

## OCCURRENCE OF OLIGOCHAETA SPECIES (ANNELIDA: CLITELLATA) IN RIVERS IN THE STATE OF SÃO PAULO (BRAZIL)

Mariana Futenma de Lima\*; Douglas Aparecido Girolli\*; Nathalie Aparecida de Oliveira Sanches\*\*; Juliano José Corbi\*\*\*; Guilherme Rossi Gorni\*\*\*\*.

\* Mestrado no PPG em Desenvolvimento Territorial e Meio Ambiente da universidade de Araraquara UNIARA

\*\* Doutorado em Desenvolvimento Territorial e Meio Ambiente pela Universidade de Araraquara.

\*\*\*Doutorado em Ciências pela Universidade Federal de São Carlos-UFSCar..

\*\*\*\* Pós-Doutorado em Engenharia Hidráulica e Saneamento pela EESC-USP.

\*Autor para correspondência e-mail: [futenma19@gmail.com](mailto:futenma19@gmail.com)

### PALAVRAS-CHAVE

Classe Oligochaeta  
Corpos hídricos  
Oligoquetos Aquáticos  
Organismos Bioindicadores  
Registro de Espécies

### KEYWORDS

Aquatic Oligochaetes  
Bioindicator Organisms  
Oligochaeta Class  
Species Record  
Water Bodies

**RESUMO:** O conhecimento da diversidade e distribuição da fauna em ecossistemas tropicais de água doce é de extrema importância ecológica, contudo estudos sobre essa temática ainda são escassos. Organismos pertencentes à Classe Oligochaeta são considerados bioindicadores importantes para análise da qualidade ambiental em ecossistemas aquáticos, porém o conhecimento detalhado sobre esses organismos é insuficiente. Este estudo teve como objetivo promover uma lista de ocorrência de espécies Oligochaeta em oito rios do Estado de São Paulo (Brasil), com o intuito de ampliar o catálogo de espécies e identificar sua relação com o estado trófico dos ambientes amostrados. As amostras foram coletadas pela Companhia Ambiental do Estado de São Paulo (CETESB) no período de 2014 a 2016 e incluem áreas com diferentes usos do solo, variando entre áreas de conservação, agropecuária e industrial. Para avaliar a eficiência das amostras coletadas nos rios foi utilizado o estimador de riqueza de espécies (Bootstrap) e curvas de acumulação de espécies randomizadas (curva do coletor). Os rios foram classificados de acordo com seu estado trófico variando de oligotrófico à hipereutrófico. Como resultado, identificamos um total de 7.398 oligoquetos distribuídos em 25 táxons, os quais pertencem às famílias: Alluroideidae, Naididae e Opisthocystidae. A espécie mais frequente registrada nesta pesquisa, presente em sete dos oito rios amostrados foi *Bothrioneurum* sp., seguida de *Pristina synclites* registrada em seis dos oito rios amostrados.

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**ABSTRACT:** The knowledge about the diversity and fauna distribution in tropical freshwater ecosystems is of extreme ecological importance, however studies on this theme are still scarce. Organisms belonging to the *Oligochaeta* Class are considered important bioindicators for environmental quality analysis, but detailed knowledge about these organisms is still insufficient. This study aims to investigate the occurrence of *oligochaeta* species in eight rivers of the State of São Paulo (Brazil), to expand the species catalogue and identify their relationship with the trophic state of sampled environments. The samples were collected by the Environmental Company of the State of São Paulo (CETESB) from 2014 to 2016 and include areas with different land uses, ranging from conservation, agricultural and industrial. We used species richness estimator (Bootstrap) and accumulation curves of randomized species (collector curve), to evaluate the efficiency of samples collected. Rivers were classified according to the trophic state, ranging from oligotrophic to hypereutrophic. As a result, we identified a total of 7,398 oligochaetes distributed in 25 taxons, which belong to the families: Alluroideidae, Naididae and Opisthocystidae. The most frequent species registered in this research, present in seven of the eight sampled rivers, was *Bothrioneurum* sp., followed by *Pristina synclites* registered in six of the eight sampled rivers.

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## INTRODUCTION

The knowledge about the diversity and fauna distribution in tropical freshwater ecosystems still presents gaps, despite the importance of these groups in processes of biomonitoring of environmental quality (HARPER, 1992). One of the most common and abundant groups in the benthic community is oligochaetes, which generally has a wide geographic distribution and can reach numerous populations (WETZEL, 1992; BRINKHURST; JAMIESON, 1971). In addition, oligochaetes are recognized as bioindicators of water and sediment quality, because they are sensitive to chemical pollution and eutrophication (MASSON *et al.* 2010).

Currently, environmental monitoring programs such as the Environmental Company of the State of São Paulo (CETESB), use the calculation of the Trophic State Index (TSI; LAMPARELLI, 2004) to evaluate the water quality in relation to nutrient enrichment. Thus, considering the degree of trophic, water bodies can be classified as: oligotrophic, mesotrophic, eutrophic and hypertrophic (CETESB, 2019).

In Brazil, we still know little about the actual number of species of the Oligochaeta Class in the continental systems. This scarcity of information occurs due to some factors, such as the large number of River basins not yet inventoried; the lack of researchers and adequate infrastructure to carry out the samplings; the loss of information that is often not available and the need for a taxonomic review for various oligochaete groups (AGOSTINHO; THOMAZ; GOMES, 2005).

Many authors carry out research on the diversity and ecology of benthic macroinvertebrates and Oligochaeta in Brazilian Rivers and Lakes (TRIVINHO-STRIXINO; CORREIA; SONODA, 2000; CORBI *et al.*, 2004; PAMPLIN; ROCHA; MARCHESE, 2005; GORNI, 2007; BEHREND *et al.*, 2012; SALES *et al.*, 2014; SANCHES *et al.*, 2016; AMO *et al.*, 2017; GOMES *et al.*, 2017; TAKEDA *et al.*, 2017; GORNI *et al.*, 2018), Reservoirs (DORNFELD *et al.*, 2006; JORCIN; NOGUEIRA, 2008; MOLOZZI *et al.*, 2011; GIROLI *et al.*, 2018; GIROLI, 2019; GIROLI *et al.*, 2020) and conservation areas (GORNI, 2007; ALVES; MARCHESE; MARTINS, 2008; GORNI; ALVES, 2008; SANCHES *et al.*, 2021).

Studies concerning taxonomy and faunal survey present important information about the biodiversity of each group, as well increase the knowledge about their distribution and habitat preference. Ecological information is used in the development of environmental monitoring and biodiversity conservation programs (AGOSTINHO; THOMAZ; GOMES, 2005). In the case of the Oligochaeta assemblages, the studies are still insufficient (SILVA, 2017; GORNI; ALVES, 2008). Despite efforts of a few experts (MARCUS, 1942; RIGHI, 1984; BRINKHURST; MARCHESE, 1989; PAMPLIN; ROCHA; MARCHESE, 2005), it is necessary to carry out new research and update information on oligochaetes in Brazil. In this context, it is necessary to emphasize the importance of bioindicator organisms, such as those belonging to the Oligochaeta Class, which can indicate the impacts resulting from industrial urban development (SILVA, 2017).

This information can aid as a basis for environmental management and for decision making on the preservation and / or recovery of Brazilian aquatic ecosystems (GIROLI, 2019). Studies on the ecology and taxonomy of these organisms should be advanced, in order to obtain knowledge of the diversity of freshwater species in Brazil (SURIANI *et al.*, 2007).

## OBJECTIVE

This study aims to investigate the occurrence of Oligochaeta species in eight rivers of the State of São Paulo (Brazil), and to expand the species catalogue, identifying the as relationship with the trophic state of sampled environments.

## METHODOLOGY

Samplings were performed by CETESB, within the sediment Quality Monitoring Network Project, in eight rivers in the State of São Paulo during the years 2014, 2015 and 2016 (Table 1 and Figure 1).

**Table 1** - Location of sampling points in rivers in the State of São Paulo, Brazil. TSI: Trophic State Index.

Water body	Municipality	Coordinate	Predominant Activity	TSI (Categories)
Jundiaí River - JUN	Indaiatuba	23°08'25"S 47°13'11"W	Industrial	Hypereutrophic
Tietê River - TIE	Biritiba Mirim	23°33'57.84"S 46°1'17.18"W	Industrial	Hypereutrophic
Moji Guaçu River - MOJ	Cubatão	23°50'08"S 46°22'17"W	Industrial	Mesotrophic
Sorocaba River - SOR	Cerquilha	23°9'33.23"S 47°47'42.53"W	Industrial	Hypereutrophic
Ribeira River - RIB	Iporanga	24°32'47"S 48°29'58"W	Conservation	Oligotrophic
Betari River - BET	Iporanga	24°36'14"S 48°36'41"W	Conservation	Oligotrophic
Batalha River - BAT	Indaiatuba	22°14'25"S 49°20'04"W	Farming	Hypereutrophic
Aguapeí River - AGUA	Lins	21°44'43"S 49°51'27"W	Farming	Hypereutrophic

**Fonte:** Dados de pesquisa 2021.

**Figure 1** - Map containing location of sampling points in rivers in the State of São Paulo.

**Fonte:** Elaborado pelos autores

The sediment samples were collected in triplicate, with Van Veen or Ponar grab samplers in the depositional riverbanks, according to the CETESB L5.309 (Technical Standard). Aiming to complement the analysis of the sampled points, the Trophic State Index (TSI) were calculated (LAMPARELLI, 2004). This index aims to classify water bodies in different degrees of trophic, evaluating the quality of the water in terms of nutrient enrichment.

Faunal identification was made using the taxonomic criteria (BRINKHURST; JAMIESON, 1971;

RIGHI, 1984; BRINKHURST; MARCHESI, 1989; TIMM, 2009). After identification, the organisms were deposited in the collection of the Water Communities Sector of CETESB.

In order to evaluate the coverage of the sample design, the Bootstrap species richness estimator was used. For calculations we use the Vegan package (OKSANEN *et al.*, 2019), software “R” version 3.1.1 (R CORE TEAM, 2017).

## RESULTS AND DISCUSSION

The oligochaete fauna found in the eight sampled rivers in the State of São Paulo is distributed within three families (Alluroididae, Naididae, Opistocystidae) and 25 species, totalizing 7,398 individuals sampled (Table 2). The result obtained by the Bootstrap richness estimator ( $29.9 \pm 1.9$ ), indicates that the sample design adopted in this study was satisfactory, considering that the recorded species richness is very close to the estimated range.

**Table 2** - Occurrence of species of oligochaetes sampled in eight rivers in the State of São Paulo, Brazil.

Taxa	Rivers							
	JUN	TIE	MOJ	SORO	BET	RIB	AGUA	BAT
Family Alluroididae								
<i>Alluroididae</i> sp. (Michaelsen, 1900)	0	0	0	0	0	+	0	0
Family Opistocystidae								
<i>Opistocysta funiculus</i> (Cordero, 1948)	0	+	0	+	0	+	+	0
Family Naididae								
Subfamily Naidinae								
<i>Allonais chelata</i> (Marcus, 1944)	+	0	0	0	0	0	0	0
<i>Aulophorus borelli</i> (Michaelsen, 1900)	0	0	+	0	0	0	0	0
<i>Aulophorus furcatus</i> (Müller, 1774)	+	0	+	0	0	0	0	0
<i>Chaetogaster diaphanus</i> (Gruithuisen, 1828)	+	+	+	0	0	0	0	+
<i>Dero digitata</i> (Müller, 1773)	0	+	0	0	0	0	0	0
<i>Dero nivea</i> (Aiyer, 1930)	0	0	0	0	+	0	0	0
<i>Dero sawayai</i> (Marcus, 1943)	0	+	+	+	0	0	0	0
<i>Nais communis</i> (Piguet, 1906)	+	+	+	+	0	0	+	+
<i>Nais variabilis</i> (Piguet, 1906)	0	+	0	0	0	0	0	0
<i>Slavina appendiculata</i> (D'Udekem, 1855)	0	+	0	+	0	0	+	+
<i>Slavina evelinae</i> (Marcus, 1942)	0	+	0	+	0	0	+	0
<i>Stephensoniana trivandrana</i> (Aiyer, 1926)	0	0	0	0	0	0	0	+
<i>Stylaria lacustres</i> (Linnaeus, 1767)	0	0	0	+	0	0	0	0
Subfamily Pristininae								
<i>Pristina americana</i> (Černosvitov, 1937)	0	+	+	0	0	0	0	0
<i>Pristina menoni</i> (Aiyer, 1929)	0	+	0	0	0	0	0	0

»»

**Table 2** - Occurrence of species of oligochaetes sampled in eight rivers in the State of São Paulo, Brazil (cont.).

<i>Pristina osborni</i> (Walton, 1906)	0	0	0	0	+	0	0	0
<i>Pristina rosea</i> (Piguet, 1906)	0	+	0	0	0	0	0	0
<i>Pristina synclites</i> (Stephenson, 1925)	+	+	0	+	0	+	+	+
<b>Subfamily Rhyacodrilinae</b>								
<i>Bothrioneurum</i> sp. (Stolc, 1886)	+	+	+	+	0	+	+	+
<i>Branchiura sowerbyi</i> (Beddard, 1892)	0	0	0	+	+	+	+	0
<b>Subfamily Tubificinae</b>								
<i>Aulodrilus pigueti</i> (Kowalewski, 1914)	0	+	0	+	0	+	0	+
<i>Limnodrilus hoffmeisteri</i> (Claparède, 1862)	+	+	+	+	0	+	0	0
<i>Limnodrilus neotropicus</i> (Černosvitov, 1939)	0	0	0	0	0	0	0	+

**Fonte:** Dados de pesquisa 2021.

The Naididae family was considered the most representative of this assemblage of Oligochaetas, presenting 92.3% of the taxa found, being divided into four subfamilies: Naidinae, Pristininae, Rhyacodrilinae and Tubificinae. See Table 2 for more details on species occurrence in the analyzed sites.

The Alluroididae was represented by only one individual identified at the family level and the Opistocystidae was represented by the species *Opistocysta funiculus*. Studies suggest that the *O. funiculus* is able to inhabit environments with low oxygen availability and a higher concentration of organic matter, characteristics generally associated with low environmental quality (PAMPLIN; ALMEIDA; ROCHA, 2006; SANCHES, 2016; GIROLI, 2019). Thus, our results corroborate previous studies, since *O. funiculus* was registered in the Tietê River, which is inserted in an area with predominantly industrial activity and was classified as hypereutrophic according to the TSI.

The most frequent species registered in this study, present in seven of the eight rivers sampled was *Bothrioneurum* sp. According to Brinkhurst and Marchese (1989), this species has a wide geographical distribution. However, in the studies by the authors Alves and Lucca (2000), MARTINS and ALVES (2008), BEHREND *et al.* (2012), SANCHES (2016) and GIROLI (2019), *Bothrioneurum* sp. demonstrated ability to tolerate polluted environments, organically enriched and with high levels of electrical conductivity. In this study, *Bothrioneurum* sp. was recorded in the Moji Guaçu River, which corroborates the results found by the authors mentioned above, since it is a river inserted in an area with predominantly industrial activity, located in the Municipality of Cubatão (microregion of Santos, State coast) and was classified as mesotrophic.

The second most frequent species recorded was *Pristina synclites* present in six of the eight rivers sampled. According to Davis (1982), this species can inhabit several habitats, from clean waters to degraded waters with industrial discharges. Similarly, authors Lin and Yo (2008) also reported that *P. synclites* is able to tolerate polluted habitats. In this research it was found in the Aguapeí River, located in the Municipality of Lins (Midwest region), which has predominantly farming and was classified as hypereutrophic according to the TSI.

## CONCLUSION

In general, this study points out the importance of biomonitoring using Oligochaeta organisms, since it is possible to correlate certain species with characteristics of the environmental quality of water bodies. Additionally, these results are of great importance for the knowledge of the taxonomic distribution of

aquatic oligochaetes in Brazilian lotic systems, assisting in water quality monitoring programs in Brazil.

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