An Acad Bras Cienc (2024) 96(4): e20231362 DOI 10.1590/0001-3765202420231362
Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

ANIMAL SCIENCE

Neotropical species of gripopterygid stoneflies (Plecoptera: Gripopterygidae)

TÁCIO DUARTE, CLAUDIO G. FROEHLICH & PITÁGORAS C. BISPO

Abstract: The family Gripopterygidae occurs in the Austral Hemisphere and comprises about 330 species within 57 genera. About 110 species belonging to 28 genera are native to South America. Some are endemic to the Andean Region, while others reside in the Neotropical Region. In this latter region, Gripopterygidae has primarily been documented in the Brazilian Atlantic Forest, inland areas, and specific regions in northeastern Argentina, southern Paraguay, and Uruguay. Our research involved examining specimens from diverse Brazilian locations and compiling data sourced from the Plecoptera literature of the Neotropical Region. In this study, we present a comprehensive list of 62 Gripopterygidae species across four genera documented in Neotropical Region: 1) *Gripopteryx* Pictet, comprising 18 described species; 2) *Guaranyperla* Froehlich, comprising three species; 3) *Paragripopteryx* Enderlein, which includes 15 species, and 4) *Tupiperla* Froehlich, with 26 species. Additionally, we have morphologically characterized a specimen of *Gripopteryx elisae* Illies collected in Santa Catarina State, Brazil. We provide detailed information about the life stages associated with each species, documented records by administrative and natural areas, and information about the institutions housing the type series of Neotropical gripopterygids.

Key words: Distribution, Diversity, Gripopteryginae, Hydrographic Regions, South America, *Gripopteryx elisae*.

INTRODUCTION

The family Gripopterygidae Enderlein 1909 (Order Plecoptera) stands as the second most diverse family in South America. Only Perlidae, which includes the highly speciose genus *Anacroneuria* Klapálek, surpasses it in diversity (Froehlich 2010, Pessacq et al. 2019). Gripopterygidae exhibits an intriguing disjunct distribution in the mainland of South America, with two distinct groups showing a distinctive distributional pattern. The first group includes the Andean species in southern Argentina and Chile, and the genus *Claudioperla* Illies, found in the Andes from Colombia to northern Argentina and Chile. These taxa represent about 45% of the overall diversity in South America, totaling 50 species. The second group consists of strictly Neotropical species, accounting for 55% of the recorded diversity in South America, with a total of 62 species (Pessacq et al. 2019, DeWalt et al. 2024).

While the number of species between the two groups is similar, examining the diversity of genera offers a distinct perspective. The Andean Region and South American transition zone (*sensu* Morrone 2015), host 24 genera of Gripopterygidae, most of which contain only one or two species. In contrast, the Neotropical Region (*sensu* Morrone 2014), supports numerous species in just four genera: *Gripopteryx* Pictet, *Guaranyperla* Froehlich, *Paragripopteryx* Enderlein, and *Tupiperla* Froehlich.

The records of the Neotropical species are also of interest. Currently, three species are

restricted to southern Uruguay: *Gripopteryx serrei* Navás, *Paragripopteryx baratinii* Benedetto, and *Paragripopteryx munoai* (Benedetto), representing 5% of the Neotropical fauna. The other 59 species are recorded in Brazil. Among these species, nine also occur outside the country: in Argentina (*Gripopteryx cancellata* (Pictet), *Gripopteryx juetah* Froehlich, *Gripopteryx serrensis* Froehlich, *Paragripopteryx klapaleki* Enderlein, *Tupiperla amandae* Bispo and Lecci, *Tupiperla flinti* Froehlich, *Tupiperla gracilis* (Burmeister), and *Tupiperla misionera* Froehlich) and Paraguay (*Gripopteryx brasiliensis* (Šámal) and *Tupiperla flinti*) (Froehlich 2002, Manzo et al. 2014, Romero 2017).

Neotropical gripopterygids are primarily distributed along the Brazilian Atlantic coast (Fig. 1). The genus *Guaranyperla* stands out as the most geographically restricted, found only in the Atlantic Forest of southeastern Brazil (Froehlich 2001, 2015). The other three genera (*Gripopteryx*, *Paragripopteryx*, and *Tupiperla*) have a broader

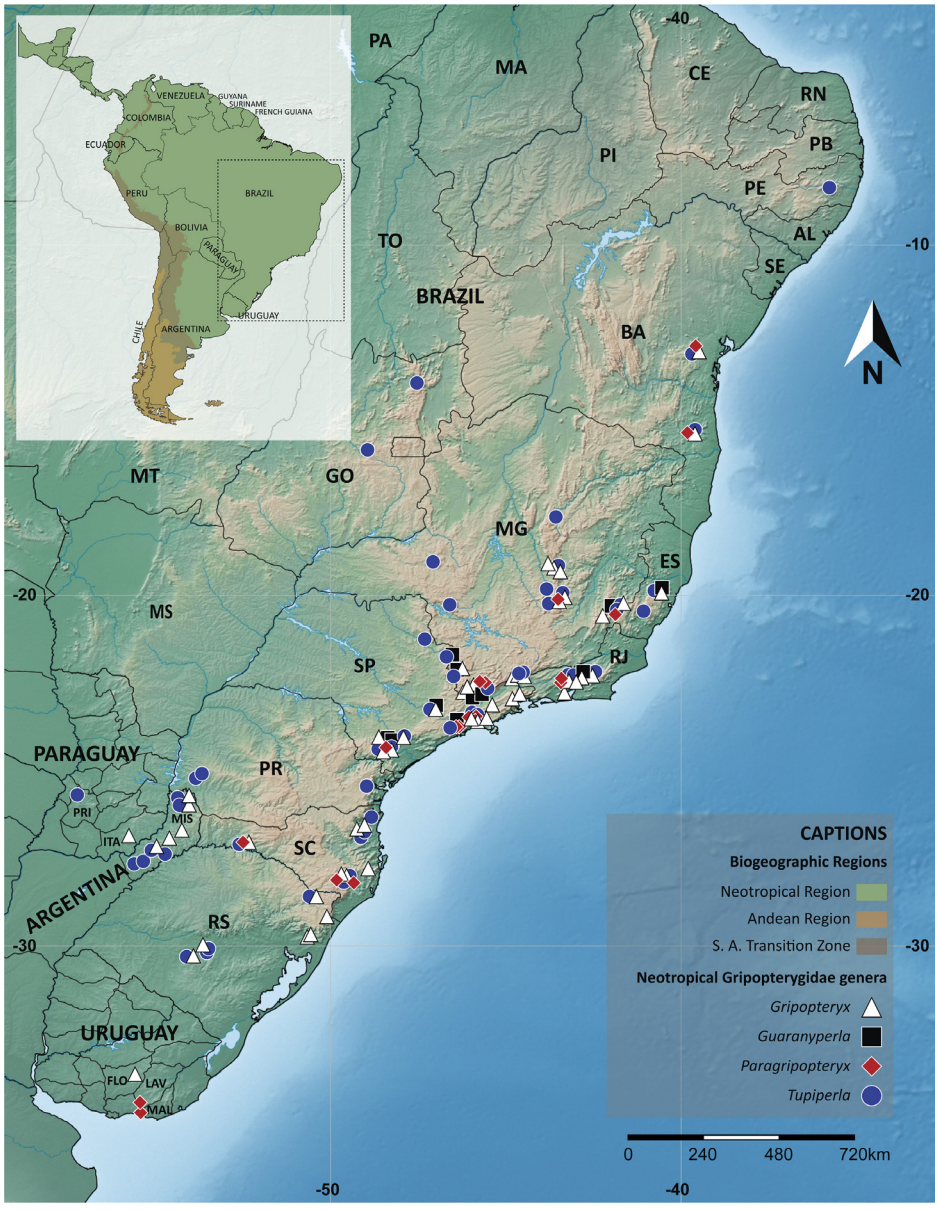

Figure 1. Distribution map of four Neotropical Gripopterygidae genera - *Gripopteryx*, *Guaranyperla*, *Paragripopteryx*, and *Tupiperla*.

distribution throughout the Brazilian Atlantic Forest, extending inland in Brazil and parts of Argentina, Paraguay, and Uruguay (Froehlich 2010, Pessacq et al. 2019).

Froehlich (2010) documents 42 Gripopterygidae species found in Brazil, northeastern Argentina, southern Paraguay, and Uruguay. The most recent list by Pessacq et al. (2019) includes 59 species, highlighting the ongoing discovery of new taxa in the region and underscoring gaps in our understanding of the regional fauna. Since Pessacq et al. (2019), *Paragripopteryx dasalmas* Duarte, Calor and Bispo, *Paragripopteryx ogum* Duarte, Calor and Bispo, and *Tupiperla claudius* Varella and Pinto have been described. Additionally, *Paragripopteryx crassila* (Jewett) has been synonymized with *Paragripopteryx klapaleki* (Duarte et al. 2022), and several new species have been discovered.

In this study, we considered the Neotropical Region as defined by Morrone (2014) to compile a comprehensive list of 62 Gripopterygidae species found in this region from literature and specimen studies. Our data mark the first recorded occurrence of *Tupiperla flinti* in Brazil. We also conducted a morphological characterization of *Gripopteryx elisae* Illies, originally described by Illies in 1964, based on examination of a male specimen and an exuvia from Santa Catarina State, Brazil. Additionally, our study provides detailed information regarding the life stages associated with each Neotropical species, records categorized by administrative and natural areas, and compiles information about the institutions housing the type series of all Neotropical gripopterygids.

MATERIALS AND METHODS

Studied specimens and sampling

Some specimens we examined originate from Brazilian institutions, including the Entomological Collection "Professor José Alfredo Pinheiro Dutra" at the Universidade Federal do Rio de Janeiro (DZRJ) and the Collection of Insects at the Center of Taxonomic Collections in the Universidade Federal de Minas Gerais (UFMG). Other specimens were collected in localities of the Bahia and Santa Catarina states in Brazil, as specified in the material examined. These specimens were primarily sourced from streams and waterfalls and were collected manually or attracted to light at dusk and night using three methods: 1) light pan traps, in which the insects were attracted by an illumination system and trapped in a pan containing ethanol (Calor & Mariano 2012); 2) light traps, in which the insects were attracted by reflective light onto a white sheet and manually collected (Vanzolini & Papavero 1967); and 3) Malaise traps, which are designed to intercept insects in flight (Malaise 1937). Subsequently, the specimens were preserved in 80% ethanol. All collected specimens have been deposited in the Collection of Aquatic Insects "Prof. Dr. Cláudio Gilberto Froehlich" (CIACGF) at the Aquatic Biology Laboratory, State University of São Paulo (UNESP), Assis, São Paulo, Brazil.

We have provided a morphological characterization of *Gripopteryx elisae* based on a male specimen reared by Dr. Luiz C. Pinho at the Universidade Federal de Santa Catarina, collected in the municipality of Urubici, Santa Catarina State, Brazil. Our comparison was facilitated by excellent photographs of the holotype, generously provided by Dr. Arnold Staniczek and his team at the Stuttgart State Museum of Natural History, Germany.

Specimen preparation and maps

We examined and photographed the specimens using a Leica M205A stereomicroscope. We processed the photographic images using the image-editing software Adobe Photoshop CC. For illustrations, we used a camera lucida and vectorized the resulting images using Adobe Illustrator CC.

We generate the species distribution map using QGis 3.28 software (QGIS Development Team 2022) and the online tool SimpleMappr (Shorthouse 2010). The map was constructed from geographic occurrence data compiled from literature, supplemented by material obtained from museums, and new collections gathered during our study. We followed Froehlich (1993, 1998) for morphological nomenclature and used Béthoux (2005) for wing venation nomenclature.

Data collection on Gripopterygidae type-specimens

To locate the type-specimens of the Neotropical gripopterygids, we consulted original descriptions and contacted institutions when doubts arose regarding their whereabouts. Table I lists the scientific collections institutions housing Gripopterygidae type-specimens, while Table II provides abbreviations for administrative and natural areas where gripopterygids are recorded.

Estimates of species richness and Cluster analysis on Gripopterygidae

We conducted our analyzes using the R environment (R Core Team 2023). To estimate species richness, we utilized data on Gripopterygidae species collected from nine hydrographic regions in South America: East

Table I. List of the institutions housing type-specimens of Gripopterygidae along with their corresponding locations.

Codes	Reference names
DZRJ	Coleção Entomológica Professor José Alfredo Pinheiro Dutra, Departamento de Zoologia da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
DZUP	Entomological Collection “Padre Jesus Santiago Moure”, Departamento de Zoologia, Universidade Federal do Paraná (UFPR), Curitiba, Paraná, Brazil.
MNRJ	Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
MZSP	Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil.
UFVB	Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.
UdelaR	Universidad de la República, Montevideo, Uruguay.
MHNG	Museum d’Histoire Naturelle de Genève, Université de Genève, Genève, Switzerland.
MLUH	Martin Luther Universität Halle-Wittenberg, Institut für Zoologie, Halle, Germany.
NHMH	Natural History Museum of Helsinki, Finlândia.
NHMW	Naturhistorische Museum Wien, Austria.
NMNH	National Museum of Natural History, Smithsonian Institution, Washington, DC, USA.
SMNS	Stuttgart State Museum of Natural History (Staatliche Museum für Naturkunde), Stuttgart, Germany.

Atlantic, East Northeast Atlantic, Paraná, Paraguay, São Francisco, Southeast Atlantic, South Atlantic, Tocantins-Araguaia, and Uruguay (Fig. 4). Nonparametric methods were applied using presence-absence data, with hydrographic regions as sampling units. These calculations were performed using the 'specpool' function from the R package *vegan* (Oksanen et al. 2022). The following richness estimators were performed: 1) Chao2; 2) first-order jackknife (Jack1); and 3) second-order jackknife (Jack2) (Magurran 2004). These methods consider the number of rare species, which are defined as the number of species that occur in just one sampling unit and the number of species that occur in two sampling units (see Magurran 2004).

We used cluster analysis to assess the affinity of Gripopterygidae fauna between basins (Legendre & Legendre 2012). Before analysis, we removed the four basins with the lowest sampling effort and number of species (less than 6 species) to minimize noise. Cluster analysis was performed using the unweighted pair-group method with arithmetic averages (UPGMA) through the 'hclust' function from the R package *vegan* (Oksanen et al. 2022). In this analysis, we employed the Jaccard dissimilarity index to assess the dissimilarity between hydrographic regions (Legendre & Legendre 2012). To avoid confusion, it is important to point out that faunal affinity between hydrographic basins is negatively related to dissimilarity.

We utilized the Cophenetic Correlation Coefficient (CCC) to measure the congruence between the dendrogram and the original dissimilarity index. A CCC greater than 0.8 indicates good congruence between the dendrogram and the original dissimilarity index (Legendre & Legendre 2012). Additionally, we tested whether the dissimilarity between basins is related to geographic distance using the Mantel test (Legendre & Legendre 2012). This analysis utilized the 'mantel.rtest' function from the R package *vegan ADE 4* (Dray & Dufour 2007).

RESULTS

Table III lists the species of Gripopterygidae occurring in the Neotropical Region. This list integrates previously published data and the

Table II. Abbreviations for administrative and natural divisions of the countries in South America.

Administrative units	
Countries	ARG, Argentina; BRA, Brazil; PRY, Paraguay; URY, Uruguay.
States of Brazil	BA, Bahia; ES, Espírito Santo; GO, Goiás; MG, Minas Gerais; PE, Pernambuco; PR, Paraná; RJ, Rio de Janeiro; RS, Rio Grande do Sul; SC, Santa Catarina; SP, São Paulo.
Departments of Paraguay and Uruguay	FLO, Florida, URY; ITA, Itapúa, PRY; LAV, Lavalleja, URY; MAL, Maldonado, URY; PRI, Paraguarí, PRY.
Province of Argentina	MIS, Misiones, ARG.
Natural divisions	
Biomes	AMF, Amazon Forest; ATF, Atlantic Forest; BSA, Brazilian Savanna; CHC, Chaco; DFO, Dry Forest; STG, Subtropical Grassland; WTL, Wetland.
Hydrographic Regions	EAT, East Atlantic; ENA, East Northeast Atlantic; PAR, Paraná; PGY, Paraguay; SAT, Southeast Atlantic; SFR, São Francisco; SOA, South Atlantic; TOA, Tocantins-Araguaia; UGY, Uruguay.

examination of specimens housed in scientific collections or recently collected specimens. It also provides information on the types and geographic records of species. Below, taxonomic comments are presented for species recorded for the first time in Brazil or within a new Brazilian state.

Gripopteryx

Gripopteryx elisae Illies 1964

(Figs. 2a–i, 3a–g)

Material examined. Holotype (male; by photographs): Brazil, Rio Grande do Sul, Bom Jesus, 1 small stream (S28°40', W50°23'), ca. 1,100 m altitude, 24.x.1961, Elise Fittkau leg. Paratypes (by photographs): 3 larvae together with the holotype. *Additional specimen*: Brazil, Santa Catarina, Urubici, Rio Sete Quedas, 11.ix.2016, L.C. Pinho and A.P. Amaral legs., 1 male, 1 exuvia *(new State record)*.

Measurements. Holotype: Body length: 8.0 mm; antenna length, 6.7 mm; head width, 1.45 mm; pronotum anterior width, 1.1 mm; pronotum posterior width, 1.36 mm; pronotum length, 1.0 mm; forewings length, 10.5 mm; number of cercomeres, 17. Larvae (n = 3): anterior wingpads length, 2.4 mm; posterior wingpads length, 1.8 mm; antenna length, 6.0 mm; 40-44 cercomeres.

The male from Urubici represents a comparatively medium sized specimen. Body length: 12.5 mm; antenna length, 10.0 mm; head width, 1.8 mm; pronotum anterior width, 1.3 mm; pronotum posterior width, 1.6 mm; pronotum length, 1.3 mm; forewings length, 13.0 mm; hind wings length, 11.0 mm; number of cercomeres, 21. Exuviae (n = 1): anterior wingpads length, 3.1 mm; posterior wingpads length, 2.2 mm; antenna length, 7.1 mm; +50 cercomeres.

Table III. Gripopterygidae species recorded in the Neotropical Region (numbered), with their respective known life stages. Published articles with the species records are given. Symbols: *The original paper; T: Type of the genus; H: Holotype; E: Exuvia; ♂: Male; ♀: Female; L: Larva; HR: Hydrographic Region.

	Species	Collection	Known life stages			Biomes	HR	Record reference
	Gripopteryx		♂	♀	L			
1	*G. brasiliensis*	(?)	●	●^{H}	-	ATF	SOA, PAR	**BRA**: **SC** (Šámal 1921* (as *Gripoptera brasiliensis*), Jewett 1959, Lecci & Froehlich 2011). **PRY**: **ITA** (Navás 1927 (as *G. zurbitui*)).
2	*G. cancellata*^{T}	MHNG	●^{H}	●	●	ATF, STG	EAT, PAR, SAT, SOA, UGY	**BRA:** (Pictet 1841*); **BA** (Duarte et al. 2014a); **ES** (Gonçalves et al. 2017); **MG** (Froehlich 1990, 1993, Gonçalves et al. 2017); **RJ** (Jewett 1960, Froehlich 1990, 1993, Nessimian et al. 2009, Lecci & Froehlich 2011, Avelino-Capistrano & Nessimian 2013); **RS** (Froehlich 1993, Novaes & Bispo 2016); **SC** (Froehlich 1993); **SP** (Froehlich 1990, 1993, Bispo & Lecci 2011, Lecci & Froehlich 2011). **ARG**: **MIS** (Romero 2017).
3	*G. caparao*	UFVB	●^{H}	-	-	ATF	SAT	**BRA: ES** (Gonçalves et al. 2017*); **MG** (Gonçalves et al. 2017).
4	*G. clemira*	MZSP	●^{H}	●	-	ATF	EAT	**BRA: BA** (Lecci & Froehlich 2011*, Duarte et al. 2014a).

Table III. Continuation.

5	*G. coruja*	MZSP	●^{H}	●	●	ATF	PAR, SAT	**BRA: ES** (Avelino-Capistrano & Nessimian 2014); **SP** (Froehlich 1993*, Bispo & Lecci 2011).
6	*G. elisae*	SMNS	●^{H}	-	●	ATF	SOA	**BRA: RS** (Illies 1964*); **SC** (**this study**).
7	*G. flinti*	MZSP	●^{H}	●	-	ATF	SAT	**BRA: RJ** (Froehlich 1993*); **SC** (**this study**); **SP** (Froehlich 1993, Bispo & Lecci 2011, Lecci & Froehlich 2011).
8	*G. garbei*	MZSP	●	●^{H}	●	ATF, DFO	EAT, PAR, SAT, SFR, SOA, UGY	**BRA: BA** (Lecci & Froehlich 2011, Duarte et al. 2014a, Lecci et al. 2014, **this study**); **ES** (Avelino-Capistrano & Nessimian 2014, Gonçalves et al. 2017); **MG** (Froehlich 1990, 1993, Gonçalves et al. 2017); **RJ** (Navás 1936*, Froehlich 1990, 1993, Nessimian et al. 2009, Avelino-Capistrano & Nessimian 2013); **SC** (Froehlich 1993); **SP** (Froehlich 1990, 1993, Bispo & Lecci 2011).
9	*G. japi*	MZSP	●^{H}	●	●	ATF	PAR	**BRA: SP** (Lecci & Froehlich 2011*).
10	*G. juetah*	MZSP	●^{H}	●	●	ATF	PAR, SAT	**BRA: ES** (Gonçalves et al. 2017); **MG** (Froehlich 1990, Gonçalves et al. 2017); **RJ** (Nessimian et al. 2009); **SP** (Froehlich 1990*). **ARG: MIS** (Romero 2017).
11	*G. liana*	MZSP	●^{H}	●	●	ATF, BSA	SFR	**BRA: MG** (Froehlich 1993*).
12	*G. maculosa*	MNRJ(?)	●^{H}	●	-	ATF	SAT	**BRA: ES** (Jewett 1960, Froehlich 1993, Avelino-Capistrano & Nessimian 2014); **RJ** (Jewett 1960*, Froehlich 1993).
13	*G. pardina*	MZSP	-	●^{H}	-	ATF	SAT	**BRA: RJ** (Navás 1936*).
14	*G. pilosa*	MZSP	●^{H}	●	●	ATF	PAR, SAT	**BRA: ES** (Gonçalves et al. 2017); **MG** (Froehlich 1990*, Gonçalves et al. 2017); **RJ** (Froehlich 1990, Nessimian et al. 2009, Avelino-Capistrano & Nessimian 2013); **SP** (Froehlich 1990).
15	*G. pinima*	MZSP	●^{H}	●	●	ATF	EAT, SAT	**BRA: BA** (Lecci & Froehlich, 2011, Duarte et al. 2014a, Lecci et al. 2014, **this study**); **ES** (Avelino-Capistrano & Nessimian 2014); **MG** (Castillo-Velásquez et al. 2024); **SP** (Froehlich 1993*, Bispo & Lecci 2011).
16	*G. reticulata*	NHMW	●^{H}	●	●	ATF, BSA	PAR, SAT, SFR, SOA	**BRASIL: ES** (Gonçalves et al. 2017); **MG** (Froehlich 1990, 1993, Gonçalves et al. 2017); **RJ** (Brauer 1866*, Navás 1932 (as *Klapopteryx zikanina*), Jewett 1960, Froehlich 1990, 1993, Nessimian et al. 2009, Lecci & Froehlich 2011, Avelino-Capistrano & Nessimian 2013); **RS** (Novaes & Bispo 2016); **SP** (Jewett 1960, Froehlich 1990, 1993, Lecci & Froehlich 2011, Bispo & Lecci 2011).
17	*G. serrensis*	MZSP	●^{H}	●	●^{E}	ATF	PAR, SOA	**BRA: RS** (Froehlich 1993*); **SC** (Lecci & Froehlich 2011). **ARG: MIS** (Romero 2017).
18	*G. serrei***	SMNS	-	●^{H}	-	STG	PGY	**URY: FLO** (Navás 1930*, Zwick 1984).
	Gripopteryx sp.	-	-	-	●	ATF	UGY	**BRA: RS** (Restello et al. 2007).
	Guaranyperla		♂	♀	L	**Biomes**	**HR**	**Record reference**
1	*G. beckeri*	MZSP	●^{H}	-	-	ATF	PAR	**BRA: MG** (Froehlich 2001*).

Table III. Continuation.

2	*G. guapiara*[T]	MZSP	●	●[H]	●	ATF	PAR	**BRA: SP** (Froehlich 2001*, 2015, Bispo & Lecci 2011).
3	*G. nitens*	MZSP	●	●[H]	●	ATF	PAR, SAT	**BRA: SP** (Froehlich 2001*, 2015).
	Guaranyperla sp.	-	-	-	●	ATF	PAR, SAT	**BRA: ES** (Froehlich, 2001, Gonçalves et al. 2017); **MG** (Froehlich, 2001); **RJ** (Avelino-Capistrano & Nessimian 2013 (as *G. guapiara*)).
Paragripopteryx			♂	♀	L	**Biomes**	**HR**	**Record reference**
1	*P. anga*	MZSP	●[H]	●	●	ATF	PAR, SAT	**BRA: SP** (Froehlich 1969*, 1994, Bispo & Lecci 2011).
2	*P. baratinii*	UdelaR(?)	●[H]	●	-	STG	SOA	**URY: LAV** (Benedetto 1983*).
3	*P. blanda*	MZSP	●[H]	●	●	ATF	PAR, SAT	**BRA: SC** (Duarte et al. 2022); **SP** (Froehlich 1969*, 1994, Bispo & Lecci 2011).
4	*P. dasalmas*	MZSP	●[H]	●	-	ATF	EAT	**BRA: BA** (Duarte et al. 2022*).
5	*P. delicata*	MZSP	●[H]	●	●[E]	ATF	PAR	**BRA: SP** (Froehlich 1994*).
6	*P. egena*	MZSP	●[H]	●	-	ATF	PAR, SAT, SOA	**BRA: ES** (Gonçalves et al. 2017); **SC** (Duarte et al. 2022); **SP** (Froehlich 1994*, Bispo & Lecci 2011).
7	*P. guardae*	MZSP	●[H]	●	●	ATF	PAR	**BRA: SP** (Froehlich 1994*).
8	*P. hamata*	MZSP	●[H]	●	-	ATF	PAR, SAT	**BRA: SP** (Froehlich 1994*, Bispo & Lecci 2011).
9	*P. intervalensis*	MZSP	●[H]	●	-	ATF	PAR, SAT	**BRA: ES** (Gonçalves et al. 2017, Duarte et al. 2022); **MG** (Duarte et al. 2022); **SC** (Duarte et al. 2022); **SP** (Bispo & Lecci 2011*).
10	*P. kapilei*	MZSP	●[H]	-	●	ATF	PAR, SAT	**BRA: SC** (Duarte et al. 2022); **SP** (Bispo & Lecci 2011*).
11	*P. klapaleki*[T]	NHMH	●[H]	●	●	ATF	PAR, SAT, UGY	**BRA: RJ** (Enderlein 1909*, Nessimian et al. 2009); **SC** (Duarte et al. 2022); **SP** (Froehlich 1969, Bispo & Lecci 2011). **ARG: MIS** (Romero 2017).
12	*P. merui*	MZSP	●[H]	-	●[E]	ATF	PAR	**BRA: ES**, **MG** (Gonçalves et al. 2017 (as *P. klapaleki*), Duarte et al. 2022); **SP** (Froehlich 1994*).
13	*P. munoai*	UdelaR	●[H]	●	●	STG	SOA	**URY: MAL** (Benedetto 1969*).
14	*P. ogum*	MZSP	●[H]	●	-	ATF	SOA	**BRA: SC** (Duarte et al. 2022*).
15	*P. paranapiacabae*	MZSP	●[H]	-	-	ATF	PAR, SAT	**BRA: SP** (Bispo & Lecci 2011*).
	Paragripopteryx sp.	-	-	-	●	ATF	EAT, SAT, UGY	**BRA: BA** (Duarte et al. 2014a); **ES** (Avelino-Capistrano & Nessimian 2014); **RS** (Restello et al. 2007).
Tupiperla			♂	♀	L	**Biomes**	**HR**	**Record reference**
1	*T. amandae*	MZSP	●[H]	●	-	ATF	PAR, SAT	**BRA: SP** (Bispo & Lecci 2011*). **ARG: MIS** (Manzo et al. 2014, Romero 2017).
2	*T. amorimi*	MZSP	●[H]	●	-	ATF	PAR	**BRA: MG** (Froehlich 2016*).
3	*T. barbosai*	DZRJ	●[H]	-	-	ATF	SAT	**BRA: RJ** (Avelino-Capistrano & Nessimian 2013*).
4	*T. bispoi*	MZSP	●[H]	●	-	ATF	EAT	**BRA: BA** (Duarte et al. 2014a*).
5	*T. claudius*	DZUP	●[H]	-	-	ATF	SOA	**BRA: PR** (Varella & Pinto 2023*).

Table III. Continuation.

6	*T. eleonorae*	MZSP	●^{H}	●	-	ATF	PAR, SAT	**BRA: SP** (Froehlich 1994*, Bispo & Lecci 2011).
7	*T. flinti*	NMNH	●^{H}	●	-	ATF, CHC	PAR, PGY, SOA, UGY	**BRA: PR** (**this study**); **RS** (**this study**). **ARG: MIS** (Froehlich 2002*, Romero 2017). **PRY: PRI** (Froehlich 2002).
8	*T. froehlichi*	MZSP	●^{H}	-	-	ATF	SAT	**BRA: SP** (Bispo & Lecci 2011*).
9	*T. gracilis*^{T}	MLUH	●^{H}	●	?	ATF, BSA	PAR, SAT, SFR, UGY	**BRA:** (Burmeister 1939*, Illies 1963 (*in part*)); **ES** (Gonçalves et al. 2017); **MG** (Froehlich 1998, 2016, Novaes & Bispo 2014); **RJ** (Froehlich 1998, Nessimian et al. 2009, Avelino-Capistrano & Nessimian 2013); **SP** (Froehlich 1969, 1998, Bispo & Lecci 2011). **ARG: MIS** (Romero 2017).
10	*T. guariru*	MZSP	●^{H}	●	-	ATF, DFO	EAT	**BRA: BA** (Duarte et al. 2014b*).
11	*T. illiesi*	MZSP	●^{H}	●	?	ATF	PAR, SAT	**BRA: SP** (Froehlich 1998*).
12	*T. jumirim*	MZSP	●^{H}	●	-	BSA	TOA	**BRA: GO** (Bispo & Froehlich 2007*).
13	*T. misionera*	NMNH	●^{H}	-	-	ATF	PAR, SOA	**BRA: PR** (**this study**); **RS** (Novaes & Bispo 2016); **SC** (**this study**). **ARG: MIS** (Froehlich 2002*, Romero 2017).
14	*T. modesta*	MZSP	●^{H}	●	-	ATF	PAR	**BRA: SP** (Froehlich 1998*).
15	*T. oliveirai*	MZSP	●^{H}	●	-	BSA	TOA	**BRA: GO** (Froehlich 1998*); **MG** (**this study**).
16	*T. pessacqi*	MZSP	●^{H}	●	-	ATF	SOA, UGY	**BRA: SC** (Duarte et al. 2019*).
17	*T. pinhoi*	MZSP	●^{H}	-	-	ATF	UGY	**BRA: SC** (Duarte et al. 2019*).
18	*T. reichardti*	MZSP	●^{H}	●	-	ATF	PAR, SAT	**BRA: MG** (Froehlich 1998); **RJ** (Avelino-Capistrano & Nessimian 2013); **SP** (Froehlich 1998*).
19	*T. robusta*	MZSP	●^{H}	●	●	ATF	PAR, SAT	**BRA: ES** (Avelino-Capistrano & Nessimian 2014, Gonçalves et al. 2017); **MG** (Novaes & Bispo 2014, Gonçalves et al. 2017); **RJ** (Froehlich 1998); **SP** (Froehlich 1998*).
20	*T. sepeensis*	MZSP	●^{H}	-	-	STG	SOA	**BRA: RS** (Novaes & Bispo 2016*).
21	*T. serrulata*	MZSP	●^{H}	●	-	ATF	SOA	**BRA: SC** (Duarte et al. 2019*).
22	*T. sulina*	MZSP	●^{H}	●	-	ATF	SOA	**BRA: SC** (Froehlich 1998*).
23	*T. tessellata*	NHMW	●	●^{H}	-	ATF, BSA, STG	EAT, ENA, PAR, SAT, SFR, SOA, UGY	**BRA: BA** (Duarte et al. 2014a); **ES** (Avelino-Capistrano & Nessimian 2014, Gonçalves et al. 2017); **MG** (Froehlich 1998, Gonçalves et al. 2017); **PE** (Lecci et al. 2014); **RJ** (Brauer 1868*, Navás 1916, Jewett 1960, Froehlich 1998, Avelino-Capistrano & Nessimian 2013); **RS** (Novaes & Bispo 2016); **SC** (Jewett 1959, 1960); **SP** (Froehlich 1998, Bispo & Lecci 2011).
24	*T. ubuntu*	MZSP	●^{H}	●	-	ATF	SOA	**BRA: SC** (Duarte et al. 2019*).
25	*T. umbya*	MZSP	●^{H}	●	-	ATF	PAR, SAT	**BRA: SP** (Froehlich 1998*, Bispo & Lecci 2011).
26	*T. zwicki*	MZSP	●^{H}	-	-	ATF	SOA, UGY	**BRA: SC** (Duarte et al. 2019*).

Comparative diagnosis. *Gripopteryx elisae* is a small to medium-sized species typically brown in color. The male can be identified by the widened T10, characterized by a distinctly rounded latero-posterior area and a slightly elevated median-posterior region, densely covered with small, fine hairs. The elongated and curved paraprocts terminate in a rounded apex, with the outer basal half provided with delicate setae while the distal part remains uncovered. The subgenital plate is wide, forming a trapezoidal structure, with dark brown stripes

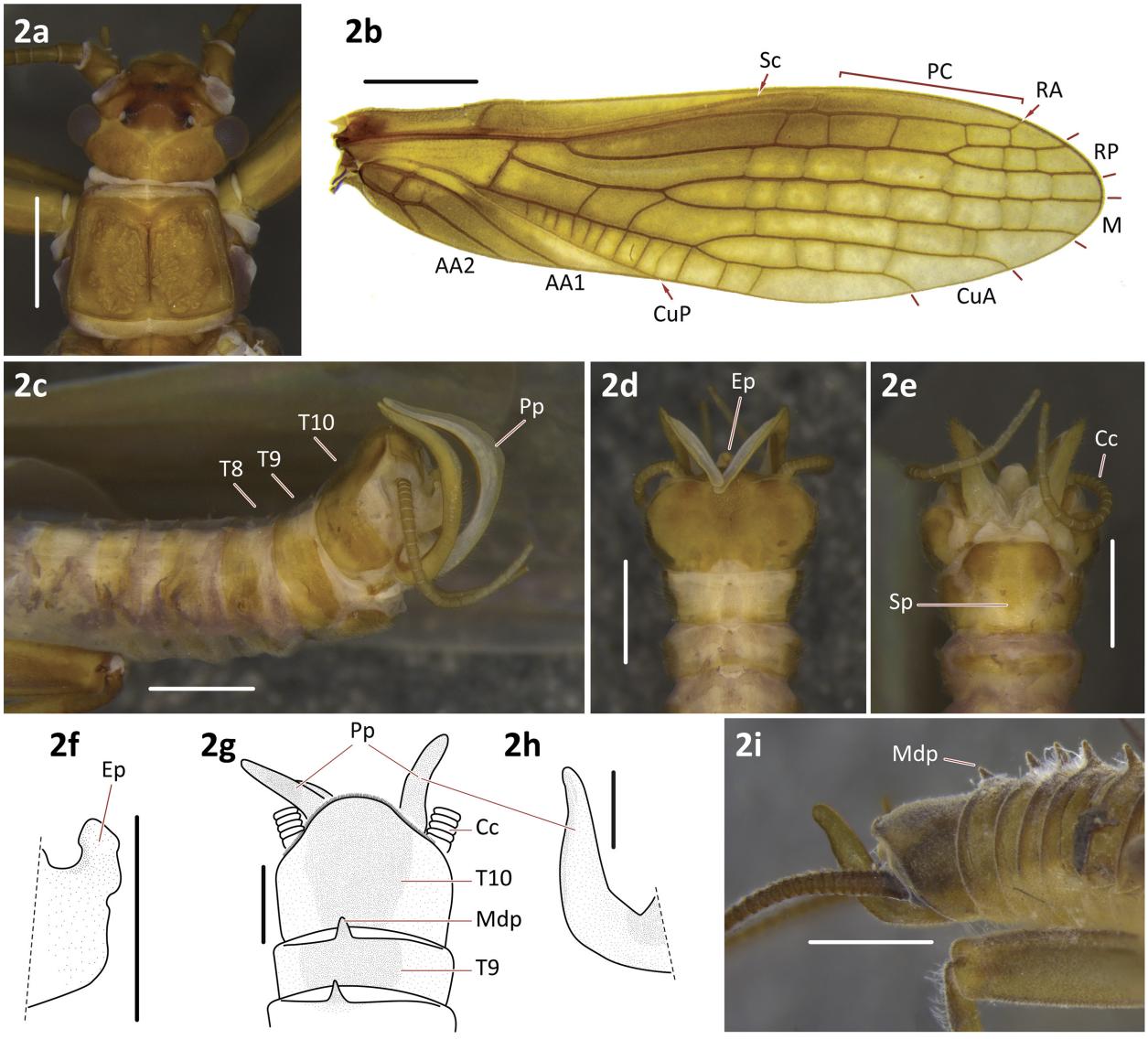

Figure 2. ***Gripopteryx elisae*** **specimen from Urubici, Santa Catarina, Brazil. Adult male, head and pronotum in dorsal view (2a). Male forewing (2b). Male abdomen and terminalia in lateral (2c), dorsal (2d), and ventral views (2e). Schematic of the male epiproct in lateral view (2f). Schematic of the three distal abdominal segments of the exuvia in dorsal view (2g). Schematic of the exuvia's paraproct in lateral view (2h). Abdominal segments of the exuvia in lateral view showing the dorsal processes and paraproct (2i). Abbreviations: AA1, first anterior analis; AA2, second anterior analis; Cc, cercus; CuA, anterior cubitus; CuP, posterior cubitus; Ep, epiproct; M, media; PC, pterostigmatic cell; Pp, paraprocts; RA, anterior radius; RP, posterior radius; Sc, subcosta; Sp, subgenital plate; Mdp, median-dorsal process; T8, tergum 8; T9, tergum 9; T10, tergum 10. (Scale bar: a, c, d, e, i: 1.0 mm; b, f, g, h: 0.5 mm).**

at each latero-posterior corner and depigmented mid and central areas. Distinguishing it from *Gripopteryx flinti* Froehlich, which also exhibits a widened T10, the latter has a median-posterior region separated by small clefts. Additionally, *Gripopteryx flinti* exhibits an elliptical subgenital plate, while its long paraprocts have a thin apex with a small sharp point directed outward.

The larvae of *Gripopteryx elisae* exhibit characteristics similar to those of *Gripopteryx reticulata* Brauer, *Gripopteryx garbei* Navás, and *Gripopteryx cancellata*, including the lack of spines or processes on the thorax. Abdominal T1–9 exhibit a row of short, pointed median-dorsal processes, while T10 is rounded and lacks a terminal process. In contrast, the paraprocts of *Gripopteryx elisae* are elongated, strongly curved upwards, with a broad basal half bearing small spiny setae and the final third slightly curved outward, culminating in a rounded apex. In *Gripopteryx reticulata*, the paraprocts extend dorsally, with the apex clearly bending backwards, while those of *Gripopteryx garbei* are elongated, pointing backwards, with a sinuous outer margin, and those of *Gripopteryx cancellata* are strongly rounded and simple.

Characterization of specimen from Urubici, Santa Catarina, Brazil. *Coloration*: general color brown. *Head*: brown, occiput surface rough, coronal and frontal sutures of the epicranial line lighter, central frons area darker (Fig. 2a). Ocelli and eyes black. Clypeus brown, labrum lighter shade of brown. Maxillary palps light brown, 5-segmented, first, second, and fourth segments short, third and fifth segments longer. Labial palps light brown, 3-segmented, third segment rounded. Antennae brown, long, antenomeres covered with very small fine hairs. *Pronotum*: brown, trapezoidal shape, narrow laterally, margins well-marked, surface rough, a dark middle line at central area. *Legs*: brown. Femur with a parallel brown stripe. Tibia with a perpendicular suture in the proximal region, two spurs distally. Tarsi with first tarsomere of medium length, second tarsomere short and third tarsomere long. *Wings*: membranous pale brown (Fig. 2b), forewing with slight transverse spot between pterostigmatic cell and anal area, posterior area lighter; pterostigmatic crossveins absent; RA unforked; RP forked, bearing two crossveins; CuA forked. Hind wing with M3+4, near its separation from M1+2, partially fused to CuA, veins separate near the posterior margin of the wing; CuA unforked; 6th anal vein fused to the margin of the wing. *Cerci*: multisegmented, cercomeres gradually increasing in size along the length of the cerci, cercomeres bearing small fine hairs.

Male. *Abdominal segments*: segments 1–8 predominantly membranous, segment 9 laterally sclerotized (Fig. 2c), segment 10 wide, entirely sclerotized. *Terga*: terga 1–9 bearing residual median-dorsal processes on the posterior margin; tergum (T) 10 latero-posterior margin strongly rounded, median-posterior area slightly elevated and curved downward, central area densely covered with small fine hairs (Figs. 2c–d). *Sterna*: sterna 5–8 feature a transversal sclerotized band in posterior margin; sternum (St) 9 wide, forming a trapezoidal subgenital plate that extends to approximately one-third of St10 (Fig. 2e); each latero-posterior corner of the subgenital plate features a dark brown stripe, mid and central areas depigmented (Fig. 2e). *Paraprocts*: long, relatively narrow, strongly curved upwards and converging to meet above T10; outer margin of the basal half bearing a delicate hairline, inner margin carries a sclerotic stripe; middle region slightly wider; final third bare, slightly angled, gradually tapering, and culminating in a rounded apex (Figs. 2c–d). *Epiproct*: predominantly membranous, fully visible beneath T10, base broad; inner margin

carries a sclerotic stripe, small teeth absent (Figs. 2c, 2e, 2f).

Female. Unknown.

Exuvia. *Body*: general color brown to dark brown, covered by small spiny setae. *Head*: antennae dark brown, long, basal antenomeres short and wide, becoming longer and narrower along the antennal length; a sparse fringe of delicate hair dorsally on the basal half of antennae, posterior margin of each antenomere bearing small spiny setae. *Thorax*: lack of spines or processes, only small and inconspicuous discal elevations; pronotum squared, meso- and metanotum posterior margin with small, inverted V-shaped suture; wingpads fully developed. *Legs*: brown. Femur and tibia outer margin bearing a dense fringe of hairs, those of the femur interspersed with small spiny setae; tibiae distal region bearing two spurs. Tarsi brown, first and second tarsomeres short, third tarsomere long; inner face of tarsomeres bearing small spiny setae. *Abdomen*: T1–9 bearing a short, pointed median-dorsal processes on the posterior margin; T10 rounded, devoid of a median process, posterior margin bearing small spiny bristles (Figs. 2g, 2i). Gills dark. *Paraprocts*: long, strongly curved upwards, basal half broad bearing small spiny setae, final third slightly curved outward, gradually tapering and culminating in a rounded apex (Figs. 2h, 2i). *Cerci*: long, basal cercomeres short and wide, becoming longer and narrower along the cerci length; in each cercomere, a sparse fringe of delicate hair interspersed with sparse spiny hair dorsally on basal half, posterior margin bearing small spiny setae.

Taxonomic remarks. *Gripopteryx elisae* was originally described by Illies (1964) based on a newly emerged male and additional material consisting of three larvae from the municipality of Bom Jesus, Rio Grande do Sul State, Brazil. We examined a male specimen and an exuvia collected in the municipality of Urubici, Santa Catarina State, Brazil, which is 140 km away from the type locality of *Gripopteryx elisae*. While the studied specimen shares certain characteristics with *Gripopteryx elisae*, we did observe pertinent variations in body length and the shape of specific structures, which are discussed below.

The adult male forewing depicted in Illies (1964) shows a forked RP vein that bears two crossveins (fig. 1a in Illies 1964). Additionally, it exhibits long and curved paraprocts culminating in a rounded apex (fig. 1d in Illies 1964). All these specific traits are consistent with the characteristics of the male specimen from Urubici. Nonetheless, Illies' specimen is proportionally smaller in comparison to the one collected in Urubici. While the body size of *Gripopteryx elisae* holotype reaches a length of 8.0 mm, the Urubici specimen measures 12.5 mm. Another difference lies in the forewing length, with the *Gripopteryx elisae* holotype measuring 10.5 mm, while the Urubici specimen measures 13.0 mm. The count of cercomeres also differs between the specimens, with the *Gripopteryx elisae* holotype having 17 cercomeres and Urubici specimen featuring 21.

Illies (1964) provided a brief description of *Gripopteryx elisae*, but it is likely that many traits may have been overlooked or not thoroughly described. For example, Illies mentions that T10 of *Gripopteryx elisae* holotype is broad and transversely rectangular in dorsal view (as shown in Fig. 3a). The subgenital plate is not fully described by him; it is mentioned as being short and covering approximately half the width of St9 (as shown in Fig. 3b). Furthermore, Illies describes the paraprocts as long and narrow, with a broadly rounded apex that extends beyond the posterior margin of T10 (as shown in Fig. 3c). Additionally, the epiproct is noted as being weakly developed, resembling a short cone, and it is almost entirely concealed beneath T10.

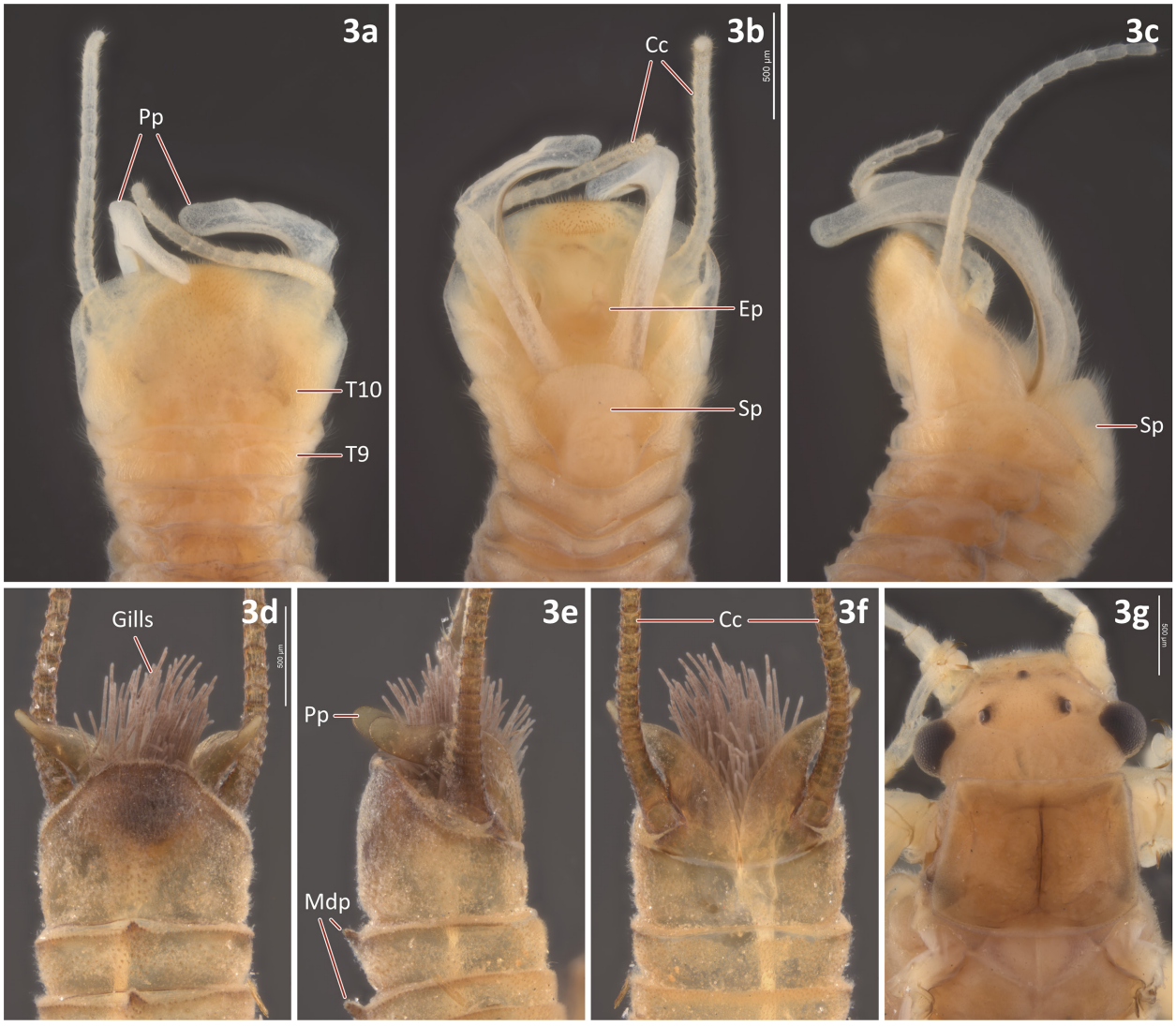

Figure 3. ***Gripopteryx elisae*** **type-specimen from Bom Jesus, Rio Grande do Sul, Brazil. Adult male terminalia in lateral (3a), dorsal (3b), and ventral views (3c). Terminalia of larva in dorsal (3d), lateral (3e), and ventral views (3f). Adult male, head and pronotum in dorsal view (3g). Abbreviations: Cc, cercus; Ep, epiproct; Pp, paraprocts; Sp, subgenital plate; Mdp, median-dorsal process; T9, tergum 9; T10, tergum 10. (Scale bar: 0.5 mm).**

In contrast, the male specimen from Urubici presents a slightly different T10 morphology. It exhibits a broad shape, exhibiting a latero-posterior area that is distinctly rounded and a median-posterior area that is slightly elevated and curved downward. This elevated region is densely covered with small, fine hairs (Figs. 2c–d). The subgenital plate does not match completely the holotype of *Gripopteryx elisae*. Instead, it is wide and forms a trapezoidal structure that extends almost the entire width of St9 (Fig. 2e). The paraprocts are long and narrow, exhibiting a curvature along their length and a subtle angulation in the upper third (Figs. 2c–d). As for the epiproct, it appears as a membranous structure with a broad base. Unlike Illies' description, it is fully exposed beneath T10 (Figs. 2c, 2f).

Illies characterizes the larvae of *Gripopteryx elisae* as slender and uniformly brown. The

thorax lacks spines or processes, which are confined to the dorsal posterior margin of abdominal T1–9 (as shown in figs. 2a–b of Illies 1964). The paraprocts are described as exhibiting a concave outer margin, being broadly rounded on the posterior margin, and directed towards the outer corner (Figs. 3d–f). Similarly, the exuvia from Urubici exhibits a smooth thorax, lacking spines or processes, which extend from abdominal T1–9, as also noted in *Gripopteryx reticulata*, *Gripopteryx garbei*, and *Gripopteryx cancellata*. In contrast, the paraprocts in the Urubici exuvia are elongated in comparison and exhibit a pronounced upward curvature, with the final third slightly curved outward, gradually tapering to form a rounded apex (Figs. 2h, 2i).

As reported by Dr. P. Zwick (personal communication), the holotype of *Gripopteryx elisae* precisely matches the illustration found in the description (Illies 1964). The original illustrations of *Gripopteryx elisae* were meticulously crafted with photographic precision by Helle Borggreen, a Swedish artist, under the guidance of J. Illies. The only minute detail missing from her depiction is the exceedingly delicate setae along the exterior of the slender, rigid basal half of the paraprocts (as shown in Fig. 3a–c). In contrast, the broader, softer distal part of the paraprocts remains uncovered, as also observed in the Urubici specimen. Although the holotype was described as apparently freshly emerged, it is a fully formed specimen. Discrepancies in T10 between the two specimens may stem from distinct levels of turgidity. While the holotype's abdominal tip was detached and may have lost fluid and turgor to the ethanol solution where it is stored, the Urubici specimen displays full turgidity.

Considering the restricted availability of Urubici specimens, consisting of only one specimen and its exuvia, we have refrained from introducing a new specific name within the *Gripopteryx* genus, despite the notable observed variations. The dilemma here is that the limited number of specimens analyzed in our study precludes the observation of any intraspecific morphological variation that might exist within *Gripopteryx elisae*, which we are unable to detect due to the lack of sufficient material from the type locality, as well as from Urubici and the areas between these two regions. Therefore, our approach has involved providing a comprehensive account of the specimen, followed by a detailed comparison with *Gripopteryx elisae*' holotype. This comparative analysis includes photographs showcasing both the recently discovered specimen (Fig. 2) and the holotype (Fig. 3), as well as Illies' Illustrations (Illies 1964). To achieve a more conclusive determination concerning the potential validity of a new species designation within the genus, additional material is imperative. Gathering specimens from both the type locality of *Gripopteryx elisae* and Urubici will be essential for a more decisive resolution.

***Gripopteryx flinti* Froehlich 1993**

Material examined. Brazil, Santa Catarina, São Bonifácio, Cachoeira Dona Bebê, S27°54'31'', W48°54'45'', 29.ix.2016, T. Duarte and V.A. Gomes legs., 1 male *(new State record)*.

Remarks. The type material of this species is from Nova Friburgo Municipal Park and Itatiaia National Park, both located in Rio de Janeiro State, as well as Caraguatatuba Forest Reserve (Serra do Mar State Park) in São Paulo State, as documented by Froehlich (1993). Additional specimens from São Paulo State were studied by Bispo & Lecci (2011) and Lecci & Froehlich (2011). For a complete distribution range see Table III. The studied specimen was collected in the municipality of São Bonifácio, Santa Catarina, Brazil, far 1,300 kilometers away from the type locality. Specifically, the specimen was

collected at the Dona Bebê waterfall, which is situated along the Serraria River. This area rests at the west edge of the Serra do Tabuleiro State Park, which is situated within the confines of the Atlantic Forest, boasting elevations between 400 to 1,270 meters above sea level (m. a.s.l.). The Serraria River receives tributaries originating in the State Park. The examined specimen is probably a recently emerged male, exhibiting a pale yellowish-dark hue, in contrast to the dark brown coloration as described by Froehlich (1993). Despite this, the specimen is in accordance with the detailed description and illustrations provided by both Froehlich (1993) and Lecci & Froehlich (2011). The examination of this specimen has led to the extension of the distribution range of this species farther south in the Brazilian Atlantic Forest.

Gripopteryx garbei Navás 1936

Material examined. Brazil, Bahia, Wenceslau Guimarães, State Ecological Station of Wenceslau Guimarães, Serra Grande Stream, S13°35'43'', W39°43'12'', 07.x.2010, A.R. Calor et al. legs., 1 male; same data, except for: 09.iii.2011-iv.2011, 1 male; same data, except for: S13°35'34'', W39°42'52'', 09.x.2010, light pan trap, 1 male; same data, except for: waterfall, S13°35'35.4'', W39°42'51.2'', 513m, 06.ix.2013, light pan trap, A.R. Calor, T. Duarte and E.S. Dias legs., 2 males; same data, except for: 07.ix.2013, 6 males; same data, except for: 1 male; same data, except for: 1 male; same data, except for: 08.ix.2013, 2 males; same data, except for: 4 males.

Remarks. The type locality of this species is from the Serra de Macaé, Rio de Janeiro State, as documented by Navás (1936). However, the species is widely distributed across the Brazilian Atlantic Forest, as indicated in Table III. The male specimens under examination were collected within the State Ecological Station of Wenceslau Guimarães, nestled in the municipality that bears the same name, in Bahia State, Brazil. The area covers approximately 2,400 hectares, functioning as a crucial buffer zone within the Central Atlantic Forest Ecological Corridor. This enclave presents an elevation that spans from 500 to 1,000 m. a.s.l., and it is part of the hydrographic basin that surrounds the South Recôncavo River, which in turn is linked as a sub-basin of the Almas River (Bahia 2010). The specimens studied match the description and illustrations provided by Froehlich (1993), representing an additional record in Bahia State.

Gripopteryx pinima Froehlich 1993

Material examined. Brazil, Bahia, Wenceslau Guimarães, State Ecological Station of Wenceslau Guimarães, Serra Grande Stream, headquarters, 10.x.2010, A.R. Calor et al. legs., 1 male, 1 female; same data, except for: waterfall, S13°35'35.4'', W39°42'51.2'', 10.x.2010, light pan trap, A.R. Calor et al. legs., 3 males; same data, except for: 1 male; same data, except for: 06.ix.2013, 3 males; same data, except for: 1 male; same data, except for: 07.ix.2013, 5 males; same data, except for: 08.ix.2013, 2 males, 1 female; same data, except for: 1 male; same data, except for: 1 male; same data, except for: 1 male, 1 female; same data, except for: light trap: 1 male; same data, except for: 1 male; same data, except for: 1 male.

Remarks. The type material of this species is from the Biological Station of Boracéia (23°38'S, 45°52'W), with additional specimens from the Biological Station of Paranapiacaba (23°47'S, 46°19'W), both located in São Paulo State, Brazil, as documented by Froehlich (1993). Table III enumerates additional records pertaining to the species. We examined several male and female specimens collected from the State Ecological Station of Wenceslau Guimarães in Bahia State, Brazil. The specimens studied match the description and illustrations provided

by Froehlich (1993), representing an additional record in Bahia State.

Tupiperla

Tupiperla flinti Froehlich 2002

Material examined. Brazil, Paraná, Céu Azul, Parque Nacional Iguaçu, Azul Stream 3rd order, céu 04, (DZRJ #3435), S25º09'10.9'', W53º43'44.9'', 08.ix.2012, A.P.M. Santos leg., 1 male *(new Country record)*; Brazil, Rio Grande do Sul, Bom Jesus, E. Fittkau leg., 3 males, 1 female *(new Country record)* (in SMNS).

Remarks: The type series of this species was collected in the Province of Misiones, Argentina and the Department of Paraguarí, Paraguay, as documented by Froehlich (2002). We studied specimens collected in the Iguaçu National Park, Paraná State, as well as those from the municipality of Bom Jesus in Rio Grande do Sul State, Brazil. The Iguaçu National Park is a protected area shared between Brazil (Paraná State) and Argentina (Misiones Province), situated along the border of these two countries, and located within the boundaries of the Atlantic Forest, with elevations ranging from 200 to 800 m. a.s.l. The Azul stream, where a male specimen was collected, is a tributary of the Floriano River, which originates in the northern part of the National Park in Brazil and flows southward into the Iguaçu River, near the border with Misiones. The studied specimens exhibit a distinctive brownish stripe extending from behind the eye to the pronotum pleura, as also described for *Tupiperla misionera* (Froehlich 2002). This same feature can be observed in other species of the genus (*Tupiperla amandae*, *Tupiperla eleonorae* (Froehlich), *Tupiperla gracilis*, *Tupiperla oliveirai* Froehlich, *Tupiperla froehlichi* Bispo and Lecci, *Tupiperla guariru*, and *Tupiperla amorimi* Froehlich). Additionally, an unreported characteristic of this species is the presence of a small tooth on the inner margin of the distal half of the paraprocts. Despite this novel observation, the specimens are consistent with the description and illustrations provided by Froehlich (2002). This is the first record of the species within Brazilian territory.

Tupiperla misionera Froehlich 2002

Material examined. Brazil, Santa Catarina, Orleans, Minador Stream - #63, S28º10'24'', W49º24'37'', 06.vii-19.viii.2013, Malaise, L.C. Pinho et al. legs., 2 males *(new State record)*; same data, except for: #66, S28º10'28'', W49º24'36'', 14.viii-12.x.2013, Malaise, L.C. Pinho et al. legs., 4 males; same data, except for: #70, S28º10'35'', W49º24'36'', 12.x-10.ix.2013, Malaise, L.C. Pinho et al. legs., 1 male; Brazil, Paraná, Céu Azul, Manoel Ribas Stream, céu 04, (DZRJ #3490), 06.ix.2012, light trap, A.P.M. Santos leg., 2 males *(new State record)*.

Remarks: The type material of this species (Froehlich 2002) is a single male specimen from Misiones Province, Argentina. Novaes & Bispo (2016) documented the species in the municipality of Santa Margarida do Sul, Rio Grande do Sul State, Brazil. We examined male specimens collected from both São Joaquim National Park in Santa Catarina and Iguaçu National Park in Paraná State, Brazil. São Joaquim National Park is characterized by cliffs of the Serra Geral, with elevations ranging from 400 to 1,500 m. a.s.l. The Minador stream, where part of the specimens was collected, originates at the boundaries of Serra Furada State Park, enters São Joaquim National Park, and flows southward into the Laranjeiras River, reaching the municipality of Orleans. Details about the Iguaçu National Park in Paraná State, see "Remarks" of *Tupiperla flinti*. The specimens match with the description and illustrations provided by Froehlich (2002). These findings represent new records farther north in the Brazilian Atlantic Forest and are the

first records for both Paraná and Santa Catarina states, Brazil.

Tupiperla oliveirai Froehlich 1998

Material examined. Brazil, Minas Gerais, Serra do Salitre, RPPN Cachoeira do Campo, S19°10'06.3", W46°34'09.4", 11-15.x.2012, light trap, A.R. Lima leg. (UFMG IPL 1600023), 1 male *(new State record)*; same data, except for: (UFMG IPL 1600026), 1 female; same data, except for: (UFMG IPL 1600027), 1 female.

Remarks. The type material of this species is from the municipality of Pirenópolis, Goiás State, Brazil, as documented by Froehlich (1998). We examined male and female specimens from Serra do Salitre, Minas Gerais State, 580 km away from the type locality. The Serra do Salitre is characterized by the high-altitude tropical weather, with an altitudinal range from 800 to 1,300 m. a.s.l. The stream where the specimens were collected is situated on private property, mainly without native vegetation, most of the area surrounding the stream is comprised of coffee monoculture and pasture, with arboreal vegetation restricted to a strip of 5 to 10 meters along the stream's course. *Tupiperla oliveirai*, alongside *Tupiperla jumirim* Bispo and Froehlich, comprise the two species of Gripopterygidae in Brazil known to inhabit high-altitude regions in central Brazil. The specimen we examined represents a new record for the Minas Gerais State, Brazil.

Distribution of strictly Neotropical gripopterygids

We discovered new expansion records within Brazil for five species. *Gripopteryx elisae* and *Tupiperla misionera* now have their northernmost records in Brazilian Atlantic Forest. *Gripopteryx flinti* and *Tupiperla oliveirai* represent the southernmost records in the Brazilian Atlantic Forest and Brazilian Savanna, respectively. Furthermore, *Tupiperla flinti* is documented in Brazil for the first time, signifying an eastward extension from Misiones (Argentina) and Paraguarí (Paraguay) into Paraná and Rio Grande do Sul states, Brazil. Additionally, *Gripopteryx garbei* and *Gripopteryx pinima* are newly recorded within the Atlantic Forest in Bahia State, Brazil.

Most of the Gripopterygidae species are concentrated in the Southeast and South administrative regions of Brazil (Fig. 1). São Paulo State stands out with 32 species recorded, followed by Santa Catarina State with 20, Minas Gerais State with 17, and Espírito Santo State hosting 16 species. The latter two states have records of *Guaranyperla* sp. Rio de Janeiro State follows closely with 15 species. In the southeastern Brazilian states, all Gripopterygidae genera have been recorded. In the southern states, Santa Catarina hosts three genera (*Gripopteryx*, *Paragripopteryx*, and *Tupiperla*), Rio Grande do Sul has two genera (*Gripopteryx* and *Tupiperla*), and Paraná has one genus (*Tupiperla*). In other regions, Goiás State in the Center-West Region reports two *Tupiperla* species. In the Northeast Region, Pernambuco and Bahia states report one species (*Tupiperla*) and eight species (*Gripopteryx*, *Paragripopteryx*, and *Tupiperla*), respectively. No Gripopterygidae species have been recorded in the North administrative region of Brazil.

In southern Uruguay, Gripopterygidae species have been documented in different departments. *Gripopteryx serrei* is found in the Florida Department, while *Paragripopteryx baratinii* and *Paragripopteryx munoai* are recorded further south, in the Maldonado and Lavalleja Departments, respectively. In Paraguay, *Tupiperla flinti* has been documented in the western part, in the Paraguarí Department, while *Gripopteryx brasiliensis* has been recorded in the southern part, in the Itapúa Department (Froehlich 2010). Moving to northeastern

Argentina, a group of eight species is concentrated in the Misiones Province, including *Gripopteryx cancellata*, *Gripopteryx juetah*, *Gripopteryx serrensis*, *Paragripopteryx klapaleki*, *Tupiperla amandae*, *Tupiperla flinti*, *Tupiperla gracilis*, and *Tupiperla misionera* (Froehlich 2002, Manzo et al. 2014, Romero 2017).

Most gripopterygids, comprising 56 species (about 90% of the total), are documented within the Atlantic Forest biome in South America (Fig. 4a). Among these, 48 species are unique to this biome, representing around 77% of the total species (or 86% of the Atlantic Forest fauna). The Brazilian Savanna ranks second with seven recorded species, including two that are unique to this biome, namely *Tupiperla jumirim* and *Tupiperla oliveirai*. These two biomes share five species between them. The Subtropical Grassland houses six recorded species, with four being endemic: *Gripopteryx serrei*, *Paragripopteryx baratinii*, *Paragripopteryx munoai*, and *Tupiperla sepeensis* Novaes and Bispo. Both the Dry Forest and Chaco biomes have only one recorded species of Gripopterygidae each. Specifically, *Gripopteryx garbei* has been documented in both the Dry Forest and the Atlantic Forest in Brazil, while *Tupiperla flinti* has been documented in the Chaco in Paraguay and the Atlantic Forest in Brazil. The Amazon and Wetland biomes do not have any documented Gripopterygidae species.

Neotropical Gripopterygidae species have been documented in nine Hydrographic Regions: East Atlantic, East Northeast Atlantic, Paraná, São Francisco, Southeast Atlantic, South Atlantic, Tocantins-Araguaia, Paraguay, and Uruguay (Fig. 4b). The Paraná and Southeast Atlantic

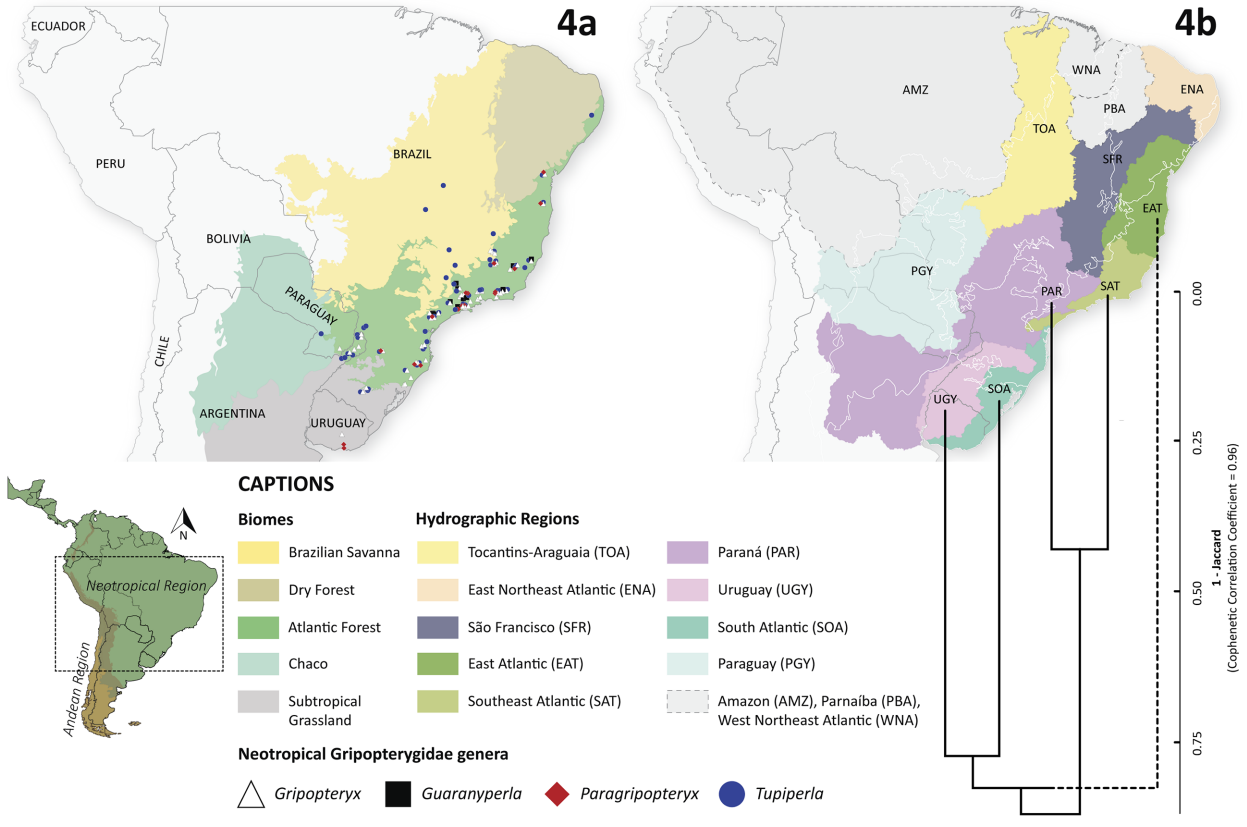

Figure 4. Distribution of Neotropical gripopterygid genera across Biomes (4a) and species clustering based on Hydrographic Regions (4b).

regions stand out with the highest number of recorded species, reporting 35 and 31 species, respectively. In the Paraná region, 20% of gripopterygids are endemic, while the Southeast Atlantic region boasts 19.4% endemic species. These two regions share 24 species in common. The Paraguay region, which hosts two recorded species, exhibits 50% endemism. The Tocantins-Araguaia region, housing two recorded species of *Tupiperla*, exhibits 100% endemism.

When evaluating the affinity of the Gripopterygidae fauna between hydrographic regions using cluster analysis, we disregarded those regions with less sampling effort and fewer species (less than 6 species). Our analysis revealed that the fauna from Paraná and Southeast Atlantic regions, which are the best sampled, exhibited the highest affinity at approximately 60% (Fig. 4b). The fauna from Uruguay and South Atlantic showed an affinity of approximately 25%. In addition, this cluster (Uruguay + South Atlantic) shared an affinity of approximately 20% with the East Atlantic fauna (Fig. 4b).

The Mantel test indicated that geographic distance is not correlated with Gripopterygidae faunal dissimilarity ($r = 0.14$; $p = 0.43$ns for 999 permutations). Among the hydrographic regions not considered in these analyses, the East Northeast Atlantic had one recorded species, São Francisco had five species, Tocantins-Araguaia had two species, and Paraguay had two species. We highlight that the two species recorded in Tocantins-Araguaia do not occur in any other basin.

The species richness estimators, Chao2, Jack1, and Jack2, highlight a significant gap in our knowledge of gripopterygids. Chao2 yields the most conservative estimate, suggesting the potential existence of 78 Neotropical species, indicating an additional 16 species beyond current documentation. In contrast, Jack1 and Jack2 offer slightly higher estimates, suggesting 88 and 95 species, respectively, which could mean 26 to 33 additional species yet to be documented. Fig. 5 presents the cumulative number of documented Gripopterygidae species in the Neotropical Region over the years.

Type-specimens, sex-based descriptions, and knowledge about larvae

Currently, 50 out of 62 Gripopterygidae type-specimens (80.6%) are curated in Brazilian institutions. Of these, 47 specimens are housed at MZSP in São Paulo State. The remaining type-specimens in Brazil are held at UFVB in Minas Gerais State (specifically, *Gripopteryx caparao* Gonçalves, Novaes & Salles), DZRJ in Rio de Janeiro State (specifically, *Tupiperla barbosai* Avelino-Capistrano & Nessimian), and DZUP in Paraná State (specifically, *Tupiperla claudius* Varella & Pinto). These four collections also contain numerous additional specimens from various species recorded in South America.

The remaining type-specimens are curated in the following institutions: one specimen at UdelaR, Uruguay (*Paragripopteryx munoai*), six specimens in Europe (Austria: NHMW, including *Gripopteryx reticulata* and *Tupiperla tessellata* (Brauer); Germany: MLUH, *Tupiperla gracilis*; SMNS, *Gripopteryx elisae* and *Gripopteryx serrei*; Switzerland: MHNG, *Gripopteryx cancellata*), and two specimens in the USA (NMNH, *Tupiperla flinti* and *Tupiperla misionera*). The type-specimen of *Paragripopteryx crassila*, previously synonymized with *Paragripopteryx klapaleki*, is located at the California Academy of Science in the USA (Duarte et al. 2022). Three type-specimens, namely *Paragripopteryx baratinii*, *Gripopteryx brasiliensis*, and *Gripopteryx maculosa* Jewett, are currently considered lost. The first was previously held in the UdelaR collection, while the second was part of the P. Kempny collection, but their current whereabouts remain unknown.

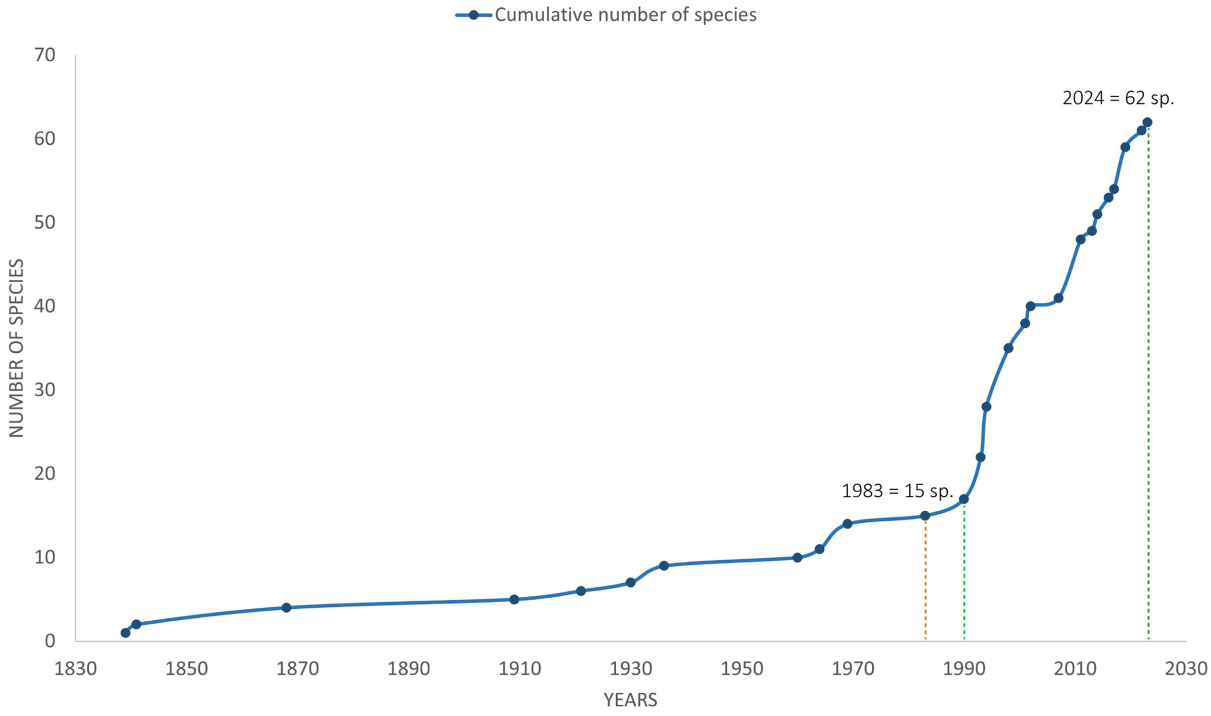

Figure 5. Cumulative number of Gripopterygidae species described in the Neotropical Region from 1839 to 2024.

Tragically, the third type-specimen, *Gripopteryx maculosa*, was lost in a fire incident at MNRJ in 2018.

Among the 62 gripopterygids recorded in the Neotropical Region, a significant 96.8% have had their males described. This proportion decreases to 77.4% for male + females and 35.5% for adult + larvae/exuviae, as detailed in Table III. Regarding genera, *Guaranyperla* stands out with the highest percentage of described larvae, representing 66.7% of its species (larvae of two out of three species are known). *Gripopteryx* follows closely, with descriptions available for 11 out of 18 species (61.1%). *Paragripopteryx*, with 15 species, has eight known larvae (53.3%). Finally, *Tupiperla* has the least information available, with 26 species and only one described larva (3.8%).

DISCUSSION

Examining Gripopterygidae species distribution has proven invaluable in revealing their geographical range and unique distribution patterns. This examination has highlighted the necessity for continual research and monitoring, exposing new species records and distribution variations. Historically, inadequate research investment in certain regions of South American countries has resulted in a limited number of documented species (Froehlich 2011). In Brazil, for example, a concentration of species in the Southeast and South administrative regions, particularly in states like São Paulo and Santa Catarina, not only underscores the importance of these areas in terms of diversity but also reflects the greater sampling effort in these regions. Conversely, the scarcity of recorded species in regions such as the Northeast and Center-West administrative regions raises questions about why these areas remain devoid of recorded species, indicating the need for more extensive surveys in these regions.

The high level of endemism among Gripopterygidae species within the Atlantic Forest biome, where 77% of species are unique,

emphasizes the critical importance of conserving this biome to protect these insect populations. Most Neotropical gripopterygids are documented in Atlantic Forest areas across the southeastern and southern states of Brazil, extending into northeastern Argentina and southern Paraguay. These records are closely associated with the Paraná and Southeast Atlantic hydrographic regions, recognized for their significant levels of endemism. Additionally, the presence of 24 common species contributes to a high pairwise similarity among them (Fig. 4b).

An important observation when studying the Gripopterygidae fauna of the Neotropical Region is that the majority of the species, as shown in Figure 1, are concentrated along the coastal areas of Serra do Mar, Serra da Mantiqueira, and Serra Geral. These regions are home to numerous national and state parks, collectively forming a crucial biodiversity corridor that supports both identified species and those yet to be discovered. Understanding the historical distribution of the Gripopterygidae family in the Neotropical Region involves not only collecting efforts but also comprehending significant geological and climatic events that have shaped South American landscapes and hydrology. In this context, phylogenetic studies are essential to understand the role of these events in the diversification and distribution of the family in the Neotropical Region.

Hermann Burmeister described the first Gripopterygidae species from the Neotropical Region in 1839. Following this initial discovery, it took 150 years (1839-1989) for only 15 species of this family to be identified in the region (Fig. 5). However, starting in 1990, the pace of species descriptions accelerated significantly, with 47 new species being described in just over 30 years. Despite these advances, species richness estimators reveal significant gaps in our knowledge, suggesting that only 64% to 78% of the actual species diversity has been documented. It is important to highlight that, as the sample is not homogeneous between the hydrographic regions, there might be bias in our estimates. Nevertheless, our results indicate that a significant effort will still be necessary to obtain a more comprehensive understanding of Gripopterygidae species diversity in the Neotropical Region. Further collection efforts, especially in unexplored regions, are essential to reveal the true extent of species diversity.

Taxonomic studies within the Gripopterygidae family, and Plecoptera in general, have predominantly focused on examining adult male genital characters such as T10, paraprocts, epiproct, and subgenital plate. In contrast, females and larvae have received significantly less attention. Until the mid-20th century, only nine species of Gripopterygidae were known in the analyzed region of South America, with five of these described based on females: *Gripopteryx brasiliensis*, *Gripopteryx garbei*, *Gripopteryx pardina* Navás, *Gripopteryx serrei*, and *Tupiperla tessellata*. During that period, researchers attempted equal treatment of both sexes, with some designating females as holotypes (Brauer 1866, Šámal 1921, Navás 1930, Navás 1936). However, contemporary trends now primarily focus on describing females in association with males or when they significantly differ from closely related species, as noted by Froehlich (2001) in the case of *Guaranyperla*. One likely reason for this shift in taxonomic focus was the substantial increase in species descriptions from the second half of the 20th century onward. This surge necessitated a significant change in taxonomy approaches within the group, leading to the predominant selection of males as the designated holotype.

The shift towards male-centric descriptions in Gripopterygidae can be attributed to the fact that males often exhibit multiple distinct genital

structures that are highly effective in species differentiation. In contrast, examining female genital traits can pose technical challenges, especially in genera where differentiation is complex. As a result, the identification and classification of Gripopterygidae have heavily relied on studying male genitalia. This emphasis has led to a substantial predominance of described males and a significant number of unassociated female specimens within the family.

Knowledge about Neotropical gripopterygid larvae is limited, reflecting the Haeckelian shortfall in biodiversity (Faria et al. 2020). Among the four Neotropical genera, *Guaranyperla* stands out with the highest percentage of known larvae, encompassing three species with two described larvae. *Gripopteryx* and *Paragripopteryx* also have well-documented larval stages, with descriptions available for 11 and eight larvae, respectively. In contrast, *Tupiperla*, the most diverse South American genus of Gripopterygidae with 26 species, has the least information available, with only one larva described by Froehlich (1969). However, ongoing debate persists regarding the species to which this uniquely described larva belongs.

In his study, Froehlich (1969) attributed the larva to *Tupiperla gracilis*, considering the genus monotypic at that time. However, in his revision of *Tupiperla* (Froehlich 1998, p. 33), he stated for *Tupiperla* sp. D, 'The nymph figured in Froehlich (1969, fig. 34) does not belong to *Tupiperla gracilis* and neither to *Tupiperla illiesi* Froehlich, the more common species in the locality, and may belong to this species.' *Tupiperla* sp. D was previously grouped with *Tupiperla gracilis* and *Tupiperla illiesi* from the Biological Station at Paranapiacaba, São Paulo, Brazil (Froehlich 1969). Recently, specimens of *Tupiperla gracilis* were collected in the municipality of Assis, São Paulo State, by the team headed by the third author (PCB). The analysis of this collected material, including adults and larvae, holds the potential to shed further light on this taxonomic issue.

The current research on Gripopterygidae larvae across different genera reveals a significant disparity, emphasizing the urgent need for innovative strategies to fill these knowledge gaps. Despite advances in understanding adult morphology over the past two decades, a critical concern remains: approximately 64% of Neotropical species lack information on their early life stages. This Haeckelian shortfall goes beyond taxonomic gaps, indicating a fundamental lack of knowledge about larval development in these insects. Understanding larval stages is crucial for insights into their evolutionary history, ecology, and can enhance taxonomic diagnoses at the genus level.

Focusing on the often-neglected aspects of Gripopterygidae species can unlock important information for taxonomy, evolutionary biology, ecological understanding, and conservation efforts. Despite the historical emphasis on males and the challenges in studying females and larvae, a comprehensive study of their morphological characters, including genitalia, provides several advantages: 1) species identification and classification: morphological characters of females and larvae can help distinguish closely related species, especially when males are cryptic; 2) taxonomic clarification: deeper understanding of female and larval morphology may reveal overlooked species or correct misclassifications, refining the family's classification system; 3) phylogenetic studies: detailed examinations of female and larval characteristics provide additional data for phylogenetic analyses; 4) ecological insights: insights into female and larval traits can reveal adaptations, reproductive-related behaviors, habitat preferences, and other ecological

aspects, enhancing understanding of their roles ecosystems; and 5) conservation: a better understanding of female and larval morphology is essential for identifying and protecting threatened or endangered species, as accurate species identification is the foundation of effective conservation strategies. By prioritizing these aspects of Gripopterygidae species, we can advance our knowledge across multiple disciplines, thereby contributing to broader scientific understanding and conservation efforts.

Acknowledgments

The authors thank Dr. Fernando Silveira† who kindly provided the material of Gripopterygidae from UFMG, Belo Horizonte/MG. The authors also thank the invaluable assistance of Dr. Luis Carlos de Pinho (FAPESC 11323/2012–9 and grant from the PIBIC program), who not only provided support in Florianópolis/SC but also generously donated the material of Gripopteryx elisae. The authors thank Drs. Arnold Staniczek and Milan Pallmann of Germany's Stuttgart State Museum of Natural History for providing photographs of Gripopteryx elisae type material. The fieldwork in southern Brazil was facilitated by the support of Drs. Victor A. Gomes and Carla Floriano, to whom we extend our sincere thanks. Lastly, we are grateful to Drs. Pablo Pessacq, Albane Vilarino, and Rogério Campos for their valuable insights and contributions that significantly enhanced the presentation of the results in this study. Unfortunately, Professor Claudio G. Froehlich (second author) passed away on November 27, 2023 (age 96) while we were finalizing this manuscript. He actively participated in both the conception of this work, which began in 2018, and the revisions, the first of which was in July 2019 and the last in October 2023. Unfortunately, he passed away before the manuscript was submitted. Professor C. G. Froehlich had a prolific career and trained numerous researchers in the taxonomy and ecology of aquatic insects. He alone described a substantial percentage of the recorded Plecoptera diversity in Brazil. Regarding the Neotropical Gripopterygidae, among the current 62 species, 31 were described by him as a single author or as a co-author. This paper is a posthumous tribute to our generous friend and professor C. G. Froehlich, who trained several generations of entomologists and who made valuable contributions to the knowledge about the diversity of Neotropical aquatic insects. Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, grants 2015/11580-3 and 2016/22213-4 for TD; and grants 2019/22833-0 and BIOTA 2021/05986-8 for PCB) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, grants 306400/2022-7 and PROTAX 441119/2020-4 for PCB) provided partial financial support for this study. TD had Postdoctoral Fellowships of the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina (RESOL-2022-788-APN-DIR#CONICET). The authors declare no conflict of interest.

REFERENCES

AVELINO-CAPISTRANO FS & NESSIMIAN JL. 2013. A new species and new records of Gripopterygidae (Plecoptera) from the Serra dos Órgãos, Rio de Janeiro State, Brazil. Zootaxa 3683: 185-191. http://dx.doi.org/10.11646/zootaxa.3683.2.7.

AVELINO-CAPISTRANO FS & NESSIMIAN JL. 2014. Novos registros da fauna de Plecoptera (Insecta) para o Estado do Espírito Santo, Brasil. Bol Mus Biol Mello Leitão, Nova Sér 33: 5-18.

BAHIA 2010. Relatório técnico: caracterização da Estação Ecológica Estadual Wenceslau Guimarães. Governo do Estado da Bahia, Secretaria do Meio Ambiente, Salvador, 140 p.

BENEDETTO L. 1969. A new species of stonefly of the family Gripopterygidae (Plecoptera) from Uruguay. Beitr Neotrop Fauna 6: 145-151. http://dx.doi.org/10.1080/01650526909360424.

BENEDETTO L. 1983. Plecopteros del Uruguay I: *Paragripopteryx baratinii* n. sp. Stud Neotrop Fauna Environ 18: 19-23.

BÉTHOUX O. 2005. Wing venation pattern of Plecoptera (Insecta: Neoptera). Illiesia 1: 52-81.

BISPO PC & FROEHLICH CG. 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: 213-217. http://dx.doi.org/10.1080/01650420701411184.

BISPO PC & LECCI LS. 2011. Gripopterygidae (Plecoptera) from Paranapiacaba mountains, southeastern Brazil. Ann Limnol - Int J Limnol 47: 373-385. http://dx.doi.org/10.1051/limn/2011052.

BRAUER F. 1866. Familie Perlidae. In: Neuropteren. Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorf-Urbair. Aus der

Kaiserlich-Königlichen Hof- und Staatsdruckerei in Commission bei K. Gerold's Sohn, Vienna. Zoologischer Theil 2, Band (1: A) 4: 51-52.

BURMEISTER H. 1839. Handbuch der Entomologie. Plecoptera. 2: 863-881.

CALOR AR & MARIANO R. 2012. UV Light Pan traps for Collecting Aquatic Insects. EntomoBrasilis 5(2): 164-166. https://doi.org/10.12741/ebrasilis.v5i2.187.

CASTILLO-VELÁSQUEZ RM, GONÇALVES MC & SALLES FF. 2024. Diversity and Ecological Distribution of Plecoptera of Minas Gerais, Brazil. Neotrop Entomol 1-13. https://doi.org/10.1007/s13744-024-01177-y.

DEWALT RE, HOPKINS H, NEU-BECKER U & STUEBER G. 2024. Plecoptera Species File. https://plecoptera.speciesfile.org. Accessed August 30, 2023.

DRAY S & DUFOUR A. 2007. The ade4 Package: Implementing the Duality Diagram for Ecologists. J Stat Softw 22(4): 1-20. https://doi.org/10.18637/jss.v022.i04.

DUARTE T, CALOR AR & BISPO PC. 2022. Systematic revision and phylogeny of *Paragripopteryx* Enderlein, 1909 (Plecoptera: Gripopterygidae). PLoS ONE 17(3): e0264264. https://doi.org/10.1371/journal.pone.0264264.

DUARTE T, LECCI LS & CALOR AR. 2014a. Stoneflies (Insecta: Plecoptera) from Serra Bonita, Bahia, Brazil: new species and updated records for Northeastern. Zootaxa 3779: 081-092. http://dx.doi.org/10.11646/zootaxa.3779.1.9.

DUARTE T, BISPO PC & CALOR AR. 2014b. A new species of *Tupiperla* Froehlich, 1969 (Plecoptera: Gripopterygidae) from the Serra da Jibóia, Bahia, Brazil. Zootaxa 3835: 140-144. http://dx.doi.org/10.11646/zootaxa.3835.1.9.

DUARTE T, NOVAES MC & BISPO PC. 2019. Five new species of *Tupiperla* Froehlich, 1969 (Plecoptera: Gripopterygidae). Zootaxa 4671(4): 511-526. https://doi.org/10.11646/zootaxa.4671.4.3.

ENDERLEIN G. 1909. Klassification der Plecopteren sowie Diagnosen neuer Gattungen und Arten. Zool Anz 34: 385-419.

FARIA LRR, PIE MR, SALLES FF & SOARES EDG. 2020. The Haeckelian shortfall or the tale of the missing semaphoronts. J Zool Syst Evol Res 59: 359-369. https://doi.org/10.1111/jzs.12435.

FROEHLICH CG. 1969. Studies on Brazilian Plecoptera 1. Some Gripopterygidae from the Biological Station at Paranapiacaba, State of São Paulo. Stud Neotrop Fauna Environ 6: 17-39. http://dx.doi.org/10.1080/01650526909360412.

FROEHLICH CG. 1990. Brazilian Plecoptera 6. *Gripopteryx* from Campos do Jordão, State of São Paulo (Gripopterygidae). Stud Neotrop Fauna Environ 25(4): 235-247. http://dx.doi.org/10.1080/01650529009360823.

FROEHLICH CG. 1993. Brazilian Plecoptera 7. Old and new species of *Gripopteryx* (Gripopterygidae). Aquat Insects 15(1): 21-38. http://dx.doi.org/10.1080/01650429309361496.

FROEHLICH CG. 1994. Brazilian Plecoptera 8. On *Paragripopteryx* (Gripopterygidae). Aquat Insects 16: 227-239. http://dx.doi.org/10.1080/01650429409361559.

FROEHLICH CG. 1998. Seven new species of *Tupiperla* (Plecoptera: Gripopterygidae) from Brazil, with a revision of the genus. Stud Neotrop Fauna Environ 33: 19-36. http://dx.doi.org/10.1076/snfe.33.1.19.2170.

FROEHLICH CG. 2001. *Guaranyperla*, a new genus in the Gripopterygidae (Plecoptera). In: Domínguez E (Ed), Trends in Research in Ephemeroptera and Plecoptera, Kluwer Academic/Plenum Publisher, New York, p. 377-383.

FROEHLICH CG. 2002. Two New Species of *Tupiperla* (Plecoptera: Gripopterygidae) from the Missions Area of Argentina and Paraguay. Aquat Insects 24: 37-40. http://dx.doi.org/10.1076/aqin.24.1.37.4906.

FROEHLICH CG. 2010. Catalogue of Neotropical Plecoptera. Illiesia 6: 118-205.

FROEHLICH CG. 2015. Taxonomic notes on *Guaranyperla* (Plecoptera: Gripopterygidae). Illiesia 11(14): 175-178. http://illiesia.speciesfile.org/papers/Illiesia11-14.pdf.

FROEHLICH CG. 2016. *Tupiperla* (Plecoptera: Gripopterygidae) from southwestern Minas Gerais State, Brazil, with the description of *Tupiperla amorimi* n. sp. Zootaxa 4103(2): 174-176. http://doi.org/10.11646/zootaxa.4103.2.7.

GONÇALVES MC, NOVAES MC & SALLES FF. 2017. Studies on Gripopterygidae (Plecoptera) from Espírito Santo State, Brazil. Zootaxa 4291: 563-571. https://doi.org/10.11646/zootaxa.4291.3.8.

ILLIES J. 1963. Revision der südamerikanischen Gripopterygidae (Plecoptera). Mitt Schweiz Entomol Ges 36: 145-248.

ILLIES J. 1964. Neue Plecopteren aus Südamerika. Gewässer und Abwässer 36: 49-57.

JEWETT SG. 1959. Some stoneflies from Santa Catarina, Brazil (Plecoptera). Am Midl Nat 61: 148-161. http://dx.doi.org/10.2307/2422347.

JEWETT S. 1960. Notes and descriptions concerning Brazilian stoneflies. Arch Mus Nac (Rio de J) 50: 167-184.

LECCI LS, DUARTE T & CALOR AR. 2014. Plecoptera do Semiárido: conhecimento atual e desafios. In: Bravo F & Calor AR (Eds), Artrópodes do Semiárido: Biodiversidade e Conservação. 1th Edition. Printmídia, Feira de Santana, p. 91-98.

LECCI LS & FROEHLICH CG. 2011. Taxonomic revision of *Gripopteryx* (Pictet, 1841) (Plecoptera: Gripopterygidae). Zootaxa 2792: 1-21.

LEGENDRE P & LEGENDRE L. 2012. Numerical ecology. Elsevier Science, Amsterdam, The Netherlands.

MAGURRAN AE. 2004. Measuring Biological Diversity. Blackwell Publishing, Oxford, UK.

MALAISE R. 1937. A new insect trap. Entomol Tidskr 58: 148-160.

MANZO V, ROMERO F, RUEDA MARTIN P, MOLINERI C, NIETO C, RODRIGUEZ J & DOMINGUEZ E. 2014. Insectos acuáticos del Parque Provincial Urugua-í, Misiones, Argentina. Rev Soc Entomol Arg 73(3-4): 155-170.

MORRONE JJ. 2014. Biogeographical regionalisation of the Neotropical region. Zootaxa 3782(1): 001-110.

MORRONE JJ. 2015. Biogeographical regionalisation of the Andean region. Zootaxa 3936(2): 207-236. http://dx.doi.org/10.11646/zootaxa.3936.2.3.

NAVÁS L. 1916. Familia Pérlidos. In: Neurópteros sudamericanos. 3.a Serie. Brotéria (Série Zoológica) 14: 26-28.

NAVÁS L. 1927. Plecópteros. In: Veinticinco formas nuevas de insectos. Bol Soc Ibér Ci Nat 26: 64-69.

NAVÁS L. 1930. Plecópteros. In: Insectos del Museo de Paris. Brotéria - Série Zoológica 24: 14.

NAVÁS L. 1932. Plecópteros. In: Insectos suramericanos. 5.a Serie. Revista Real Acad Ci Madrid 29: 58-63.

NAVÁS L. 1936. Plecópteros. In: Insectos del Brasil. 5a. Serie. Rev Mus Paul 20: 726-732.

NESSIMIAN JL, AVELINO-CAPISTRANO F, CORREIA BL & COSTA JM. 2009. Espécies de Plecoptera (Insecta) registradas no Estado do Rio de Janeiro, Brasil. Arch Mus Nac (Rio de J) 67(3-4): 313-319.

NOVAES MC & BISPO PC. 2014. Plecoptera from Minas Gerais State, southeastern Brazil. Zootaxa 3856(3): 433-442. https://doi.org/10.11646/zootaxa.3856.3.8.

NOVAES MC & BISPO PC. 2016. A New species and records of Gripopterygidae (Plecoptera) from Rio Grande do Sul State, Southern Brazil. Zootaxa 4175(5): 487-490. http://doi.org/10.11646/zootaxa.4175.5.7.

OKSANEN J ET AL. 2022. vegan: Community Ecology Package. R package version 2.6-4, <https://CRAN.R-project.org/package=vegan>.

PESSACQ P, ZUÑIGA MDC & DUARTE T. 2019. An updated checklist of Neotropical Plecoptera. Zoosymposia 16: 182-209.

PICTET FJ. 1841. Histoire Naturelle Générale et Particulière des Insectes Névroptères. Famille des Perlides. Geneva, Kessmann. https://doi.org/10.5962/bhl.title.124172.

QGIS DEVELOPMENT TEAM. 2022. QGIS geographic information system. Open-Source Geospatial Foundation Project. https://qgis.osgeo.org.

R CORE TEAM. 2023. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

ROMERO F. 2017. Estado del conocimiento del orden Plecoptera en la provincial de Misiones, Argentina. Acta Zool Lilloana 61(1): 42-54.

ŠÁMAL J. 1921. Plécoptères sud-américains nouveaux. Bull Ann Soc r belge Ent 61: 109-112.

SHORTHOUSE DP. 2010. SimpleMappr, an online tool to produce publication-quality point maps. https://www.simplemappr.net. Accessed May 26, 2022.

VANZOLINI PE & PAPAVERO N. 1967. Manual de coleta e preparação de animais terrestres e de água doce. Secretaria de Agricultura do Estado de São Paulo, São Paulo, Brazil.

VARELLA RC & PINTO AP. 2023. 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. Rev Bras Entomol 67(spe): e20230072. https://doi.org/10.1590/1806-9665-RBENT-2023-0072.

ZWICK P. 1984. Notes on Plecoptera (12). *Gripopteryx serrei* Navás. Aquat Insects 6(3): 148. http://dx.doi.org/10.1080/01650428409361177.

How to cite
DUARTE T, FROEHLICH CG & BISPO PC. 2024. Neotropical species of gripopterygid stoneflies (Plecoptera: Gripopterygidae). An Acad Bras Cienc 96: e20231362. DOI 10.1590/0001-3765202420231362.

Manuscript received on January 3, 2024;
accepted for publication on July 28, 2024

TÁCIO DUARTE[1]
https://orcid.org/0000-0002-4150-3857

CLAUDIO G. FROEHLICH[2]
https://orcid.org/0000-0002-2217-3098

PITÁGORAS C. BISPO[3]
https://orcid.org/0000-0002-7356-8882

[1]Universidad Nacional de la Patagonia, Centro de Investigación Esquel de Montaña y Estepa Patagónica (CIEMEP), 780 Gral. Roca Street, Esquel, CB 9200, Argentina

[2]Universidade de São Paulo, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Ribeirão Preto, 3900 Bandeirantes Avenue, Vila Monte Alegre, 14040-900 Ribeirão Preto, SP, Brazil

[3]Universidade Estadual Paulista, Faculdade de Ciências e Letras de Assis, Laboratório de Biologia Aquática, 2100 Dom Antônio Avenue, Parque Universitário, 19806-900 Assis, SP, Brazil

Correspondence to: **Tácio Duarte**
E-mail: tacioduarte@alumni.usp.br

Author contributions

All authors contributed to the study conception and design. All authors performed species sampling and material preparation. TD wrote the first draft of the manuscript, and all authors commented on previous versions of the manuscript. PCB conducted the analyses of species richness and clustering of hydrographic regions. All authors read and approved the final manuscript.