ABSTRACT. This study provides a comprehensive checklist of Odonata species from the protected area of Mananciais da Serra. The survey was conducted in the endangered Atlantic Forest domain at the southern Serra do Mar mountain chain within a well-preserved area in the municipality of Piraquara, state of Paraná, Brazil. Adults and larvae were sampled between June 2017 and March 2020 using different techniques in numerous mesohabitats, including phytotelmata, pools, small streams, and large reservoirs. A total of 1,708 specimens from 9 families, 43 genera and 84 species were sampled resulting in 53 new records for the state of Paraná, almost doubling the known occurrence records for dragonflies and damselflies in that state. Furthermore, two hitherto undescribed females from the genera Planiplax and Heteragrion, four ultimate stadium larvae from Planiplax, Neocordulia, Heteragrion, and Acanthagrion, and five undescribed species were detected, one each from the genera Heteragrion, Progomphus, Brechmorhoga, Erythrodiplax, and Dasythemis. The estimated richness of odonates in this area is greater than 100 species, while the observed richness corresponding to almost 10% of all Odonata species in Brazil, the species-richest country in the world. These results reiterate the need to investigate undersampled areas to improve knowledge on diversity, taxonomy, and distribution of neotropical species. Finally, taxonomic notes for some species, including the rare corduliid Neocordulia mambucabensis Costa & T.C. Santos, 2000, are provided.

KEY WORDS. Anisoptera, conservation, damselfly, inventory, systematics, Zygoptera.
domain is approximately 12%, and these remnants are spread in hundreds of thousands of fragments, most of them smaller than 50 ha (Ribeiro et al. 2009). The three largest fragments are in the Serra do Mar, from the states of Santa Catarina at the southern end to Rio de Janeiro in the north, encompassing 13% of the total preserved remnants of Atlantic Forest (Ribeiro et al. 2009).

The Atlantic Forest is the most important component of the natural landscape of Paraná’s territory, originally covering 98.1% of its total area (see Campanini and Schaffer 2010). Today, this coverage is 13.1% (SOS Mata Atlântica 2018). The Paraná’s Atlantic Forest has four main vegetational formations: grassland, Tropical Atlantic Forest, Semideciduous Seasonal Forest, and the Araucaria Forest (Roderjan et al. 2002) and encompasses the Araucaria, Interior and Serra do Mar biogeographical sub-regions (sensu Silva and Casteletti 2003). The transition between the Araucaria and Serra do Mar biogeographical sub-regions corresponds to the same transition between the Araucaria Forest and Tropical Atlantic Forest formations at the Serra do Mar mountain chain (see Ribeiro et al. 2009).

Dragonflies and damselflies (Odonata) remain as aquatic larvae during most of their post-embryonic life. They are essential components of aquatic communities, responsible for several ecosystem services, keeping the structure and the cycling of nutrients, and are bioindicators of environmental quality (e.g. Oertli 2008, Silva et al. 2010). Brazil has the richest assemblage of these insects (Pinto and Kompier 2018) with more than 900 species (Pinto 2020), and it is estimated that there are many species not yet described (Souza et al. 2017). The Odonata richness of the Atlantic Forest has been estimated to represent 50% of all Brazilian species of the order (Pinto and Kompier 2018). A single site in the Serra dos Orgãos formation is the worldwide hotspot with more than 200 species (Kompier 2015).

Studies focusing on the diversity of odonates in southern Brazil started at least half of a century ago (e.g. Costa 1971, Teixeira 1971), region that includes the type localities of several species – e.g. the Libellulidae Libellula hercula Karsch, 1889 and the Gomphidae Progomphus virginiace Belle, 1973 (Karsch 1889, Belle 1973). Notwithstanding, the region lacks compilations of distributional records at the species level, as well as regional inventories with comprehensive checklists. Efforts to understand the diversity of odonates in southern Brazil have dramatically increased in the last decade, at least for Pampean and Atlantic Forest formations in the state of Rio Grande do Sul (e.g. Renner et al. 2016, 2017, Dalzochio et al. 2018, Pires et al. 2019). However, knowledge about Odonata of Paraná is still meager. For example, Vianna and De Marco (2012) found a maximum of approximately 20 species in a single assemblage recorded within a quadrate area 1-degree cell in size, based on a review of the historical records and a few specimens deposited in collections.

The studied area at Piraquara municipality belongs to the Metropolitan Region of Curitiba, region that has been visited by scientists at least since 1896 when B. Bicego collected the holotype of the millipede Leptodesmus decipiens Brölemann, 1902 (Schubart 1955), now in the genus Brasilodesmus Brölemann, 1929 (Pena-Barbosa 2020). The municipality houses one of the significant remnants of Atlantic Forest near the state capital Curitiba, in the Serra do Mar mountain chain (Reginato and Goldenberg 2007). This municipality includes the region of “Mananciais da Serra” (MASE), a conservation area of high biological importance (Rosa 2007). This is a direct consequence of its particular scientific interest, and the locality has been the subject of several surveys, such as faunistic and floristic inventories (Cáceres 2004, Reginato and Goldenberg 2007, Anjos and Navarro-Silva 2008, Bianchi et al. 2012). It is the type-locality for many species of insects (e.g. Dalmolin et al. 2004, Paladini and Cavichioli 2015), and a sanctuary for threatened or rare mammalian species (Cáceres 2004). In addition, it represents a well-preserved ecotone between Araucaria and Tropical Atlantic Forests due to more than 100 years of conservation policies in that area (Reginato and Goldenberg 2007). The natural and artificial water bodies of MASE favor the existence of a wide variety of mesohabitats, which potentially maintain a high diversity of dragonflies.

The goal of this study is to provide a comprehensive checklist of damselflies and dragonflies from the region of Mananciais da Serra, southern Atlantic Forest. In addition, the compositional diversity (alpha component) is addressed, and new state records and taxonomic notes including the rare Corduliidae s.l. Neocordulia mambucabensis Costa & T.C. Santos, 2000 are given.

MATERIAL AND METHODS

This study was conducted in an ecotone between the Araucaria Forest and Tropical Atlantic Forest (Reginato and Goldenberg 2007) in a fragment of Atlantic Forest in the Serra do Mar mountain chain, maintained by the water and waste management company of the state of Paraná (SANEPAR). This area includes the “Mananciais da Serra” (MASE) and the drainage system of the reservoirs Piraquara I and Piraquara II, in the municipality of Piraquara, Paraná, Brazil (Figs 1–3).

Historically, the protected area “Mananciais da Serra” emerged with the creation of the first public water supply system of Curitiba, capital of the state of Paraná, in 1908 (see Cordeiro 2008). Today, the Mananciais da Serra protected area shelters the historical heritage of the supply system that was replaced by two subsequent reservoirs resulting from the damming of the Piraquara River, the main river of the Piraquara sub-basin (SUDERHSA 2000). The area name, the so-called Mananciais da Serra, refers to the water supply system of the Piraquara sub-basin and the forested area in the watershed, that is partially protected by Pico do Marumbi State Park (Paraná State government Decrees #7300, 1990 and #1531, 2007) and Environmental State Protection Area of Piraquara (Paraná State government Decree # 1754, 1996).

For this survey we considered the vegetal formation separated into two areas: the Tropical Atlantic Forest area (TF), corresponding to the MASE area (Fig. 3, Table 1, sampling sites 10–23), and the Araucaria Forest area (AF), corresponding to the
sites outside of the MASE delimitation (Fig. 3, Table 1, sampling sites 1–9). The AF sampling sites were on the banks of reservoirs Piraquara I and II, composed of mostly lentic systems in an open landscape and perturbed sites, and partially riparian forest and some small forested areas around the reservoirs including some lotic or forested sampling sites. In contrast, most TF sampling sites were forested areas and running waters, with a few exceptions of lentic and semi-lentic habitats such as the “Natural pool” (Fig. 7, Table 1, sampling site 16).

Multiple water body types were investigated, including puddles, pools, tanks, dams and streams (Figs 4–9). The adults were collected between June 2017 and March 2020 using three methods: (1) a malaise trap in the field for 144 non-continuous days (from November 2018 to March 2020); (2) 60 active collection events using aerial entomological nets; and (3) occasional sampling of larvae using sieves. A total of 23 sampling sites were investigated (Figs 1–3). Coordinates and mesohabitats are presented in Table 1. Live specimens were photographed in the field or in a portable studio over a white background.

The specimens were identified at species level with the aid of stereomicroscopes and compared to original descriptions and specimens previously identified by specialists. Species of dubious status due to insufficient taxonomic information (e.g. Limnetron Förster, 1907), specimens in poor condition (e.g. in Brechmorhoga Kirby, 1894), or genera with putative undescribed species (e.g. Heteragrion Selys, 1862) are cited as sp., but when possible through examination they were recognized as distinct entities. The specimens were dried in absolute acetone and deposited in the Ento-
Figures 4–9. Mesohabitats of the sampling sites of Odonata in the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil: (4) Piraquara II reservoir banks; (5) Piraquara II reservoir with macrophytes; (6) Rio Ipiranguinha river; (7) Natural pool; (8) streamlet with semi-lotic water at Aqueduto site; (9) Cayguava catchment reservoir of the old Piraquara supply system. Photos: (4–7, 9) BRA; (8) APP; all in 2019.
Table 1. Sampling sites, coordinates and mesohabitats description for Odonata at the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil. Catchments refers to small dams of the old water supply system.

| Collection site | Coordinates | Mesohabitats |
|-----------------|-------------|-------------|
| 1. RPIV. Piraquara II reservoir bank | -25.509284° -49.038360° | Composite site, predominantly lentic, banks lacking macrophytes, riparian area with grassland; lotic system composed by small second order stream from the grassland flowing into the reservoir |
| 2. RPII. Piraquara II reservoir bank | -25.507368° -49.031490° | Lentic with abundant macrophytes and forested riparian area |
| 3. RPIII. Piraquara II reservoir bank | -25.510484° -49.032375° | Composite site, predominantly lentic, partially inhabited for macrophytes, banks lacking macrophytes; semi-lotic spots formed by small tributaries of Rio Piraquara river throughout the site |
| 4. Piraquara II reservoir adjacent area | -25.510865° -49.029077° | Lentic, pool linked to Piraquara II reservoir covered with macrophytes and riparian forested area composed by exotic Pinus spp. |
| 5. RPI. Piraquara II reservoir bank | -25.509353° -49.027647° | Lentic, with abundant macrophytes of many species; riparian area composed by open grass field and forest with semi-lotic channels near reservoir |
| 6. RPII. Piraquara II reservoir bank | -25.512844° -49.025808° | Composite site, lentic spot composed by swamps with grasses and many macrophytes species; lotic spot is as fourth order river tributary of the Piraquara II reservoir |
| 7. River II. River with riparian forest | -25.516721° -49.008813° | Lotic, fourth order river with modified riparian forest, shaded with sandy bottom |
| 8. Farm marsh. Flood area near to the dirt road | -25.519690° -49.005925° | Lentic, a shallow swamp with grass vegetation |
| 9. Road. Running water above road | -25.501302° -49.001491° | Lotic, shallow stream over a dirt road |
| 10. Base lodge | -25.492325° -48.994150° | Open field, grass camp at front of the base lodge |
| 11. River I. River in forested area | -25.495550° -48.989764° | Lotic with a well-preserved riparian forest, bottom with rocks, leaf litter and sand |
| 12. Salto catchment. Stream in forested area | -25.502778° -48.985278° | Composite site, lentic spot formed by damming of a stream rock bottom, a partially shaded artificial pool with dense leaf litter bottom |
| 13. Carvalho catchment. Stream in forested area | -25.496389° -48.980000° | Composite site with open and forested areas; lentic spot composed by the largest artificial pool with concrete bottom; lotic system composed by first and second order streams with bottom with abundant leaf litter, sand, and rocks; |
| 14. Braço do Carvalho catchment. Stream in forested area | -25.493333° -48.978333° | Composite site; lentic formed by an artificial pool with concrete bottom with abundant leaf litter and sandy bottom; lotic, a second order forested stream with rocky bottom |
| 15. Stream near to Carambola catchment | -25.487807° -48.975641° | A partially shaded third order stream with a well-preserved riparian forest, large rocks, sand, and leaf litter bottom |
| 16. Natural pool | -25.490625° -48.974656° | Lentic, a sunny natural shallow pool in an opened area with clay bottom, riparian area with native herbaceous-shrub vegetation and few exotic Pinus spp. |
| 17. Mico catchment | -25.488889° -48.976111° | Lotic, a first order stream in an out of order dam, a secondary riparian forest |
| 18. Trail between Braço do Carvalho catchment and Ipiranguinha River | -25.493333° -48.978333° | Composite site; main trail crossing many types of typical lentic to lotic mesohabits, from artificial pools, small rainy pools, phytotelmata (bamboos and bromeliads) to seepages, streams, and rivers; predominantly shaded (forested) with open spots; |
| 19. Aqueduto. Forested area with small streams | -25.486289° -48.974170° | Lotic, first order streams/streamletts with a well-preserved riparian forest; Semi lentic shallow pools in flooded areas |
| 20. Cayguava catchment. Stream in forested area | -25.482792° -48.970836° | Composite site; lotic formed by a second order stream with well-preserved riparian forest, rocky bottom; lentic spot is the artificial pool of the Cayguava catchment with sand and leaf bottom |
| 21. Site F. Flooded forested area | -25.481960° -48.970261° | Lotic and semi-lotic, shallow pools with slow flowing water |
| 22. Iporan catchment. Stream in forested area | -25.480000° -48.968889° | Composite site; lotic is a second order stream with well-preserved riparian forest; rocky bottom; lentic spot is the artificial pool, of the Iporan reservoir catchment with sandy and leaf bottom |
| 23. Ipiranguinha river. River in forested area | -25.475547° -48.961192° | Composite site; lotic is a third order river with well-preserved riparian forest, rocky bottom; lentic correspond to the artificial pool of the Ipiranguinha catchment with sandy and leaf bottom |

mological Collection Padre Jesus Santiago Moure, Departamento de Zoologia, Universidade Federal do Paraná, Curitiba (DZUP), and in the Entomological Collection of the Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro (MNRJ).

In order to investigate new occurrence records, the known distributions of each species were compiled from publications in scientific journals, books, catalogs and specialized literature (e.g. original descriptions and revisions), and gray literature such as unpublished monographs, dissertations and thesis, meeting abstracts, websites, or even records lacking voucher material were disregarded. Digital databases (e.g. Web of Science) were regularly checked for update the data on the species occurrence. The full reference list with previous records in the literature was included in the Catalog of the Brazilian Taxonomic Fauna (Pinto 2020).

Alpha diversity was analyzed based on richness and abundance. The rarefaction and extrapolation curves using
an individual-based (abundance) approach were constructed with the software EstimateS (Version 9.1.0, Colwell 2013) with extrapolation up to 15,000 individuals ($S_{\text{est}}$ and SE of Colwell et al. 2012).

RESULTS

Community richness and composition

A total of 1,708 specimens from 9 families, 43 genera and 84 species were collected and identified. The species list, sampling sites, new records of occurrences for the state of Paraná, and specimens reared (adults emerged in the laboratory) are presented in Table 2. The AF area was predominantly lentic, and TF sampling sites were mainly lotic, except for lentic or semi-lentic habitats such as the “Natural pool” (see Table 1, sampling site 16, Fig. 7). The “Natural pool” was the richest site with 25 species (8 exclusives). The richest and more abundant families were Libellulidae and Coenagrionidae (Figs 10, 11). No species with crepuscular behavior was collected. The rarefaction and extrapolation curves with their standard deviation based on the number of individuals (Fig. 12) shows the observed richness resulted in an estimated richness of 69 species for TF (observed 52 spp.) and 106 species for the regional pool (observed 84 spp./sampling effort of 79.24%).

A significant portion of the community, 36 species, had five or fewer specimens collected, from which 20 were single or two specimens.

Table 2. Species list, abundance, and new state records for Odonata at the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil. Sampling sites 1–21 as in Table 1.

| Taxa              | Sampling site | Abundance | Reared larvae | Araucaria Forest | Tropical Atlantic Forest | New state Record |
|-------------------|---------------|-----------|---------------|------------------|--------------------------|------------------|
| Zygoptera         |               |           |               |                  |                          |                  |
| ’Perilestidae’    |               |           |               |                  |                          |                  |
| Perilestes fragilis Hagen in Selys, 1862 | 12, 13, 22 | 24         | x             | x                | x                        |                  |
| Lestidae          |               |           |               |                  |                          |                  |
| Archilestes exoletus (Hagen in Selys, 1862) | 12, 16 | 5          |               | x                |                          |                  |
| Lestes auritus Hagen in Selys, 1862 | 4, 16 | 29         |               |                 |                          |                  |
| L. pictus Hagen in Selys, 1862 | 12, 16 | 6          |               |                 | x                        |                  |
| L. tricolor Eriehson in Schomburgk, 1848 | 5 | 2          | x             |                 |                          |                  |
| Heteragrionidae   |               |           |               |                  |                          |                  |
| Heteragrion aurantiacus Selys, 1862 | 7, 11 | 7          |               | x                | x                        | x                |
| H. freddiemercuryi Lencioni, 2013 | 11, 12, 13, 18, 20–23 | 212 | x |                |                          |                  |
| Heteragrion sp. A | 12, 13, 18–20, 22 | 54 | x |                |                          |                  |
| Heteragrion sp. B | 11–13, 18, 20 | 52 | x |                |                          |                  |
| Calopterygidae    |               |           |               |                  |                          |                  |
| Hetaerina brightwelli (Kirby, 1823) | 11–13, 20, 21, 23 | 23 | x |                |                          |                  |
| H. hebe Selys, 1853 | 7, 12, 13 | 5          |               | x                | x                        | x                |
| H. longipes Hagen in Selys, 1853 | 11, 12, 19, 20, 23 | 11 | x |                |                          |                  |
| H. rosa Selys, 1853 | 1 | 3          | x             |                 |                          |                  |
| Mnesarete borchgravi (Selys, 1869) | 18 | 3          |               |                 | x                        |                  |
| Coenagrionidae    |               |           |               |                  |                          |                  |
| Acanthagrion gracile (Rambur, 1842) | 1, 2, 4–6, 15 | 21 | x |                |                          |                  |
| A. lancea Selys, 1876 | 1–6, 16 | 55         | x             | x                | x                        |                  |
| A. truncatum Selys, 1876 | 3, 4, 6, 15 | 8          | x             |                 |                          |                  |
| Acratobasis macilenta (Rambur, 1842) | 7 | 1          | x             |                 |                          |                  |
| Argio sordido Hagen in Selys, 1865 | 12, 13, 18–20, 22, 23 | 218 | x |                |                          |                  |
| Fornipeionura sancta (Hagen in Selys, 1860) | 12, 13, 16–20, 22, 23 | 79 | x |                |                          |                  |
| Homeura chellera Selys, 1876 | 16, 8, 13, 16, 20 | 65 | x |                |                          |                  |
| Ischnura capreolus (Hagen, 1861) | 2, 3, 5, 6, 8, 16 | 30 | x |                |                          |                  |
| I. fluviatilis Selys, 1876 | 3, 4, 13, 16 | 6          | x             |                 |                          | x                |
| Leptagrion elongatum Selys, 1876 | 16 | 1          |               |                 |                          |                  |
| L. macrurum (Burmeister, 1839) | 12, 13, 16, 18, 20, 21 | 31 | x |                |                          |                  |
| Minagrion meciostegastrum (Selys, 1876) | 5, 7 | 3          |               |                 |                          |                  |
| M. waltheri (Selys, 1876) | 6 | 1          |               |                 |                          |                  |
| Oxyagrion simile Costa, 1978 | 16 | 47         |               |                 |                          |                  |
| O. terminale Selys, 1876 | 1–6, 8, 9 | 45 | x |                |                          |                  |
| Telebasis carmesina Calvert, 1909 | 4, 6 | 2          |               |                 |                          | x                |
| T. theodori (Navás, 1934) | 5, 6 | 13         | x             |                 |                          | x                |
| T. willinki Fraser, 1948 | 2–6, 16 | 43 | x |                |                          |                  |

Continues
### Taxa

#### Anisoptera

| Taxa                                | Sampling site | Abundance | Reared larvae | Araucaria Forest | Tropical Atlantic Forest | New state Record |
|-------------------------------------|---------------|-----------|---------------|------------------|--------------------------|------------------|
| Anisoptera                          |               |           |               |                  |                          |                  |
| Aeshnidae                           |               |           |               |                  |                          |                  |
| Castoraeschna castor (Brauer, 1865) | 16            | 1         |               | x                | x                        |                  |
| Castoraeschna cf. margaretiae Juritz, 1979 | 16            | 1         |               |                  | x                        |                  |
| Coryphaeschna perennis (McLachlan, 1887) | 2-6           | 9         |               |                  | x                        | x                |
| Limnetron sp.                       | 12-14, 20, 22, 23 | 13 |               |                  |                          |                  |
| Remartinia i. luteipennis (Burmeister, 1839) | 6             | 1         |               |                  | x                        |                  |
| Rhionaeschna bonariensis (Rambur, 1842) | 8             | 1         |               |                  | x                        |                  |
| R. brasiliensis (von Ellenrieder & Costa, 2002) | 5             | 1         |               |                  | x                        |                  |
| R. canula (Rambur, 1842)            | 3             | 1         |               |                  | x                        |                  |
| R. decessus (Calvert, 1953)         | 16, 20, 22    | 5         |               |                  | x                        | x                |
| R. punctata (Martin, 1908)          | 12-14, 20, 22 | 19        |               |                  | x                        | x                |
| R. planaltica (Calvert 1952)        | 4, 10, 12-14, 16, 18, 20 | 28 |               |                  |                          |                  |
| Gomphidae                           |               |           |               |                  |                          |                  |
| Aphylla theodorina (Navás, 1933)    | 16            | 2         |               |                  | x                        | x                |
| Phyllogomphoides annectens (Selys, 1869) | 11, 20, 22   | 7         |               |                  |                          |                  |
| Phyllocycla diphylla (Selys, 1854)  | 1             | 1         |               |                  |                          | x                |
| Progomphus complicatus Selys, 1854  | 5, 7, 20      | 4         |               |                  |                          | x                |
| Progomphus aff. gracilis Hagen in Selys, 1854 | 11, 13, 20, 22 | 32 |               |                  |                          |                  |
| Cordulidae                          |               |           |               |                  |                          |                  |
| Neocordulia mambucabensis Costa & T.C. Santos, 2000 | 11, 12, 22 | 7 |               |                  |                          |                  |
| Libellulidae                         |               |           |               |                  |                          |                  |
| Brechmorhoga nubecula (Rambur, 1842) | 18            | 1         |               | x                | x                        | x                |
| Brechmorhoga sp. A                  | 22            | 1         |               |                  |                          |                  |
| Brechmorhoga sp. B                  | 13, 20, 23    | 3         |               |                  |                          |                  |
| Dasythemis minckii minckii (Karsch, 1889) | 2, 4, 6, 13, 19, 20 | 18 |               |                  |                          | x                |
| Dasythemis sp.                      | 1, 6          | 4         |               |                  | x                        | x                |
| Dasythemis sp.                      | 2, 3, 5, 6    | 13         |               |                  |                          |                  |
| Erythrodiplax acantha Borror, 1942  | 16            | 17        |               |                  |                          | x                |
| E. anomalua (Brauer, 1865)          | 4, 6          | 5         |               |                  | x                        |                  |
| E. castanea (Burmeister, 1839)      | 2, 5, 6, 165  | 42        |               |                  | x                        | x                |
| E. fusca (Rambur, 1842)             | 1, 3, 5, 6, 20 | 10         |               |                  |                          | x                |
| E. hyalina Förster, 1907            | 4, 13, 16     | 5         |               |                  | x                        | x                |
| E. media Borror, 1942               | 1–6, 22       | 48        |               |                  | x                        | x                |
| E. melanorubra Borror, 1942         | 1–7, 13, 16   | 100       |               |                  | x                        | x                |
| E. paraguayensis (Förster, 1905)    | 3, 16         | 4         |               |                  | x                        |                  |
| Erythrodiplax sp.                   | 1, 3, 5, 6    | 36        |               |                  |                          |                  |
| Macrothemis imitans imitans (Karsch, 1891) | 1–3          | 9         |               |                  | x                        |                  |
| M. tenuis Hagen, 1868               | 7             | 1         |               |                  |                          |                  |
| Miathyria marcella (Selys in Sagra, 1857) | 2, 5, 7, 10, 13 | 7        |               |                  |                          | x                |
| M. simplex (Rambur, 1842)           | 2, 3, 5, 6    | 6         |               |                  |                          |                  |
| Micrathyria hypodidyma Calvert, 1906 | 2, 3, 5–7   | 24        |               |                  |                          | x                |
| M. stawianski Santos, 1953          | 5             | 1         |               |                  |                          |                  |
| M. ungulata Förster, 1907           | 15            | 2         |               |                  |                          |                  |
| M. venezuelae De Marmels, 1989      | 12, 15        | 3         |               |                  |                          | x                |
| Nephepeltia flavivirgata (Karsch, 1889) | 5, 6         | 10        |               |                  |                          | x                |
| Oligoclada laetitia Ris, 1911       | 1–3           | 9         |               |                  |                          |                  |
| Orthemis discolet (Burmeister, 1839) | 1, 13        | 4         |               |                  | x                        |                  |
| Pantala flavescens (Fabricius, 1798) | 1, 4, 6, 10, 13, 16 | 18     |               |                  |                          | x                |
| Perithemis moosae Kirby, 1889       | 2–6           | 13        |               |                  |                          |                  |
| Planixalis erythropygus (Karsch, 1891) | 1–5         | 25        |               |                  |                          | x                |
| Tauriphila xipha Ris, 1931          | 2, 3, 5, 6    | 10        |               |                  |                          | x                |
| Tramea binotata (Rambur, 1842)      | 6, 16         | 2         |               |                  |                          | x                |
| T. cophysa Hagen, 1867              | 5, 16         | 3         |               |                  |                          |                  |
| T. rustica De Marmels & Rácenis, 1982 | 3, 6         | 7         |               |                  |                          |                  |

9 Families, 43 genera, 84 species

1,708
doubletons. All families were more abundant in the Tropical Forest area except for Libellulidae.

The hitherto unknown females of *Heteragrion freddiemercuryi* Lencioni, 2013 and *Planiplax erythropyga* (Karsch, 1891) were collected. Four species with unknown larvae emerged in the laboratory: (1) *P. erythropyga*, (2) *N. mambucabensis*, (3) *Heteragrion* sp., and (4) *Acanthagrion lancea* Selys, 1876 (Fig. 16), so these ultimate stadium (F-0) exuviae are available for description. In addition, five undescribed species were detected, one from each genera: *Heteragrion* (Heteragrionidae), *Progomphus* Selys, 1854 (Gomphidae), *Brechmohoga*, *Erythrodiplax* Brauer, 1868, and *Dasystemis* Karsch, 1889 (Libellulidae), which will be described elsewhere.

## Taxonomic notes

Five of the identified species are of special taxonomic interest because they are poorly known, exhibited morphological variation, or their occurrence was unexpected in the region investigated. Such species are commented below.

**Heteragrion freddiemercuryi** (Fig. 15). The second most abundant species in the survey, it was originally described from Peruíbe, a lowland area at 10 m a.s.l. in the state of São Paulo (Lencioni 2013). In the studied area it was found an abundant population living in a highland area from 1,000 m a.s.l., extending its range considerably and calling into question its lowland habitat preferences.

**Forcepsioneura sancta** (Hagen in Selys, 1860). *Forcepsioneura* Lencioni, 1999, a small genus of forest-dependent damselflies

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Figure 12. Rarefaction and extrapolation curves up to 15,000 individuals (show only to 5,000) based on abundance data in the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil. Diamonds shows the observed richness: Pool regional (green), 84 species in 1,708 individuals (estimated richness 106 spp.); Tropical Atlantic Forest (TF, blue), 52 species in 1028 individuals (estimated richness 69 spp.).
Figures 13–18. Habitus of Zygoptera species from the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil: (13) *Perilestes fragilis*, ‘Perilestidae’; (14) *Lestes auritus*, Lestidae; (15): *Heteragrion freddiemercury*, Heteragrionidae; (16) *Acanthagrion lancea*, Coenagrionidae; (17) *Leptagrion macrurum*, Coenagrionidae; (18) *Telebasis carmesina*, Coenagrionidae. Photos BRA; 13, 15, 17 and 18 in 2019; 14 and 16 in 2020.
endemic to Brazil, recently was discovered to be more diverse and taxonomically intricate than previously suspected (Pinto and Kompier 2018, Pimenta et al. 2019). Some species are strongly similar, forming complexes, and are diagnosed based on minor morphological differences on the caudal appendages. At first glance, the collected specimens from MASE appeared all to belong to the most widespread species *E. sancta*. However, closer inspection allows us to distinguish two series. Most specimens are consistent with those from the type locality at Lagoa Santa, Minas Gerais, hence, are typical *E. sancta* in coloration, dimensions, and in the shape of caudal appendages (see Machado 2001). Others are larger, with a greenish-orange mesepimeral stripe, cercus with mediobasal process acute and a thinner ventrobasal process that is curved inward, strongly similar to the poorly known *F. haerteli* Machado, 2001 from Santa Catarina. However, the genus is pending a full revision to clarify the status of the available names and specific limits (Pinto and Araujo 2020), including these nominally two cited species. Thus tentatively, it was preferred to consider all specimens as *E. sancta*.

*Neocordulia mambucabensis* (Fig. 21). We collected a series of adults (six males and one female) in different periods and at three different collection sites in MASE, allowing us to discuss its taxonomic status. The taxonomy of the genus *Neocordulia* Selys, 1882 is plagued by imprecision and misidentifications. Thus, species-level determination has been challenging, with several specific questionable statuses (see Pinto and Carvalho 2011). This is critical, and females, especially, are poorly known; for example, six of the 16 species, the female is still undescribed. The sampled adults and larvae can improve the species delimitation. *Neocordulia mambucabensis* was described based on a male holotype and female paratype from the Rio Mambucaba river, collected in the highlands (approximately 2,000 m a.s.l.) in the Serra da Bocaina National Park (Costa and Santos 2000). Both specimens were collected among a series of ultimate stadium larvae of *Neocordulia* reared in laboratory, and among the five adults emerged in the laboratory are representatives of three distinct species at least. Based on inconsistencies and new data of specimens from MASE, we suspect that the allotype (paratype) female of *N. mambucabensis* was misidentified, as well as the additional females in Kompier (2015). This data, including the description of the unknown larvae, is under preparation and will be published elsewhere.

*Erythrodiplax acantha* Borror, 1942. This species was described based on a series of four males collected by F.W. Bauer in São Paulo Capital (Borror 1942), and few additional data has been published about this species. It has recently been considered as Critical Endangered on the RedList of that state (Pinto 2018, São Paulo State government Decree # 63.853). It can be considered an exception within the large and taxonomically difficult genus *Erythrodiplax*, easily identified by its unique vesica spermalis (penis) shape, especially by the thorn-shaped (spine) median process (Borror 1942). The eleven examined males agree well with the original description (Borror 1942: 199) except in respect to general coloration. Our specimens were somewhat lighter, and all are brownish-yellow, instead of black and brown like the type series. The postfrons are not clearly flattened and lack bluish metallic reflections, although they show weak purplish metallic reflections. Usually, color variation may be explained due to ontogenetic changes, an aspect well documented in the genus, including in the taxonomic revision of Borror (1942). For instance, in *Erythrodiplax hyalina* Förster, 1907, the general coloration in males varies from brownish-yellow to light greenish in young specimens to black frons with purple metallic reflections and brownish-black synthorax with bluish pruinosity in older specimens (Borror 1942). However, the coloration in *E. acantha* cannot be explained only by the age of the specimens because all captured males were apparently mature, showing evidence of senility such as pruinosity and a hardened exoskeleton. Most likely the differences in the coloration and unflattened postfrons are populational phenomena. The collected specimens were compared with some more typical males from the state of Minas Gerais and did not see any significant differences except in the coloration. The population of Minas Gerais showed a range of variation in the coloration (polychromatism); some specimens are very dark with bluish pruinosity while others present coloration similar to the specimens from MASE.

*Planiplax erythropygum* This species is considered rare in collections, and recorded from Argentina, Uruguay, south of Brazil at state of Rio Grande do Sul (Santos 1949, von Ellenrieder and Muzón 2008) and north to state of Rio de Janeiro (Kompier 2015). Even though periodically, males exhibit a perching behavior, spending most of their time flying along the banks, making them difficult to collect. Individuals of this species were abundant in one sampling site (Fig. 4), allowing for the successful collection of 15 males in a single collecting event in over 3 hours. The males were abundant near the banks without macrophytes, probably the preferred mesohabitat of the species. Comparing the posterior hamule of MASE specimens to those illustrated by Santos (1949) and (Garrison et al. 2006), they are significantly distinct. Further investigations should evaluate if these variations correspond to geographical phenomena, illustration skills, or if more than a single species are involved.

**Geographic records**

A total of 53 new occurrence records were observed for the state of Paraná (Table 2, Figs 13–24). The species recorded for the first time to Paraná and their previous known distributions compiled from the literature are presented in Appendix 1.

**DISCUSSION**

**Community richness and composition**

This first inventory for Mananciais da Serra revealed an impressively rich community with 84 species occurring in a small area. The sampling effort based on estimated richness (106 spp.) is near to 80% (Fig. 12) and shows the potential for
Figures 19–24. Habitus of Anisoptera species from the protected area Mananciais da Serra, Piraquara municipality, state of Paraná, Brazil: (19) *Rhionaeschna punctata*, Aeshnidae; (20) *Aphylla theodorina*, Gomphidae; (21) *Neocordulia mambucabensis*, Corduliidae s.l.; (22) *Erythrodiplax castanea*; (23) *Planiplax erythropyga*, Libellulidae; (24) *Tramea rustica*, Libellulidae. Photos BRA; all in 2019.
future research. The actual richness (current pool of species) is possibly up to 100 species due to the expected occurrence of species not sampled as common species with wide distribution ranges such as *Erythemis vesiculosa* (Fabricius, 1775) and *Erythrodiplax umbrata* (Linnaeus, 1758), the crepuscular species from genera such as *Triacanthagyna* Selys, 1883 and the sighted but not collected *Erythemis attala* (Selys in Sagra, 1857), *Perithemis icteropectra* (Selys in Sagra, 1857), and an unidentified species of *Mecistogaster* Rambur, 1842, *Gynacantha* Rambur, 1842 and *Libellula* Linnaeus, 1758. Another indicator of the higher richness is that more than half of the registered species (36) had less than five specimens collected, possibly a consequence of the disparities of collection effort across the sampling sites and relative abundance in the field.

The “Natural pool” sampling site is unique among the other sites in TF distinctly characterized as a lentic system. The rocky soil does not support the development of large trees, so this area is not shaded by forest. Such feature influences the physical, chemical, and biological conditions of this aquatic environment and permits most insolation, one of the abiotic features most important in filtering Odonata species occurrence (see Dijkstra and Clausnitzer 2006). So, it turns to a kind of refuge within predominantly lotic systems and forested areas. These aspects allow the occurrence of a unique faunal composition with some well-established abundant species, such as *Lestes auritus* Hagen in Selys, 1862, *Oxyagrion simile* Costa, 1978, *Erythrodiplax acantha*, and *Erythrodiplax castanea* (Burmeister, 1839). Notably, this faunal group is composed of 14 species with lentic habitat preferences (Table 2) that also occur in the AF area, including eight exclusive species and three that occurred in neighboring TF sampling sites.

All families were more abundant in TF except Libellulidae. Despite being the richest family, its representatives occurred at a low frequency in TF, possibly due to the low availability of the characteristically lentic system and its preference; similar results were found by Pires et al. (2019).

Different collection methods can be complementary, assisting in sampling the true diversity of Odonata in inventories (De Almeida et al. 2013). Besides the gaps obtained on larvae taxonomy, in this study, the rearing of larvae obtained by sieving method was important to obtain adults of rare species and females, the latter proportionally less abundant than males in collections (e.g. Paulson and Jenner 1971, see also De Almeida et al. 2013). Five of the seven specimens of *Progomphus aff. gracilis* Hagen in Selys, 1854 were collected with a sieve, as was the rare species *Neoconglidia mambucabensis*, including the single female. Furthermore, the sieve method allowed for sampling a single female, still undescribed formally, of *P. erythropygta*, four of five females of *Limnetron* sp. and four of five females of *Phyllogomphoides ancetens* (Selys, 1869). In addition, the collection of larvae can improve the records of crepuscular species, as shown by Reels (2011) and discussed by Pinto (2019).

Similarly to other exploratory survey research, the crepuscular species (besides sight) were not sampled (Renner et al. 2016, 2017), possibly due to timing of the survey (Reels 2011), collector negligence due to its flier behavior as in some cordulids (see Pinto 2019) or the shortened flying period that makes them less susceptible to capture.

**Geographic records**

The richness of 84 species in the sampling site was much higher than all the previous records for the entire state of Paraná (60 spp., checklist based on unpublished data), and the 53 new occurrences almost duplicated the state records. This can be explained largely because of undersampling, potentiated by gaps of entomological collections studies or data compilation surveys (Vianna and De Marco 2012). Some of the new records were expected and predictable such as widespread species (e.g. *Acanthagrion gracile* (Rambur, 1842), species recorded in Paraná’s neighboring states in the Rio Grande do Sul and Santa Catarina (e.g. *Leptagrion macrum* (Burmeister, 1839), *Telebasis carmesina* Calvert, 1909, *Lestes auritus* Hagen in Selys, 1862, Figs 14, 17, 18). Some records are notable because they contribute to expanding the known species occurrence (e.g. *Rhionaeschna punctata* (Martin, 1908), Fig. 19) or because they are rare in collections (e.g. *N. mambucabensis* and *P. erythropygta*, Figs 21, 23). An endangered species for the state of São Paulo (Pinto 2018), *E. acantha*, was recorded.

**Concluding remarks**

Our study allows us to reach the following conclusions. The richness maintained by Mananciais da Serra represents 9.3% of the Brazilian Odonata (data based on Pinto 2020) and 74.3% of the species known for the state of Paraná. This survey is a clear example of how undersampled areas represent gaps of knowledge that can lead to inconsistencies, such as distribution patterns. The high number of new records and the new species are evidence of a neglected area and alerts us to its potential odonate richness. The female described in the original description of *N. mambucabensis* pertaining to another species of the genus. Considering the high deforestation of Paraná’s Atlantic Forest and the majority of remnants concentrated in small fragments, it should be investigated, as proposed by Paulson (2006), to understand how this partitioning of forest cover can influence Odonata diversity and how the fauna recolonizes reforested areas. The data presented here are unprecedented and contribute to the taxonomic and morphological knowledge of the local Odonata community, including adults and larvae.

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**LITERATURE CITED**

Anjos AF, Navarro-Silva MA (2008) Culicidae (Insecta: Diptera) em área de Floresta Atlântica, no Estado do Paraná, Brasil. Acta Scientiarum, Biological Sciences 30(1): 23–27. http://www.redalyc.org/articulo.oa?id=187115911004

Barbosa MS, Borges LR, Vilela DS, Venâncio H, Santos, JC (2019). Odonate Communities of the Sucupira Reservoir, Rio Uuberabinha, Minas Gerais, Brazil. Papéis Avulsos de Zoologia 59: e20195922. http://doi.org/10.11606/1807-0205/2019.59.22

Bastos RC, Brasil LS, Carvalho FG, Calvão LB, Silva JOA, Juen L (2019) Odonata of the state of Maranhão, Brazil: Wallacean shortfall and priority areas for faunistic inventories. Biota Neotropica 19(4): e20190734. http://doi.org/10.1590/1676-0611-BN-2019-0734

Belle J (1973) A revision of the new world genus Progomphus Selys, 1854 (Anisoptera: Gomphidae). Odonatologica 2: 191–308.

Bianchi JS, Bento CM, de Andrade Kersten R (2012) Epífitas vasculares de uma área de ecótono entre as Florestas Ombrófilas Densa e Mista, no Parque Estadual do Marumbi, PR. Estudos de Biologia 34(2): 37–44. http://doi.org/10.7213/estud.biol.6121

Borror DJ (1942) A revision of the libelluline genus *Erythrodiplax* (Odonata). The Ohio State University, Columbus, 286 pp.

Braby MF, Williams MR (2016) Biosystematics and conservation biology: critical scientific disciplines for the management of insect biological diversity. Austral Entomology 55: 1–17. http://doi.org/10.1111/aen.12158

Cáceres NC (2004) Occurrence of *Conopatus chinga* (Molina) (Mammalia, Carnivora, Mustelidae) and other terrestrial mammals in the Serra do Mar, Paraná, Brazil. Revista Brasileira de Zoologia 21(3): 577–579. https://doi.org/10.1590/S0101-817520040002000020

Campanili M, Schaffer WB (2010) Um retrato dos estados. In: Campanili M, Schaffer WB (Ed.) Mata Atlântica: patrimônio nacional dos brasileiros. Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Departamento de Conservação da Biodiversidade, Núcleo Mata Atlântica e Pampa, Brasília, 131–280.

Carvalho AL, Salgado LGV (2004) Two new species of *Aeshna* in the punctata group from southeastern Brazil (Anisoptera: Aeshnidae). Odonatologica 33(1): 25–39.
Oertli B (2008) The use of dragonflies in the assessment and monitoring of aquatic habitats. In: Córdoba-Aguilar A (Ed.) Dragonflies and Damselflies: Model organisms for ecological and evolutionary research. Oxford University Press, New York, 79–95. https://doi.org/10.1093/acprof:oso/9780199230693.003.0007

Oliveira U, Paglia AP, Brescovit AD, de Carvalho CJB, Silva DP, Rezende DT, Leite FSA, Batista AN, Barbosa JPP, Stehmann JR, Ascher JS, Vasconcelos MF, De Marco P Jr, Löwemberg-Neto P, Dias PG, Ferro VG, Santos AJ (2016) The strong influence of collection bias on biodiversity knowledge shortfalls of Brazilian terrestrial biodiversity. Diversity and Distributions 22(12): 1232–1244. https://doi.org/10.1111/ddi.12489

Paladini A, Cavichioli RR (2015) A new genus and new species of spittlebug (Hemiptera: Cercopidae: Ischnorhininae) from Southern Brazil. Zoologia (Curitiba) 32(1): 47–52. http://doi.org/10.1590/S1984-46702015000100007

Paulson D (2006) The importance of forests to neotropical dragonflies. In: Cordeiro-Rivera A (Ed.) Forests and Dragonflies. Pensoft, Sofia, Series Faunistica, 79–101.

Paulson DR, Jenner CE (1971) Population structure in overwintering larval Odonata in North Carolina in relation to adult flight season. Ecology 52(1): 96–107. https://doi.org/10.2307/1934740

Pena-Barbosa JPP (2020) Chelodesmidae. In: Taxonomic Catalog of Fauna of Brasil. PNUD. http://fauna.jbrj.gov.br/fauna/faunadobrasil/72556 [Accessed: 06/01/2020]

Pimenta ALA, Pinto AP, Takiya DM (2019) Integrative taxonomy and phylogeny of the damselfly genus Forcepsioneura Lencioni, 1999 (Odonata: Coenagrionidae: Protoneurinae) with description of two new species from the Brazilian Atlantic Forest. Arthropod Systematics & Phylogeny 77: 397–415. https://doi.org/10.1260/0167-0260.2019-2

Pinto AP (2018) Odonata. In: Espécies ou subespécies da fauna silvestre regionalmente extintas ou ameaçadas de extinção no estado de São Paulo. Diário oficial do Estado de São Paulo, vol. 128, # 221, Decree # 63.853.

Pinto AP (2019) First report on the dragonflies from Parque Estadual da Ilha do Cardoso, state of São Paulo, Brazil, with notes on the morphology and behavior of Lauromacromia picinguaba (Odonata: Corduliidae s.l.). Studies in Neotropical Fauna and Environment 54(1): 48–60. https://doi.org/10.2307/1934740

Pinto AP (2020) Odonata. In: Taxonomic Catalog of Fauna of Brasil. PNUD. http://fauna.jbrj.gov.br/fauna/faunadobrasil/171 [Accessed: 18/10/2020]

Pinto AP, Araujo BR (2020) A new damselfly of the genus Forcepsioneura from the Atlantic Forest of south-eastern Brazil (Odonata: Coenagrionidae). Odonatologica 49(1/2): 107–123. http://doi.org/10.5281/zenodo.3823335

Pinto AP, Carvalho AL (2011) Unending Mistake on the Distribution of the South American Emerald Neocordulia (Mesocordulia) batesi batesi (Selys, 1871). Argia 23(1): 7–8.

Pinto AP, Kompier T (2018) In honor of conservation of the Brazilian Atlantic Forest: description of two new damselflies of the genus Forcepsioneura discovered in private protected areas.
areas (Odonata: Coenagrionidae). Zoologia (Curitiba) 35: e21351. https://doi.org/10.3897/zoologia.35.e21351
Pires MM, Kotzian CB, Sganzerla C, Prass G, Dalzochio MS, Périco E (2019) Diversity of Odonata (Insecta) in Seasonal Deciduous Forest fragments in southern Brazil (state of Rio Grande do Sul), with a new record for the state and comments on the seasonal distribution of the species. Biota Neotropica 19(4): e20190769. https://doi.org/10.1590/1676-0611-BN-2019-0769
Reels GT (2011) Emergence patterns and adult flight season of Anisoptera at a managed wetland site in Hong Kong, southern China. International Journal of Odonatology 14(1): 33–48. https://doi.org/10.1080/13887890.2011.570155
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
Renner S, Périco E, Ely GJ, Sahlén G (2017) Preliminary dragonfly (Odonata) species list from the Pampa biome in Rio Grande do Sul, Brazil, with ecological notes for 19 new records for the State. Biota Neotropica 17(4): e20170374. https://doi.org/10.1590/1676-0611-BN-2017-0374
Renner S, Périco E, Sahlén G (2016) List of Odonates from the State of Mato Grosso do Sul, Brazil. Biota Neotropica 16(3): e20150132. https://doi.org/10.1590/1676-0611-BN-2015-0132
Ribeiro MC, Metzger JP, Martensen AC, Ponzoni FJ, Hirotta MM (2009) The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation 142(6): 1141–1153. https://doi.org/10.1016/j.biocon.2009.02.021
Roderjan CV, Galvão F, Kuniyoshi YS, Hatschbach GG (2002) As unidades fitogeográficas do estado do Paraná, Brasil. Ciência & Ambiente 24(1): 75–92.
Rodrigues ME, Roque FDO (2017) Checklist de Odonata do Estado de Mato Grosso do Sul, Brasil. Iheringia, Série Zoolóogia 107: 107–111. https://doi.org/10.1590/1678-4766e2017117
Rosa MR (2007) Áreas prioritárias para conservação, uso sustentável e repartição de benefícios da biodiversidade brasileira: atualização - Portaria MMA no. 9, de 23 de janeiro de 2007. Secretaria Nacional de Biodiversidade e Florestas, Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Brasília, 300 pp.
Santos ND (1949) Planiplax machadoi n. sp. e notas sobre outras espécies (Odonata, Libellulidae). Revista Brasileira de Biologia 9(4): 427–432.
Santos ND (1970) Odonatas de Itaitiaia (estado do Rio de Janeiro) da coleção Zikán, do Instituto Oswaldo Cruz. Atas da Sociedade de Biologia do Rio de Janeiro 13(5–6): 203–205.
Schubart O (1955) Materiais para uma fauna do estado de São Paulo: Os leptodesmidae. Arquivos do Museu Nacional 42(2): 507–540.
Silva DP, De Marco P, Resende DC (2010) Adult Odonate abundance and community assemblage measures as indicators of stream ecological integrity: A case of study. Ecological Indicators 10(3): 744–752. https://doi.org/10.1016/j.ecolind.2009.12.004
Silva JMC, Casteleti CHM (2003) Status of the biodiversity of the Atlantic Forest of Brazil. In: Galindo-Leal C, Câmara IG (Eds) The Atlantic Forest of South America: biodiversity status, threats, and outlook. Center for Applied Biodiversity Science and Island Press, Washington, DC, 43–59.
SOS Mata Atlântica (2018) Atlas dos remanescentes florestais da Mata Atlântica período 2016–2017. SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. http://mapas.sosma.org.br/dados
Souza MM, Pires EP, Brunismann AG, Milani LR, Pinto ÂP (2017) Dragonflies and damselflies (Odonata) from the wetland of the Rio Pandeiros, northern region of Minas Gerais State, Brazil, with a description of the male of Archaeogomphus vanbrinki Machado (Anisoptera: Gomphidae). International Journal of Odonatology 20(1): 13–26. https://doi.org/10.1080/13887890.2017.1281848
SUDERHSA (2000) Mapa das Sub-Bacias do Alto Iguaçu. Instituto das Águas do Paraná, Superintendência de Desenvolvimento de Recursos Hídricos e Saneamento Ambiental. http://www.aguasparana.pr.gov.br/modules/conteudo/conteudo.php?conteudo=90
Teixeira RMC (1971) Contribuição para o conhecimento da fauna odonatológica do Rio Grande do Sul. Arquivos do Museu Nacional 54: 17–24.
Troudet J, Grandcolas P, Blin A, Vignes-Lebbe R, Legendre F (2017) Taxonomic bias in biodiversity data and societal preferences. Scientific Reports 7(1): 9132. https://doi.org/10.1038/s41598-017-09084-6
Vianna DM, De Marco P (2012) Higher-taxon and cross-taxon surrogates for odonate biodiversity in Brazil. Natureza & Conservação 10(1): 34–39. https://doi.org/10.1038/s41598-017-09084-6
von Ellenrieder N (2003) A synopsis of the Neotropical species of ‘Aeshna’ Fabricius: the genus Rhionaeschna Förster (Odonata: Aeshnidae). Tijdschrift voor Entomologie 146(1): 67–207.
von Ellenrieder N (2009) Databasing dragonflies: state of knowledge in the Neotropical region. Agrion 13(2): 58–72.
von Ellenrieder N, Muzón J (2008) An updated checklist of the Odonata from Argentina. Odonatologica 37(1): 55–68. http://natuurtijdschriften.nl/record/592615

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Appendix 1. List of the 53 species recorded for the first time to the state of Paraná with previous known distribution data.

1. *Perilestes fragilis* Hagen in Selys, 1862 (Fig. 13)
   Distribution: Guyana[?], BRAZIL: AM[?], MG, ES, RJ, SP, PR*.
   Remarks: The records from the state of Amazonas and Guyana most likely is due to misidentifications because it is an endemic species of Atlantic Forest; thus, these occurrences should be checked.

2. *Lestes auritus* Hagen in Selys, 1862 (Fig. 14)
   Distribution: Argentina, BRAZIL: MG, RJ, PR*, SC, RS.

3. *Lestes pictus* Hagen in Selys, 1862
   Distribution: Peru, Argentina, BRAZIL: MG, RJ, PR*, SC, RS.

4. *Heteragrion freddiemercuryi* Lencioni, 2013 (Fig. 15)
   Distribution: BRAZIL: SP, PR*.
   Remarks: See taxonomic notes.

5. *Heteragrion aurantiacum* Selys, 1862
   Distribution: Paraguay, Argentina, BRAZIL: MG, ES, RJ, SP, PR*.

6. *Hetaerina brightwelli* (Kirby, 1823)
   Distribution: BRAZIL: PA, MG[?], ES, RJ, SP, PR*.
   Remarks: Santos (1970) cited this species from National Park of Itatiaia without locality. Itatiaia massif is in the boundaries of Rio de Janeiro and Minas Gerais, thus the record for MG pending confirmation.

7. *Hetaerina hebe* Selys, 1853
   Distribution: Venezuela, BRAZIL: PB[?], MG, ES, RJ, SP, PR*, SC[?], RS.
   Remarks: Garrison (1990) cited PB doubtful; specimens from SC most likely is this species but pending confirmation.

8. *Hetaerina longipes* Hagen in Selys, 1853
   Distribution: Paraguay, Argentina, BRAZIL: MG, ES, RJ, SP, SC, PR*, RS.

9. *Hetaerina rosea* Selys, 1853
   Distribution: Peru, Bolivia, Paraguay, Argentina, Uruguay, BRAZIL: CE, SE, RO, MT, GO, BA, MG, MS, ES, RJ, SP, PR*, RS.
   Remarks: Northern South America records most likely refers to other species (cf. Mauffray and Tennessen 2019). Thus, records northern than Bolivia (e.g. Peru, Mexico as cited by Heckman 2008) must be checked.

10. *Acanthagrion gracile* (Rambur, 1842)
    Distribution: Peru, Bolivia, Paraguay, Argentina, Uruguay, BRAZIL: CE, SE, MT, GO, BA, MG, MS, ES, RJ, SP, PR*, RS.
    Remarks: Northern South America records most likely refers to other species (cf. Mauffray and Tennessen 2019). Thus, records northern than Bolivia (e.g. Peru, Mexico as cited by Heckman 2008) must be checked.

11. *Acanthagrion lancea* Selys, 1876 (Fig. 16)
    Distribution: Colombia[?], Peru, Paraguay, Argentina, Uruguay, BRAZIL: MG, MS, ES, RJ, SP, PR*, SC, RS.

12. *Acanthagrion truncatum* Selys, 1876
    Distribution: Venezuela, Guyana. BRAZIL: PI, TO, MT, GO, BA, MG, MS, SP, PR*.

13. *Acanthagrion truncatum* Selys, 1876
    Distribution: Venezuela, Guyana. BRAZIL: PI, TO, MT, GO, BA, MG, MS, SP, PR*.

14. *Aceratobasis macilenta* (Rambur, 1842)
    Distribution: BRAZIL: MG, RJ, SP, PR*, SC.

15. *Argia sordida* Hagen in Selys 1865
    Distribution: BRAZIL: MG, MS, ES, RJ, SP, PR*.
    Remarks: Record to MS is out of Atlantic Forest domain, distant from hitherto known records, thus must be checked.

16. *Ischnura capreolus* (Hagen, 1861)
    Distribution: Mexico south to Panama. Trinidad and Tobago, Colombia, Venezuela, Ecuador, Peru, Bolivia, Guyana, Suriname, French Guiana, Paraguay, Argentina, Uruguay, BRAZIL: RR, AP, PA, AM, AC, PI, CE, PB, PE, SE, MT, RO, GO, BA, MG, MS, ES, RJ, SP, PR*, RS.

17. *Ischnura fluviatilis* Selys, 1876
    Distribution: Venezuela, Ecuador, Peru, Bolivia, Guyana, Suriname, French Guiana, Chile, Paraguay, Argentina, Uruguay, BRAZIL: AP, PA, AM, MA, CE, PB, PE, MT, RO, GO, MG, MS, ES, RJ, SP, PR*, RS.

18. *Leptagrion elongaturn* Selys, 1876
    Distribution: BRAZIL: BA[?], ES, RJ, SP, PR*.
    Remarks: Lencioni (2017) mentioned this species from BA, but it was not found records in the literature, thus the occurrence in that state pending confirmation.

19. *Leptagrion macrum* (Burmeister, 1839) (Fig. 17)
    Distribution: BRAZIL: BA, ES, RJ, SP, PR*, SC.

20. *Telebasis carmesina* Calvert, 1909 (Fig. 18)
    Distribution: Bolivia, Paraguay, Argentina, BRAZIL: MT, MG, MS, ES, RJ, SP, PR*, SC, RS.

21. *Telebasis theodori* (Navás, 1934)
    Distribution: Argentina, BRAZIL: PR*, SC, RS.

22. *Telebasis willinki* Fraser, 1948
    Distribution: Bolivia, Paraguay, Argentina, Uruguay, BRAZIL: BA, MG, MS, SP, PR*, RS.

23. *Castoraeschna castor* (Brauer, 1865)
    Distribution: Suriname, BRAZIL: MG[?], ES, RJ, SP, PR*.
    Remarks: Santos (1970) cited from National Park of Itatiaia without locality. Itatiaia massif is in the boundaries of Rio de Janeiro and Minas Gerais, thus the record for MG pending confirmation.

24. *Rhionaeschna confusa* (Rambur, 1842)
    Distribution: Chile, Paraguay, Argentina, Uruguay, BRAZIL: RJ, PR*, SC, RS.

25. *Rhionaeschna decreasus* (Calvert, 1953)
    Distribution: BRAZIL: RJ, PR*.
    Remarks: Part of the records in von Ellenrieder (2003) and Carvalho and Salgado (2004) refers to *R. decreasus*-complex and *R. punctata*-complex (Silva et al. in prep.).

26. *Rhionaeschna punctata* (Martin, 1908) (Fig. 19)
    Distribution: BRAZIL: MG, ES, RJ, SP, PR*, SC, RS.
Remarks: Part of the records in von Ellenrieder (2003) and Carvalho and Salgado (2004) refers to R. decessus-complex and R. punctata-complex (Silva et al. in prep.).

27. Aphylla theodorina (Navás, 1933) (Fig. 20)
Distribution: Venezuela, Peru, Guyana, Paraguay, Argentina, Uruguay, BRAZIL: PE, SE, MT, RO, MG, MS, ES, RJ, SP, PR*, RS.

28. Phyllocypha diphylla (Selys, 1854)
Distribution: Venezuela, Argentina[?], BRAZIL: AM[?], AL, MG, ES, SP, PR*.
Remarks: Heckman (2006, p. 615) cited occurrence to Argentina and AM (latter record reproduced in Koroiva et al. 2020), but the last updated checklist from Argentina (Lozano et al. 2020) do not cite this record and we did not find other references citing these records.

29. Progomphus complicatus Selys, 1854
Distribution: Paraguay, Argentina, BRAZIL: CE, BA, MG, ES, RJ, SP, PR*, RS.

30. Neocordulia mambucabensis Costa & T.C. Santos, 2000 (Fig. 21)
Distribution: Brazil: RJ, PR*. Remarks: See taxonomic notes.

31. Brechmorhoga nubeula (Rambur, 1842)
Distribution: Mexico, Belize, Costa Rica, Panama, Trinidad and Tobago, Colombia, Venezuela, Ecuador, Peru, Paraguay, Argentina, BRAZIL: AM, CE, BT, BA, MG, ES, RJ, SP, PR*, SC, RS.

32. Dasythemis mincki mincki (Karsch, 1890)
Distribution: Paraguay, Argentina, Uruguay, BRAZIL: GO, MG, ES, RJ, SP, PR*, RS.

33. Diastatopus intensa Montgomery, 1940
Distribution: Colombia, Peru, Paraguay, Argentina, Uruguay, BRAZIL: PA[?], MT, MG, MS, RJ, SP, PR*, RS.
Remarks: Heckman (2006, p. 147) cited occurrence to PA, but no original record was found.

34. Dythemis nigra Martin, 1897
Distribution: Mexico south to Panama, Trinidad and Tobago, Colombia, Venezuela, Ecuador, Peru, Guyana, Suriname, French Guiana, Paraguay, Argentina, BRAZIL: RR, PA, AM, CE, PE, SE, MT, RO, GO, BA, MG, MS, ES, RJ, SP, PR*, SC, RS.

35. Erythemis peruviana (Rambur, 1842)
Distribution: USA south to Panama, Trinidad and Tobago, Colombia, Venezuela, Guyana, Suriname, French Guiana, Ecuador, Peru, Bolivia, Paraguay, Argentina, Uruguay, BRAZIL: RR, AP, PA, AM, MA, CE, PE, SE, MT, RO, GO, BA, MG, MS, ES, RJ, SP, PR*, SC, RS.

36. Erythrodiplax acantha Borror, 1942
Distribution: BRAZIL: GO, SP, PR*.
Remarks: See taxonomic notes.

37. Erythrodiplax anomala (Brauer, 1865)
Distribution: Argentina, BRAZIL: BA, RJ, SP, PR*, RS.

38. Erythrodiplax castanea (Burmeister, 1839) (Fig. 22)
Distribution: Belize, Guatemala, Costa Rica, Trinidad and Tobago, Colombia, Venezuela, Guyana, Suriname, French Guiana, Ecuador, Peru, Bolivia, Paraguay, Argentina, BRAZIL: PA, AM, CE, PE, SE, MT, RO, GO, BA, MG, MS, ES, SP, RJ, PR*, SC.

39. Erythrodiplax hyalina Förster, 1907
Distribution: Paraguay, Uruguay, BRAZIL: MG, RJ, SP, PR*, SC, RS.

40. Erythrodiplax media Borror, 1942
Distribution: Bolivia, Paraguay, Argentina, Uruguay, BRAZIL: MA[?], SE, MG, RJ, SP, PR*, SC, RS.
Remarks: De Marco (2008) recorded this species to MA, in a transitional site between Caatinga and Amazonia. Due to strongly out from the known distribution in the Southern Atlantic Forest, Pampean and Chacoan formations, it may be a misidentification pending confirmation.

41. Erythrodiplax melanorubra Borror 1942
Distribution: Venezuela, Ecuador, Peru, Bolivia, French Guiana, Chile, Paraguay, Argentina, BRAZIL: MG, MS, RJ, SP, PR*, SC, RS.

42. Erythrodiplax paraguayensis ( Förster, 1905)
Distribution: Colombia, Venezuela, Ecuador, Bolivia, Guyana, Suriname, Paraguay, Argentina, Uruguay, BRAZIL: RR, MA, CE, MT, MG, MS, RJ, SP, PR*, RS.

43. Macrothemis imitans imitans Karsch, 1890
Distribution: Colombia, Venezuela, Ecuador, Bolivia, Guyana, Suriname, Paraguay, Argentina, BRAZIL: MT, BA[?], MG, MS, ES, RJ, SP, PR*, SC, RS.

44. Macrothemis tenuis Hagen, 1868
Distribution: Argentina, BRAZIL: MG, ES, RJ, SP, PR*.

45. Miathyria marcella (Selys in Sagra, 1857)
Distribution: USA to Panama, Trinidad and Tobago, Colombia, Venezuela, Ecuador, Peru, Bolivia, Guyana, Suriname, French Guiana, Paraguay, Argentina, Uruguay, BRAZIL: RR, AP, PA, AM, MA, CE, PE, SE, MT, BA, MG, MS, ES, RJ, SP, PR*, RS.

46. Miathyria simplex (Rambur, 1842)
Distribution: Mexico, Belize, Guatemala, Honduras, Costa Rica, Panama, Cuba, Haiti, Dominican Republic, Puerto Rico, Trinidad and Tobago, Colombia, Venezuela, Ecuador, Peru, Guyana, Suriname, French Guiana, Paraguay, Uruguay, BRAZIL: PA, AM, MT, MS, ES, RJ, SP, PR*, RS.

47. Micrathyria venezuelae De Marmels, 1989
Distribution: Venezuela, Ecuador, Paraguay, Argentina, Uruguay, BRAZIL: AM, PR*.

48. Nephepelta flavifrons (Karsch, 1889)
Distribution: Mexico, Belize, Guatemala, Honduras, Costa Rica, Colombia, Venezuela, Ecuador, Peru, Bolivia, Suriname, French Guiana, Paraguay, Argentina, BRAZIL: RR, AP, PE, MT, RO, BA, MG, ES, RJ, SP, PR*, SC, RS.

49. Oligocladia laetitia Ris, 1911
Distribution: Argentina, BRAZIL: MG, MS, RJ, SP, PR*, RS.

50. Planiplax erythropygna (Karsch, 1891) (Fig. 23)
Distribution: Argentina, Uruguay, BRAZIL: RJ, PR*, RS.
51. *Tauriphila xiphea* Ris, 1931  
Distribution: Paraguay, Argentina, Uruguay, BRAZIL: ES, RJ, PR*, RS.

52. *Tramea binotata* (Rambur, 1842)  
Distribution: USA to Panama, Trinidad e Tobago, Colombia, Venezuela, Ecuador, Peru, Suriname, French Guiana, Paraguay, Argentina, BRAZIL: AM, PE, SE, MT, BA, MG, MS, ES, RJ, SP, PR*, RS.

53. *Tramea rustica* De Marmels & Rácenis, 1982 (Fig. 24)  
Distribution: Colombia, Venezuela, Bolivia, Suriname, French Guiana, Paraguay, Argentina, BRAZIL: AM, MT, RO, MG, MS, RJ, PR*.