new species, the longitudinal bands are irregular, usually surrounded by a straw-yellow band between two narrower brown-to-black bands. Additionally, the white scales may have a slightly gray tone.

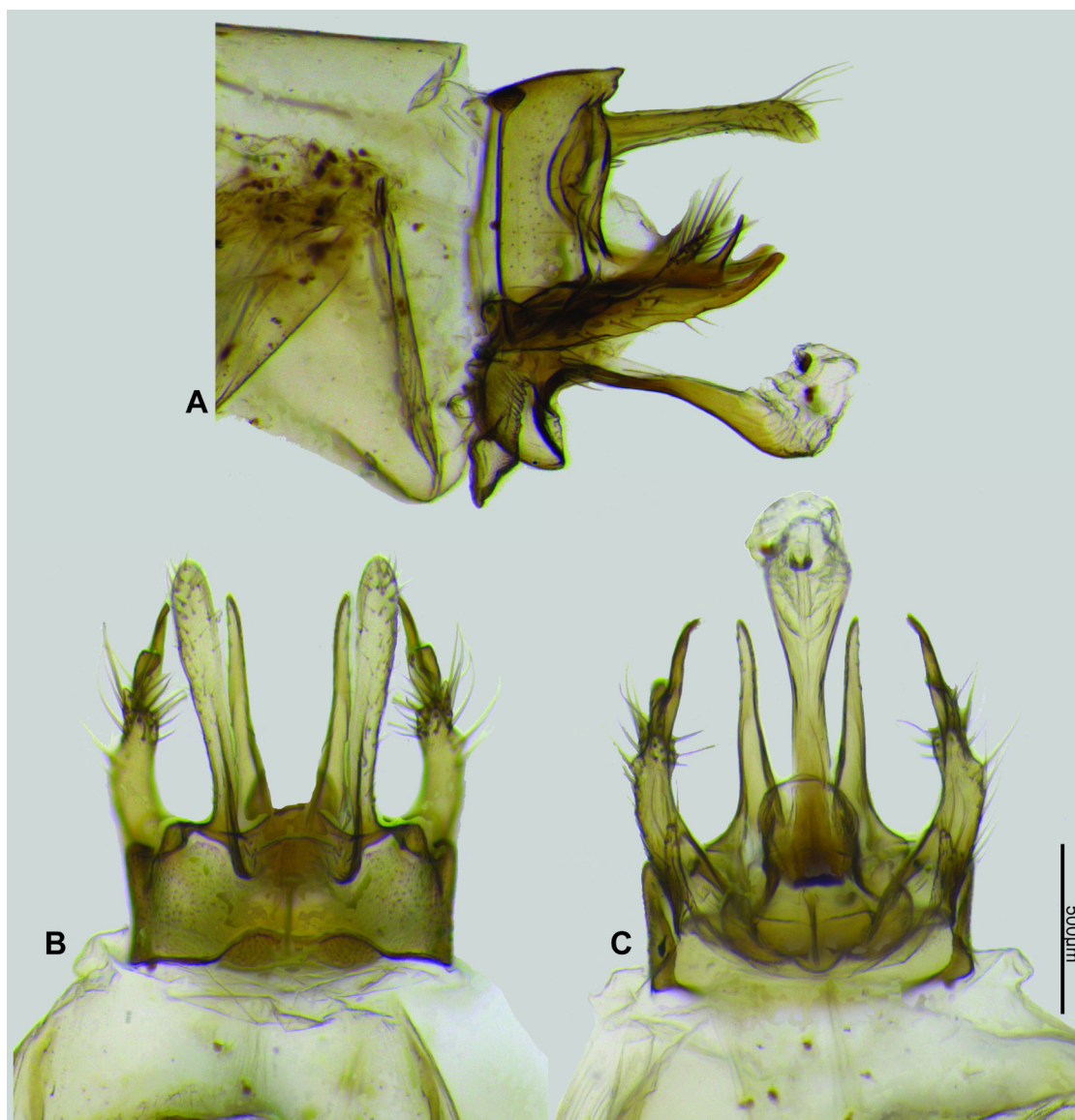


**Figure 3** *Nectopsyche tridentata*, new species. Male. A, picture of the forewing of a dry preserved paratype; B, picture of the forewing of an alcohol preserved paratype; C, forewing; D, hind wing; E, genitalia, dorsal view; F, genitalia, lateral view; G, inferior appendage, ventral view; H, phallic apparatus, lateral view.

Although *N. taleola*, *N. acutiloba*, and *N. diminuta* are similar due to their wing color, it was not possible to point out enough characteristics that allow us to recognize them as members of the same species group, in the same way as Holzenthal and Rios-Touma (2018) assigned *N. paramo* as a member of the *gemma*-group, and *N. spiloma* (Ross, 1944) as a member of the *albida*-group or as Bonfá Neto and Salles (2023) assign *N. splendida* (Navás, 1917) as a member of the *candida*-group. Although these species present similarities in specific genital structures, such as the presence of a basoventral lobe and an apicomesal lobe in *N. acutiloba* and *N. taleola*, or the simple and long inferior appendages in the three of them, other characteristics in their genitalia are distinct. Segment IX in *N. taleola* is concave dorsad and the tergum X is short, tapering distally (Flint, 1974). *Nectopsyche acutiloba* has the segment IX with a prominent tridentate mesodorsal projection, in dorsal view, the tergum X triangular tapering to a strong dark sclerotized tip, in lateral view, and the inferior appendage with an apicomesal lobe originating near

its base, very sclerotized (Flint, 1974). *Nectopsyche diminuta* has a short mesodorsal process, in dorsal view, as well as its inferior appendage is sinuous. Additionally, *N. diminuta* has a periphalic process, which is absent in *N. acutiloba*, *N. taleola*, and *N. tridentata* n. sp.

The species color description was based on three specimens, which were somewhat rubbed during pinning. Hence, some setae were lost, especially on the specimens' heads and thorax. The holotype is conserved in alcohol, which caused some loss and color change in the wing setae and scales. However, one of the paratypes is a pinned specimen, so the scale color and pattern on the forewing were included in the description. Despite the color change, the distribution pattern of setae and scales on the forewing was preserved. Mostly, we observed that gray scales turn to white, while brown and yellowish-brown setae and scales turn into yellow and pale yellow. This change was consistently observed in alcohol-preserved specimens of *N. tridentata* n. sp.



**Figure 4** *Nectopsyche tridentata*, new species. Male genitalia. A, lateral view; B, dorsal view; C, ventral view.

### ***Nectopsyche froehlichii*, new species**

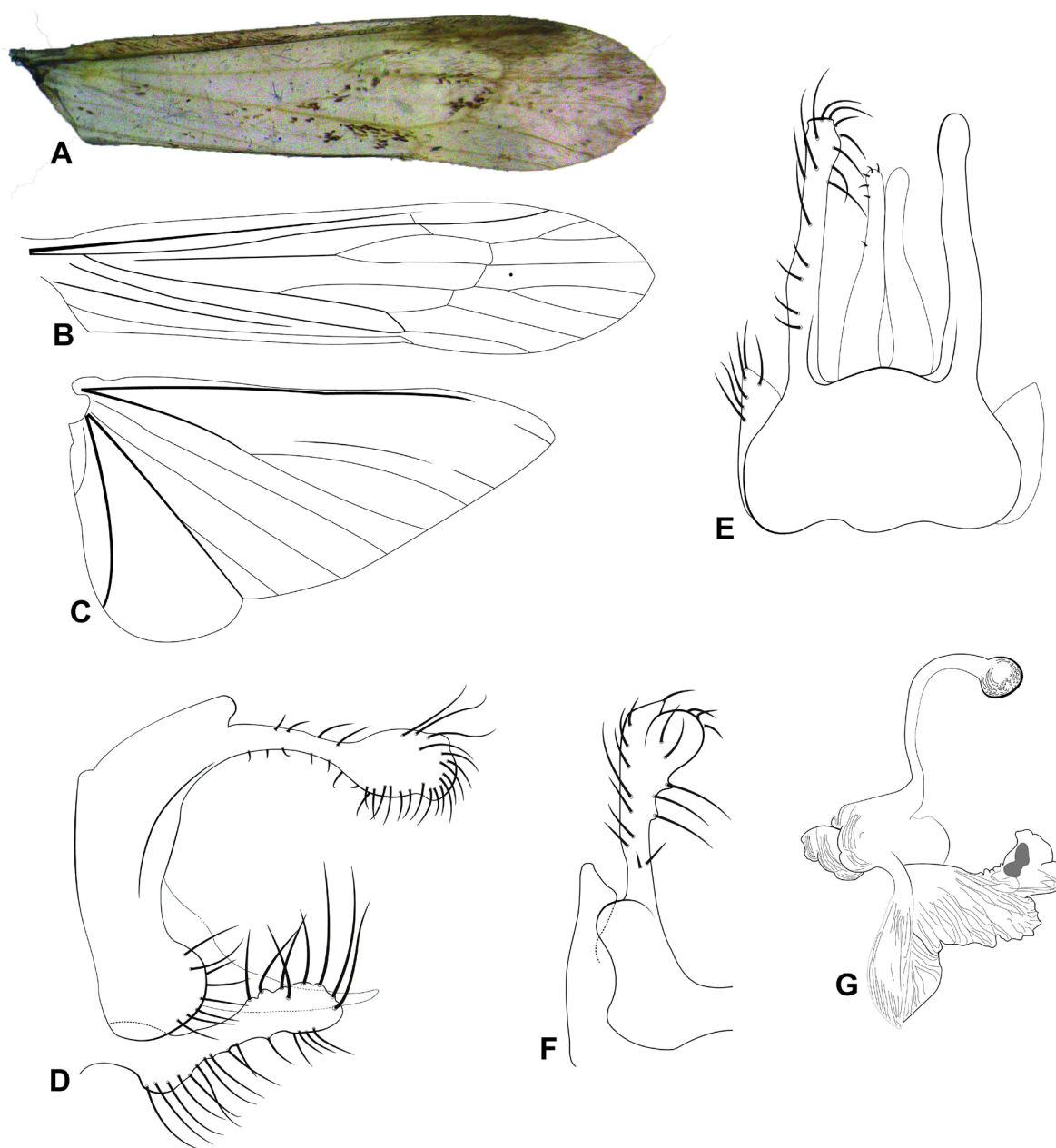
urn:lsid:zoobank.org:act:18D932BD-56F7-40F5-B1E8-DFE5D7A75FF3  
(Figures 2; 5A–G; 6A–C)

**Diagnosis.** *Nectopsyche froehlichii* n. sp. is similar to *N. diminuta* and *N. separata* (Banks, 1920) due to the presence of a short and narrow segment IX (Figs. 5D; 6A), elongate preanal appendage, slightly bent ventrally (Figs. 5E, D; 6A, B), the tergum X thin, with acute apex (Figs. 5D; 6A), the presence of peripheral process (Figs. 5G; 6A) and especially due to the slightly sinuous inferior appendage with somewhat rounded apex (Figs. 5D; 6A). However, the presence of a strongly constricted basal half of the preanal appendage (Figs. 5D; 6A), the peripheral process with a distinctly enlarged and wrinkled apex (Figs. 5G; 6A), and the absence of a setose basoventral lobe on the inferior appendage (Figs. 5D; 6A) are very distinctive characteristics of *N. froehlichii* n. sp.

**Description.** Adult male (alcohol). Length of forewing 5.5–6.5 mm (mean 5.7 mm, n = 5). Head pale-yellow, with small dark brown setae near the eyes; antennae pale-yellow, scape stout, with short, dark brown setae; labial and maxillary palps pale brown; eyes large, black, width around 0.3x

interocular distance. Thorax pale-yellow, with few dorsal setae, two or three pairs of setal warts; legs yellow; forewing hyaline, light brown setae over wing, yellow and dark brown scales distally (specimens preserved in alcohol; Fig. 5A); hind wing hyaline (Fig. 5B). **Male genitalia.** Segment abdominal IX narrow, rectangular, about 3x as high as long, posterolateral margin ventrally produced, with acute apex in dorsal view, rounded in lateral view, setose (Figs. 5D; 6A); without mesodorsal protuberance. Preanal appendage setose, elongate, cylindrical, strongly enlarged distally, with apical setae. Tergum X lateral process narrow, rounded apex, with short apical and subapical setae, dorsal view (Figs. 5E; 6B, C). Inferior appendage cylindrical, constricted at midlength, with irregular margin at dorsal distal 1/3rd and along ventral length, prominent long ventral and apical setae (Figs. 5D, F; 6A), with ventral rounded hump at base, projected ventrally, apex slightly enlarged, ventral view (Figs. 5F; 6C); posterolateral lobe rounded, flat in ventral view (Figs. 5F; 6B), basoventral lobe absent. Phallic apparatus sclerotized, distinct peripheral process, with apex curved, globose, rugose; phallobase narrow basally, gradually widening along its length; endotheca membranous, distended; one phalotremal sclerite present, horseshoe-shaped (Figs. 5G; 6C).





**Figure 5** *Nectopsyche froehlichii*, new species. Male. A, photo of the forewing of alcohol preserved specimen; B, forewing; C, hind wing; D, genitalia, lateral view; E, genitalia, dorsal view; F, inferior appendage, ventral view; G, phallic apparatus, lateral view.

**Material examined. Holotype. Male: Brazil: Pará:** Barcarena, Mucuruçá basin, 01°34'24"S, 48°42'35"W, alt 24 m, 19. ii.19, light trap, Andrade, A.L, Bastos, R.C, Rocha, T.S, Cruz, G.M (MZSP). **Paratypes:** same data as holotype, except 01°34'43"S, 48°41'35"W, alt 18 m, 1 male (MPEG); same, except 01°34'10"S, 48°41'25"W, alt 24 m, 3 males (UFBA).

**Etymology.** The species name honors Prof. Dr. Claudio G. Froehlich, FBQ's first advisor in Faculdade e Filosofia, Ciências e Letras (Universidade de São Paulo), for his outstanding contributions to aquatic insect studies, especially in the Neotropics.

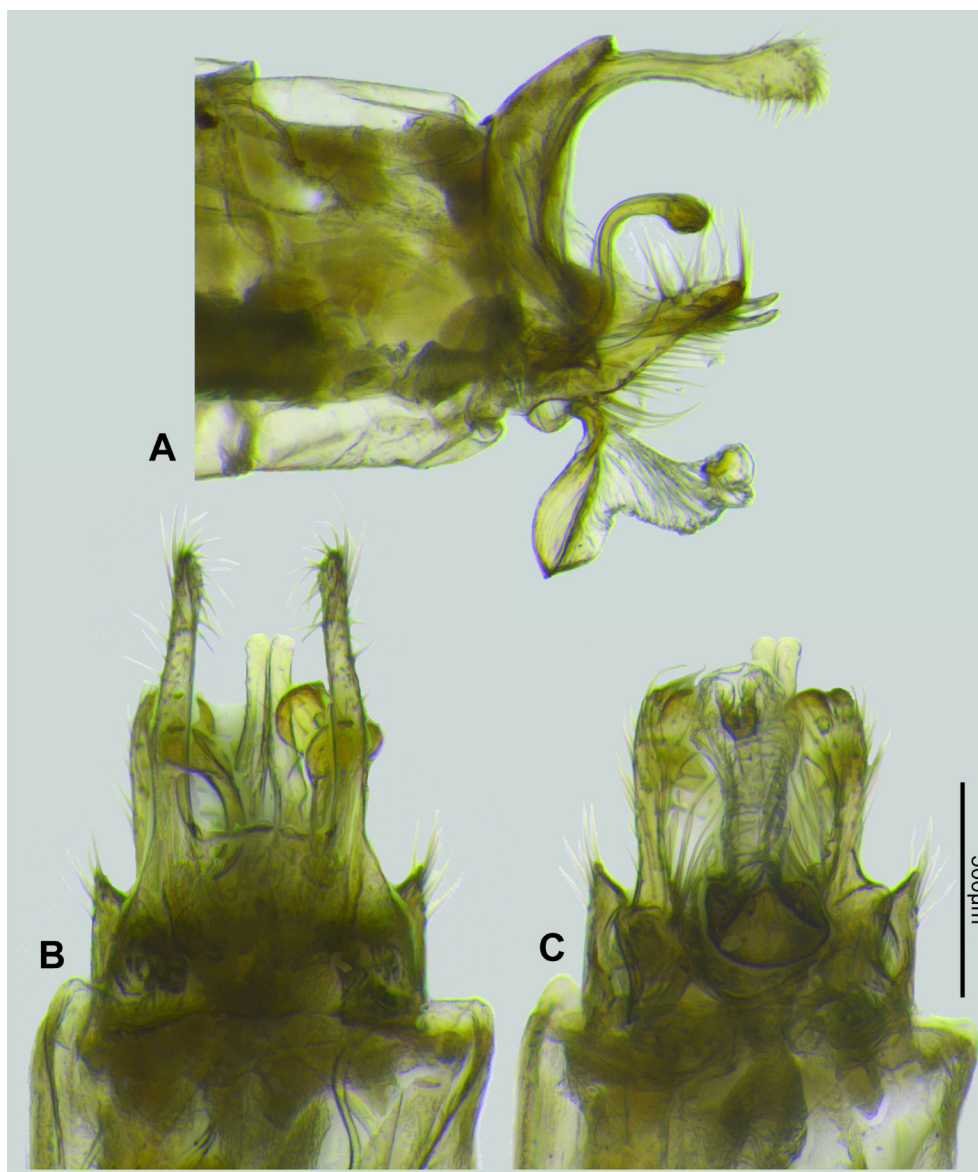
**Taxonomic notes:** The holotype and paratypes of this species are stored in alcohol, hence scales and setae color are not fully addressed here. Although some wing setae and scales were lost, color differences may be observed between *N. froehlichii* n. sp. and the similar species, *N. separata* and *N. diminuta*. They act complementarily to the genital characters previously pointed out. *Nectopsyche froehlichii* n. sp. presents darker

scales on the forewing than in *N. separata*. The scales are mostly brown or dark brown in the new species, while they are described as mostly white, with some black strips on veins, black spots in the wings' apical third, and three yellowish oblique bands (Banks, 1920) in *N. separata*. The scales on the forewing of *N. froehlichii* n. sp. are similar to those in *N. diminuta* (considering the descriptions of *N. diminuta* in Banks (1920) and pictures provided by Flint (1974)). Both share long scale stripes in different tones of brown interspaced by narrow white stripes.

**New records of *Nectopsyche* from Pará state, Brazil** (Figure 5).

#### ***Nectopsyche acutiloba* Flint, 1974**

Literature records:



**Figure 6** *Nectopsyche froehlichii*, new species. Male genitalia. A, lateral view; B, dorsal view; C, ventral view.

Flint (1974); Blahnik et al. (2004); Paprocki et al. (2004); Paprocki and França (2014); Holzenthal and Calor (2017); Oláh and Oláh Jr (2017).

**Material examined.** **Brazil: Pará:** São Domingos do Capim, Sítio do Sr. Elsinho, próximo a comunidade Itabocal, Igarapé, 01°46'39"S, 47°44'28"W, alt 27 m, 03.vii.2022, luz, col. Assunção, O.T., Reis, R.T.G., 1 male (MPEG); same, except 2 males (MPEG).

**Distribuição.** Brazil (Minas Gerais, and Pará states), Guyana, Suriname.

#### *Nectopsyche adusta* Flint, 1983

Literature records:

Flint (1983); Angrisano and Sganga (2007); Calor (2011); Paprocki and França (2014); Holzenthal and Calor (2017).

**Material examined.** **Brazil: Pará:** Bragança, Jiquiri, ramal Arauá, sítio Cururutua, Igapó 01°04'42.2"S, 46°44'14.58"W, alt 19 m, 08.vii.2022, luz, col. Quinteiro, F.B., Costa, A.M., 1 male (MPEG).

**Distribuição.** Argentina, Brazil (Minas Gerais, São Paulo, and Pará states).

#### *Nectopsyche jenseni* (Ulmer, 1905)

Literature records:

Ulmer (1905) in *Leptocella*; Banks (1913); Mangeaud (1996); Cohen (2004); Paprocki et al (2004); Paprocki and França (2014); Holzenthal and Calor (2017) Oláh and Oláh Jr (2017).

**Material examined.** **Brazil: Pará:** Barcarena, Rio Murucupi, 01°32'53"S, 48°45'03"W, 19. ii.19, alt 24 m, light trap, Andrade, A.L, Bastos, R.C, Rocha, T.S, Cruz, G.M., 1 male (MPEG).

**Distribution:** Argentina, Brazil (Amazonas, and Pará states).

#### *Nectopsyche quatuorguttata* (Navás, 1922)

Literature records:

Navás (1922) in *Leptocella*; Schmid (1949); Flint (1974, 1996); Cohen (2004); Nogueira and Cabette (2011); Paprocki and França (2014); Holzenthal and Calor (2017); Desidério et al (2017); Ríos-Touma et al, (2017).

**Material examined.** **Brazil: Pará:** Bragança, Jiquiri, ramal Arauá, sítio Cururutua, Igapó 01°04'42.2"S, 46°44'14.58"W, alt 19 m, 08.vii.2022, luz, col. Quinteiro, F.B., Costa, A.M., 1 male (MPEG).

**Distribution.** Bolivia, Brazil (Maranhão, Minas Gerais, and Pará states), Guyana, Paraguay, Peru, Suriname.

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### Conflicts of interest

The authors declare no conflicts of interest.

### Author contribution statement

OTA was responsible for data curation, investigation, and writing the manuscript. FBQ was responsible for conceptualization, data curation, supervision, writing, and reviewing.

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