Environmental factors and benthic Oligochaeta (Annelida, Clitellata) assemblages in a stretch of the Upper São Francisco River (Minas Gerais State, Brazil)

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(With 5 figures)

Abstract

The Oligochaeta forms an important part of the macroinvertebrates inhabiting sediments of lotic ecosystems. It has an important role in the cycling of matter and energy transfer in these environments. The aim of this study is to analyse limnological variables, their influence on the structure and diversity of benthic oligochaete taxocenosis in a stretch of the Upper São Francisco River and its tributary the Piumhi River. Samples were taken in two climatic periods, the dry season in October 2006 and 2007 and the rainy season in March 2007 and 2008 at three points along the Piumhi River and six points along the São Francisco River. The sediment of the São Francisco consisted predominantly of sand and clay, whereas the sediment of the Piumhi was mainly sandy. Six species of oligochaete occurred in the Piumhi River while seven were found in the São Francisco. Of these, *Pristina synclites* Stephenson, 1925, *Pristina americana* Cernosvitov, 1937, *Bothrioneurum* sp. Stolc, 1888 and *Limnodrilus hoffmeisteri* Claparede, 1862 occurred in the sediment of both rivers. *L. hoffmeisteri* showed the highest numerical abundance in the Piumhi River and *Brinkhurstia americana* (Brinkhurst, 1964) and *L. neotropicus* Cernosvitov, 1939 were the most abundant species in the São Francisco River. The highest oligochaete density was recorded in the Piumhi during the dry seasons. Canonical correspondence analyses (CCA) of sediment characteristics explained most of the data variability and the association of the presence of oligochaete species in the Piumhi and São Francisco Rivers with the limnological variables (grain size composition and total nitrogen and phosphorus concentrations in the sediment).

Keywords: biodiversity, benthic community, river ecology, oligochaetes.

Fatores ambientais e associações de Oligochaeta (Annelida, Clitellata) em um trecho do Alto Rio São Francisco (Minas Gerais, Brasil)

Resumo

Os Oligochaeta constituem uma parte importante dos macroinvertebrados bentônicos que habitam os sedimentos dos ecossistemas lóticos e tem papel relevante na ciclagem da matéria e transferência de energia nestes ambientes. O objetivo deste trabalho foi analisar as variáveis limnológicas e suas incidências sobre a estrutura e a diversidade da taxocenose de Oligochaeta presentes na comunidade bentônica de um trecho do alto rio São Francisco e de seu tributário, rio Piumhi. As coletas foram realizadas em dois períodos climáticos, o seco em outubro de 2006 e 2007 e o chuvoso em março de 2007 e 2008, amostrando-se três pontos no rio Piumhi e seis pontos no rio São Francisco. Os sedimentos do rio São Francisco foram predominantemente arenosos e argilosos, e no rio Piumhi ocorreram principalmente substratos arenosos. No rio Piumhi, ocorreram seis espécies de oligoquetos, enquanto que no rio São Francisco registrou-se a presença de sete espécies. Destas, *Pristina synclites* Stephenson, 1925, *Pristina americana* Cernosvitov, 1937, *Bothrioneurum* sp. Stolc, 1888 e *Limnodrilus hoffmeisteri* Claparede, 1862 ocorreram no sedimento de ambos os rios. *L. hoffmeisteri* foi registrada com maior abundância numérica no rio Piumhi e *Brinkhurstia americana* (Brinkhurst, 1964) e *L. neotropicus* Cernosvitov, 1939 foram as espécies mais abundantes no rio São Francisco. Os maiores valores de densidade foram registrados no rio Piumhi durante os períodos secos. As análises de correspondência canônica (CCA) para as características do sedimento permitiram explicar a variabilidade dos dados, associando a composição de espécies Oligochaeta, presentes nos rios Piumhi e São Francisco, com as variáveis limnológicas (composição granulométrica e concentrações de nitrogênio e fósforo total no sedimento).

Palavras-chave: biodiversidade, comunidade bentônica, ecologia de rios, oligoquetos.

1. Introduction

Lotic ecosystems are generally highly variable throughout space and time (Gordon et al., 1992) and they represent habitats subject to changes along their course such as physical and chemical conditions and biotic communities (Vanotte et al., 1980).

Among these communities, benthic macroinvertebrates play a very significant part, both structurally and functionally, in the energy flow and nutrient cycling of matter in the ecosystem, mainly by processing the organic matter found there (Covich et al., 1999; Callisto et al., 2001).

One of the principal groups of benthic macroinvertebrates, the Oligochaeta (Annelida, Clitellata) plays a relevant role in the aquatic system food webs, acting as a source of food for turbellarian flatworms, chironomids, crabs, amphipod crustaceans, amphibians, fish and birds (Ezcurra de Drago et al., 2007). Most species feed on detritus, using bacteria as a source of nutrients (Brinkhurst et al., 1972). They are also noted for living in intrinsic association with sediment. Some species of this class are considered useful as sediment quality indicators, owing to their high tolerance of environmental risk factors, especially the toxic effects of metals and allochthonous pollutants (Marchese and Ezcurra de Drago, 1999; Prygiel et al., 2000), or conversely to being typical of well conserved habitats (Dumnicka, 1994).

The occurrence and distribution of oligochaetes in aquatic systems, as they belong to the benthic fauna, depends mainly on the type of substrate and its physical and chemical properties, biological interactions and food availability (Verdonschot, 2001).

Currently there are about 5,000 known species of Oligochaeta in the world, 1,700 of which are aquatic. Among these, 1,100 are found in continental surface water and the rest in salt water (Wetzel et al., 2006). In South America, the number of oligochaete species is yet uncertain, but Righi (1999) reported that around 70 species of freshwater oligochaete have been described in Brazil.

The relative difficulty in identifying oligochaete down to species level and their frequent omission from analyses of the structure and composition of the macroinvertebrates in lotic ecosystems has impoverished our knowledge of the local fauna (Alves et al., 2006, 2008).

With the above points in mind, we decided to analyse the structure and the diversity of the Oligochaeta taxocenosis in a section of the upper São Francisco River basin, both in the river itself and in the lower reaches of its tributary, the Piumhi River. In view of the great disturbance of the ecosystem of the Piumhi engendered by its diversion from the Grande River water system to that of the São Francisco, a hypothesis was raised that this event has exerted a negative influence on this assemblage. In addition, the study included a limnological description of the rivers in question and an investigation of the influence of seasonal changes in abiotic variables on the oligochaetes.

2. Material and Methods

2.1. Study area

São Francisco River, whose upper reaches (and the affluent Piumhi River) are mapped in Figure 1, is 2,700 km long and has one of the five greatest drainage basins in Brazil, which covers an area of around 645,000 km^2 and is formed by 168 tributaries (Godinho and Godinho, 2003). The upper São Francisco basin has been changed radically by the economic activity in the region, notably crop farming and cattle raising, which has transformed most of the original vegetation – Atlantic Forest and shrubby savannah (cerrado) biomes – into monocultures and pasture. Furthermore, in 1963, during the construction of the hydroelectric power station of Furnas on the Grande River, the beds of the interconnected streams Limpo and Sujo were lowered and widened to allow the water of the Piumhi River (and all its tributaries) to flow into the São Francisco River.

In general, the river waters in this upper stretch of São Francisco basin is well oxygenated, it has a nearly neutral pH, with moderate conductivity and low nutrient concentrations (Suriani-Affonso, 2010).

2.2. Abiotic and biotic variables

Samples were taken in October 2006 and 2007 and March 2007 and 2008, representing the dry and the rainy seasons respectively. There were three sample sites on the Piumhi River and six on the São Francisco River. Three of these were upstream from the confluence with the Piumhi and three downstream (Figure 1).

Rainfall data for 2006, 2007 and 2008 were acquired from the Municipal Autonomous Water and Sewage Board (SAAE) from the town of Piumhi. The rate of flow of each river was calculated by multiplying the cross-sectional area at the sampling site (in m^2) by the speed of the water current at that site (m/s), measured in situ with a General Oceanic 2030 flowmeter. The particle size distribution in the sediments was determined by the method described by Suguio (1973). The organic matter content of the substrate was analysed by complete digestion with hydrogen peroxide, see Buckman and Brady (1979). The total contents of the nutrients (phosphorus and nitrogen) in the sediment were determined by the methods of Andersen (1976) and APHA (2002), respectively.

Triplicate samples of material containing oligochaetes were taken from the bottom at each site using a van Veen with a sampling area of 333 cm^2. The samples were washed in a sieve of 0.21 mm mesh and the retained material was preserved in a 10% formaldehyde solution. Oligochaetes were sorted by hand, preserved in 70% ethanol and subsequently identified to the species level with the help of keys published by Righi (1984) and Brinkhurst and Marchese (1992). Those species of oligochaetes that were formerly included in the family Tubificidae were assigned

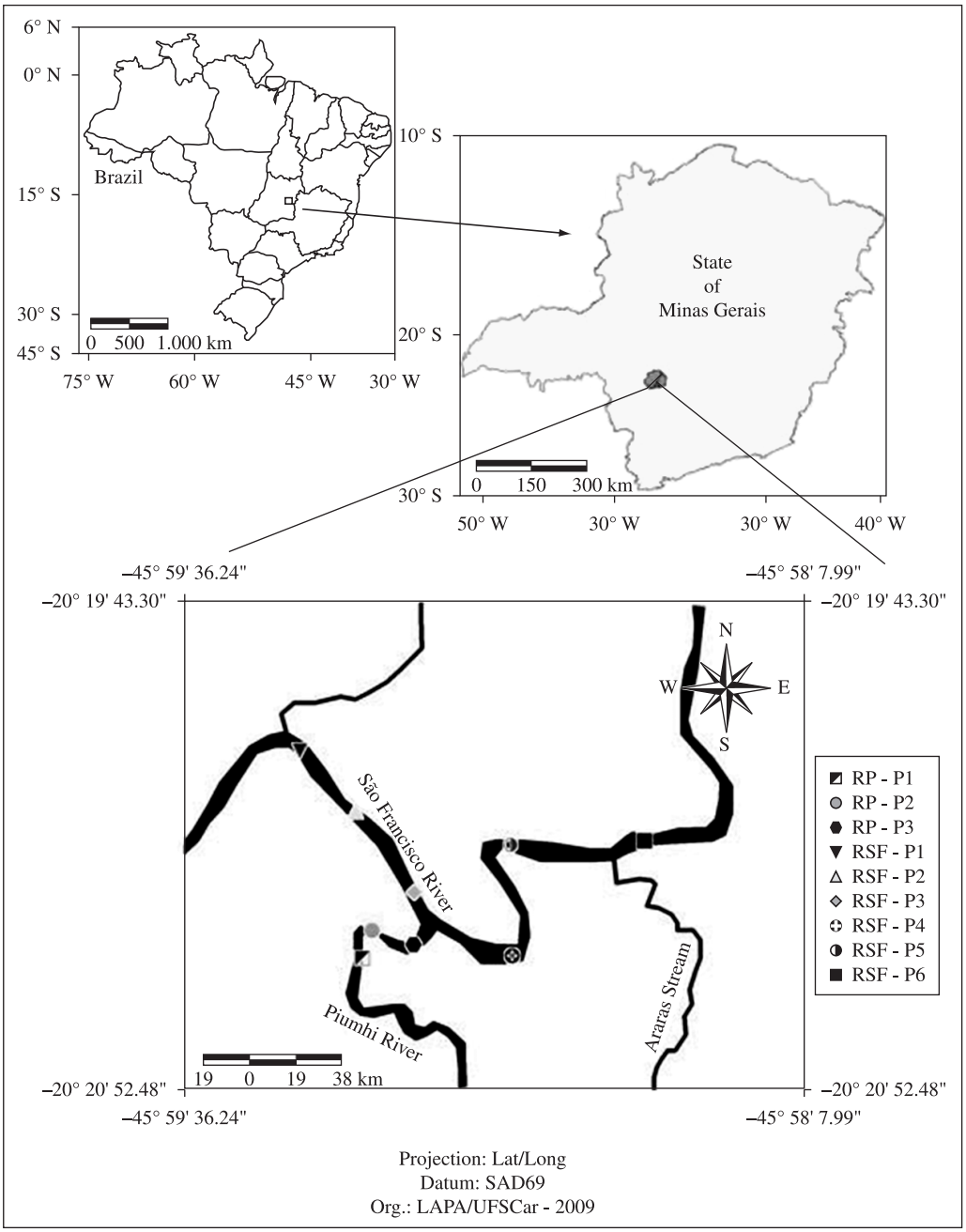

Figure 1. Geographical location of the upper São Francisco River and its tributary, Piumhi River, in Minas Gerais State, Brazil (Source: Google Earth, adapted by Luiz Eduardo Moschini).

to the family Naididae, in keeping with the new system proposed by Erséus et al. (2008).

Canonical Correspondence Analysis (CCA) was used to detect possible correlations between oligochaete species and sediment characteristics, at the various sampling sites and collection periods. Analyses were run using the XLSTAT 2009 computer program.

3. Results and Discussion

From the rainfall data, the four collection periods were allocated to the rainy and dry seasons. Thus, October 2006 and 2007 came at the end of the dry season and March of 2007 and 2008 at the end of the wet season. Moreover, the rates of flow in the two rivers reflected these facts as can be seen in Figure 2, where the higher rates are in March. It

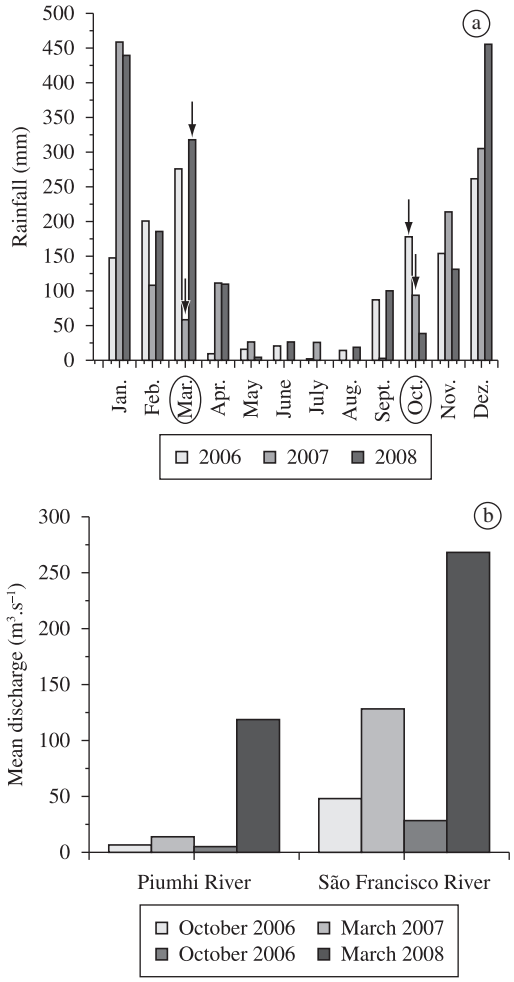

Figure 2. a) Average monthly rainfall (mm) recorded in the Piumhi and São Francisco rivers in 2006, 2007 and 2008 (data provided by SAAE, Piumhi, Minas Gerais, Brazil); b) Mean water flow rates ($m^3.s^{-1}$) recorded in Piumhi and São Francisco rivers during the samples in October 2006 and 2007 (dry season) and March 2007 and 2008 (rainy season).

is also clear that the mean flow rates of the São Francisco River are higher than those of its tributary Piumhi. Overall, the maximum discharge was 269.0 $m^{-3}s^{-1}$, in March 2008, and the minimum was 4.6 $m^{-3}s^{-1}$ in the Piumhi River at October 2007.

The particle-size profiles in the sediment in the rivers at the times and places where oligochaetes were sampled are shown in Figure 3. It can be seen that the sediment of the Piumhi River was predominantly composed of fine and medium sand whereas in the São Francisco River, clay and sand predominated in the sediment during the period of study. In a study of the Das Velhas River (Minas Gerais State, Brazil), another tributary of the upper São Francisco basin, França et al. (2006) found that the sediments contained mainly fine and very fine sand, a similar particle size profile to that found in the stretches of the Upper São Francisco River and of its tributary the Piumhi River, as recorded in the present study, probably reflecting a regional soil characteristic.

Table 1 shows the contents of organic matter and total nitrogen and phosphorus in the sediment of each river. Sediments of both rivers can be classified as mineral sediments as they contain less than 10% organic matter. The total nitrogen content of the Piumhi River sediment varied between 0.05 $mg.g^{-1}$ and 0.84 $mg.g^{-1}$ while in the São Francisco River it varied between 0.07 $mg.g^{-1}$ and 0.60 mg.g-1. These values can be compared to those recorded in the Jacupiranga River (SP, Brazil) sediments by Cunha and Calijuri (2008), where nitrogen varied between 0.07 $mg.g^{-1}$ and 1.06 $mg.g^{-1}$.

Phosphorus content recorded in the Piumhi River sediments ranged from 9.09 $\mu g.g^{-1-}$ to 56.13 $\mu g.g^{-1-}$. The corresponding values for the São Francisco River were 14.65 $\mu g.g^{-1}$ to 41.07 $\mu g.g^{-1}$.

The levels of total phosphorus existing in the sediments of these two rivers might be regarded as high, compared to the range of total phosphorus contents (0.12-10.5 $\mu g.g^{-1}$) recorded in the Jacupiranga River (Cunha and Calijuri, 2008).

The taxonomical composition, total number of individuals and number of taxa of oligochaetes recorded at each sampling time and site are shown in Table 2 for the Piumhi River and in Table 3 for the São Francisco River.

Six species were found in the Piumhi River sediment: *Dero (Aulophorus) furcatus* (Müller, 1773)*, Dero (Dero) sawayai* Marcus, 1943, *Pristina americana*, *Pristina synclites*, *Bothrioneurum* sp. and *Limnodrilus hoffmeisteri*. All these species belong to the family Naididae and the total number collected in this study was 52 individuals. The highest number of taxa (4) was recorded at site 2 in October 2006 (dry season), while the most abundant species was *L. hoffmeisteri* with 40 specimens. Similarly, Martins et al. (2008) recorded this species as being the most abundant among the subfamily Tubificinae in the São Pedro Stream (Minas Gerais State, Brazil). The large number of *L. hoffmeisteri* found in the Piumhi sediment may be explained by the organic enrichment of this stretch of river, indicated by the relatively high values of electrical conductivity, nitrogen and phosphorus compounds content. The presence of this species in freshwater is widely used as a marker for organic pollution (Marchese and Ezcurra de Drago, 1999).

In the São Francisco River, seven oligochaete species were recorded, one more than in the Piumhi. These included one member of the family Alluroididae, *Brinkhurstia americana*, and six of the Naididae: *Allonais chelata* (Marcus, 1944); *Pristina americana*, *Pristina synclites*; *Bothrioneurum* sp., *Limnodrilus hoffmeisteri* and *Limnodrilus neotropicus*. The total number of specimens was 67, most of them belonging to *B. americana* and *L. neotropicus*, with 23 each. The number of *B. americana* in the São Francisco samples exceeded the highest number (19) found by Pamplin et al. (2005) in the Ponte Nova Reservoir (São Paulo State, Brazil).

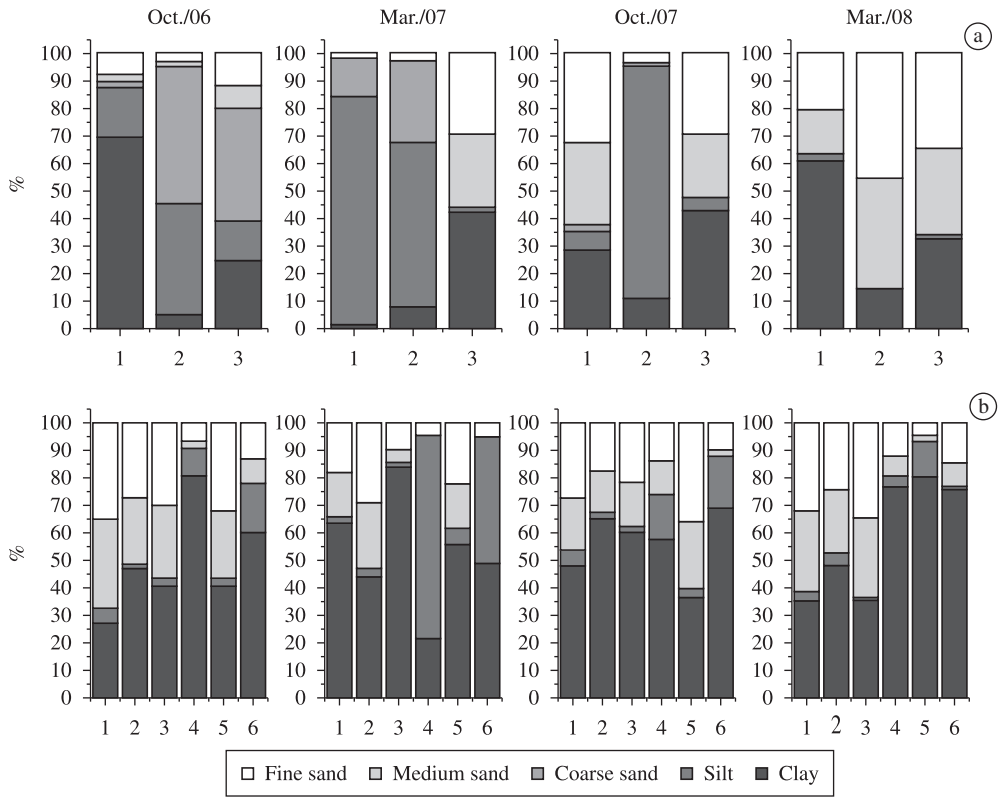

Figure 3. a) Sediment grain size composition at sampling sites in the Piumhi; and b) São Francisco rivers in October 2006 and 2007 (dry season) and March 2007 and 2008 (rainy season).

Table 1. Contents of organic matter and total nitrogen and phosphorus in the sediment of the Piumhi and São Francisco rivers in dry (October 2006 and 2007) and rainy (March 2007 and 2008) seasons.

	Organic matter (%)				TKN (mg.g^{-1})				TP (µg.g^{-1})			
					Piumhi River							
Sites	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**
1	0.91	0.21	2.49	2.87	0.21	0.05	0.42	0.75	29.30	14.18	41.70	41.86
2	0.34	0.24	0.81	3.48	0.09	0.05	0.09	0.84	9.09	9.37	20.79	56.13
3	1.31	1.51	5.09	2.93	0.25	0.33	0.57	0.65	25.29	30.32	37.58	53.28
					São Francisco River							
Sites	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**	**Oct/06**	**Mar/07**	**Oct/07**	**Mar/08**
1	3.29	1.50	3.10	2.27	0.53	0.23	0.26	0.56	34.57	20.50	19.12	37.11
2	2.15	2.12	3.00	1.55	0.43	0.44	0.21	0.47	26.02	32.51	22.63	30.81
3	3.92	0.83	3.34	2.17	0.56	0.24	0.18	0.58	29.97	17.52	22.98	33.14
4	0.52	0.44	3.06	0.92	0.14	0.12	0.39	0.21	22.37	24.77	32.35	25.77
5	2.16	1.88	4.10	0.43	0.30	0.52	0.60	0.12	23.50	27.51	41.07	18.44
6	0.98	0.37	1.03	1.18	0.18	0.07	0.12	0.26	19.90	14.65	17.49	28.99

In a study of the oligochaetes in the upper Paraná River (Paraná State, Brazil), Takeda (1999) recorded the presence of *L. neotropicus* and the dominance of *B. americana* in the sediment near the river banks.

The presence of *Dero* (*Aulophorus)* and *Allonais* in the benthic community of these rivers was to be expected, given the typically broad distribution of these organisms in freshwater in the tropics and subtropics (Timm, 1999).

In the São Francisco River, the lowest recorded total density was 9 ind.m^{-2} observed at sites 4 and 6 in October 2006, and the highest density, 80 ind.m^{-2}, was found at sites 1 and 3, in October 2007 (Figure 4). This mean value was

Table 2. Taxonomic composition and total individuals number of oligochaetes species sampled at sites in the Piumhi River in dry (October 2006 and 2007) and rainy (March 2007 and 2008) seasons.

	October 2006			March 2007			October 2007			March 2008		
	Sites			Sites			Sites			Sites		
	1	2	3	1	2	3	1	2	3	1	2	3
PHILO ANNELIDA												
Class Oligochaeta												
Family Naididae												
Subfamily Naidinae												
Dero (*Aulophorus*) *furcatus*	-	1	-	-	-	-	-	-	-	-	-	-
Dero (*Dero*) *sawayai*	-	-	1	-	-	-	-	-	-	-	-	-
Pristina americana	-	-	-	1	-	-	-	-	-	-	-	-
Subfamily Pristininae												
Pristina synclites	-	6	-	-	-	-	-	-	-	-	-	-
Subfamily Rhyacodrilinae												
Bothrioneurum sp.	-	2	-	-	-	-	-	-	-	-	-	1
Subfamily Tubificinae												
Limnodrilus hoffmeisteri	4	13	2	1	4	-	-	-	14	2	-	-
Total individuals number	4	22	3	2	4	-	-	-	14	2	-	1
Total Taxa	1	4	2	1	1	-	-	-	1	1	-	1

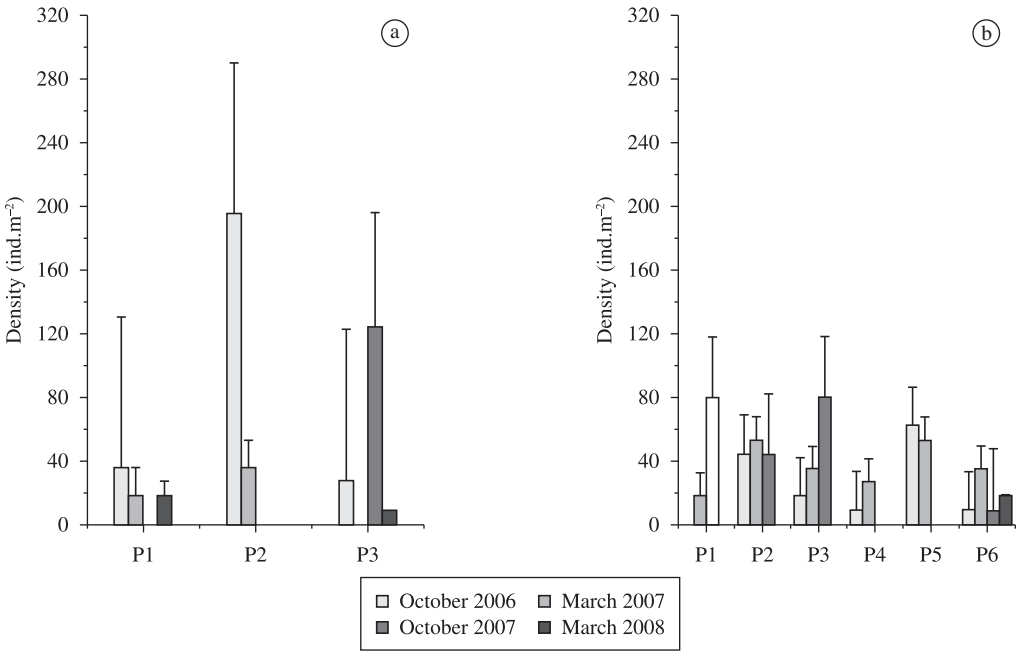

Figure 4. a) Mean density of oligochaetes in the sediment of Piumhi; and b) São Francisco rivers at sampling sites and times: October 2006 and 2007 (dry season) and March 2007 and 2008 (rainy season).Lines and bars show standard deviation.

lower than that recorded in the Piumhi River (Figure 4), where the density reached 195 ind.m^{-2} at site 2 in a dry period (October 2006), while the minimum for the tributary was recorded at site 3 in a rainy period (March 2008).

Oligochaete density in the Piumhi River differed between the seasonal periods. The higher densities were observed in the samples taken in the dry periods. In the São Francisco River, this regular pattern occurred only at

Table 3. Taxonomic composition and total individuals number of oligochaetes species sampled at sites in the São Francisco River in dry (October 2006 and 2007) and rainy (March 2007 and 2008) seasons.

	October 2006						March 2007						October 2007						March 2008					
	Sites						Sites						Sites						Sites					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
PHILO ANNELIDA																								
Class Oligochaeta																								
Family Alluroididae																								
Brinkhurstia americana	-	2	1	-	1	1	2	3	4	1	-	2	2	2	2	-	-	-	-	-	-	-	-	-
Family Naididae																								
Subfamily Naidinae																								
Allonais chelata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Subfamily Pristininae																								
Pristina americana	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pristina synclites	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subfamily Rhyacodrilinae																								
Bothrioneurum sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subfamily Tubificinae																								
Limnodrilus hoffmeisteri	-	2	-	1	5	-	-	-	-	-	3	-	-	1	2	-	-	-	-	-	-	-	-	-
Limnodrilus neotropicus	-	1	-	-	-	-	-	3	-	-	3	1	7	2	5	-	-	1	-	-	-	-	-	-
Total individuals number	-	5	2	1	7	1	2	6	4	3	6	4	9	5	9	-	-	1	-	-	-	-	-	2
Total Taxa	-	3	2	1	3	1	1	2	1	2	2	3	2	3	3	-	-	1	-	-	-	-	-	1

a few sites (sites 1, 3 and 5) and in other sites there was no difference in the oligochaete density between rainy and dry seasons.

It is probable that the great instability of the São Francisco River bed, resulting from the stronger flow of water, and the local characteristics of the substrate (predominantly clay) influences the oligochaete population more directly than seasonal factors. A similar situation was observed by Martins et al. (2008) in the São Pedro Stream, where tubificids were recorded in higher numbers in the dry period. The occurrence of higher densities in the droughts could be due to the greater stability of the habitat, where the organisms are not dragged along the bottom by strong currents, as happens in the rains (Montanholi-Martins and Takeda, 1999; Ribeiro and Uieda, 2005).

The Canonical Correspondence Analysis (CCA) of the association between the particle size fractions, organic matter content and nutrient (nitrogen and phosphorus) contents of the sediment in each sample and the oligochaete species found in the sample of the benthic community are shown in Figure 5 with separate charts for the two rivers. These analyses were able to explain 88.12 and 99.43% of the total variance of these data for the Piumhi and São Francisco rivers, respectively.

In the Piumhi River, axis 1 explained 65.82% of this variance. It shows that the species *D.* (*A.*) *furcatus*, *D.* (*D.*) *sawayai*, *P. synclites*, *Bothrioneurum* sp. and *L. hoffmeisteri* occurred in the highest densities at sites 2 and 3 of this river in October 2006 (dry period). It can also be seen from this axis that these species and samples are

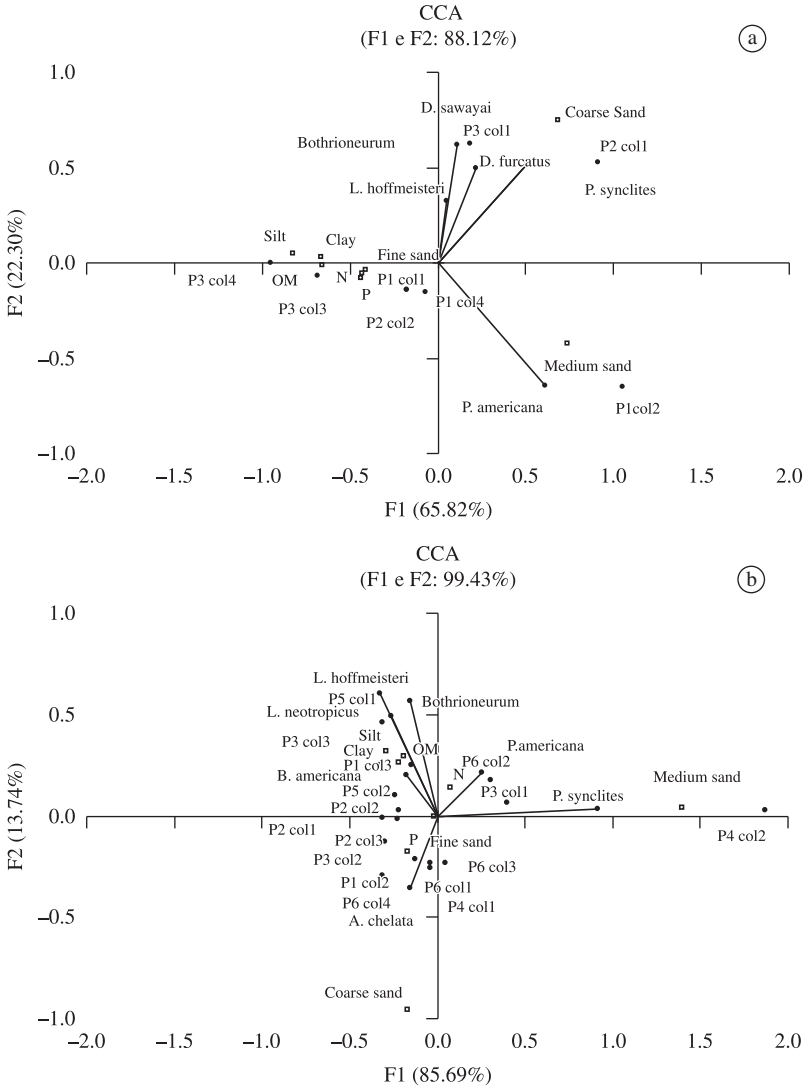

Figure 5. a) Ordination chart produced by canonical correspondence analysis of the grain size composition, organic matter, total nitrogen and phosphorus contents of the sediment and the oligochaete species sampled in the Piumhi; and b) São Francisco rivers in dry (October) and rainy (March) season. Key: Col1 = October 2006; Col2 = March 2007; Col3 = October 2007; Col4 = March 2008; N = total nitrogen; and P = total phosphorus.

correlated with the coarse sand fraction of the sediment. The occurrence of *P. americana* at site 1 during a rainy period (March 2007) was associated with a predominance of medium sand in the sediment. Axis 2 explained 22.30% of the data variance. At sites 1 (October 2006 and March 2008), 2 (March, 2007) and 3 (October, 2007 and March 2008), there was a prevalence of fine particles (fine sand, silt and clay) and high concentrations of organic matter, total nitrogen and total phosphorus.

When CCA was applied to the São Francisco River data, axis 1 explained 85.69% of the variance. In Figure 5, it can be seen that oligochaetes *B. americana*, *Bothrioneurum* sp., *L. hoffmeisteri* and *L. neotropicus* predominated and where the sediment was rich in organic matter. *P. americana* was found at sites 3 (October 2006) and 6 (March 2007) in association with high nitrogen contents in sediment. *P. synclites* was recorded only at site 4 in March 2007. These two *Pristina* species were associated with medium sand in the sediment. Axis 2 explained only13.74% of the variance in the data. *A. chelata*, which appeared only at site 6 in March 2008 (rainy season), was associated with fine sand and high phosphorus content in the sediment.

The sediment characteristics have an important role in structuring benthic macroinvertebrate communities, as it is composed of a great variety of organic and inorganic materials, originating from both autochthonous and allochthonous sources, which provide the habitats, microhabitats, food and protection for the benthic organisms (Callisto and Esteves 1996). The association noted in the Piumhi River, of *D.* (*A.*) *furcatus*, *D.* (*D.*) *sawayai*, *P. synclites*, *Bothrioneurum* sp. and *L. hoffmeisteri* with coarse sandy sediment, is probably related to their occurrence in the dry season. Thus, Lenat et al. (1981) pointed out that, while a sandy substrate is normally an unstable habitat during periods of sluggish flow (for example in the dry season) it may become stable and consequently be colonised by periphyton and associated with macroinvertebrates.

It was noted above that *L. hoffmeisteri* was associated with sediments composed of fine particles in the São Francisco River. The work of Stacey and Coates (1996) and Marchese and Ezcurra de Drago (1999) corroborates this association and these authors also recorded this species in habitats enriched with high organic loads. Similarly, *L. neotropicus* occurred in the São Francisco River in predominantly silt and clay sediments with high contents of organic matter. Thus, Alves et al. (2006) found in the Água Branca Stream (São Paulo State, Brazil) that *L. neotropicus* occurred in a sandy substrate with an appreciable quantity of allochthonous material (branches, leaves). The same authors noted that this species showed no detectable correlation with potentially polluted habitats.

In both Piumhi and São Francisco rivers, species of *Pristina* were found in association with sandy beds. Alves et al. (2006) reported a similar situation in the Pinheirinho Stream (São Paulo State, Brazil), where the species richness of the family Naididae was higher in sandy sediments.

The sediment particle size fraction is sometimes a more effective explanatory variable than the physical and chemical properties of the water, traditionally used by limnologists (Ward, 1992). Thus, the grain size profile, by playing an important part in structuring the benthic macroinvertebrate community, could be a determining factor in the changes in a community associated with human activities that can lead to erosion and silting, as well as other modifications in the physical make up of sediment (Fonseca et al., 1998).

In view of the economic and ecological importance of the São Francisco River, wider - ranging studies along the length of its basin should be carried out, not only to have a more complete view of the biotic and abiotic structure of this ecosystem, but also to provide a scientific basis for its preservation.

4. Conclusions

An appreciable difference was observed in the particle size fractions of the rivers. The Piumhi sediment was mainly sand (from coarse to fine) and the São Francisco sediment mainly clay, with a portion of fine to medium sand.

The oligochaete taxocenosis of both rivers were quite similar, consisting of 6 species in the Piumhi River and 7 in the São Francisco, with 4 species in common. Thus, the species richness and diversity of each assemblage were very similar, despite the transposition of the Piumhi River.

The species found exclusively in the São Francisco were *B. americana*, *A. chelata* and *L. neotropicus*, while *D.* (*A.*) *furcatus* and *D.* (*D.*) *sawayai* were seen only in the Piumhi River.

Seasonal change in the abundance of oligochaetes was more evident in the Piumhi River, where the density was higher in the dry period, probably on account of the greater physical stability of the sandy substrate at lower rates of flow.

The rather low species richness and the dominance of *L. hoffmeisteri* in the Piumhi River and *B. americana* and *L. neotropicus* in the São Francisco resulted in the low overall diversity of the Oligochaeta in these rivers.

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