



In honor of the Claudio Gilberto Froehlich's career: *Tupiperla claudius* sp. nov. (Plecoptera: Gripopterygidae), a new stonefly from Pico do Marumbi State Park, Paraná State, southern Brazil

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ABSTRACT

A new species of Gripopteryginae stonefly, *Tupiperla claudius* sp. nov. (holotype male deposited in DZUP: Brazil, Paraná State, Piraquara municipality, Pico do Marumbi State Park), is described and diagnosed based on seven adult males. The new species differs from its congeners by the long T10 extension, dorsally with straight lateral margins and tip truncated, protruding into a pair of short downward teeth in lateral view; paraproct long, surpassing the T10 extension dorsally, with a basal membranous-like area and a row of minute spines on the middle of the appendage length dorsally. Specimens of *T. claudius* sp. nov. from the Protected Area Mananciais da Serra in the Serra do Mar represent the very first gripopterygids recorded in the state of Paraná and are also a remarkable record for the genus for the southern Brazilian Atlantic Forest.

Introduction

Gripopterygidae stoneflies have a southern hemisphere distribution (Fochetti and Figueroa, 2008; DeWalt and Ower, 2019; Duarte et al., 2019), with 313 extant species (see DeWalt and Ower, 2019). In South America, they represent the second-most diverse family of Plecoptera and stand as the species-richest family within the suborder Antarctoperlaria (see Fochetti and Figueroa, 2008; Pessacq et al., 2019). There are almost 110 species occurring on the continent, which encompass both the Neotropical and Andean Regions (Pessacq et al., 2019). From the 28 genera within the family, only *Gripopteryx* Pictet, 1841, *Guaranyperla* Froehlich, 2001, *Paragripopteryx* Enderlein, 1909, and *Tupiperla* Froehlich, 1969, have been recorded in Brazil, totaling 57 species (Lecci and Froehlich, 2023).

The taxonomic background of the establishment of *Tupiperla* is well-known. Froehlich (1969) introduced *Tupiperla* based on examination of adults and nymphs from the Biological Station at Paranapiacaba in São Paulo state. This material was first identified by him as *Semblis gracilis* Burmeister, 1839, the single included species and originally

designated as type species of the genus. Many years later, the same author (Froehlich, 1998) revised the genus and renamed part of the males of *S. gracilis* from Paranapiacaba as a new species (i.e., *T. illiesi*), redescribed the female, transferred one species each from *Gripopteryx* and *Paragripopteryx* to *Tupiperla* and finally described six other new species from the Atlantic Forest of southeastern and southern Brazil. He also redefined the diagnostic characters, making the taxonomic limits clearer, indeed, the taxon as whole became morphologically and taxonomically better known after Froehlich's paper.

Giving the amended characterization of *Tupiperla* by Froehlich (1998, 2001), adults male and female can be diagnosed from other Brazilian gripopterygid genera by the remarkable single anteroventral femoral spine (shared with *Guaranyperla*), forewing (Fw) crossveins dark bordered (also in some species of *Gripopteryx*, *Guaranyperla*, and *Paragripopteryx*), and the free apical costal space (ACS; pterostigmatic cell *sensu* Froehlich, 1998) lacking crossveins (some species of *Gripopteryx* and a single species of *Paragripopteryx* also have the ACS free). Such as most gripopterygid stoneflies, the ultimate coloration ranging from light brown to dark brown. Male terminalia shows a protruded

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T10 extension (T10e) that displays variable lengths and shapes (similar to some species of *Paragripopteryx*), lacking epiproct (such as in *Guaranyperla*, some species of *Gripopteryx* and *Paragripopteryx*), and it has a long paraproct (similar size is also observed in *Guaranyperla*, *Paragripopteryx* and some species of *Gripopteryx*). Except for the femoral spine, no character allows females to be confidently assigned to the genus. Despite this limitation, the females of the majority of the species in the genus have been described; the females of only seven species remain unknown (see Table 1 in Duarte et al., 2019).

Nymphs of *Tupiperla* are known since 1960's, primarily because they also exhibit the anteroventral femoral spine of adults, as well as by the rectangular pronotum, as wide as head, with anterior margin straight (see Froehlich, 1969). However, there is no true correspondence between nymphs and adults of any species. The female nymph described and illustrated as *T. gracilis* by Froehlich (1969), was further considered by him to pertain to an uncertain species (Froehlich, 1998).

Tupiperla is a typical Neotropical genus, distributed in Brazil, Paraguay, and Argentina. Amongst the 25 species, 24 are recorded in Brazil, being 23 endemic to the country and occurring mainly in the Atlantic Forest (Pessacq et al., 2019). There are few records from Cerrado (e.g., Bispo and Froehlich, 2007) and Pampa domains (Novaes and Bispo, 2016).

Current diagnosis of *Tupiperla* can be considered suitable both for species allocation and for the association of specimens to the genus, but some characters are conflicting. For instance, *T. jumirim* Bispo & Froehlich, 2007 either lacks femoral spines or has minute femoral spines (Bispo and Froehlich, 2007). Besides, the ACS in *T. serrulata* Duarte et al., 2019 is crossed by a weak crossvein in the Fw (Duarte et al., 2019). Such unexpected variations have led authors argued about taxonomically reliability of some diagnostic characters (e.g., Bispo and Froehlich, 2007). *Tupiperla* share numerous characteristics with the other three gripopterygid genera found in Brazil. However, the lack of a comprehensive phylogenetic analysis focused on *Tupiperla* keeps the relationship with other genera uncertain and precludes a robust diagnosis. Nevertheless, a recent cladistic analysis based on morphological data focused on phylogenetics relationships of *Paragripopteryx*, revealed a well-supported clade including *Tupiperla* and *Guaranyperla* and three homoplastic synapomorphies were proposed to *Tupiperla*: (1) ventral margin of femur of nymph smooth, lacking a fringe of bristles; (2) distal margin of male subgenital plate triangular, with rounded tip; (3) female subgenital plate lacking a unsclerotized spot on the middle (Duarte et al., 2022).

One of the biggest challenges to many fields of biological sciences and species conservation in the Anthropocene is a lack of primary data and knowledge about living biodiversity (e.g., Hortal et al., 2015). Plecoptera taxonomic and distribution data in the Neotropics, including Brazil, are far from complete (Pessacq et al. 2019). The gripopterygids of southern Brazil are poorly known. There are few occurrence records for *Gripopteryx*, *Paragripopteryx*, and *Tupiperla* (Pessacq et al., 2019). For this last genus nine species have been recorded, six from the Atlantic Forest in the Santa Catarina State (Duarte et al., 2019), and three from Pampa in the Rio Grande do Sul State (see Novaes and Bispo, 2016). When considering the stoneflies in the state of Paraná, there is no published primary data on the occurrence of any Gripopterygidae, which represents a significant gap in the knowledge for the Southern Atlantic Forest region (see Jusviak and Pinto, 2023). Pessacq et al. (2019, fig. 7) reported two *Tupiperla* records from the western region of Paraná, but no species or source of data is mentioned, rendering them pending publication and validation.

Aquatic insect assemblages in the Protected Area Mananciais da Serra (MASE) in the east region of Paraná State have received attention in recent years due to generation of new data, description of new species and assessment of anthropic impacts (Silva et al., 2020; Araujo and Pinto, 2021; Araujo et al., 2022). The MASE is a remnant of native forest within the Metropolitan Region of Curitiba, located in

the ecotone between the Araucaria and Tropical Forest (Araujo et al. 2022). Studies on Gripopterygidae at MASE began a few years ago with Kim Jusviak's unpublished undergraduate monograph in 2019. In that work, the occurrence of *Gripopteryx*, *Paragripopteryx*, and *Tupiperla* was recognized (see Jusviak and Pinto, 2023). Through a reexamination of this material, we have identified individuals that exhibit phenotypic distinctions from the recognized species of *Tupiperla*. As a result, we consider these individuals to belong to an undescribed species.

In this study, we describe a new *Tupiperla* species from MASE, the very first gripopterygid to be recorded from the Serra do Mar Mountain Chain in Paraná State. *Tupiperla claudius* sp. nov. is diagnosed and illustrated based on adult males and named after Dr. Claudio Gilberto Froehlich, one of the most prominent stonefly researchers in the Neotropical Region.

Material and methods

The material examined is deposited in the following collections:

DZRJ – Entomological Collection Prof. José Alfredo Pinheiro Dutra, Departamento de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil;

DZUP – Entomological Collection Padre Jesus Santiago Moure, Departamento de Zoologia, Universidade Federal do Paraná (UFPR), Curitiba, PR, Brazil (<http://grbio.org/cool/5xp9-edpx>);

UFVB – Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, MG, Brazil.

Specimens were collected in the Protected Area Mananciais da Serra (MASE) at the Pico do Marumbi State Park, Piraquara municipality, state of Paraná, Brazil. They were taken using a light sheet trap in the Carvalho catchment (see Silva et al., 2020), and Malaise traps (type Gressitt and Gressitt, 1962) over a water body at Urú and Iporan catchments. They were fixed and preserved in 80% ethanol and examined under stereomicroscopes up to 80x. All measurements (in mm) were done with the aid of a stereomicroscope with graduated eyepiece lens. Photos were taken either with digital camera using a 100 mm dedicated macro lens, using Helicon Remote (4.4.3 W) and focus stacking on Helicon Focus (8.8.2), or with a Leica stereomicroscope equipped with a camera, and source images were combined using the LAS Montage software (version 4.7).

The morphological comparative study was undertaken based on examination of specimens, including types, and the literature containing descriptions (e.g., Froehlich, 1969, 1998; Duarte et al., 2019). A total of 11 *Tupiperla* species (about 44% of species in the genus) were studied, including nearly all similar species, either from the type series, topotypes, or *bona fide* identified specimens. The nomenclature for external morphology was based on Froehlich (1969, 1998), head morphology on Stark et al. (2009) and wing venation on Béthoux (2005). Following abbreviations were used: ACS = apical costal space; a.s.l. = above sea level; Fw = forewing; Hw = hindwing; S1–10 = abdominal segments; T1–10 = abdominal terga; T10e = T10 extension, the terminal tergal process on tergite of S10.

Results

Tupiperla claudius sp. nov.

[url:lsid:zoobank.org:act:1FD53F2E-C6D3-4C92-900D-FC67FD77006C](https://zoobank.org/act:1FD53F2E-C6D3-4C92-900D-FC67FD77006C) (Figs. 1–2)

Type material examined

Holotype, male: BRAZIL. Paraná State: Piraquara municipality, Pico do Marumbi State Park, Mananciais da Serra (SANEPAR), Caixa do Carvalho -25.4964, -48.9817, 1021 m a.s.l., light sheet, 20.I.2022, A.P. Pinto, J. Ehlert & L. Polizeli leg. (DZUP 287469).

Paratypes (6 males): 1 male, same data as holotype but Caixa do Urú -25.4844, -48.9728, 1051 m a.s.l., Malaise trap, 23.IX-27.X.2018, B.R. Araújo leg. (DZUP 287406); 1 male, same data but Caixa do Iporan -25.4800, -48.9689, 1053 m a.s.l., 28.XI-11.XII.2018, A.P. Pinto & B.R. Araújo leg. (DZUP 287407); 1 male, same data but 20.XII.2018-17.I.2019 (DZUP 287408); 1 male, same data but (DZRJ, ex-DZUP 287409); 1 male, same data but (UFV, ex-DZUP 287470); 1 male, same data, but 17.I-01.II.2019 (DZUP 287410).

Etymology: This species is named after Dr. Claudio Gilberto Froehlich (10th June 1927-27th November 2023), a pioneer researcher and one of the most influential specialists on the taxonomy of Neotropical Plecoptera since the second half of the 20th century. His contribution to the knowledge of Brazilian stoneflies is unparalleled, having described two genera and over 90 extant species (see Pessacq et al., 2019). His first name in Portuguese, Claudio, from the classical Latin origin Claudius, is an adjective masculine in the nominative singular. We chose here the specific name *claudius* (noun in apposition, not declinable) to celebrate his long and prolific career on stonefly taxonomy.

Diagnosis: A small-sized brown colored gripopterygid with an anteroventral femoral spine, terminalia lacking epiproct and with a long-protruded tergal extension (T10e) on S10, typical of the genus *Tupiperla*. The male of *Tupiperla claudius* sp. nov. can be distinguished from its congeners by the long T10e with short distal teeth (Figs. 2a-d), in dorsal view (Fig. 2a) with straight lateral margins, slightly divergent posteriorly, and posterior margin truncated with a shallow mesial concavity; the long blade-shaped paraprot, exceeding the T10e at both the posterior and dorsal margins in lateral view (Figs. 2c-d), a basal membranous-like area, and a row of spines on the middle of paraprot length from 0.3 proximal to 0.8 distal, the basal and apical edges of the row not visible laterally.

The T10e rectangular-shaped, with lateral margin near straight and long (≥ 1.5 times longer than wide) in dorsal view and the paraprot blade-shaped (a typical non-clavated sword-shaped), and long in lateral view, allows to differ *T. claudius* sp. nov. from all other *Tupiperla* except from *T. illiesi* Froehlich, 1998, *T. sepeensis* Novaes and Bispo, 2016, *T. pessacqi* Duarte et al., 2019, *T. tessellata* (Brauer, 1866), *T. serrulata* Duarte et al., 2019, and *T. pinhoi* Duarte et al., 2019.

Tupiperla claudius sp. nov. can be distinguished from these species by the tip of T10e truncated with a small mesial concavity in dorsal view (Fig. 2a; bifid with a large V- or U-shaped concavity in *T. sepeensis*, *T. pessacqi*, *T. tessellata*, *T. serrulata*, and *T. pinhoi*); long paraprot, exceeding dorsally and posteriorly the T10e length (Figs. 2a-d; as long as or shorter than T10e in *T. illiesi*, *T. pessacqi*, *T. tessellata*, and *T. pinhoi*); dorsal margin of paraprot with a row of minute spines (Fig. 2c, dorsal margin smooth, lacking spines in *T. pessacqi* and *T. tessellata*, possibly too in *T. sepeensis*); paraprot minute spines visible laterally on 0.4-0.6 posterior of paraprot length (Fig. 2c; visible on 0.2-0.8 in *T. pinhoi* and 0.7-1.0 in *T. serrulata*); lateral surface of paraprot smooth (at distal 0.8-0.9), not acute projected subapically (Fig. 2d; project into a strong thorn-like spine in *T. illiesi* and *T. sepeensis*).

Based on body size, geographic distribution, terminalia and especially the length and nearly truncated tip of T10e, *T. claudius* sp. nov. can be confounded with *T. illiesi*, but the longer paraprot bearing minute spines on dorsal margin and with no subapical spine will allow distinguish *T. claudius* from *T. illiesi* (paraprot with ill-defined minute spines on dorsal margin and subapically a strong thorn-like spine laterally).

Holotype male description: General coloration of body brown to dark brown, light brown ventrally, wing membrane and base of legs light brown, most of arthrodial membranes and large parts of S1-5 sternites white.

Head (Fig. 1a): Head dark brown. Labium basally light brown, apically yellowish-white; labial and maxillary palpi brown, membranes white. Labrum 0.4 anterior with a semicircular yellowish-white pale spot. Clypeus brown ventrally, dark brown dorsally. Rounded mesial depression and small area adjacent to eyes on epicranium light brown. Protruded areas around ocelli black. Antennae 50-segmented.

Thorax (Fig. 1a): Prothorax brown to dark brown; pronotum brown with margins, mesial line, a pair of larger liver-shaped anterior and smaller rounded posterior spots dark brown; in dorsal view rectangular, narrower than head (maximum width of pronotum / maximum width of head about 0.8) with anterolateral margins rounded. Meso- and metathorax brown to dark brown.

Legs (Fig. 1a): Legs brown, 0.2-0.3 apical of femora and tibiae irregularly dark brown, distal spine on anteroventral margin of femora, smaller in prothoracic legs. Tarsomere length II < I < III in all legs.

Wings (Figs. 1a-b): light brown with irregular lighter areas more pronounced in Fw, membrane densely covered by minute hair-like setae, veins mostly dark brown, distal crossveins in the radio-anal space almost hyaline, wing margins bearing longer hair-like setae; ACS lacking crossveins, membrane densely marked with dark dots. Venation. Fw: RA unforked; RP unforked or forked; CuA long forked, 3-5 ra-rp crossveins; 1 crossvein in RP fork; 5 rp-m crossveins; 3-4 crossveins in the M fork; 6 m-cua crossveins; 1 crossvein in CuA fork; 6 cua-cup crossveins. Hw: RA unforked; RP forked; posterior branch of M and CuA partially fused; α AA2 partially fused to AA1; 3 ra-rp crossveins; no crossvein in RP fork; 3-4 rp-m crossveins; 2-3 crossveins in M fork; 1 cua-cup crossvein.

Abdomen: Background color white, with large dark areas; dark areas on tergites brown, sternites light brown; white portions dubiously less sclerotized. T1 with a narrow transverse brown stripe posteriorly; T2 dark areas laterally, a pair of small rounded spots dorsally; T3-5 with an interrupted dark brown proximal ring, dark brown area covering about of half of segment length, with a mesial white elongated concavity; T6 with a complete dark brown proximal ring, with a pair of semicircular brown spots mesially linked to the proximal ring; T7-9 with complete dark brown proximal ring, dark areas dorsolaterally; T10 mostly dark brown, a semicircular white spot on 0.3 proximal. Terminalia (Figs. 2a-d): T10e long (2 times longer than wide), base narrower, slightly widening to apex (Fig. 2a), lateral margins almost straight, slightly divergent posteriorly, posterior margin truncated with a small mesial concavity in dorsal view; in lateral view (Figs. 2c-d) dorsally straight ending posteriorly into a pair of short downward curved teeth. Cercus 18-segmented, as long as S7-10 length, not reaching the tip of wings; segments dark brown, each with a thin white ring on tip. Paraproct (Figs. 2a-d) brown with irregular dark brown areas, 9 times longer than wide, blade-shaped, with roughly blunt tip, clearly surpassing T10e length posteriorly and dorsally; tips in dorsal and ventral views convergent (Figs. 2a-b); in lateral view (Figs. 2c-d) slightly sinuous, half of length wide convex, apex curved dorsally into a short blunt pointed tip; a membranous-like area at about basal 0.3; a single row of minute spines on the middle covering 0.50 of total paraprot length, basally and apically the spines are on the internal surface, medially on dorsal margin, visible in internal view (Figs. 2c-d). Subgenital plate (Fig. 2b) brown, a large oval posterior middle area dark brown; in ventral view roughly kite-shaped, posterior margin triangular.

Male Paratypes variation: Paratype males are similar to holotype, differing by general body coloration lighter, yellowish-brown to yellowish-white; some lacking definite coloration patterns of lighter and darker areas.

Wings (Fig. 1b): Fw: 0-1 crossvein in RP fork; 4-6 rp-m crossveins; 3-5 crossveins in M fork; 5-7 m-cua crossveins; 0-3 crossveins in CuA fork; 6-7 cua-cup crossveins. Hw: 2-5 ra-rp crossveins; 0-1 crossvein in RP fork; 3-5 rp-m crossveins.

Abdomen: Proportionally shorter; S1-8 sternites slightly darker. Mesial concavity on posterior margin of T10e deeper in dorsal view. Cercus 15-18 segments.

Female and nymphs: Unknown.

Measurements (mm). Holotype, male: total length (excluding antennae) 9.5; head maximum width 1.02; pronotum maximum

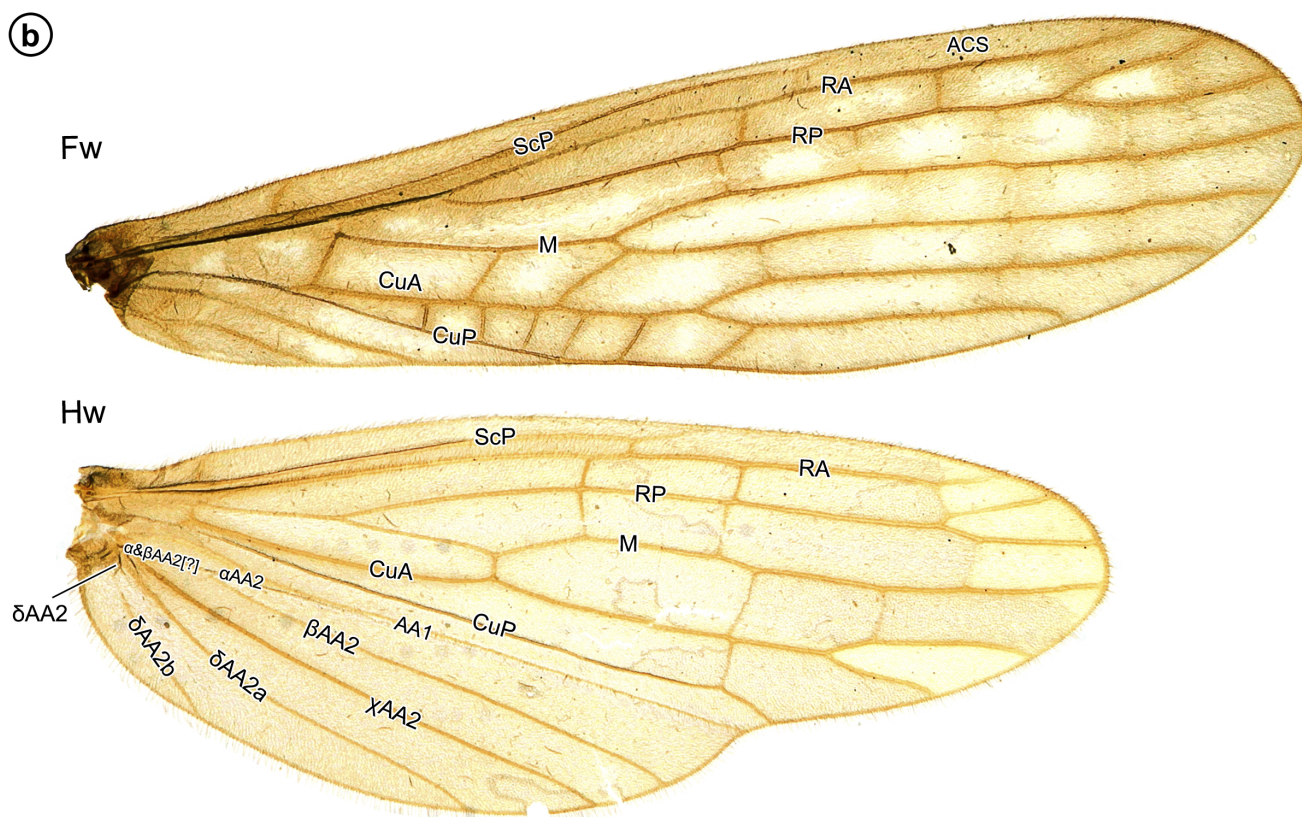
width 0.80; pronotum length 0.68; Fw length 8.0; Hw length 6.7; antenna length 8.3; **Paratypes male (n = 6)**: total length 9.1–9.6; head maximum width 1.06–1.12; pronotum maximum width 0.80–0.86; pronotum length 0.60–0.72; Fw length 7.6–8.4; Hw length 6.4–6.6.

Remarks

Except for the holotype, the other six specimens on the type series appear to be “teneral” or young emerged males due to the softly and lightly colored tegument.



Tupiperla claudius sp. nov.
HOLOTYPE BRAZIL: PR



Tupiperla claudius sp. nov.
PARATYPE BRAZIL: PR

Figure 1. *Tupiperla claudius* sp. nov. from Pico do Marumbi State Park, Paraná State, Brazil: (a) habitus of the male holotype (DZUP 287469); (b) wings of male paratype (DZUP 287408). Abbreviations: AA1 = first anterior anal; AA2 = second anterior anal; ACS = apical costal space; CuA = anterior cubitus vein; CuP = posterior cubitus; Fw = forewing; Hw = hindwing; M = media; RA = anterior radius; RP = posterior radius; ScP = subcosta.

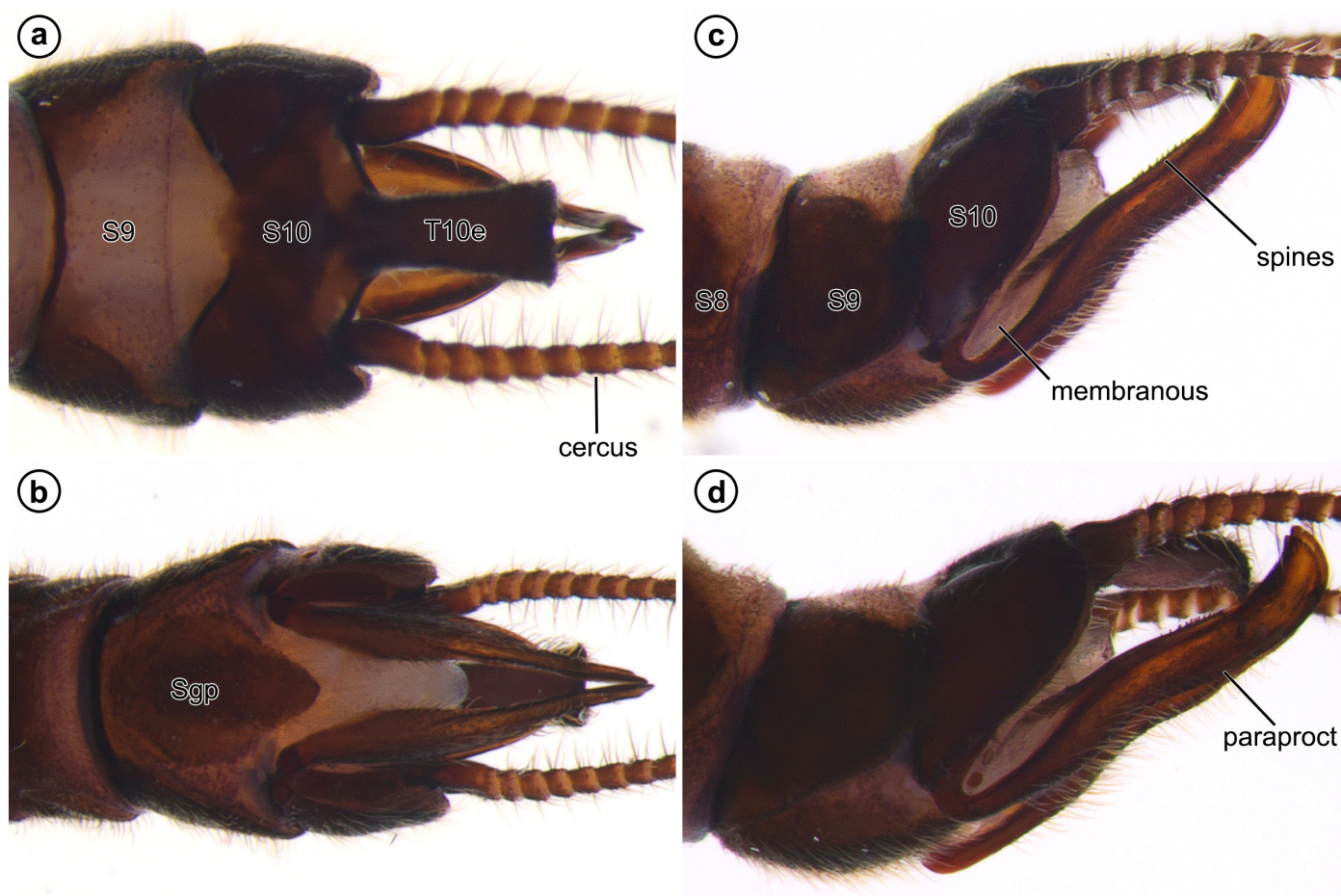


Figure 2. *Tupiperla claudius* sp. nov. from Pico do Marumbi State Park, Paraná State, Brazil, terminalia of the male holotype (DZUP 287469): (a) dorsal view; (b) ventral view; (c) lateral view; (d) lateroventral view. Abbreviations: S8–10 = abdominal segments; Sgp = subgenital plate; T10e = T10 extension, terminal tergal process on tergite of S10.

Discussion

The generic limits among South American gripopterygids have been challenged with discovery of new taxa and reassessment of diagnostic characters. Recent studies have shown that some genera would not be monophyletic (e.g., Duarte et al., 2022). Notwithstanding generic robust diagnosis relies on well supported phylogenetic hypotheses, all the diagnostic characters proposed to *Tupiperla* by Froehlich (1998, 2001) agree with the characteristics observed in *T. claudius* sp. nov. as follows: (1) one anteroventral femoral spine; (2) ACS free, lacking crossveins; (3) T10e ending posteriorly into a pair of teeth; and (4) epiproct undistinguished. As a result, the new species agrees with the current definition of the genus.

Our hypothesis is that the observed morphological disparity in the terminalia between the Pico do Marumbi State Park specimens and all other known *Tupiperla* corresponds to an undescribed species, which is introduced here. This hypothesis is based on assuming that distinct shapes in these structures provide evidence of a unique evolutionary history through reproductively isolated population. Hence, the lineages demonstrate a putative spatiotemporal cohesion among their individuals. These criteria are largely used for species delimitation and identification in this genus (e.g., Froehlich, 1998; Bispo and Froehlich, 2007; Duarte et al., 2019). However, intraspecific variations due to a plethora of phenomena, such as geographic isolation may lead to incorrect conclusions. As a result, additional data, and analytical approaches to support terminalia's phenotypic type criteria

are welcome. The same is true for females and nymphs. We are unable to associate unidentified nymphs and females collected in the same site, due to the poor knowledge about this stage and sex for most of these gripopterygid species. In this way, new studies integrating both morphological and molecular data should enlighten these issues and must be conducted to allow for more precise correspondence among adult males and females as well as nymphs, not only for this newly introduced species, but also for the 25 species currently classified under *Tupiperla*.

The discovery and description of *Tupiperla claudius* sp. nov. from Paraná corresponds to the very first record of any Gripopterygidae species to the State. The distribution range of the genus has now extended over the limits of the Serra do Mar in that State. Previously, the occurrence of *Tupiperla* species in the region could only be inferred from records in the neighboring areas of the Atlantic Forest, such as Argentina and Paraguay to the west, and the Brazilian states of São Paulo and Santa Catarina to the north and south, respectively (see Table 1 in Duarte et al., 2019). Pessacq et al. (2019, figure 7) show two unidentified *Tupiperla* records from the western region of Paraná. However, neither the species nor the data source is specified, rendering these records pending validation.

The type locality of *T. claudius* sp. nov.—Protected Area Mananciais da Serra (MASE)—comprises a well-preserved forested fragment in one of the largest remnants of the Atlantic Forest, located near the Curitiba metropolitan region, Paraná State (see Araujo and Pinto, 2021). The MASE represents an Araucaria-Tropical Atlantic Forest ecotonal formation that has been under environmental protection for more than

a century (Reginato and Goldenberg, 2007). Despite recent efforts to investigate the regional biodiversity and ecological filters of aquatic insects within this poorly studied area (e.g., Silva et al., 2020; Araujo and Pinto, 2021; Araujo et al., 2022), the MASE region remains largely uninvestigated. Except for dragonflies (Odonata), many groups of insects, including stoneflies, lack available data. Most of the bias observed in primary biological data promotes the excess records of more appealing organisms as birds, to the detriment of less charismatic ones, in spite of their importance in many areas such as biological, evolutionary, ecological, and ecosystem conservation (Troudet et al., 2017). Gaps or sampling bias are widely recognized in Brazil (Oliveira et al., 2016), and they are augmented when primary data about Brazilian stoneflies, particularly assemblages found in the southern Atlantic Forest, are considered. Based on unpublished data and an ongoing study focused on stoneflies from MASE, preliminary findings allow for the identification of at least nine Gripopterygidae species apart from *Tupiperla claudius* **sp. nov.** These species belong to the genera *Gripopteryx*, *Guaranyperla*, *Paragripopteryx* and *Tupiperla*, and they have not yet documented in the state of Paraná (Varella et al., in prep.).

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

RCV and APP conceived the study, compiled, organized, and analyzed the data, wrote the manuscript, revised, and approved its definitive version.

References

Araujo, B. R., Pinto, A. P., 2021. Dragonflies (Insecta: Odonata) from Mananciais da Serra, a Tropical-Araucaria Forest ecotonal remnant in the southern Atlantic Forest, state of Paraná, Brazil. *Zool.* 38, 1-18. <https://doi.org/10.3897/zoologia.38.e55283>.

- Araujo, B. R., Pinto, A. P., Padial, A. A., 2022. Influence of landscape homogenization due to river damming on dragonfly (Odonata) community structuring in a subtropical forest in the southern Atlantic Forest. *Ecohydrol.* 15 (3), e2419. <https://doi.org/10.1002/eco.2419>.
- Béthoux, O., 2005. Wing venation pattern of Plecoptera (Insecta: neoptera). *Illiesia* 1 (9), 52-81. Available in: <http://illiesia.speciesfile.org/papers/Illiesia01-09.pdf> (accessed 16 August 2023).
- Bispo, P. C., Froehlich, C. G., 2007. Stoneflies (Plecoptera) from northern Goiás State, central Brazil: new record of *Kempnyia oliveirai* (Perlidae) and a new species of *Tupiperla* (Gripopterygidae). *Aquat. Insects* 29 (3), 213-217. <https://doi.org/10.1080/01650420701411184>.
- DeWalt, R. E., Ower, G. D., 2019. Ecosystem services, global diversity, and rate of stonefly species descriptions (Insecta: plecoptera). *Insects* 10 (4), 99. Available in: <https://www.mdpi.com/2075-4450/10/4/99> (accessed 16 August 2023).
- Duarte, T., Novaes, M. C., Bispo, P. D. C., 2019. Five new species of *Tupiperla* Froehlich, 1969 (Plecoptera: gripopterygidae). *Zootaxa* 4671 (4), 511-526. <https://doi.org/10.11646/zootaxa.4671.4.3>.
- Duarte, T., Calor, A. R., Bispo, P. D. C., 2022. Systematic revision and phylogeny of *Paragripopteryx* Enderlein, 1909 (Plecoptera: gripopterygidae). *PLoS One* 17 (3), e0264264. <https://doi.org/10.1371/journal.pone.0264264>.
- Fochetti, R., Figueroa, J. M. T., 2008. Global diversity of stoneflies (Plecoptera; Insecta) in freshwater. *Hydrobiol.* 595, 365-377. <https://doi.org/10.1007/s10750-007-9031-3>.
- Froehlich, C. G., 1969. Studies on Brazilian Plecoptera 1. Some Gripopterygidae from the biological station at Paranapiacaba, state of São Paulo. *Stud. Neotrop. Fauna Environ.* 6 (1), 17-39. <https://doi.org/10.1080/01650526909360412>.
- Froehlich, C. G., 1998. Seven new species of *Tupiperla* (Plecoptera: Gripopterygidae) from Brazil, with a revision of the genus. *Stud. on Neotropic. Fauna Environ.* 33 (1), 19-36. <https://doi.org/10.1076/snfe.33.1.19.2170>.
- Froehlich, C. G., 2001. *Guaranyperla*, a new genus in the Gripopterygidae (Plecoptera). In: Domínguez, E. (Ed.), *Trends in Research in Ephemeroptera and Plecoptera*. Kluwer Academic/ Plenum Publishers, New York, pp. 377-383.
- Gressitt, J. L., Gressitt, M. K., 1962. An improved Malaise trap. *Pac. Insects* 4 (1), 87-90.
- Hortal, J., Belo, F., Diniz-Filho, J. A. F., Lewinsohn, T. M., Lobo, J. M., Ladle, R. J., 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. *Annu. Rev. Ecol. Evol. Syst.* 46, 523-549. <https://doi.org/10.1146/annurev-ecolsys-112414-054400>.
- Jusviak, K. D. B., Pinto, A. P., 2023. Arthropoda, Hexapoda, Plecoptera. In: Straube, F.C. (Ed.), *Inventário da fauna de Curitiba*. Prefeitura Municipal de Curitiba, Curitiba, pp. 93-95. Available in: <https://archive.org/details/inventario-da-fauna-de-curitiba-straube-ed-2023> (accessed 16 August 2023).
- Lecci, L., Froehlich, C. G., 2023. Gripopterygidae Enderlein, 1909. In: *Catálogo taxonômico da Fauna do Brasil*. Rio de Janeiro. Available in: <http://fauna.jbrj.gov.br/fauna/faunadobrasil/1291> (accessed 16 August 2023).
- Novaes, M. C., Bispo, P. D. C., 2016. A new species and records of Gripopterygidae (Plecoptera) from Rio Grande do Sul State, southern Brazil. *Zootaxa* 4175 (5), 487-490. <https://doi.org/10.11646/zootaxa.4175.5.7>.
- Oliveira, U., Paglia, A. P., Brescovit, A. D., Carvalho, C. J. B., Silva, D. P., Rezende, D. T., Leite, F. S. F., Batista, J. A. N., Barbosa, J. P. P. P., Stehmann, J. R., Ascher, J. S., Vasconcelos, M. F., Marco Junior, P., Lowenberg-Neto, P., Dias, P. G., Ferro, V. C., Santos, A. J., 2016. The strong influence of collection bias on biodiversity knowledge shortfalls of Brazilian terrestrial biodiversity. *Divers. Distrib.* 22 (12), 1232-1244. <https://doi.org/10.1111/ddi.12489>.

- Pessacq, P., Zúñiga, M. D. C., Duarte, T., 2019. An updated checklist of Neotropical Plecoptera. *Zoosymposia* 16, 182-209. <https://doi.org/10.11646/zoosymposia.16.1.15>.
- Reginato, M., Goldenberg, R., 2007. Análise florística, estrutural e fitogeográfica da vegetação em região de transição entre as Florestas Ombrófilas Mista e Densa Montana, Piraquara, Paraná, Brasil. *Hoehnea* 34 (3), 349-360. <https://doi.org/10.1590/S2236-89062007000300006>.
- Silva, V. D. A., Salles, F. F., Pinto, A. P., 2020. *Thraulodes marianoi* sp. nov., a remarkable new species of mayfly (Ephemeroptera: Leptophlebiidae) with dark wings from the southern Brazilian Atlantic Forest. *Zootaxa* 4860 (1), 92-100. <https://doi.org/10.11646/zootaxa.4860.1.4>.
- Stark, B. P., Froehlich, C., Zúñiga, M. C., 2009. South American Stoneflies (Plecoptera). In: Adis, J., Arias, J., Golovatch, S., Wantzen, K. M., Rueda-Delgado, G. (Eds.), *Aquatic Biodiversity in Latin America*. Vol. 5. Pensoft, Sofia-Moscow, 154 pp.
- Troudet, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., Legendre, F., 2017. Taxonomic bias in biodiversity data and societal preferences. *Sci. Rep.* 7 (1), 9132. <https://doi.org/10.1038/s41598-017-09084-6>.