

# Spatial and bathymetric distribution of the macrobenthic fauna of the Ribeirão das Anhumas reservoir (Américo Brasiliense-SP, Brazil).

CORBI, J.J.<sup>1</sup> & TRIVINHO-STRIXINO, S.<sup>2</sup>

<sup>1</sup> Programa de Pós-Graduação em Ecologia e Recursos Naturais, Universidade Federal de São Carlos, Departamento de Hidrobiologia, Via Washington Luiz, Km 235 - C.P 676, CEP. 13.565-905, São Carlos - SP, Brazil, e-mail: pjcorbi@iris.ufscar.br.

<sup>2</sup> Laboratório de Entomologia Aquática, Departamento de Hidrobiologia, Universidade Federal de São Carlos, Via Washington Luiz, Km 235 - C.P 676, CEP. 13.565-905, São Carlos, SP, Brazil, e-mail: strixino@power.ufscar.br.

**RESUMO: Distribuição espacial e batimétrica da fauna macrobentônica da Represa do Ribeirão das Anhumas (Américo Brasiliense-SP, Brasil).** A estrutura taxonômica e a distribuição da comunidade macrobentônica da Represa do Ribeirão das Anhumas, localizada no Município de Américo Brasiliense-SP, foi analisada através de coletas em três setores da Represa (I; II; III). As amostras de sedimento recolhidas mensalmente, entre os meses de Outubro de 1999 e Fevereiro de 2000, com auxílio de pegador tipo Ekman-Birge (225cm<sup>2</sup>), totalizaram 135 unidades amostrais. Chironomidae (Diptera) com 20 gêneros, Oligochaeta com 10 espécies, Polymitarcyidae (Ephemeroptera) com 1 espécie e Chaoboridae (Diptera) com 1 espécie foram os táxons mais representativos. A análise de agrupamentos (Cluster), utilizando UPGMA com distância Euclidiana, delimitou duas áreas de distribuição espacial dessa macrofauna: Área 1 - localizada junto ao banco de macrófitas aquáticas, próximo à cabeceira, caracterizada pela maior variedade faunística e predominância de Oligochaeta; Área 2 - ocupando aproximadamente 70% da represa, englobando além das regiões mais profundas, as pralhas artificiais com margens abertas (sem vegetação), na qual *Coelotanypus* (Chironomidae), *Campsurus* (Polymitarcyidae) e Chaoboridae (Diptera) foram os grupos mais numerosos. A análise batimétrica indicou padrões diferenciados de distribuição dos vários táxons; Oligochaeta se concentrou nas regiões menos profundas, próximas às margens, ao contrário de Polymitarcyidae e Chaoboridae que foram mais numerosos nas zonas mais profundas.

**Palavras-chave:** Macroinvertebrados bentônicos, distribuição espacial e batimétrica, Chironomidae (Diptera), Oligochaeta, represa.

**ABSTRACT: Spatial and bathymetric distribution of the macrobenthic fauna of the Ribeirão das Anhumas Reservoir (Américo Brasiliense - SP, Brazil).** The taxonomic structure and distribution of the macrobenthic community of the Ribeirão das Anhumas Reservoir, located in Américo Brasiliense (São Paulo State, Brazil), was analyzed through sampling in three sectors of the reservoir (I; II; III). Monthly from October 1999 to February 2000, 135 unit samples were collected, using an Ekman-Birge grab (225cm<sup>2</sup>). Chironomidae (Diptera) with 20 genera, Oligochaeta with 10 species, Polymitarcyidae (Ephemeroptera) with 1 species and Chaoboridae (Diptera) with 1 species were the most expressive groups. The Cluster analysis utilizing UPGMA with Euclidean distance for the fauna, delimited two distribution areas: Area 1 - located on the stands of macrophytes and characterized by the highest faunistic diversity, with the predominance of Oligochaeta; Area 2 - the largest area, occupying 70% of the reservoir, and characterized by the predominance of sand deposits (without plant cover); *Coelotanypus* (Chironomidae), *Campsurus* (Polymitarcyidae) and

Chaoboridae (Diptera) are dominant. The bathymetric analyses indicated different patterns of taxa distribution. Oligochaeta was concentrated in shallower regions, near the shore, whereas Polymitarcyidae and Chaoboridae are more expressive in the deeper areas.

**Key-words:** Benthic macroinvertebrates, spatial and bathymetric distribution, Chironomidae (Diptera), Oligochaeta, reservoir.

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## Introduction

The nature of the sediment, water, and location (depth), together with the oxygen and food availability are the main factors determining the structure and distribution of the macrobenthic community in the lentic environments (Bechara, 1996; Horne & Goldman, 1994; Esteves, 1988; Strixino & Strixino, 1980; Nilsson, 1972; Cummins & Lauff, 1969). In São Paulo State there are few natural lentic systems with the exception of such places as oxbow lakes of great rivers (Mogi-Guaçu, Tietê). On the other hand, there are numerous reservoirs of large dimensions and small reservoirs constructed throughout the state with the most different purposes (generation of electricity, agriculture, recreation, etc). In São Paulo State, most of the ecological studies on benthic fauna have been restricted to artificial systems (Pamplim, 1999; Strixino & Trivinho-Strixino, 1998; Soriano, 1997; Strixino & Strixino, 1982; Strixino & Strixino, 1980). The Ribeirão das Anhumas Reservoir, built for recreation purposes and located in agricultural area, apparently not heavily impacted by anthropic activity, was chosen to carry out the present study on the macrobenthic fauna through the analysis of the taxonomic structure, as well as spatial and bathymetric distribution of this community.

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## Material and methods

The sediment sampling through October 1999 to February 2000 (rainy season) was monthly performed within three sectors (I, II and III) of the reservoir: I, in the upstream reach of the reservoir; II, in the intermediate region (between the dam and the upstream reach) and III, near the dam. In each sector, three sampling zones were defined (Left shore LS, Center C and Right shore RS). In whole, 135 unit samples (15 in each sampling zone) were taken using an Ekman-Birge grab (225cm<sup>2</sup>). The material collected was transported to the laboratory, washed in a sieve with mesh of 0.21mm, selected on illuminated tray and fixed in 70% alcohol. The organism identification was made at the lowest possible taxonomic level on the basis of the available published data (Trivinho-Strixino & Strixino, 1995; Brinkhurst & Marchese, 1991; Merritt & Cummins, 1984; Righi, 1984; Wiederholm, 1983). The analyses of the spatial distribution (analysis of grouping using the Euclidean distance measurement and the UPGMA method of grouping by using Statistica program) and bathymetric distribution of the macrobenthic fauna were performed considering the relative participation of the taxa. The following main classes were taken into account: eudominant (> 10%), dominant (> 5 < 10%), subdominant (> 2 < 5%), recessive (> 1 < 2%) and subrecessive (< 1%) (Strixino & Trivinho-Strixino, 1998).

In the course of the fauna sampling, samples of sediment were also collected, for grain size analysis and organic matter analysis. The organic matter content was determined as the mass loss after ignition (550°C, 4 hours) in dry fractions of sediment (dried in stove; 105°C, 12 hours), in accordance with the techniques described by Bolt (1969) and Maitland (1979). The grain size analysis was performed using the technique proposed by Medina (1972), with the modifications introduced by Giovanni Strixino (Có, 1994). The physical and chemical variables of the water (pH, temperature, dissolved oxygen and electric conductivity) were measured *in situ*, by using a Water Quality Checker device (Horiba). The analysis for total nitrogen and phosphorus in water were performed by using the techniques described by Valderrama (1981). Measures of the depth throughout the entire reservoir were taken to construct the bathymetric map.

## Study site

The Ribeirão das Anhumas reservoir, constructed in 1965 (Fig. 1) is located in Américo Brasiliense, a town in the State of São Paulo, Brazil. Occupying a total area of 0.82km<sup>2</sup> it is located at 544m of altitude, in the geological Botucatu Formation outcrop (São Bento Group) (Troppmaier, 2000). With predominance of sandy-muddy sediments, it presents an average depth of 3,70m and a maximum depth of 7,60m. Built for recreation purposes, it presents an artificial beach, forested and pasture areas in its surroundings. In the upstream reach of the reservoir there is an exuberant aquatic vegetation compound mainly by stands of *Cabomba*, *Scirpus*, *Pontederia*, *Egeria*, *Salvinia* and *Eleocharis*. The main morphometric characteristics of the reservoir are presented in Figure 1.

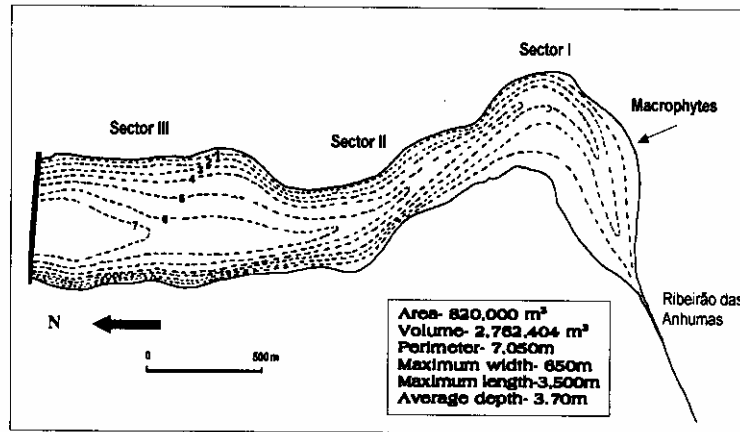


Figure 1: Ribeirão das Anhumas reservoir (Américo Brasiliense - SP, Brazil), with the main flisionomic and morphometric features. Distinction for the three sectors of the fauna sampling.

## Results

Among the seven groups of macroinvertebrates collected (Table I), Chironomidae (Diptera), Oligochaeta, Polymitarcyidae (Ephemeroptera) and Chaoboridae (Diptera) were numerically the most expressive, totaling 1,770 individuals (88% of fauna). Libellulidae (Odonata), Baetidae (Ephemeroptera) and Gastropoda (Mollusca) showed minor participation, contributing only with 12% of the individuals. The group analysis, applied for the fauna, delimited two units that made possible the definition of two areas of fauna distribution in the reservoir: 1- area characterized by the presence of aquatic macrophytes, near to upstream reach (LS I, C I, RS I); 2- main area, enclosing approximately 70% of the reservoir area and including the deepest region as well as the artificial beaches in open areas (without plant cover) (LS II, C II, RS II, LS III, C III, RS III) (Fig. 2). In the Area 1, there were found numerous taxa of Oligochaeta, mainly of the Naididae family, Chironomidae (*Chironomus*, *Ablabesmyla*, *Labrundinia* and *Tanytarsini sp.*), Libellulidae (Odonata), Baetidae (Ephemeroptera) and Gastropoda (Mollusca). In the Area 2, Chironomidae (*Coelotanypus* and *Aedokritus*), *Campsurus* (Polymitarcyidae) and Chaoboridae (Diptera) were the more characteristic groups. A summarized picture representing the main features of both areas is given in Tables II and III. The bathymetric distribution analysis of the most expressive taxa and the most characteristic Chironomidae genera evidenced different patterns of distribution. Oligochaeta was more abundant at lesser depths (< 3 meters) (shore areas in the upstream reach), in contrast to the larvae of Chaoboridae and nymphs of *Campsurus* that predominated at the highest depths (> 5m) (Fig. 3). Among the Chironomidae, *Aedokritus* and *Fissimentum* were characteristics of the deepest areas (> 4m), while *Coelotanypus* was more numerous nearby the shore areas (< 3m). The larvae of *Chironomus* not present a defined bathymetric distribution (Fig. 4).

Table 1: Relative participation of the macrobenthic fauna taxa in the nine zones of the Ribeirão das Anhumas Reservoir (Américo Brasillense - SP, Brazil). LS I, C I; RS I (sector I); LS II, C II, RS II, LS III, C III, RS III (sectors II and III).

Taxa/ Zones	LS I	CI	RS I	LS II	CII	RS II	LS III	CIII	RS III
Chaoboridae				■	■	■	●	■	◆
Chironomidae									
<i>Ablabesmyia</i>	●	●	◆		□	●	●	◆	●
<i>Aedokritus</i>				□	■	◆	●	●	■
<i>Beardius</i>	○	●							
<i>Chironomus</i>	□	●	◆	□	●		●	●	●
<i>Coelotanypus</i>		◆	●	■	●	◆	■	◆	■
<i>Cricotopus</i>	□								
<i>Cryptochironomus</i>	●			□					
<i>Dicrotendipes</i>		●			□				
<i>Djalmabatista</i>					●		◆	●	●
<i>Fissimentum</i>				□	◆	■	○	●	
<i>Goeldichironomus</i>	○								
<i>Labrundinia</i>	●	●	◆				○	□	
<i>Nimbocera</i>	○	●					●	□	
<i>Parachironomus</i>	○		●				●	○	
<i>Polypedilum</i>	●	●	●				●	●	
<i>Rheotanytarsus</i>	○								
<i>Tanytarsini sp</i>	□	●	●		○		○		
<i>Tanytarsus</i>							○		
<i>Thlenemanniella</i>	○								
<i>Zavreillella</i>	□		○						
Ephemeroptera									
<i>Campsurus</i>				■	■	◆	■	■	■
Baetidae									
Oligochaeta									
<i>Allonais chelata</i>	■	■	■						
<i>Allonais paraguayensis</i>			◆						
<i>Brinkurstia americanus</i>	○								
<i>Dero (A.) pectinatus</i>	■		■						
<i>Dero (D.) multibranchiata</i>	●	□	◆						
<i>Dero (D.) nivea</i>	□								
<i>Dero (D.) obtusa</i>	●		●						
<i>Opistocysta funiculus</i>	■		■						
<i>Pristina breviseta</i>			□						
<i>Slavina evellinae</i>			□						
Odonata									
Libellulidae	●	●	●						
Gastropoda	◆	◆	◆			●	○		□

■ > 10%    ◆ 5-10%    ● 2-5%    □ 1-2%    ○ <1%

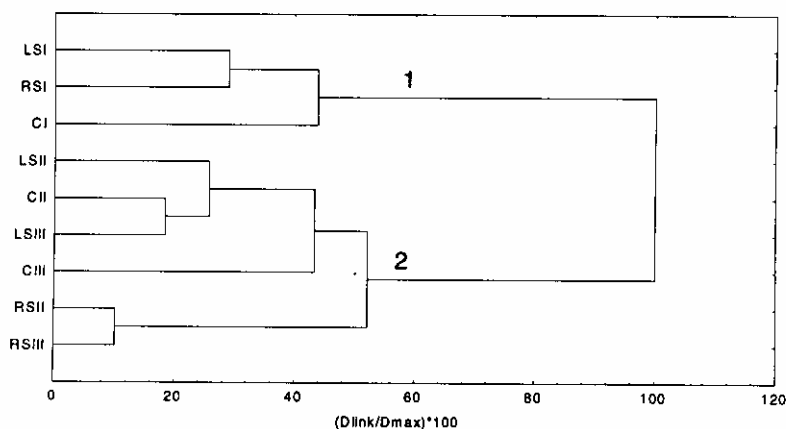
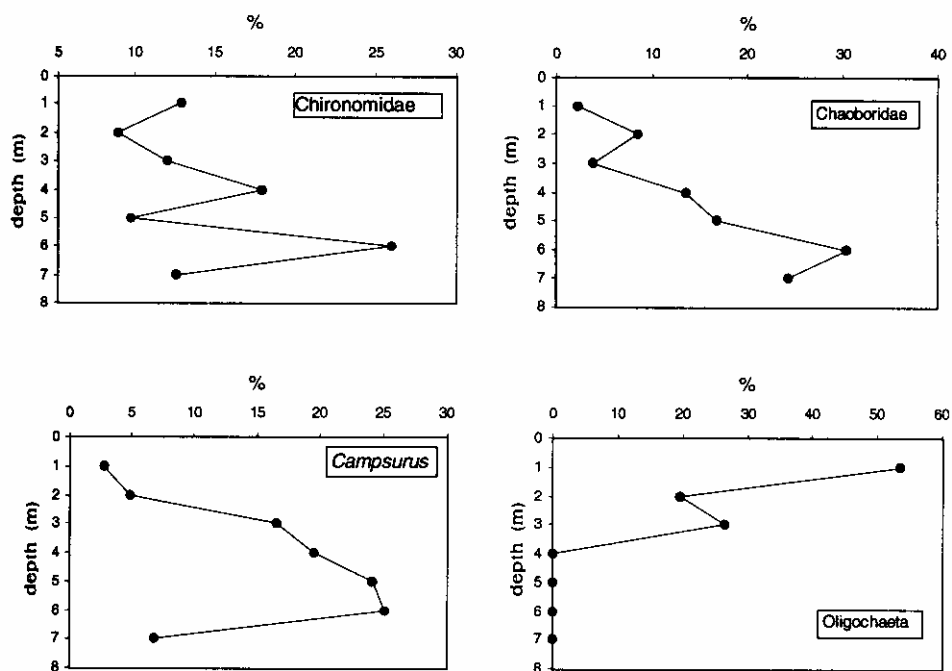


Figure 2: Resulant dendrogram of the grouping analysis (Euclidean distance) applied on the macrobenthic fauna of the Ribeirão das Anhumas Reservoir with distinction of the two delimited areas (Américo Brasillense - SP, Brazil). LSI, CI; RSI (sector I); LS II, C II, RS II, LS III, C III, RS III (sectors II and III).

**Table II:** Characterization of the major areas of the Ribeirão das Anhumas reservoir, delimited according to its predominant macrofauna, physical characteristics, oxygen dissolved concentration in the water and median numeric densities (of the two areas) with confidence limits of +/-95% (Américo Brasiliense - SP, Brazil).

Área	Characteristics	Predominant taxa (*)	Dissolved oxygen	n°m <sup>-3</sup> (X±.C.95%)
1	Macrophytes presence Depths < 3m Organic Matter (> 20%) Sandy sediments (Fine Sand)	Naididae Gastropoda <i>Abiabesmyla</i> <i>Labrundinia</i> <i>Chironomus</i> <i>Tanytarsini</i> sp	8 - 10mg/l	1,253 (1,020-1,478)
2	Artificial beaches (Sandy) Opened areas (without plant) Sandy sediments (Coarse Sand) Depths (> 7m) Organic Matter (< 20%)	<i>Campsurus</i> Chaoboridae <i>Coelotanypus</i> <i>Aedokritus</i> <i>Fissimentum</i>	5 - 7mg/l	622 (510-724)

\* Taxa had been related according to the decreasing dominance.



**Figure 3:** Bathymetric distribution of the most expressive groups of benthic macroinvertebrates on Ribeirão das Anhumas Reservoir (Américo Brasiliense - SP, Brazil).

Table III: Physical and chemical characteristics of the water and sediment of the two areas of Ribeirão das Anhumas Reservoir (Américo Brasiliense - SP, Brazil). Area 1- near to upstream reach (sector. I); 2- main area, enclosing approximately 70% of the reservoir (sectors II and III).

Variables	Area	
	1	2
Dissolved Oxygen (mg/l)	8 - 10	5 - 7
pH	7.5 - 8.0	6.0 - 6.5
Electric Conductivity ( $\mu\text{S}/\text{cm}$ )	38	29
Temperature ( $^{\circ}\text{C}$ )	21	25
Organic Matter (%)	120 - 40	1-20
Predominant Sediments	Fine Sand	Coarse Sand
Total Nitrogen ( $\mu\text{g}/\text{l}$ )	287	307
Total Phosphorus ( $\mu\text{g}/\text{l}$ )	20	26

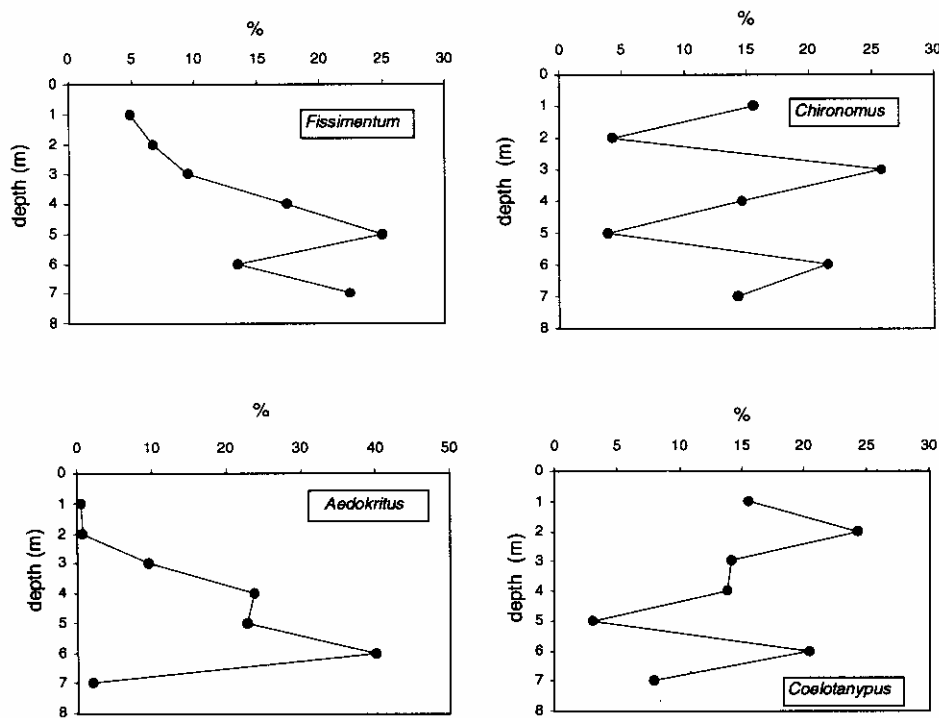


Figure 4: Bathymetric distribution of the most expressive Chironomidae genera in Ribeirão das Anhumas Reservoir (Américo Brasiliense - SP, Brazil).

## Discussion

The differences in the composition of the substratum (presence or absence of aquatic macrophytes) and the features of the surroundings of the reservoir (presence or absence of vegetation, artificial beaches) seem to have been the main element guiding the spatial distribution of the macrobenthonic community of the Ribeirão das Anhumas Reservoir. These considerations also are confirmed by previous studies (Strixino & Trivinho-Strixino, 1998; Oertli, 1995; Wetzel, 1993; Harper, 1992; Kuflikowski, 1986). The rich aquatic

vegetation in Area 1 produced higher richness and number of individuals, with predominance of Naididae. Similar results were obtained elsewhere (Có, 1994; Kuflikowski, 1986; Strixino & Strixino, 1980; Có, 1979) that is the presence of Naididae was preferential at lower depths on sandy substrates or associated with aquatic macrophytes. The nymphs of *Campsurus* constituted the most abundant group in the Area 2, and were found in large amounts, practically at all the depths of the reservoir. The genus is pointed as inhabitant of clean waters with high concentrations of dissolved oxygen (Pérez, 1988; Wetzel, 1993). However, Pamplim (1999) observed its presence in the Americana reservoir at reverse conditions, e.g. in waters with low oxygen concentrations. Chaoboridae predominated at higher depths areas (> 5m) with muddy-sandy sediments. Studies of Milho's lake carried out by Có (1994) and Strixino & Strixino (1980) in the Lobo Reservoir also pointed out Chaoboridae as the main taxa that occupy preferably the region with predominance of organic sediment in the highest depths. The association of this group with the sediment does not seem to be so striking like Oligochaeta. Its larvae are epibenthonic and are known to perform vertical migrations (Arcifa, 1997). The larvae of *Coelotanytus*, in the same way as *Campsurus*, were widely distributed in the reservoir, however with somehow higher concentration in the coastal areas with thick sand predominance (artificial beaches). According to Fittkau & Roback (1983) the larvae of this genus inhabit this type of sediment in the lakes and rivers with low water speed. The predominance of *Fissimentum* in the muddy sediments of the highest depths confirms the comments by Cranston & Nolte (1996) regarding preferential microhabitat of this genus.

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