Oligochaeta (Annelida: Clitellata) in the Juruena River, MT, Brazil: species indicators of substrate types

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Abstract: Oligochaeta assemblages are important components in freshwater environments, where their abundance and composition may indicate aspects related to water quality and sediment. The lack of information about these communities in Brazilian aquatic environments, as well as the application of native species as bioindicators of lotic environmental, stimulated the conception of this paper. Thus, the aim was to study the community of aquatic Oligochaeta in selected stretches of the Juruena River (MT), thereby generating grounds for future environmental monitoring action in lotic ecosystems. For this purpose, samples were analyzed at bimonthly intervals during the period from January to November 2009, in stretches of the Juruena River (Amazon River Basin) located in the State of Mato Grosso (MT). Two methods were used to collect the organisms: a) “D” network in small clusters of fixed macrophytes in the sediment on the river banks; and b) Ekman-Birge dredge in fine sediment. Preliminary results were 584 organisms distributed in 22 taxa. Of these, 22 valid species were identified. This number corresponds to approximately 25% of the aquatic oligochaete species registered in Brazil. Of these species, *Limnodrilus hoffmeisteri*, *Dero nivea* and *Pristina rosea* can be associated with organic enrichment conditions and/or some level of environmental degradation.

Keywords: Freshwater oligochaetes, bioindicators, lotic environments, freshwater environments.


Palavras-chave: Oligoquetos aquáticos, bioindicadores, ambientes lóticos, ambientes de água doce.
Introduction

Oligochaeta are some of the most abundant groups in continental aquatic macrofauna and play an important role in the process of decomposition and cycling of organic matter in freshwater ecosystems (Ragonha & Takeda, 2014, Cesar & Henry 2017). These organisms are found in almost all fresh aquatic environments (Cesar & Henry 2017), living in sediment and water columns (Rodrigue & Reynolds 2011), and in association with other organisms (Corbi et al. 2004, Alves & Gorni 2007, Gorni & Alves 2007, Gorni & Alves 2008, Oda 2015).

In addition, these worms have limited mobility and are influenced by the habitat characteristics in which they are found (Behrend et al. 2012). Thus, the richness and abundance of Oligochaeta is directly related to environmental variables (Marchese & Drago 1999, Jablonska, 2014), such as availability of food resources (Martins & Silveira, Alves 2011); dissolved oxygen (Dornfeld et al. 2006); type of substrate (Moretto et al. 2013); water temperature (Nascimento & Alves 2009), thus being considered indicators of specific habitats.

However, although common in freshwater environments (Timm et al. 2001), knowledge about Oligochaeta fauna in Brazilian fresh waters is still fragmented and incomplete (Alves et al. 2008, Takeda et al. 2017). This lacuna is mainly due to the concentration of studies related to the spatial distribution of benthic invertebrate fauna, with emphasis on insect larvae (Roque & Trivinho-Strixino 2001, Sanseverino & Nessimian, 2001), the great extent of the still unexplored parts of the Brazilian hydrographic basins (Joly et al. 2011) and the low financial investment in scientific research in the country (Agostinho et al. 2005, Magurran 2011).

However, since the 1980s, taxonomic identification keys developed specifically for South America (Brinkhurst & Marchese 1989) and Brazil (Righi 1984) encouraged new research on the Oligochaeta, addressing aspects of their ecology (Petsch et al. 2015, Rodrigues et al. 2016), their geographic distribution (Gorni & Alves, 2008, Gomes et al. 2017), their composition in anthropologically disturbed environments (Behrend et al. 2012, Rosa et al. 2014) and their use as test organisms in ecotoxicological experiments (Corbi et al. 2015, Lobo & Espindola 2016).

However, the lack of information about these organisms in Brazilian aquatic environments is still evident in many regions (Gomes et al. 2017), as well as the use of native species as bioindicators of the quality of the country’s aquatic ecosystems. Thus, the main objective of this paper was to study the aquatic Oligochaeta community in selected stretches of the Juruena River (MT), providing information for future action of environmental monitoring in lotic ecosystems.

Material and Methods

1. Study area

For the analysis of the Oligochaeta assemblages, samples were analyzed at bimonthly intervals during the period from January to November 2009. For the regular samplings, five sites were selected from the Juruena River (Amazon River Basin), located in the State of Mato Grosso (MT) (Figure 1).

The region is demarcated by humid tropical climates to contrasting seasons. Regionally the rainy season has its beginning, usually in the month of September until the month of April. From December to March are characterized by an increase in regional rainfall (Tardy, 1986). The basin is mainly sheltered by Ombrophilous Forest (Instituto Brasileiro de Geografia Estatística, 1992). In the upper portion of the basin, close to the Juruena, the vegetation is classified as “Cerrado”. The soils in the basin are largely composed of red-yellow Acrisols (29%), red-yellow Oxisols (27%) and Arenosols (18%) (Empresa Brasileira de Pesquisa Agropecuária, 1980).

The headwaters of Rio Juruena are situated at the Paracatu Plateau, in a savanna ecosystem (“cerrado”). In this area the water is totally transparent and poor in nutrients (N, P, and Ca). Biochemical oxygen demand (BOD) and fecal coliform bacteria are low, demonstrating that anthropic contributions are insignificant. Macrophytes are not abundant and are distributed in discrete and sparse stands, sometimes covering a sand plateau onshore.

The collection sites were selected considering: i) prevailing habitats, ii) easy access, and iii) adequate sites for the use of benthic fauna samplers (details of the geographical location of the sites are shown in Table 1).

2. Data collection

The collection of organisms followed the methodology described by Dowling (1984) and Peckrasky (1984). Thus, two methods of collecting zoobenthos were used: a) the D-net sampler in small groups of fixed macrophytes on the river margin; and b) Ekman-Birge dredge in fine sediment to collected sediment and associated organisms.

The net, with 0.30 m mesh openings, was dragged 1.0 m by the macrophyte roots, making a capture area of 0.3 m². The dredge, with an area of 0.0225 m², was launched in locations close to the margins in depths of up to 3 m. As an adopted procedure, two samples (replicas) were made with the net and dredge at each sampling site (a total of 50 sample units). Still at the sites, the collected samples were washed in a sieve with a mesh of 0.21 mm opening, fixed in 10% formalin and preserved in 70% alcohol. In the laboratory, the samples were washed again on a 0.021mm mesh granulometric sieve. The organisms were screened in a WILD® stereomicroscope with a maximal increase of 30 times.
Oligochaeta as indicators of different substrate types

Table 1. Relative abundance of aquatic Oligochaeta species in Juruena River, and geographic coordinates of the sampling sites. +: ≤ 10%; ◊: 10 < 50%; ■: ≥ 50%.

<table>
<thead>
<tr>
<th>Species/Coordinates</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
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<tbody>
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<td>Allonais chelata</td>
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<td>Allonais inaequalis</td>
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<tr>
<td>Aulodrilus pigueti</td>
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<tr>
<td>Aulophorus costatus</td>
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<tr>
<td>Aulophorus lodeni</td>
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<tr>
<td>Branchiura sowerbyi</td>
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<tr>
<td>Brinkhurstia americana</td>
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<td>□</td>
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</tr>
<tr>
<td>Dero digitata</td>
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<td></td>
<td></td>
<td>■</td>
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<tr>
<td>Dero pectinata</td>
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<td></td>
<td>■</td>
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<tr>
<td>Dero savayai</td>
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<td></td>
<td>■</td>
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<tr>
<td>Dero nivea</td>
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<tr>
<td>Haplotaxis aedeochaeta</td>
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<tr>
<td>Limnodrilus hoffmeisteri</td>
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<td>+</td>
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<tr>
<td>Nais communis</td>
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<td>Nais elinguis</td>
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<td>Nais variabilis</td>
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</tr>
<tr>
<td>Narapa bonettoi</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Pristina leidyi</td>
<td>+</td>
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<tr>
<td>Pristina rosea</td>
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<td>Pristina menoni</td>
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<tr>
<td>Slavina evelinae</td>
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<td>+</td>
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All biological material identified was deposited in the Laboratory of Ecology and Aquatic Ecotoxicology (LEEA) linked to the Department of Hydraulics and Sanitation, School of Engineering of São Carlos, University of São Paulo.

In order to verify the sensitivity of the species to the different habitats, fixed macrophytes, mainly Podostemacean species on the river margin (collected with a D-net sampler) and fine sediment (Ekman-Birge dredge) we applied Indicator Species Analysis (ISA) (Dufrene & Legendre, 1997) (alpha = 0.05). This analysis combines species relative abundance with their relative frequency of occurrence in the various groups of samplers. This analysis was made using the “indicspecies” package (De Caceres & Legendre, 2009) in R software (R Core Team, 2017), with 10,000 permutations.

Results

A total of 584 organisms were identified in 22 valid species comprising 11 genera. This number corresponds to less than 1% of the aquatic species described in the world and approximately 1/4 of the species registered in Brazil (Christoffersen 2007, Martin et al. 2008). The relative abundance of the Oligochaeta species are shown in Table 1. The specie *Brinkhurstia americana* showed a relative abundance greater than 50% of the total fauna in all the points sampled.

The Indicator Species Analysis (ISA) reveals five indicator species of fixed macrophytes (*Aulophorus costatus*, *Dero pectinata*, *Dero digitata*, *Dero savayai* and *Dero nivea*), and four indicator species from fine sediment (*Aulodrilus pigueti*, *Limnodrilus hoffmeisteri*, *Aulophorus lodeni* and *Narapa bonettoi*) (Table 2).

Discussion

Listed below are the species, according to the nomenclature proposed by Timm (2017) with respective records from the Brazilian territory and ecological considerations.

**Allonais chelata**

Table 2. Indicator Species in two collected habitats on the Juruena River (fixed macrophytes and fine sediment). IV (%): species indicator value obtained by 10,000 permutations (using the Monte Carlo Method).

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Habitat</th>
<th>IV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aulodrilus pigueti</em></td>
<td>Fine sediment</td>
<td>36.1</td>
</tr>
<tr>
<td><em>Aulophorus costatus</em></td>
<td>Fixed macrophytes</td>
<td>29.7</td>
</tr>
<tr>
<td><em>Aulophorus lodeni</em></td>
<td>Fine sediment</td>
<td>20.9</td>
</tr>
<tr>
<td><em>Dero digitata</em></td>
<td>Fixed macrophytes</td>
<td>20</td>
</tr>
<tr>
<td><em>Dero pectinata</em></td>
<td>Fixed macrophytes</td>
<td>25.1</td>
</tr>
<tr>
<td><em>Dero sawayai</em></td>
<td>Fixed macrophytes</td>
<td>20</td>
</tr>
<tr>
<td><em>Dero nivea</em></td>
<td>Fixed macrophytes</td>
<td>20</td>
</tr>
<tr>
<td><em>Limnodrilus hoffmeisteri</em></td>
<td>Fine sediment</td>
<td>36.1</td>
</tr>
<tr>
<td><em>Narapa bonnetoi</em></td>
<td>Fine sediment</td>
<td>20.9</td>
</tr>
</tbody>
</table>


**Allonais inaequalis**
Distribution - **São Paulo**: associated with gastropods of the species *Pomacea bridgesii* (Gorni & Alves 2006); associated with aquatic macrophytes (Alves; Gorni, 2007); and sponges of the species *Metania spinata* (Gorni & Alves 2008a). It was also collected in the sediment of urban streams (Alves et al. 2006; Sanches et al. 2016). **Rondônia**: Cuniã lake by Gomes et al. (2017).

**Aulodrilus pigueti**

**Aulophorus costatus**

**Aulophorus lodeni**

**Branchiura sowerbyi**
Distribution - **São Paulo**: Tietê River (Marcus 1942, 1943, Du Bois-Reymond Marcus 1949a); in the Salto Grande eutrophic Reservoir (Dornfeld et al. 2006); Americana Dam by Pamplin et al. (2006); in the Monjolinho dam in the city of São Carlos (Fusari & Fonseca-Gessner 2006); Tietê River reservoirs by Pamplin et al. (2005) and by Suriani et al. (2007) and in a marginal lagoon of the Mogi-Guaçu River (Alves & Strixino 2000, 2003). **Paraná**: in several reservoirs in the state of Paraná (Moretto et al. 2013) and in the Iguacu River (Behrend et al. 2012). **Piauí**: Poti River by Sales et al. (2014).

**Brinkhurstia americana**
Distribution - **São Paulo**: urban streams (Alves & Lucca 2000, Alves et al. 2006; Sanches et al. 2016); in the Ribeirão das Anhumas reservoir (Corbi & Trivinho-Strixino 2002); sediments of the Ponte Nova and Bariri reservoirs (Pamplin et al. 2005). **Paraná**: Ivinhema River and associated with the macrophyte *Eichhornia azurea* in the Patos lake (Montanholi-Martins & Takeda 2001), in the Paraná River (Montanholi-Martins & Takeda 1999); in Ivinhema River and Baía River (Behrend et al. 2009) in Iguacu River (Behrend et al. 2012) and in several reservoirs in the state of Paraná (Moretto et al. 2013). **Mato Grosso do Sul**: Negro River (Takeda et al. 2000).

**Dero digitata**
et al. 2013) and associated with the macrophytes *Hydrilla verticillata* and *Egeria najas* collected in the Paraná River and Leopoldo Backwater (Behrend et al. 2013). **Rio Grande do Sul:** in areas of irrigated rice fields (Sternert et al. 2012).

**Dero pectinata**

Distribution – **Paraná:** Patos Lake, in the floodplain of the Paraná River (Montanholi-Martins & Takeda 2001), in different floodplain habitats of the Paraná River (Ragonha & Takeda 2014). **São Paulo:** was collected in reservoirs (Marcus 1943, Pamplin et al. 2005), in sediment of Ribeirão das Anhumas reservoir (Corbi & Trivinho-Strixino, 2002); in an urban stream (Alves & Lucca 2000, Alves et al. 2006) and in Tietê river reservoirs (Suriani et al. 2007). **Mato Grosso do Sul:** Negro River (Takeda et al. 2000).

**Dero sawayai**

Distribution: **São Paulo:** in streams (City of São Paulo) and Rio Claro by Marcus (1943), associated with gastropods (Gorni & Alves, 2006), associated with submerged macrophytes (Alves & Gorni 2007); associated with the sponge *Metania spinata* (Gorni, Alves, 2008a) and in urban impacted streams (Sanches et al. 2016). **Paraná:** associated with the macrophytes *Hydrilla verticillata* and *Egeria najas* collected in the Paraná River and the Leopoldo Backwater (Behrend et al. 2013), in the Iguazu River (Behrend et al. 2012) and the Paraná River in the Ilha Grande National Park, between the states of Mato Grosso do Sul and Paraná (Ragonha et al. 2013); in different floodplain habitats of the Paraná River (Ragonha & Takeda, 2014); in tributaries of the Paraná River (Ragonha et al. 2014); in Baia River in artificial substrates (Fujita et al. 2015) and Ivinhema and Baía rivers (Behrend et al., 2009). **Minas Gerais:** associated with decomposing leaves of *Eichhornia azurea* in Manacás Lake (Martins et al. 2011). **Ceará:** was found among individuals of the species *Stolella agilis f. iheringi* (Marcus 1942, 1943). **Alagoas:** was found in the city of Satuba, in an artificial tank (Marcus 1943, 1944). **Pernambuco:** São Francisco River (Marcus 1943, 1944). **Rio Grande do Sul:** in areas of irrigated rice fields (Sternert et al. 2012).

**Dero nivea**

Distribution: **São Paulo:** macrophyte rhizosphere (Correia &Trivinho-Strixino 1998); marginal lagoon of the Mogi-Guaçu River (Alves & Strixino 2000); associated with macrophytes in Infernão Lagoon (Trivinho-Strixino et al. 2000); in the sediments of the Ribeirão das Anhumas reservoir (Corbi & Trivinho-Strixino 2002), in Tietê river reservoirs (Pamplin et al. 200, Suriani et al. 2007); associated with gastropods (Gorni & Alves 2006), in submerged macrophytes (Alves & Gorni 2007); associated with the sponge *Metania spinata* (Gorni & Alves 2008a) and in urban impacted streams (Sanches et al. 2016). **Paraná:** Ilha Grande National Park, between the states of Mato Grosso do Sul and Paraná (Ragonha et al. 2013); in the Paraná River (Ragonha & Takeda 2014), in several reservoirs in the state of Paraná (Moretto et al. 2013); in the Paraná River tributaries (Ragonha et al. 2014) and Ivinhema and Baía rivers (Behrend et al. 2009). **Rio Grande do Sul:** Quadros lagoon, with muddy sediment and weakly brackish water (Marcus 1944). **Minas Gerais:** occurred in a stream of the Atlantic Forest (Rosa et al. 2015); in the São Pedro stream (Martins et al. 2008) and in an urban stream (Frizzera & Alves 2012). **Piauí:** Poti River by Sales et al. (2014).

**Nais communis**

Distribution: **São Paulo:** associated with the sponge *Ephydatia crateriformis* (Marcus, 1943), the sponge *Radiospongilla amazonenses* (Corbi et al. 2005) and the sponge *Metania spinata* (Gorni & Alves 2008a); associated with the macrophytes (Trivinho-Strixino et al. 2000, Alves & Gorni 2007); sediment of urban streams (Alves & Lucca 2000); associated with gastropods (Gorni & Alves 2006, Martins & Alves 2008); sediment of the Monjolinho River (Alves et al. 2006); associated with bryophytes of the genus *Fissidens* sp. and *Philonotis* sp. (Gorni & Alves 2007); Campo do Meio and Galharada streams (Gorni; & Alves 2008b, Gorni & Alves 2012), streams of the Intervales Park (Alves et al. 2008); was detected in impacted urban streams (Rosa et al. 2014, Sanches et al. 2016). **Minas Gerais:** detected in first order streams of preserved areas (Rodrigues et al. 2013) and in an urban stream (Frizzera & Alves 2012). **Paraná:** Paraná River, in the Ilha Grande National Park, between the states of Mato Grosso do Sul and Paraná (Ragonha et al. 2013), in the Iguaçu River (Behrend et al. 2012); in different floodplain habitats of the Paraná River (Ragonha & Takeda 2014, Petch et al. 2015); associated with the macrophytes *Hydrilla verticillata* and *Egeria najas* collected in the Paraná River and Leopoldo Backwater (Behrend et al. 2013); in tributaries of the Paraná River (Ragonha et al., 2014); Baía River, in artificial substrates (Fujita et al. 2015) and Ivinhema and Baía rivers (Behrend et al. 2009). **Alagoas:** was found by Marcus (1944) in the Paulo Afonso waterfall. **Pará:** near Belterra by Marcus (1942) and Du-Bois Reymond Marcus 1947, 1949a, 1949b).

**Nais elinguis**

Distribution - **São Paulo:** associated with the gastropod *Pomacea bridgesii* (Gorni & Alves 2006).
**Nais variabilis**

Distribution - **São Paulo**: associated with Odonata larvae *Elasmosthemis cannacrioides* and *Mnesarete* sp. (Corbi et al. 2004); associated with submerged aquatic macrophytes (Alves & Gorni, 2007); leaf litter of Galharada stream (Gorni & Alves 2008b, Gorni & Alves 2012) and was detected in impacted urban streams (Sanches et al. 2016).

**Minas Gerais**: it was detected in first order streams of preserved areas (Rodrigues et al. 2013). **Mato Grosso do Sul**: Negro River (Takeda et al. 2000).

**Narapa bonettoi**

Distribution - **Paraná**: Ivinhema River (Montanholi-Martins; Takeda, 2001; Takeda et al. 2001); the Parana River (Montanholi-Martins & Takeda 1999); Ivinhema and Baia River (Behrend et al. 2009); in several reservoirs in the state of Paraná (Moretto et al. 2013), in floodplain areas of the Paraná River (Ragonha & Takeda 2014, Petsch et al. 2015) and in tributaries of the Paraná River (Ragonha et al. 2014). **São Paulo**: Gouveia stream (Alves et al. 2006; Alves et al. 2006). **Mato Grosso do Sul**: Negro River (Takeda et al. 2000).

**Pristina leidyi**

Distribution - **São Paulo**: associated with colonies of *Ephydatia crateriformis* sponges, in the Araguaí River sediment (Marcus 1943); (Alves & Gorni 2007), associated with the *Metania spinata* sponge (Gorni & Alves 2008a), associated with gastropods of the species *Pomacea bridgesii* (Gorni & Alves 2006), associated with submerged macrophytes (Gorni & Alves 2008b), in mesohabitats of the Galharada stream (Gorni & Alves 2012) and was detected in impacted urban streams (Sanches et al. 2016). **Paraná**: in Ivinhema River (Behrend et al. 2009); Iguacu River (Behrend et al. 2012); in tributaries of Paraná River (Ragonha et al. 2014) and Baia River, in artificial substrates (Fujita et al. 2015). **Minas Gerais**: occurred associated with decomposing leaves of *Eichhornia azurea* in Manacás Lake (Martins et al. 2011); in first order streams of preserved areas (Rodrigues et al. 2013) and associated with bryophytes of the genus *Fissidens* sp. (Gorni & Alves 2006), associated with submerged macrophytes (Gorni & Alves 2008b), in mesohabitats of the Galharada stream (Gorni & Alves 2012) and was detected in impacted urban streams (Sanches et al. 2016). **Pernambuco**: in the Tietê River associated to the plant of the genus *Stoelela agilis* (Marcus 1942). **Rio Grande do Sul**: in areas of irrigated rice fields (Stenert et al. 2012). **Mato Grosso do Sul**: Negro River (Takeda et al. 2000). **Minas Gerais**: urban streams (Frizzera & Alves 2012). **Pernambuco**: Near São Bartolomeu (Marcus 1942, 1943). **Pará**: in several rivers of the state (Marcus 1942, Du Bois-Reymond Marcus 1947, 1949a, 1949b).

Based on species distribution patterns and habitat preference (ISA) in the Juruaena River, we concluded that *Dero* species are associated with marginal regions of aquatic ecosystems, mainly occurring as aquatic macrophytes. This condition demonstrates the susceptibility of this species group to samplers such as D-net. *Limnoderilus hoffmeisteri*, *Aulodorilus pigueti*, *Narapa bonettoi* and *Aulophorus lodesi* were related with depositional zones, where fine sediments occur. *L. hoffmeisteri* are also registered as being associated to organic enrichment conditions and/or some degree of environmental degradation.

Thus, in order to increase the efficiency of future environmental quality monitoring programs carried out in the region, cautious monitoring of these species in other parts of the Amazon River Basin is advisable.

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**Author Contributions**

Guilherme Rossi Gorni: Substantial contribution in the concept and design of the study; Contribution to data analysis and interpretation;
Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Nathalie Aparecida de Oliveira Sanches: Contribution to data collection; Contribution to manuscript preparation.

Vanessa Colombo-Corbi: Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Juliano José Corbi: Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Conflicts of interest

The author(s) declare(s) that they have no conflict of interest related to the publication of this manuscript.

References


CESAR, D. A. S. & HENRY, R. 2017. Is similar the distribution of Chironomidae (Diptera) and Oligochaeta (Annelida: Clitellata) in a river and a lateral fluvial area? Acta Limnol. Bras. 29 (8).


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